Martinez Refining Company

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Via e-mail - jbovee@baaqmd.gov / www.baaqmd.gov

September 01, 2023

Jerry Bovee, P.E., QSTI
Air Quality Engineering Manager
Meteorology and Measurement Division
Bay Area Air Quality Management District
375 Beale Street, Suite 600
San Francisco, CA 94105

Subject: **MRC Response to 2023-07-19 BAAQMD Final NOD Regarding Regulation 12, Rule 15 Fenceline Air Monitoring Plan and Quality Assurance Project Plan**

Dear Mr. Bovee:

Please find enclosed Martinez Refining Company's (MRC) Response to the 2023-07-19 Bay Area Air Quality Management District's (BAAQMD) Final NOD Regarding MRC's Regulation 12, Rule 15 Fenceline Air Monitoring Plan and Quality Assurance Project Plan. The response includes a PDF containing MRC's contractor, Argos Scientific's response to the NOD comments, a revised Air Monitoring Plan, a revised Quality Assurance Project Plan (QAPP), and numerous revised or new Standard Operating Procedures (SOPs). The attached table of contents provided below is included in the attached PDF, allowing for easy access to all of these documents by accessing the bookmarks function in Adobe.

Thank you for your time in this matter. Should you have any further question, please contact me at the e-mail or number below.

Regards,

Michael Marlowe

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Attachments

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Bookmarks

Attachment 1 – Basis for Determination That Martinez Refining Company's Revised Fenceline Air Monitoring Plan and Quality Assurance Project Plan (Submitted February 15, 2023) Do Not Meet District Regulation 12-15-403

1. According to the Air Monitoring Guidelines for Petroleum Refineries (Guidelines) established pursuant to District Regulation 12-15-406 in April 2016, fenceline measurements must be continuously measured with a time resolution of five minutes, and instrumentation must meet a minimum of 75% completeness on an hourly basis, 90% of the time based on annual quarters (p. 5).

   Page 23 of the air monitoring plan (AMP) and page 7 of the quality assurance project plan (QAPP) reflect this requirement and refer to "FLM-QLT-GUI-001 Operations Guidance Document" for detailed information about how completeness is determined. However, the procedures and equations for determining data completeness outlined in reference document FLM-QLT-GUI-001 are not consistent with the procedures set forth in our December 22, 2022 letter interpreting Regulation 12-15 and the associated Guidelines (12/22/2022 letter).

   This issue is among several others previously identified in a notice of deficiency sent to Martinez Refining Company (MRC) on July 15, 2022. To aid in resolving this deficiency, Attachment 3 to our 12/22/2022 letter outlined detailed procedures MRC must use to demonstrate compliance with the data completeness requirement. The problem nevertheless remains unresolved as the AMP, QAPP, and associated standard operating procedures (SOPs) still have unacceptable procedures regarding data completeness. MRC must incorporate the content of Attachment 3 to our 12/22/2022 letter into the QAPP or associated SOPs.

   Page 7 of the QAPP details the specific formula used for determining data completeness. This formula is taken directly from the guidance put forth by the BAAQMD in the December 2022 letter. In addition on Page 9 of MSOP-TDL-002-DVC states that all data will be reviewed by senior staff on a monthly basis to ensure the prior month's data will be compliant with the BAAQMD requirements. At the end of the third month in a quarter, the data will be consolidated into a single document that will be compliant with BAAQMD requirements.

2. With regard to the detection capabilities of the hydrogen sulfide (H_2S) monitoring equipment, our 12/22/2022 letter stated that a tunable diode laser (TDL) system used to monitor H_2S must have a limit of quantitation (LOQ), which ranges from 3 to 25 ppb depending on environmental and operational conditions. In comparison to this requirement:

   a. Table 2.2 of the AMP and Table 1.2 of the QAPP state that the lower detection limit ("LDL" or alternatively "MDL") is 3 ppb for all paths; and

   b. reference document FLM-QLT-SOP-007 describes how the MDL is defined and calculated but neither the AMP, nor the QAPP, nor any of the referenced SOPs state the LOQ of the H_2S monitoring systems or state how the LOQ is defined and calculated.

   The AMP and QAPP are deficient as they are inconsistent with the specifications in our 12/22/2022 letter. MRC must revise the AMP, QAPP, and SOPs to explain how the LOQ is determined and reflect the requirement that the LOQ (not MDL) of the H_2S system be between 3 and 25 ppb.

   Table 2.2 of the AMP and Table 1.2 of the QAPP (Page 7) has been revised to reflect the fact the quantification limits for the TDL can range from 3 to 25 ppb depending on environmental and operational conditions.

   The basic definition of LoQ for the TDL air monitoring systems are presented on page 14 of the QAPP when the Air Optic TDL is described. The actual screening parameters used to determine a quantified detection of H_2S is presented on Page #1 of MSOP-003-TDL-SCC where all of the parameters and their evaluation thresholds are documented.

3. With regard to quarterly reporting, page 25 of the AMP and page 29 of the QAPP state that MRC will provide one-hour average concentration data to the Air District in a comma separated value (CSV) file, along with the signal intensity, MDL calculations, and data and supporting documentation for invalidated or flagged data. These provisions are either inconsistent with the procedures specified in our 12/22/2022 letter, or lack an adequate level of detail. In particular, attachments 2 and 3 to the letter:

    - stated that all fenceline monitoring concentration data should be provided as 5-minute averages (hourly data are not needed);
    - identified several required data elements;
    - specified formats for the required data elements;
    - specified procedures for reporting missing data;
    - specified reporting procedures for bump tests and calibration checks; and
    - specified reporting procedures for quarterly data completeness.

    These provisions are either missing or inadequately specified in the AMP, QAPP, and SOPs. The contents of attachments 2 and 3 to our 12/22/2022 letter must be included in the AMP, QAPP, or SOPs.

    The guidance provided in attachments 2 and 3 are now included as Appendix A and B in the QAPP

4. With regard to quarterly reporting:

    - page 25 of the AMP states, "Once QA/QC of the final data is completed within 60 days after the end of each calendar quarter, the refinery will provide…data in tabular format…to the BAAQMD" and
    - page 29 of the QAPP states, "Once QA/QC of the final data is completed within 60 days after the end of each calendar quarter, the refinery will provide…data in tabular format…to the BAAQMD…."

    The AMP must be revised to clearly state that the quarterly reports will be provided to the Air District no later than 60 days after the end of each calendar quarter.

Starting on Page 26 of the QAPP Addresses this finding – Section 9 Reporting

5. In discussing the required bump tests and 3-point calibration checks, pages 16-17 of the QAPP state that the following performance parameters of the TDL will be verified at least quarterly:

    - Detection Limit Range: 3-25 ppb, depending on operational conditions with precision and accuracy no greater than 15%
    - Average Path-Averaged Detection Limit 15 ppb
    - Repeatable Detection Limit of 25 ppb with light transmission less than 1%
    - Path-averaged Range of 3-5000 ppb (with the above caveats)
    - Reports to BAAQMD will follow the prescribed format provided by BAAQMD

    These provisions are inconsistent with the requirement in the Air District's 12/22/2022 letter that the accuracy and precision specifications of 15% must be met for each <u>monthly</u> bump test. The QAPP must be revised accordingly.

The above text has been removed from the QAPP. Page 1 MSOP-003-TDL-SCC Addresses this requirement that the accuracy and precision specifications of 15% must be met for each <u>monthly</u> bump test

6. With regard to quality assurance and quality control, the Guidelines require the AMP to include a QAPP that follows EPA guidelines and specifies methodologies for ensuring appropriate levels of QA/QC, data acceptance criteria, levels of data quality, data management issues and procedures, and data review and validation procedures (p. 10).

   Section 4 of the QAPP and the associated SOPs discuss QA/QC activities for the H_2S monitoring system. As a general matter, the QAPP and SOPs are incomplete, lack clarity, and are at times inconsistent with the established requirements for the H_2S TDL.

   As a preliminary matter, not all of the reference documents identified in Table 4.1 of the QAPP were provided to us. Missing documents include:

   - FLM-QLT-SOP-004
   - FLM-QLT-SOP-005
   - FLM-QLT-SOP-008
   - FLM-QLT-SOP-014
   - FLM-QLT-SOP-015
   - FLM-QLT-SOP-16
   - FLM-QLT-SOP-17
   - IMS-QLT-MAN-010
   - IMS-QLT-MAN-008

   Additional examples include the following:

   - Table 4.1 refers to reference document FLM-QLT-SOP-015 with regard to the monthly accuracy checks but references FLM-QLT-SOP-009 with regard to quarterly accuracy checks. Since reference document FLM-QLT-SOP-015 was not provided to us, it is unclear if the different references reflect an error or if there are actual differences in the procedures.
   - Table 4.1 of the QAPP provides a summary of the measurement quality objectives for each instrument and pages 23-25 of the QAPP go on to list instrument-specific QA/QC checks. However, the list on pages 23-25 is inconsistent with the content of Table 4.1.
   - Our 12/22/2022 letter stated that the detection TDL detection limit must be quantified and verified in real time. While determination of the MDL appears in Table 4.1 as a monthly requirement it is not included as a real-time check.
   - Reference document FLM-QLT-SOP-011 states an acceptance criterion for the relative standard deviation, which is inconsistent with the 15% coefficient of variation requirement stated in our 12/22/2022 letter.
   - Reference document FLM-QLT-SOP-009 states an acceptance criterion for relative accuracy, which is inconsistent with the 15% accuracy requirement stated in our 12/22/2022 letter.

   While these examples are not exhaustive, they illustrate a fundamental lack of clarity and consistency in the QAPP and SOPs. To resolve this issue, MRC must do the following:

   a. add a column to Table 4.1 to specify the system- or pollutant-specific acceptance criteria for each QA/QC check in the table (MRC may also consider splitting Table 4.1 by system or pollutant to improve clarity);
   b. revise Table 4.1 to ensure it reflects all requirements stated in our 12/22/2022 letter;

c. ensure the narrative discussion following Table 4.1 is consistent with the contents of the table;

d. provide the Air District with copies of all reference documents identified in Table 4.1;

e. review and revise all reference documents identified in Table 4.1 to state system- or pollutant-specific procedures and acceptance criteria, which are consistent with the established requirements; and

f. for each performance indicator check, corrective action, maintenance activity, QA/QC activity, data management activity, or reporting activity identified in the AMP or QAPP, provide references to the relevant SOPs.

a. Table 4.1 (starting on Page 17) has been revised to include specific acceptance criteria for each QA Check
b. Comments b through f are addressed in Section 4. The procedures have been revised to have more clarity.

Note that this is among the issues discussed in our July 15, 2022 and 12/22/2022 letters that MRC has failed to resolve. Also note that the SOPs will become part of the publicly available AMP and QAPP. As a

result, if an SOP contains confidential information, two copies must be submitted – one that has the confidential information redacted and that can be made available to the public, and another unredacted copy for internal Air District reference.

Finally, note that while MRC previously asserted a claim of confidentiality over all of the reference documents previously provided to us, we disagree that all of the information in those documents is confidential. By submitting a confidential redacted version, MRC represents to the District that it includes information recognized as trade secret under California law.

The comment on confidentiality has been removed. Argos will supply two documents. One of them will have publicly redacted comments associated with proprietary information.

7. Section 5 of the QAPP identifies a variety of maintenance activities for the H_2S monitoring system. As a general matter, the QAPP contains an insufficient level of detail regarding the methods and procedures, that will be used to perform these actions. For example, Table 5.2 states that system settings will be verified on a monthly basis but the QAPP does not explain what that involves or include procedures for performing the verification. Details that should be provided in the QAPP or in SOPs attached to the QAPP include: an explanation of the settings and how they affect instrument performance, the range of options available for each setting, typical or expected values for each setting, considerations to make when adjusting the settings, and procedures for documenting adjustments that are made. MRC must attach to the QAPP detailed SOPs for all maintenance activities and corrective actions and provide references to the relevant SOPs in the QAPP.

This section has been moved to MSOP-004-TDL-OAM. This document includes a specific procedure for performing routine maintenance for the TDL

8. With regard to the required 3-point calibration checks and bump tests, the Air District's 12/22/2022 letter stated that a failure to meet the stated accuracy and precision specifications must trigger repair, maintenance, and root cause analysis followed by repeat calibration checks or bump tests, until a passing check or test is completed. The letter also stated that all steps in this process, including results of each passing and failed calibration check and bump test, and monitor response or calibration adjustments, must be fully documented in the quarterly report submitted to the Air District. These provisions could not be found in the AMP, QAPP, or any of the SOPs and must be included.

A specific procedure was included in MSOP-003-TDL-SCC address root cause analysis (Corrective Action – Page 20). Also Appendix A page 28 numbers 7 and 8 specifies this as a requirement for reporting

9. With regard to the established precision and accuracy specifications, the Air District's 12/22/2022 letter stated that a failure to meet the specifications during two or more bump tests in any quarter, or four bump tests in any 12-month period, will result in a violation of the accuracy or precision specifications (as applicable) and QAPP requirements. The letter further stated that such occurrences will invalidate all data prior to the failed bump test going back to the last passing bump test, and that invalidated data will count against data completeness requirements. These requirements and procedures cannot be found in the QAPP or any of the SOPs and must be added.

See Appendix A, Page 28 Number 7

10. Page 27 of the AMP states that a "preliminary" QAPP has been provided and that it is to be updated with the approved AMP and finalization of equipment and contractor support for operating the monitoring equipment and website. When an AMP and QAPP are submitted for Air District review and approval, it is expected both documents are what MRC considers to be final versions. Subsequent changes to either document would require additional Air District review and approval in accordance with the procedures in Rule 12-15. As a result, language characterizing the QAPP as "preliminary" should be stricken from the AMP. It must also be made clear that the AMP and QAPP will be submitted to the Air District for approval whenever they are revised.

11.

The AMP, QAPP, and MSOP will all be marked Final

12. The AMP, QAPP, and SOPs contain unclear and unacceptable provisions regarding the data management, validation, and reporting process. For example, page 25 of the AMP and page 29 of the QAPP state that an automated system conducts quality assurance checks on data before it is reported to the public website. Those sections of the AMP and QAPP are not clear about exactly what automated checks are performed and how those checks influence what is presented on the website or submitted to the Air District in quarterly reports.

    Assuming some of the checks referred to on page 25 of the AMP and page 29 of the QAPP are the same as the real-time checks presented in Table 4.1 of the QAPP, the QAPP and the associated SOPs are equally unclear. For instance, Table 4.1 states that methane and H_2O are checked in real time as outlined in reference document FLM-QLT-SOP-001. However, we find no mention of methane or H_2O checks in that document.

    As another example, pages 10-11 of the AMP describe a process in which MRC apparently screens out all data from public view that is not at least two times the manufacturer's claimed detection limit. This practice is inappropriate and all values equal to or above the manufacturer's MDL should be reported as measured.

    To resolve these issues, MRC must:

    a. include in the QAPP a detailed process flow diagram depicting the end-to-end data handling, review, and management process from the moment of data acquisition to the quarterly submittal of final quality controlled data to the Air District;

b. revise the narrative descriptions of the data handling, review, and management process in the AMP and QAPP to clearly and fully describe the step-by-step process depicted in the flow diagram;

c. articulate all decision rules used to automatically or manually screen data;

d. illustrate the application of all auto-screening rules using real data and screen shots depicting how the auto-screened data are displayed on the public website; and

e. improve transparency about the data that has been invalidated by revising the website to allow members of the public to see two alternative views of the data – one view with invalid data removed, and another view showing all data (valid and invalid). Invalid data displayed on the website must be flagged as such and the reason for invalidation must be indicated on the website alongside the corresponding invalid data.

f.

These are addressed in Section 5 – Data Management (page 19) , Section 8 - Website and Dashboard Management (Page 24) and Appendix C – Example of Data Validation Process (Page 31) of the QAPP

The Air District's 12/22/2022 letter stated that bump tests must be performed at least monthly at a unique concentration that differs from the calibration checks. The letter went on to say that the bump check concentration should be 50 to 100 ppb and that the accuracy and precision specifications of 15% must be met for each test. While Table 4.1 of the QAPP includes a requirement for a monthly single point check and pages 16 and 17 of the QAPP briefly describe the bump tests, the QAPP lacks adequate detail to satisfy the requirements in our letter. While it is possible these details are specified in reference document FLM-QLT-SOP-008, we are unable to verify that as MRC failed to provide the document to us. MRC must ensure the contents of FLM-QLT-SOP-008 satisfy the bump test requirements in our 12/22/2022 letter and submit it to the Air District or otherwise incorporate the content of the reference document into the AMP and QAPP.

This was addressed in MSOP-003-TDL-SCC on page 2 of the document. Table 1 presents the concentration ranges for each calibration check.

Page 5 of the AMP states MRC's intent to meet the installation milestones associated with Rule 12-15 and it goes on to say that the actual time for installation, "may be delayed" for reasons outside of MRC's control. While the purpose of this statement might be to express the possibility of delays outside of MRC's control, it could be misinterpreted as providing approval for missing milestones in the rule. This language must be revised to avoid such a misinterpretation.

Comment Removed from the monitoring plan

Attachment 2 – Basis for Determination That Martinez Refining Company's Revised Fenceline Air Monitoring Plan and Quality Assurance Project Plan (Submitted February 15, 2023) Do Not Meet District Regulation 12-15-403 [CONFIDENTIAL]

1. Reference document FLM-QLT-SOP-009 outlines procedures for subjecting measurements to accuracy tests. Accuracy is defined in the document as:

$$A = \frac{\left|\overline{R} - \overline{T}\right|}{\overline{R}} \times 100$$

Where:

A is the accuracy of each measurement

$\overline{R}$ is the average value of the reference gas

$\overline{T}$ is the average value of the measurements

Generally, the term "accuracy" refers to the closeness of agreement between a measured quantity and its true value, such that a higher accuracy represents greater agreement. However, as it is defined above, higher values of "accuracy" actually reflect less agreement between the measured quantity and its true value because the formula represents error in the measurements rather than accuracy. This convention may be confusing or misleading to casual readers of the AMP, QAPP and associated SOPs, and because they are public documents, it is important that they be clear and understandable, and use plain language to the extent possible. To improve clarity, MRC must modify the formulas as shown below and revise the AMP, QAPP, and any attachments as necessary to accommodate the revised definitions.

$$\%\ Error = / \frac{x\text{--}x_{std}}{x_{std}} /\ x\ 100\%$$

2. With regard to the required 3-point calibration checks, Table 4.1 of the QAPP refers to two separate reference documents – FLM-QLT-SOP-17 and FLM-QLT-SOP-010. Aside from a difference in the stated frequency of these checks, we are unable to distinguish between the two since the FLM-QLT-SOP-17 reference document was not provided to us. In any case, the content of FLM-QLT-SOP-010 is not consistent with the requirements of our 12/22/2022 letter. For example, the letter stated that calibration checks must be performed using NIST traceable standards and that the low calibration point must be in the range of 40 to 60 ppb H_2S. These provisions could not be found in the reference document provided. In addition, the reference document appears to contain erroneous content since the frequency is incorrect and the description, measurement quality objective, acceptance criteria, and corrective action all pertain to determination of detection limits:

Frequency: Monthly

Description: Using the method outlined in the relevant EPA document for open-path air monitoring systems, the lower detection limit (LDL) will be measured for the Open-path air monitoring system.

Measurement Quality Objective: Detection limits are determined using the method outlined in the appropriate SOP. The detection limits are calculated by removing the target gas from the optical path of the monitor and measuring the detection limit. The MQO will be considered to have been met if the calculated detection limits are less than or equal to the detection described in the appropriate documentation.

Acceptance Criteria: This MQO will be considered to have been met if the calculated detection limits are less than or equal to the detection limits for gases listed in QAPP.

Corrective Action: If the system fails the detection limit check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

Section 2 of the reference document (Summary of Method) and Section 6 (Measurement Quality Objectives) also contain language referring to determination of detection limits.

MRC must clarify the difference between the two reference documents related to linearity checks, ensure they satisfy the requirements for 3-point calibration checks stated in our 12/22/2022 letter and submit them to the Air District or otherwise incorporate the content of the reference documents into the AMP and QAPP.

3. With regard to data completeness, page 8 of reference document FLM-QLT-GUI-001 states atmospheric conditions that affect accurate measurements and that are beyond the control of the refinery will not be counted against onstream efficiency requirements if appropriate documentation is provided. The document goes on to describe two methods for determining if weather-related events have impacted a monitor's signal strength. One method is to correlate a signal drop with meteorological conditions. The second method is to detect a signal drop at another open path monitor. The first approach is consistent with the Guidelines (p. 5) but the second approach is not and must be stricken from FLM-QLT-GUI-001, the AMP, QAPP, and all other associated documents.

4. Section 2 of reference document FLM-QLT-GUI-001 identifies the monitoring equipment that comprises fenceline monitoring network but it does not include the H_2S TDL system. The description must be revised to include the H_2S TDL.

5. Section 5 of reference document FLM-QLT-GUI-001 describes notifications that will be provided to the public when certain events occur. Among those events is a valid data detection above certain thresholds. The reference document states that the detection thresholds are based on levels in South Coast AQMD

Rule 1180. Rather than incorporating the thresholds by reference to a South Coast Air Quality Management District rule, the thresholds should be clearly stated in the reference document itself.

6. Reference document FLM-QLT-SOP-009 pertains to accuracy checks on the open-path systems but some of its content appears to be erroneous as the method summary and measurement quality objectives discuss determination of minimum detection limits:

2 Summary of Method

As referenced in the appropriate SOP, the following method is used to detect Minimum Detection Limits (MDLs):

The MDL shall be determined for each target gas. This number represents the lowest obtainable value for detecting that specific gas. The MDL is calculated by removing the target gas from the optical path of the monitor, then a series of 26 single-beam spectra are taken using the appropriate averaging time (either 1 min. or 5 min.). The single-beam spectra are then used to create absorption spectra, using each single beam spectrum as the background for the next spectrum. The absorption spectra are created by using the first and second single-beam spectra, the second and third, the third and fourth, etc. The resulting 25 absorption spectra are then analyzed for the target gas. The MDL is defined as two times the standard deviation of the calculated concentrations.

A summary procedure for determining MDL is as follows:

1. Remove the target gas from the optical path of the monitor
2. Choose an appropriate averaging time for the monitor
3. Acquire 26 single-beam spectra
4. Use the first single-beam spectrum as a background to create an absorption spectrum from the second single-beam spectrum
5. Use the second single-beam spectrum as a background to create an absorption spectrum from the third single-beam spectrum
6. Continue until 25 absorbance spectra are obtained
7. Analyze each absorption spectrum to determine the concentration of the target gas
8. Calculate the standard deviation of the set of concentrations
9. Multiply the standard deviation by two to obtain the MDL.

6 Measurement Quality Objectives

Description: Using the method outlined in the relevant EPA documents (EPA'S ETV Test Protocol, TO-16) and SOPs for open-path air monitoring systems, the minimum detection limit (MDL) will be measured for the Open-path air monitoring system.

Measurement Quality Objective: Detection limits are determined based on the method outlined in the relevant SOP and by following the specific procedures given below.

Acceptance Criteria: The MQO will be considered to have been met if the calculated detection limits are less than or equal to the detection limits for gases listed for the specific monitoring application.

Corrective Action: If the system fails the detection limit check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue. A corrective action plan will be issued and implemented.

MRC must revise the reference document as appropriate and resubmit it.

7. Reference document FLM-QLT-SOP-011 pertains to precision checks but some of its content appears to be erroneous as Section 2 (Summary of Method) and Section 6 (Measurement Quality Objectives) discuss determination of minimum detection limits. MRC must revise the reference document as appropriate and resubmit it.

Martinez Refining Company
Regulation 12 Rule 15 Air Monitoring Plan

Document Control				
Revision #	Revision Date	Description	Name	Signature
1	4/20/2017	Original Draft	Don Gamiles	
2	7/24/2017	Updated Draft	Don Gamiles	
3	3/11/2020	Updated to reflect company ownership change	Don Gamiles	
4.1	3/16/2020	Updated to show document control page	Don Gamiles	
4.2	5/26/2022	Updated to include TDL	Don Gamiles	
4.3	8/27/2022	Updated to include BAAQMD Comments	Don Gamiles	
4.4	2/14/2023	Updated to include TDL information	Don Gamiles	
4.5	8/28/2023	Incorporate BAAQMD comment	Don Gamiles	

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List of Acronyms

APCO – Air Pollution Control Officer for the BAAQMD.

BAAQMD – Bay Area Air Quality Management District

BTEX – Benzene, Toluene, Ethylbenzene, Xylenes

DCU – Delayed Coker Unit

EPA- Environmental Protection Agency

FTIR – Fourier Transform Infrared Spectrometer

H_2S – Hydrogen Sulfide

LDL – Lower Detection Limit LOP – Light Oil Processing

MBC – Martinez Refining Company Business Center

MET – Meteorological Station

MFO – Marine Fuel Oil

MRC – Martinez Refining Company

OEHHA – Office of Environmental Health Hazard Assessment

OPCEN – Operations Central

PPB – Parts Per Billion

QAPP – Quality Assurance Project Plan

QA/QC – Quality Assurance / Quality Control

SO_2 – Sulfur Dioxide

TDL – Tunable Diode Laser

TRI – Toxic Release Inventory

UV-DOAS – Ultraviolet Differential Optical Absorption Spectroscopy

UDL – Upper Detection Limit

WWTP – Wastewater Treatment Plant

Section 1 - Overview

On April 20, 2016, the Bay Area Air Quality Management District (BAAQMD) adopted Regulation 12 Rule 15 which requires Bay Area refineries to develop and submit an Air Monitoring Plan for APCO approval to establish and operate a fence-line monitoring system. The BAAQMD also published guidelines for refineries to meet the fence-line monitoring requirements. The Martinez Refining Company (MRC) has followed these guidelines to generate this Air Monitoring Plan for submission to BAAQMD. As presented in "Air Monitoring Guidelines for Petroleum Refineries, AIR DISTRICT REGULATION 12, RULE 15: PETROLEUM REFINING EMISSIONS TRACKING", the key elements of the BAAQMD rule and guidelines are as follows:

Requirement #1 – Gases Requiring Open-path Measurements

Refinery operators must measure benzene, toluene, ethyl benzene, and xylenes (BTEX) and hydrogen sulfide (H_2S) concentrations at refinery fence-lines with open path technology capable of measuring in the parts per billion (ppb) range regardless of path length.

Requirement #2 - Other Gases to be Considered for Measurements

Measurement of sulfur dioxide (SO_2), alkanes or other organic compound indicators, 1,3-butadiene, and ammonia concentrations are to be considered in the Air Monitoring Plan. Refinery operators must provide a rationale in the Air Monitoring Plan for not measuring all the above compounds. The rationale must address why these compounds are not contained in the compositional matrix of emissions; are not at expected concentrations measured by available equipment; and/or address the technical or other considerations that make specific measurements inappropriate or unavailable.

Requirement #3 – Fence-line Coverage

Measurements must cover populated areas within 1 mile of the refinery fence-line likely to be affected when the annual mean wind direction lies in an arc within 22.5 degrees of a direct line from source to receptors 10% of the time, or greater, based on the most representative meteorological measurements for sources likely to emit the compounds listed above at the refinery. In addition, the monitoring plan should take into consideration seasonal and short-term meteorological events.

Requirement #4 – Sample Time Resolution and Data Completeness/Retention

Fence-line measurements must be continuously measured with a time resolution of five minutes. If this is not the case, refinery operators must provide rationale in the Air Monitoring Plan for lesser time resolution based on equipment or other operational limitations. Instrumentation must meet a minimum of 75% completeness on an hourly basis 90% of the time based on annual quarters. This is further defined as:

Quarterly % Completeness = ([Hours in the calendar quarter with hour complete % ≥ 75%] / [Total hours in the calendar quarter]) × 100.

Here, an “hour” represents a distinct clock hour (0 - 23) on any given day, as opposed to a rolling 60-minute period.

Atmospheric conditions beyond the control of the refinery that affect accurate measurements, such as dense fog shall not be counted against data completeness calculations. The owner must maintain records of all information required under this rule for a period of five years after the date of the records and records must be made available to the APCO upon request.

Requirement #5– Data Presentation to the Public

Measurements must be provided to the public on a real-time basis, with appropriate Quality Assurance/Quality Control (QA/QC) measures taken to provide assurance of data accuracy.

Requirement #6 - Develop a Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPP) that follows EPA guidelines must be developed that outlines the QA/QC parameters.

Requirement #7 – Schedule to Implement 12 months after plan Approval.

MRC’s intent is to meet the installation milestones associated with Rule 12-15.

MRC’s policy is to comply with all local and federal environmental regulations including the fence -line monitoring provisions of BAAQMD Rule 12-15. This includes meeting all downwind fence-line siting requirements, uptime requirements, and reportable quantifiable detection levels. Siting included the evaluation of five years of meteorological data as well as seasonal and recurring short-term meteorological events (such as quarterly wind roses) in assessing siting positions per the BAAQMD guidance document. Site locations for the fence-line equipment were selected to strategically position the fence-line monitors using the predominant and variable meteorological conditions and topographical terrain features within the refinery. Finally, the specific chemicals that require monitoring were determined for each source area based on process knowledge.

The following sections provide a summary of MRC’s methodology for meeting the fence-line monitoring requirements of Rule 12-15.

Section 2 - Evaluation of Fence-line Requirements

Requirement #1 – Gases Requiring Open-path Measurements

As required by Rule 12-15, MRC will install open-path air monitoring systems for the detection and quantification of BTEX and H_2S. The addition of open-path H_2S systems will be completed and operational prior to January 1, 2023. MRC will notify the Air District within seven days after the system is operational and data in compliance with the QAPP is available on the website.

Requirement #2 - Other Gases to be Considered for Open-path Measurements

As required by Rule 12-15, MRC considered the measurement of sulfur dioxide (SO_2), alkanes or other organic compound indicators, 1,3-butadiene, and ammonia for inclusion in the Air Monitoring Plan. Alkanes and SO_2 will be included in the monitoring plan as they have the potential to be present in measurable quantities at SMR. 1,3-butadiene will not be included in the fence-line monitoring program because it is not produced as an intermediate or end-product at SMR and is only present in trace quantities at the refinery. Ammonia, where it is present in the form of anhydrous ammonia, is only in one location at the refinery and will already have local detection of release near the source prior to the fence-line plan implementation therefore no fence-line monitoring for ammonia is included in the plan.

Figure 2.1 Demonstration of Open-Path Average Concentration vs Point Sampler Detection

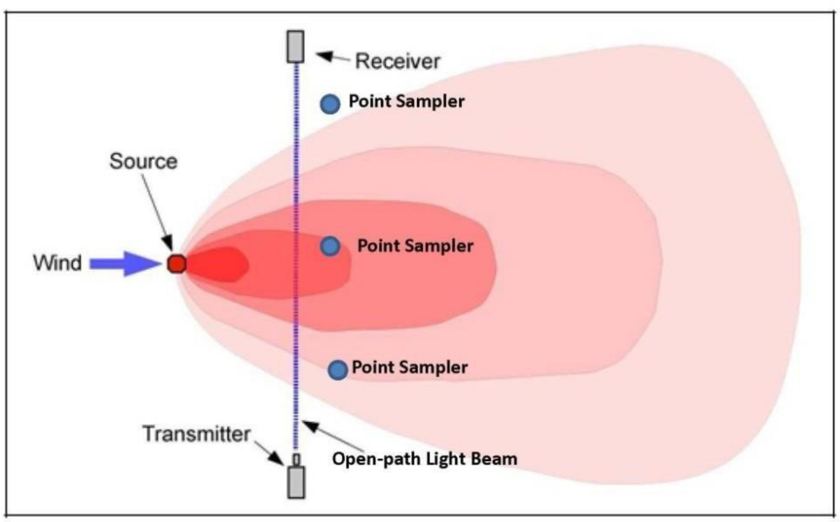


Table 2.1 presents the monitoring technologies proposed to comply with the Rule 12-15 monitoring requirements, along with the technology capabilities, common potential interferences for each instrument type and restrictions. Additional information for the Ultraviolet Differential Optical Absorption Spectroscopy (UV-DOAS), Tunable Diode Laser (TDL), Fourier Transform Infrared (FTIR), and Organic Gas Detectors (OGDs) air monitoring systems are included in the QAPP.

Technology Descriptions

The MRC fence-line monitoring program uses two different types of technologies to measure gases in the air. The first type, open-path air monitoring systems, uses beams of light to detect and quantify gases. The systems work by sending a beam of light into the open air and receiving it at a detector. When gases are present in the beam, some of the light is absorbed, and the detector can distinguish between a beam received in clean air, versus a beam when gases are present. Often gases have their own distinct way of absorbing light and may absorb light at several different wavelengths. This acts almost like a fingerprint for the gas, and by comparing known reference standards to the results from field measurements, the system can identify the gas based on which wavelength absorption patterns are present. Likewise, the quantity of light that was absorbed is a direct function of the concentration of the gas in the air. By analyzing the size of the absorption that took place, the system can estimate the average concentration of the gas along the beam path. A single open-path analyzer can send a beam of light out over half a mile. This makes these systems ideal for use as a fence-line monitoring system where a significant amount of linear distance needs to be covered. MRC is proposing BTEX and SO_2 will be detected and quantified using Open-path UV Differential Optical Absorption Spectroscopy (UV-DOAS) air monitoring systems. H_2S will be detected and quantified using open-path Tunable Diode Laser (TDL) air monitoring systems.

The second type of air monitoring system used in the monitoring program are point sampling devices. The point sample monitoring systems are suited for use in areas of the fence line that may not be suitable for open-path devices. These include areas with terrain limitations, or where sources release gases that do not absorb light well enough to be efficiently detected with an open-path system.

At MRC, a point monitoring systems will be deployed to supplement the open-path air monitoring systems to detect the total amount of organic gases present. Although this technology is a point sensor method rather than an open path, it has the capability to detect gases on a real-time basis while meeting the operational efficiency requirements presented in the rule. In addition, the point monitoring systems have an operational advantage compared to open-path systems as they will continue to operate during conditions when the open-path technologies will be inoperable due to weather events (e.g., heavy fog or rain). This additional coverage will enhance the community benefit of the fence-line system. The point monitoring systems will be deployed at strategic points along the fence-line to capture emissions from the refinery. MRC is proposing to use Organic Gas Detectors (OGD) where open path is not suitable.

In either open path or point detection, using the data in combination with the metrological station data from the MET station located on site is helpful in determining where sources originate from and where the gases are moving towards. The basic difference is demonstrated in Figure 2.1. In this figure, a gas plume is generated from a source and released into the air. As the gases are released, they are carried by the wind and begin to disperse and move away from the source. As seen in the figure, the concentration of gases in the plume will be highest in the center of the plume (shown as the darker red) and closest to the source, while gas concentrations will be less at the edge of the plume (shown as the lighter color red) as the distance from the source increases. The shape of the plume can be affected by changing terrain and meteorological conditions, but in general, this dispersion pattern is an accurate depiction of what happens after a gas release.

Table 2.1 –Monitoring Equipment Overview

Equipment	Capabilities	Interferences	Measurement Errors	Restrictions
Extractive FTIR	Detects alkanes.	Water and CO_2 which can be compensated for with analytical Software	Monitoring uses multiple regression to analyze data	None
Open-path UV	Detects Benzene, Toluene, Xylene, Ethylbenzene, and Sulfur Dioxide at path lengths up to 1,000 Meters	Ozone and Oxygen which can be compensated for with analytical software	Monitor uses partial least squares regression to analyze data	Heavy Fog and Rain
Open-path TDL	Detects Hydrogen Sulfide Gas	Water and CO_2	Monitor uses multiple regression to analyze data	Heavy Fog and Rain
Organic Gas Detectors	Detects Total Hydrocarbons. No Loss of data quality due to rain or fog	None	None	None
Meteorological Station (MET)	Wind direction and speed, temperature, dew point, rain gauge	None	None	None

Sample Analysis Method

Each analyzer has a vendor-specific method for collecting and quantifying data. Each specific analytic method is described below:

Open-path UV DOAS

The UV DOAS air monitoring system detects benzene, toluene, ethylbenzene, xylene, and sulfur dioxide on a real-time basis using beams of ultraviolet light. A beam of light is sent out in the open air to a light detector at the other end of the beam path. The system identifies gases by examining the wavelengths of UV light that have been absorbed by the gases present in the light beam. The amount of gas in the air is proportional to the amount of light absorbed at specific wavelengths. The system uses a multivariate method to quantify data. This analytic approach is critical to ensure false detections of gas do not occur. Each target gas has a spectral library of gases covering the concentration range of the analyzer. It also includes libraries of potential interfering gases such as oxygen and ozone. In addition, the system has the ability to undergo data and quality assurance checks in the field by using either sealed or flow through gas cells.

Open-path Tunable Diode Laser

The TDLs detect Hydrogen Sulfide (H_2S) gas on a real-time basis using beams of infrared light. A beam of light is sent out in the open air to a reflector that sends the beam back along the same path. If H_2S gas is present in the air, it will absorb at certain known wavelengths of the light. The tunable diode laser analyzes the light beam for H_2S gas as well as water and carbon dioxide which also absorb light in the same region as the H_2S gas. The system uses a multivariate approach to analyze the data to separate the total amount of light absorbance by each of the three gases and outputs a result for each gas. The system has the ability to undergo data and quality assurance checks using either sealed or flow through gas cells in the field.

Extractive FTIR

The FTIR has the capability to detect total non-methane hydrocarbons on a real-time basis while minimizing the impact of gases that interfere with alkane measurement such as water vapor and methane gas. The analytical method employed by the FTIR is a multiple regression technique that separates the total amount of light absorbance by the various gases and outputs a result for each gas. In the case of alkanes, this includes the contribution of interfering gases such as water vapor and methane. The system also can distinguish between various sources of alkanes. The system has the ability to undergo data and quality assurance checks in the field by monitoring known ambient gases or by using gas standards. Total alkanes, regardless of source, will be displayed on the website. However, during the monthly QA process, the data may be identified as not from the refinery depending on its spectral signature.

Organic Gas Detectors

The Organic Gas Detectors based on the principle of photoionization are referred to as Photoionization Detectors (PIDs). The systems work by inserting a sample of ambient air into a sample chamber where it is exposed to a small lamp that produces ultraviolet light. If an organic gas is present in the sample, it will interact with the UV light and become ionized. Once the gas is ionized it can be measured with a gas detector. The major advantage of the PID air monitoring system is its sensitivity and ability to measure organic gases at very low concentrations in the air. The limitation of the system is it cannot discriminate between the different types of organic gases that are in the air. In addition, the system cannot measure C2-C3 hydrocarbons but is capable of measuring the majority of gases associated with refining.

Quantification Limits

Tables 2.2 and 2.3 provide an overview of the gases covered in the fence-line program, the detection technologies employed, and the lower and upper quantification limits (LoQ and UQL) attainable under optimal conditions.

Table 2.2 – Quantification Limits for Gases Monitored by Open-Path Systems

	Path 1		Path 2		Path 3		Path 4	
Distance (m)	445		810		825		435	
Gas	**LoQ** (ppb)	**UDL** (ppb)	**LoQ** (ppb)	**UDL** (ppb)	**LoQ** (ppb)	**UDL** (ppb)	**LoQ** (ppb)	**UDL** (ppb)
Benzene	0.9	5,483	0.9	3,012	0.8	2,958	0.9	5,609
Ethyl Benzene	15	5,483	12	3,012	12	2,958	15	5,609
Hydrogen Sulfide*	3.0	5,000	3.0	5,000	3.0	5,000	3.0	5,000
Sulfur Dioxide	4.0	2,202	2.2	1,210	2.2	1,188	4.1	2,253
Toluene	1.8	2,742	1.7	1,506	1.7	1,479	1.8	2,805
Xylene	1.0	2,742	0.8	1,506	0.8	1,479	1.0	2,805

* The BAAQMD requirement for the LoQ of the H_2S includes the requirement that the systems report a value between 3 and 25 ppb under optimal environmental conditions. For the TDL air monitoring system, ideal conditions include clear air, non-condensing atmosphere, relative humidity less than 95%, and stable optical alignment.

Table 2.3 – Detection Limits for Gases Monitored by Point Source Samplers

Point Source Monitor	Detection Limits	
	MDL (ppb)	**UDL** (ppb)
Total Alkanes	75	4,200
Total Organics	10	100,000

Table 2.2 – Detection Limits for Gasses Monitored by Open-Path Systems

	Path 1		Path 2		Path 3		Path 4	
Distance (m)	**445**		**810**		**825**		**435**	
Gas	**LDL** (ppb)	**UDL** (ppb)	**LDL** (ppb)	**UDL** (ppb)	**LDL** (ppb)	**UDL** (ppb)	**LDL** (ppb)	**UDL** (ppb)
H_2S	3	5,000	3	5,000	3	5,000	3	5,000
Benzene	0.8	5,483	0.5	3,012	0.4	2,958	0.9	5,609
Ethyl Benzene	4.5	5,483	2.5	3,012	2.4	2,958	4.6	5,609
Sulfur Dioxide	4.0	2,202	2.2	1,210	2.2	1,188	4.1	2,253
Toluene	1.8	2,742	1.0	1,506	1.0	1,479	1.8	2,805
Xylene	1.0	2,742	0.5	1,506	0.5	1,479	1.0	2,805

Table 2.3 – Detection Limits for Gases Monitored by Point Source Samplers

Point Source Monitor	Detection Limits	
	LDL (ppb)	**UDL** (ppb)
Total Alkanes	75	4200
Total Organics	10	100,000

Requirement #3 – Fence-line Coverage

This section describes the process used to determine where along the SMR fence-line the air monitoring equipment will be installed. Emission sources within the physical bounds of the refinery were identified and marked based on physical location and type of emissions. These sources are shown on a map of the refinery in Figure 3.1. Each emission source location was evaluated for the types of potential emissions and summarized in Table 3.1. Note that 96+% of all equipment covered by the refinery's fugitive emissions inspection program are included in these 10 areas.

Table 3.1 – Potential Emission Types from Source Areas

Area on Site Map	Source Type	Source Name	Emission Types
Area #1	Wastewater	Effluent Treatment Plant	BTEX[1], H_2S, SO_2, Alkanes
Area #1	Loading	Wharf	BTEX, H_2S, SO_2, Alkanes
Area #2	Storage	Distribution Tanks	BTEX, Alkanes
Area #3	Storage	Distillates Tanks	H_2S, Alkanes
Area #4	Process	Operations Central	BTEX, H_2S, SO_2, Alkanes
Area #5	Storage	Recovered Oil/Rerun Tanks	BTEX, H_2S, SO_2, Alkanes
Area #6	Process	COGEN, Gasoline Blending	BTEX, SO_2, Alkanes
Area #7	Process	Light Oil Processing	BTEX, H_2S, SO_2, Alkanes
Area #8	Process	Delayed Coking	BTEX, H_2S, SO_2, Alkanes
Area #9	Storage	Crude Tanks	BTEX, H_2S, Alkanes
Area #10	Storage	Vine Hill Storage Tanks	BTEX, H_2S, Alkanes

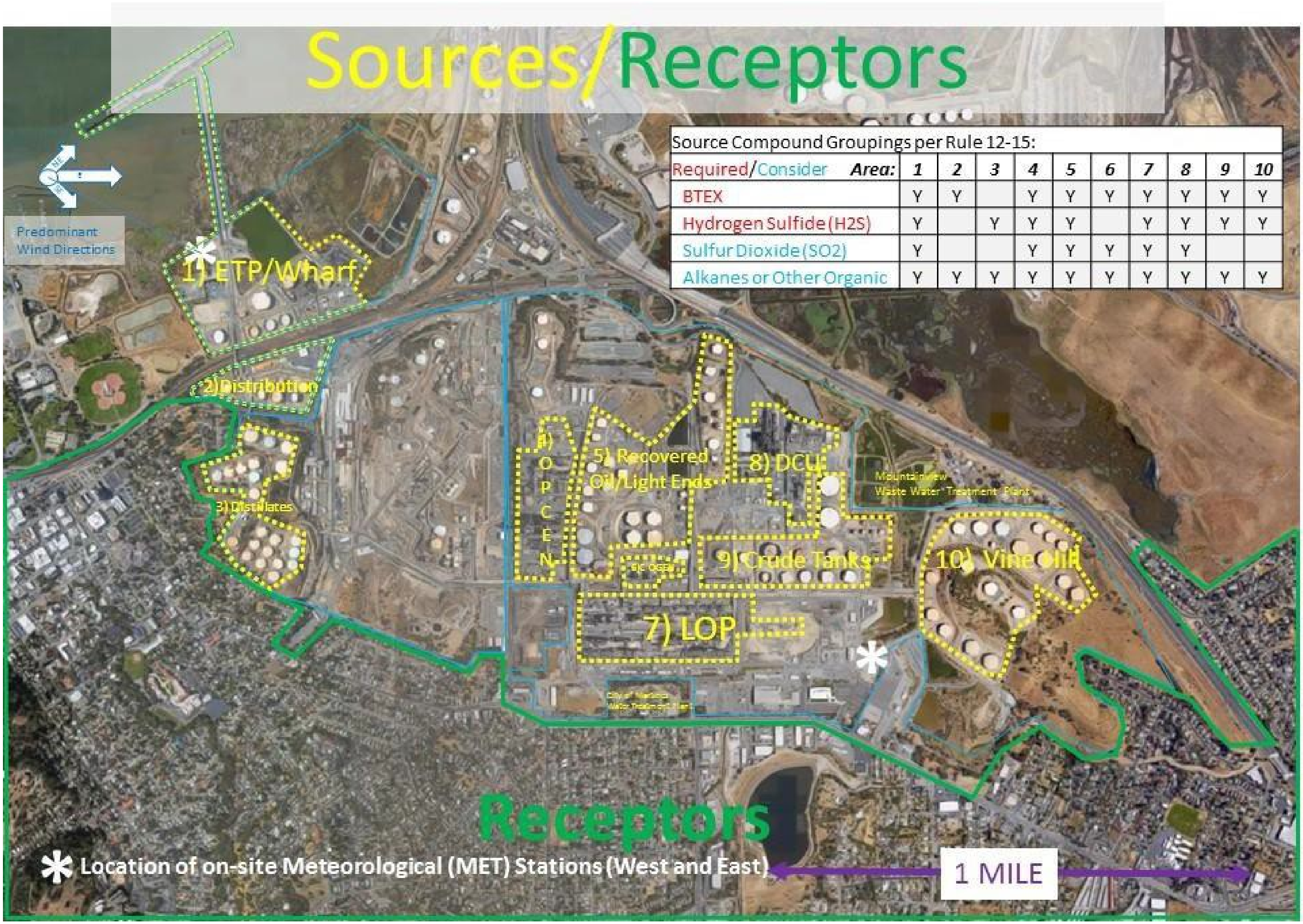
[1] BTEX includes one or more of Benzene, Toluene, Ethylbenzene, and Xylene

The fence-line monitors being installed as described in this Plan will complement and enhance air emission monitoring currently being done on the fence-line and on emission sources throughout the refinery for compliance with BAAQMD and EPA rules.

- Ground Level Monitors (GLMs) continuously sample the ambient air at four locations on the refinery fence-line and analyze for H_2S and SO_2 as required by BAAQMD regulations.
- Passive diffusion tubes are located around the refinery fence-line to be analyzed for benzene beginning in 2018 as required by EPA's Refinery Sector Rule.
- Continuous emission monitors measure NOx emissions from heater and boiler stacks, SO_2 emissions from sulfur plants, CO emissions from CO Boilers, and sulfur in fuel gas as required by both BAAQMD and EPA rules.
- Hydrocarbon detection systems surround the propane and butane storage areas to provide an early indication of any leak from these tanks.
- Several hundred thousand valves, pumps, and connections are monitored throughout the refinery to detect any low-level hydrocarbon leaks by a team of trained inspectors as required by BAAQMD and EPA rules.

Figure 3.1 – Potential Emission Sources

Sources/Receptors



Source Compound Groupings per Rule 12-15:										
Required/Consider **Area:**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BTEX	Y	Y		Y	Y	Y	Y	Y	Y	Y
Hydrogen Sulfide (H2S)	Y		Y	Y	Y		Y	Y	Y	Y
Sulfur Dioxide (SO2)	Y			Y	Y	Y	Y	Y		
Alkanes or Other Organic	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Wind Data

Meteorological data from two MRC on-site Meteorological (MET) stations operated by Western Weather were used to generate wind roses based on 2015 annual averages showing which sectors had winds blowing in each quadrant of the wind rose at least 10% of the time. The location of these MET stations can be seen in Figure 3.1. The wind roses showing these sectors are found in Figure 3.2.

The West MET station wind rose shows that the wind blows from the Southwest, West and Northwest more than 10% of the time and the East MET Station wind rose shows the wind blows from those same directions as well as from the South and Southeast. Although not shown, the 2011-2014 data were also evaluated and for all years the West MET station had the same 3 directions >10% and no other directions in any of the years. The East MET station had the same 5 directions >10% in all years except 2011 only had 4 of the directions >10% (not West) and no other directions were >10% in any of the years.

Seasonal weather patterns in the 5 years of wind data were also considered. February through October wind directions are like the annual wind roses. Calendar months November through January (labeled as Winter Conditions in Figure 3.3), show a wind direction from the East 16% and Northeast 13% of the time which accounts for most of the ~5% annual wind from either of these directions shown in Figure 3.2. Since the annual wind from these directions is much less than the 10% requirement for fence -line coverage and even during the winter period the frequency is only in the ~15% of the time range, additional fence-line coverage is not strictly required. However partial coverage for wind from these directions is included in the fence-line design as discussed below.

Figure 3.2 - Predominant Wind Direction

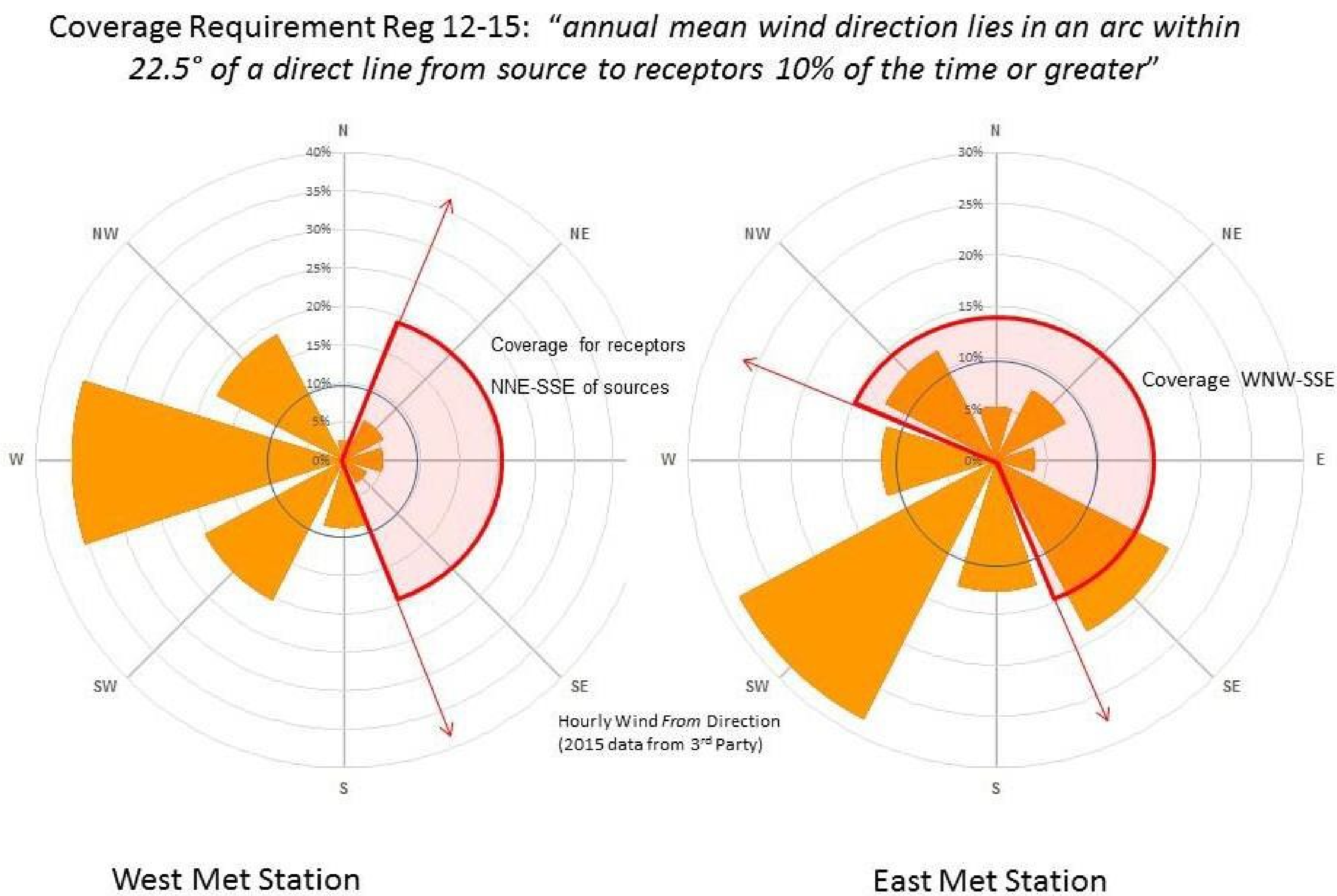
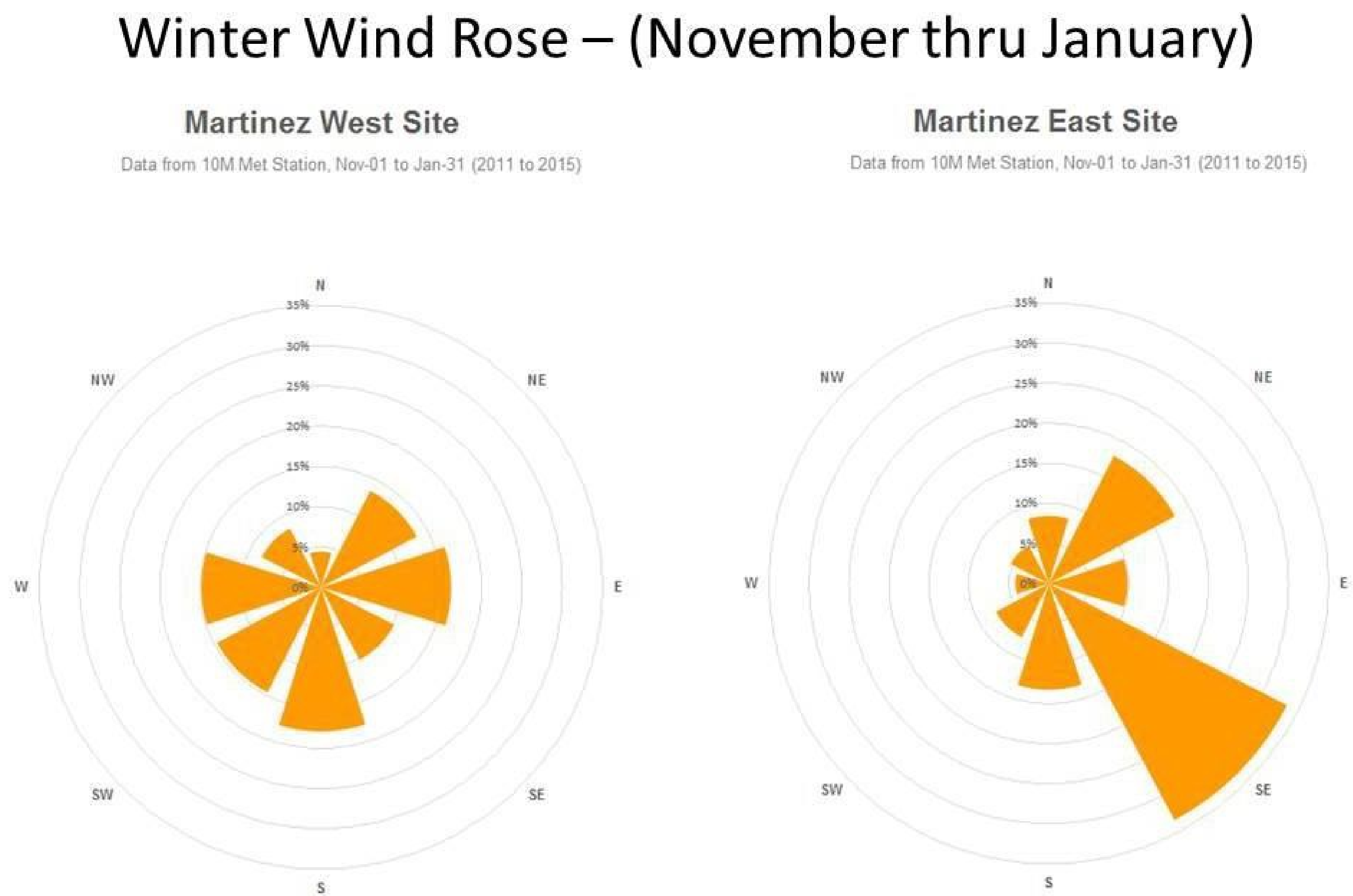


Figure 3.3 – Wind Rose During Winter Conditions



Location of Fence-line Systems

The following narrative presents the specific site location plan for the fence-line monitoring systems as shown in Figure 3.4. It is based on the source type, source location, predominant wind direction, and location of receptors. The West side includes the Wharf and Effluent Treatment Plant and stored products, and the East Side includes land east of MRC Avenue and most of the process units.

West Side of Refinery – Most of the time emissions from the west side of the refinery will move to a direction without receptors or toward the east side of the refinery (for winds from the West or Southwest). For a wind from the Northwest, emissions from the storage tanks located at Area 3 (Distillates Storage Tanks) would go to receptors to the Southeast. These tanks include heavier refined products (jet fuel, diesel, MFO) and will be monitored for alkanes and H_2S along Path 1. The endpoints C and D were selected to maximize the line of site distance for maximum fence-line coverage.

For the winter weather winds represented in Figure 3.3 when wind comes from the East or Northeast a higher percent of the time, Path 1 will also monitor for BTEX and SO_2 that could come from the process units east of Shell Avenue.

- Path #1 (see Figure 3.5 for the elevation profile) – From Site "C" at 164' elevation, the farthest southerly location of Area #3 (Distillates Storage Tanks) to Site "D" at 210' the farthest line of site location east of the source along the fence-line. Although the path is over 100' off the ground at the lowest point the path elevation is well aligned with the potential emission sources as the typical upwind sources range from 120-215' elevation.
- Path #1 will include UVDOAS to measure BTEX and SO_2, and a TDL to measure H_2S.
- Additionally, two extractive FTIR point monitoring systems will be installed at Sites "C" and "D" to detect alkanes.

Sites "A" and "B" will have point detection for detecting any hydrocarbons from Areas 1, 2, 3, or from East of Shell Avenue for wind directions from the East or Northeast. Site "A" was chosen to detect potential emissions from Area 1 (Effluent Treatment Plant and Wharf) or Area 2 (Distribution Tanks) that may go Southwest towards downtown Martinez and Site "B" was chosen as the farthest western location in the plant approximately halfway between Sites "A" and "C". As shown in Figure 3.8, the terrain is not suitable for an open path solution, however, the organic gas detectors used at Sites "A" and "B" are a good fit for detecting emissions from the potential sources in these adjacent areas.

East Side of Refinery - For the primary emission sources east of Shell Avenue, three open-path monitoring systems will be installed along the fence-line. See Figure 3.6 for the elevation profile. The specific location of the systems will be:

- Path #2 – Site "E", the Southwest corner of Area 7, Light Oil Processing facility at an elevation of 81' to Site "F", the top of the two-story Martinez Business Center (MBC) at an elevation of 55'. The lowest point between the sites is 22' with upwind sources ranging from 50-100'.

- Path #3 – Site “F”, the top of the MBC at an elevation of 55’ to Site “G” the top of a hill Southeast of Vine Hill (Area #10) at an elevation of 207’. The lowest point between the sites is 22’ with upwind sources ranging from 20-160’.
- Path #4 – Site “G”, the top of the hill Southeast of Vine hill at an elevation of 207’ to Site “H” on the ridgeline between Vine Hill and I-680 at an elevation of 102’. The lowest point between the sites is 52’ with upwind sources ranging from 20-160’.

Each of the three paths will have UV DOAS to measure BTEX and SO_2, and a TDL to measure H_2S. Additionally, two extractive FTIR point monitoring systems will be installed at Sites “F” and “G” (on the MBC and the top of the hill Southeast of Vine Hill) to detect alkanes.

No open path is possible along the ~500m between Sites “D” and “E” due to the lack of line of site from the terrain as well as half the segment is not on refinery property as shown in Figure 3.7. A point sensor to the East of Site D was considered but can only be placed about one-third of the way between sites “D” and “E” to stay within the refinery security perimeter providing little difference in detection vs. the detection at site “D” only 100-150m away.

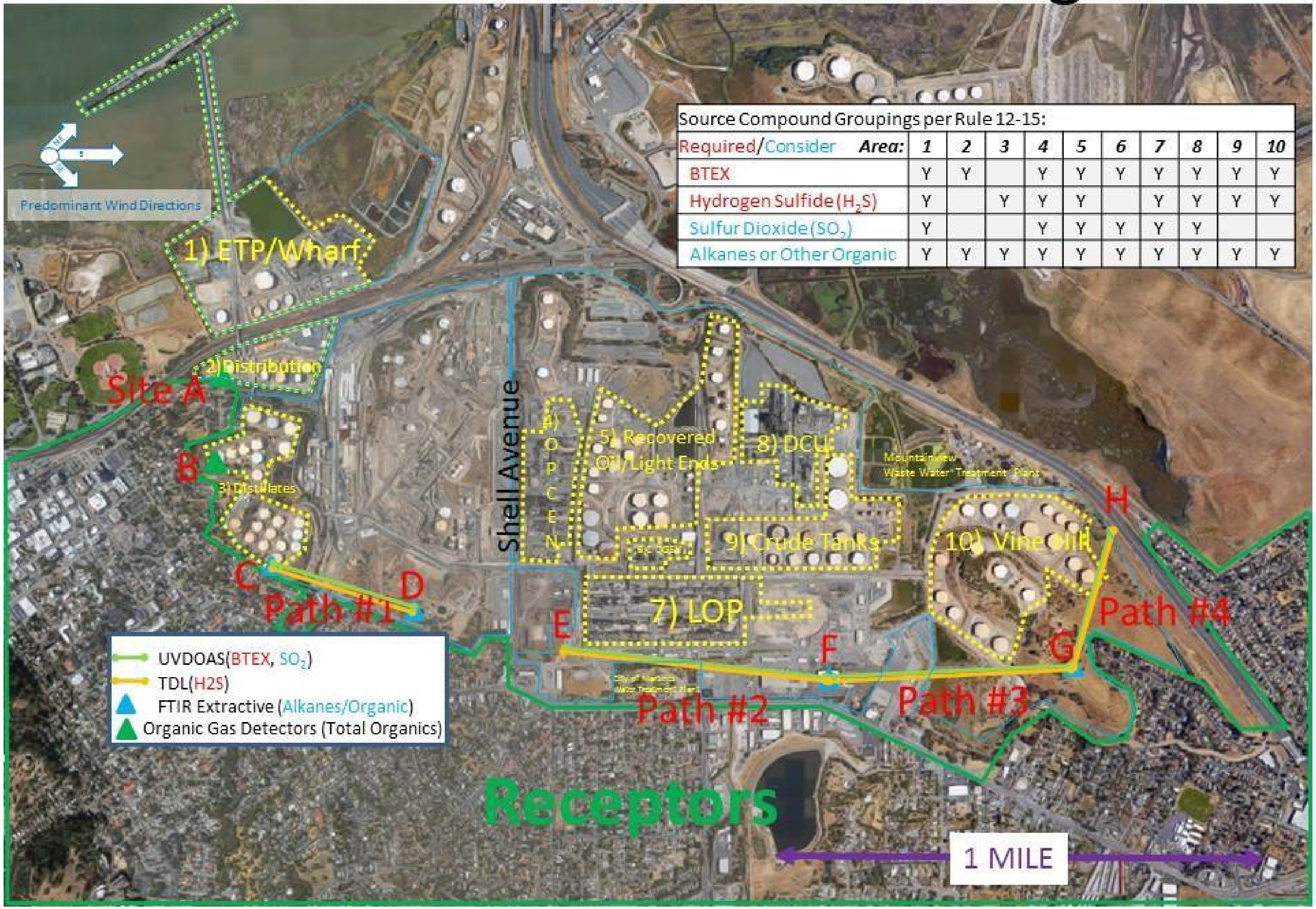
No Alkane Monitor is added at Site “E” as the emissions from predominate wind directions would be from Area 3 which is already covered for Alkanes at Site D or from Area 2 where BTEX coverage in Path #2 provides a surrogate for emissions that could come from these tanks if they could travel that far (nearly a mile) and be detectable. Area 1 would be greater than a mile from receptors near Site “E”.

No Alkane Monitor is added at site “H” due to the likelihood of false readings from the freeway and from the Mountainview Wastewater Treatment Plant. Also, BTEX provides a surrogate for alkanes for most emission sources.

There are no receptors within one mile north of Site “H” and across the North side of the refinery fence-line to the West of Area 2 Distribution, so no fence-line coverage is in the plan for this portion of the fence-line.

Figure 3.4 - Map of Fence-Line monitoring

Fence-Line Monitoring



Source Compound Groupings per Rule 12-15:

Required/Consider Area:	1	2	3	4	5	6	7	8	9	10
BTEX	Y	Y		Y	Y	Y	Y	Y	Y	Y
Hydrogen Sulfide (H_2S)	Y		Y	Y	Y		Y	Y	Y	Y
Sulfur Dioxide (SO_2)	Y			Y	Y	Y	Y	Y		
Alkanes or Other Organic	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Figure 3.5 – Elevation Profile

Path #1

Figure 3.6 – Elevation Profile

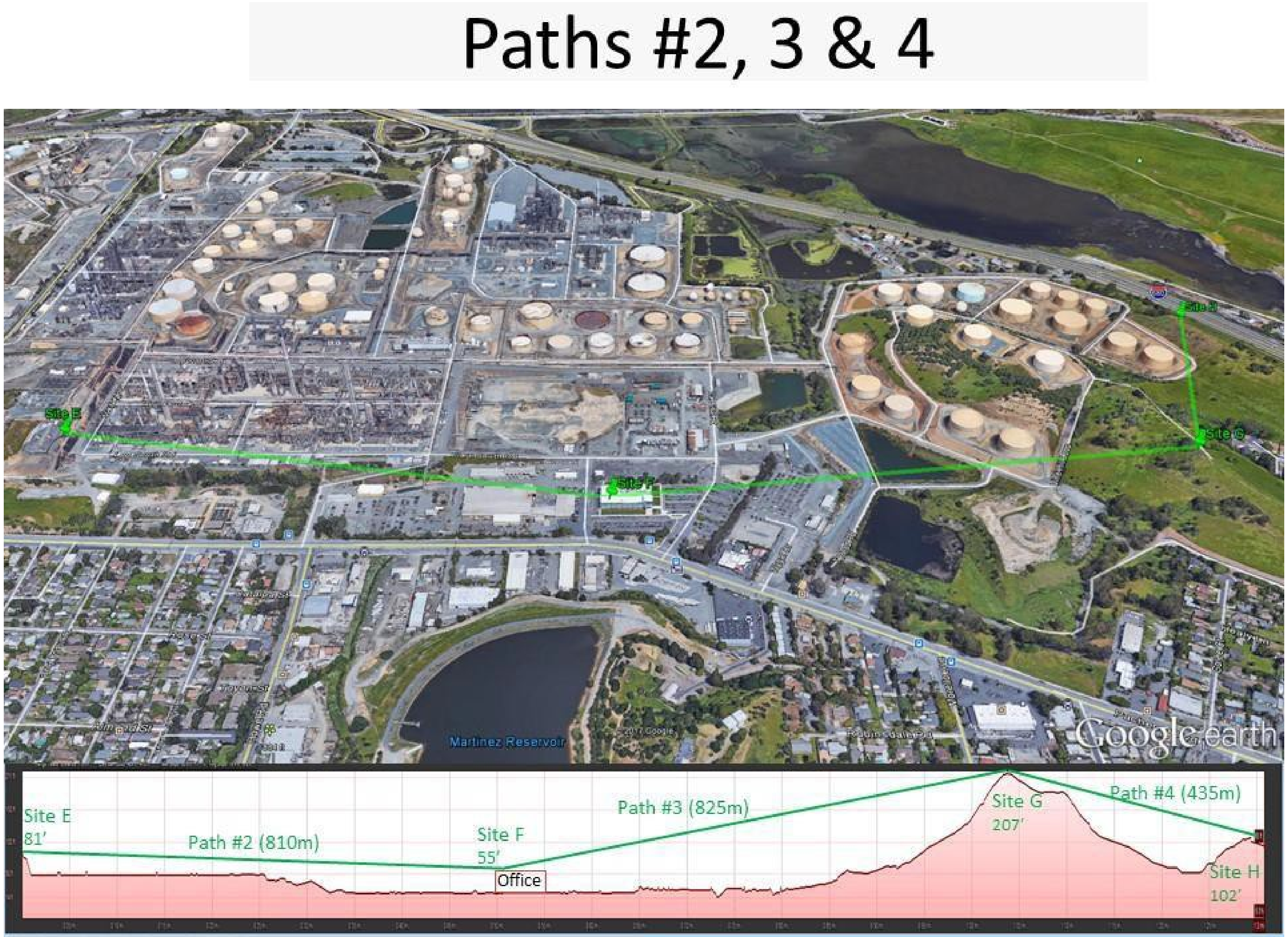


Figure 3.7 – Elevation Profile between Site D and E

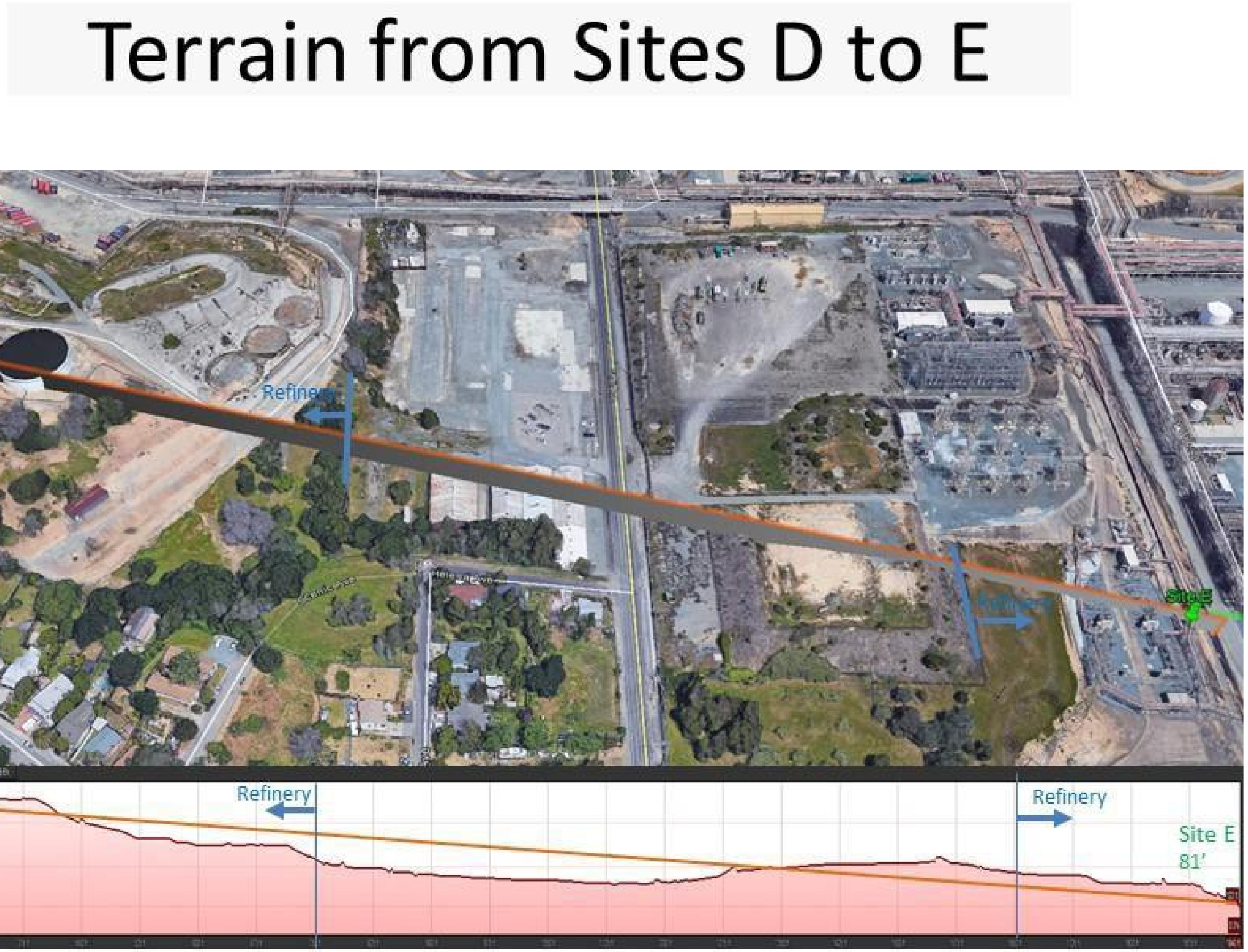
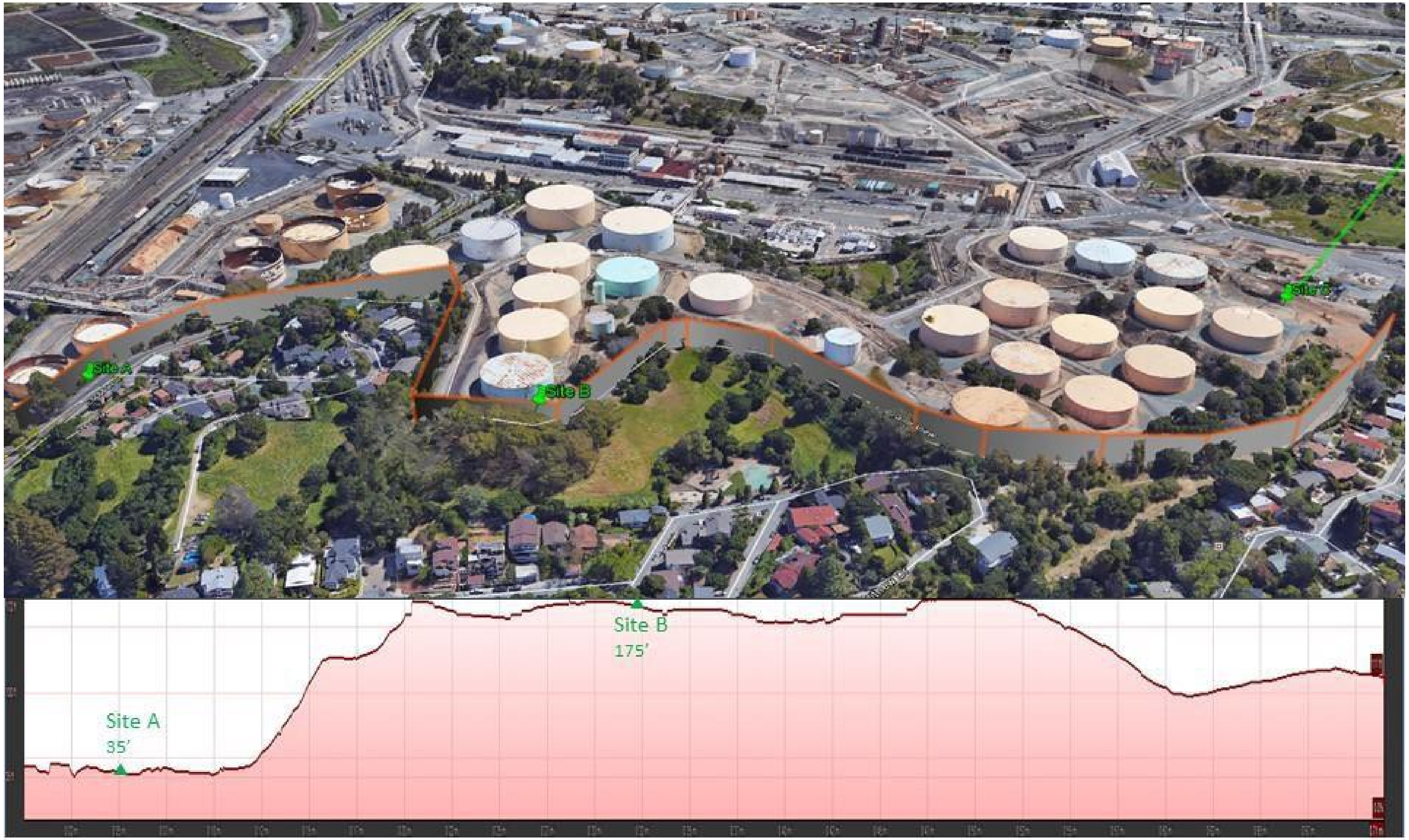


Figure 3.8 – Elevation Profile between Site A and C

Terrain from Sites A to C



Requirement #4 – Sample Time Resolution and Data Completeness

All air monitoring equipment specified for the MRC fence-line system will collect data on five- minute averages. All air monitoring equipment will meet a minimum of 75% completeness on an hourly basis 90% of the time based on annual quarters as defined earlier in this document. Atmospheric conditions beyond the control of the refinery that affect accurate measurements, such as dense fog, shall not be counted against data completeness requirements if appropriate meteorological measurements document time periods when these conditions exist.

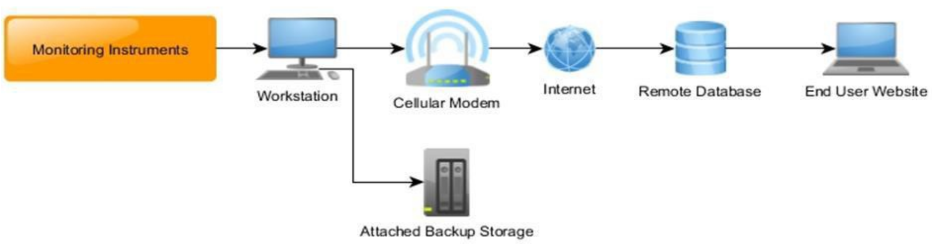
If an instrument's light signal drops below a predetermined signal strength the contractor will assess coincident signal drops on other instruments as well as the local meteorological conditions to determine the presence of rain or fog by examining current temperature, relative humidity, wind speed, dew point, and local rain gauge readings. If the local meteorological conditions are indicative of heavy rain or fog, the data will be identified and flagged as a weather-related event.

In addition to rain and fog, other types of environmental conditions beyond the control of the refinery can occur. These environmental factors include but are not limited to; strong winds, dust, and earthquakes all of which can impact the ability of open-path instruments to provide accurate measurements. In the event an instrument indicates a low signal; the data may be flagged as being caused by other environmental factors and will not be counted as instrument downtime.

Requirement #5– Data Presentation to the Public

Data from the monitoring stations will be transmitted to an Internet website where the real-time results can be viewed by the public. Figure 5.1 provides an example of how the monitoring data will be communicated to the public.

Figure 5.1 - Data Communication System



The website will be developed with input from the various stakeholders within the community and may evolve in the future as stakeholder needs change. The community website will include a message board to inform the public of relevant information as needed. For example, the message board may be updated when an analyzer is undergoing maintenance or QA/QC checks, or other conditions where an analyzer is not in an operational state for an extended period. In addition, the public will be able to send emails suggesting enhancements to the public access website or any other issue of interest to the community.

Data from the fence line monitors will be transmitted to an internet website where the near-real-time results can be viewed by the public.

Data generated by the fence line monitoring equipment undergoes review throughout the measurement and reporting process. Included in this process is automated QA/QC checks that occur before data is reported on the real-time website. Under normal circumstances, a 5- minute average measurement will appear on the website within 10 minutes of the end of the measurement period. However, the data uploaded may be impacted by internet traffic. An automated system conducts the Quality Assurance checks before the data is reported to the website. The website will also make available a rolling 24-hour trend of the 5-minute data for each gas reported.

Once QA/QC of the final data is completed within 60 days after the end of each calendar quarter, the refinery will provide one-hour average concentration data in tabular format through a comma-separated value data file to the BAAQMD. This will include the signal intensity, MDL calculations, and the data and supporting documentation for invalidated or otherwise flagged or qualified data. The BAAQMD may make the one-hour average data available to the public through a BAAQMD website or through a public records request. The refinery will make data available to BAAQMD upon request prior to the report submittal. Both real-time and QA/QC'd data will be retained for five years.

As mentioned, the data collected and reported on the public website are based on five-minute averages. This allows the system to generate data at very low detection levels (which takes more to time average) while presenting updates to the community as quickly as possible. It is important to understand that health limits for gases are based on people being exposed to average concentrations that are much longer than the 5-minute averages produced by the fence-line monitoring program. In fact, most health limits are based on exposures of 1-hour, 8-hour, or 24-hour averages, so it is important to keep the measurements from the fence-line systems in perspective. The State of California has generated guidance for acceptable exposure levels for many compounds. This guidance is published by California's Office of Environmental Health Hazard Assessment (OEHHA). For further information regarding the potential health impacts of gases that will be monitored at the Refinery fence line, please refer to the OEHHA guidelines on the topic: (https://oehha.ca.gov/chemicals).

The real-time website page will be incorporated into a larger website that will present additional resources to assist in the interpretation of the data. Information will be provided on the website to help the public understand the monitoring being done and the data being presented. Links to various public websites including the BAAQMD and OEHHA along with information about detection levels and typical background concentrations will help provide context for the data.

MRC's overall public communication process for refinery information includes the use of social media (e.g., Facebook and Twitter), media statements, and the Contra Costa County Community Warning System as appropriate. The fence-line monitoring website will be incorporated into these existing community relations programs. At the end of one year, MRC will evaluate the fence-line monitoring program by evaluating the data collected by the fence-line equipment using the Measurement Quality Objectives (MQOs) specified by the QAPP as well as the on-stream efficiency (OSE) for each analyzer. If a deficiency is found at the time of the evaluation, or at any other time, corrective actions will be initiated to address the issue and improve the system performance. MRC will engage the community through its public communication process to ensure stakeholders are informed of any changes. MRC will perform an evaluation of the fence-line systems whenever an analyzer fails to meet MQO or OSE thresholds.

Requirement #6 - Quality Assurance Project Plan

A QAPP is included as a separate attachment to be updated with the approved Air Monitoring Plan, finalization of equipment, and contractor support for operating the monitoring equipment and website.

Quality Assurance Project Plan for the Martinez Refining Company Fence-Line Monitoring Program

Revision 5.7
FLM-QLT-QAPP-001

Martinez Refining Company

	Document Control			
Revision #	Revision Date	Description	Name	Signature
1	4/20/2017	Original Draft	Don Gamiles	
2	7/24/2017	Updated Draft	Don Gamiles	
3	12/7/2018	Updated Draft	Don Gamiles	
4	08/16/2019	Updated Draft	Don Gamiles	
5	08/22/2019	Updated Draft	Don Gamiles	
5.1	03/06/2020	Updated Requirements	Don Gamiles	
5.2	03/11/2020	Change in Ownership	Don Gamiles	
5.3	05/09/2022	Incorporated TDL	Don Gamiles	
5.4	05/27/2022	Addressed Comments	Don Gamiles	
5.5	08/27/2022	Addressed BAAQMD Comments	Don Gamiles	
5.6	01/31/2023	Addressed BAAQMD change in TDL requirements	Don Gamiles	
5.7	08/23/2023	Addressed BAAQMD comments	Don Gamiles	

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List of Acronyms

APCO – Air Pollution Control Officer for the BAAQMD

BAAQMD – Bay Area Air Quality Management District

BTEX – Benzene, Toluene, Ethylbenzene, Xylenes

DQO – Data Quality Objectives

EPA – Environmental Protection Agency

FTIR – Fourier Transform Infrared Spectrometer

H2S – Hydrogen Sulfide

LDL – Lower Detection Limit

MBC – Martinez Business Center

MET – Meteorological Station

MRC – Martinez Refining Company

MQO – Measurement Quality Objectives

OEHHA – Office of Environmental Health Hazard Assessment

PPB – Parts Per Billion

QA/QC – Quality Assurance / Quality Control

QAPP – Quality Assurance Project Plan

SO2 – Sulfur Dioxide

TDL – Tunable Diode Laser

TRI – Toxic Release Inventory

UV-DOAS – Ultraviolet Differential Optical Absorption Spectroscopy

UDL – Upper Detection Limit

Section 1 – Fence-Line Monitoring Overview

On April 20, 2016, the Bay Area Air Quality Management District (BAAQMD) passed Regulation 12 Rule 15 (Rule 12-15), which mandates that Bay Area refineries formulate and submit an Air Monitoring Plan to the Air Pollution Control Officer (APCO) for approval in establishing and operating a fence-line monitoring system. The BAAQMD has also published guidelines to assist refineries in fulfilling the fence-line monitoring standards. The Martinez Refining Company has developed its Air Monitoring Plan (AMP) and Quality Assurance Project Plan (QAPP) based on these guidelines from the BAAQMD. Whenever amendments are made to the AMP or QAPP, they will be forwarded to the Air District for approval.

Martinez Refining Company's (MRC) policy is to comply with all local and national environmental regulations, including the fence-line monitoring stipulations of BAAQMD Rule 12-15. This includes meeting all requirements related to the downwind fence-line siting, operational up-time requirements, and quantifiable detection levels. The evaluation for siting the location of the equipment included five years of meteorological data and periodic seasonal and recurring weather events such as quarterly wind roses. This was to ensure optimal placement as per BAAQMD's guidance. The selected locations for the fence-line instruments strategically considered the predominant and variable meteorologic conditions and the topographical terrain features within the refinery.

Description of the Fence-Line Monitoring Program

A comprehensive overview of the fence-line monitoring program is included in the MRC Air Monitoring Plan (AMP). This program uses open-path air monitoring systems to detect and quantify benzene, ethylbenzene, sulfur dioxide, toluene, and xylene through Ultraviolet Differential Optical Absorption Spectroscopy (UV-DOAS). Total Alkanes are measured using the extractive Fourier Transform Infrared (FTIR) air monitoring methods, while Organic Gas Detectors (OGD) measure Total Organics. Hydrogen Sulfide (H_2S) levels are determined with a Tunable Diode Laser (TDL), and meteorological conditions are recorded using EPA-approved meteorological devices. Figure 1.1 offers a map detailing the refinery's air monitoring equipment placements, and Table 1.1 lists the locations of each equipment piece.

Figure 1.1 - Map of Fence-line Monitoring Program

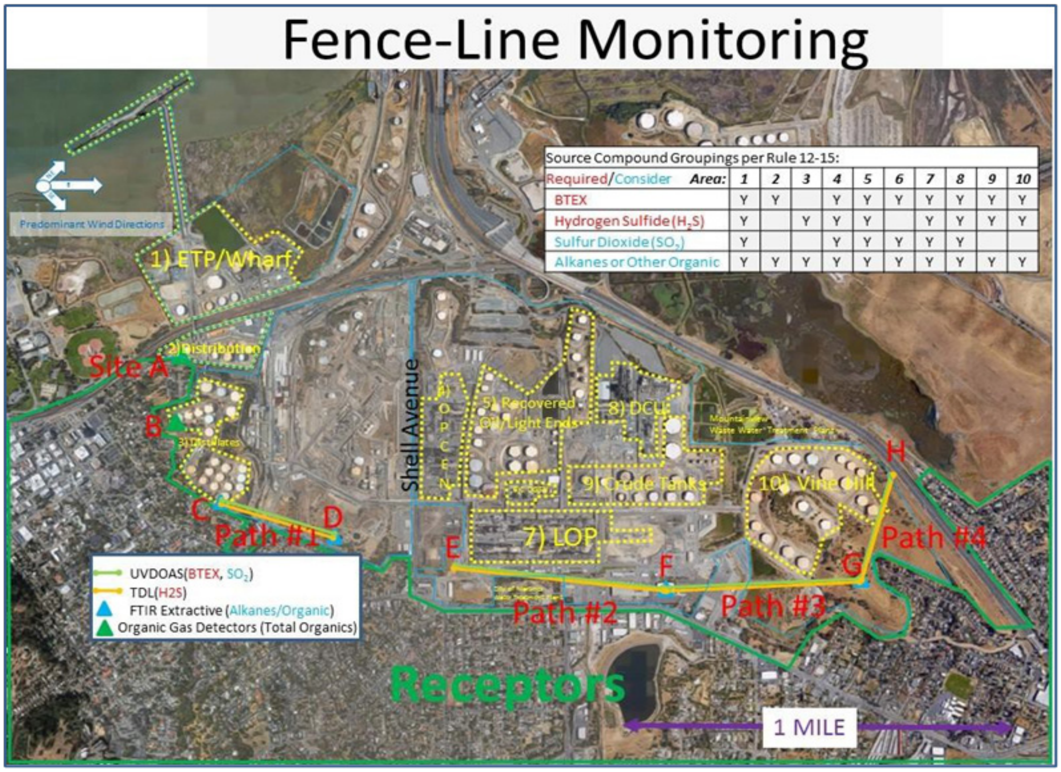


Table 1.1 - Monitoring Site Locations

Site # Name	GPS (North)	GPS (West)	Elevation (Feet)	Instrument
Site A	38°01'19.21" N	122°07'41.98" W	35	Organic Gas Detector
Site B	8°01'11.17" N	122°07'46.16" W	169	Organic Gas Detector
Site C S Distillates	38°00'59.26" N	122°07'35.22" W	164	TDL Source and UV-DOAS Source FTIR Extractive
Site D Firewater Tanks	38°00'54.02" N	122°07'17.13" W	207	UV-DOAS Receiver and TLD Reflector FTIR Extractive
Site E SW LOP	38°00'51.08" N	122°06'56.10" W	91	TDL and UV-DOAS Source
Site F MBC	38°00'47.40" N	122°06'23.04" W	55	TDL and UV-DOAS Source UV-DOAS Receiver and TDL Reflector FTIR Extractive
Site G Vine Hill	38°00'48.69" N	122°05'49.60" W	211	2 UV-DOAS Receiver and 2 TDL Reflector FTIR Extractive
Site H I-680	38°01'01.66" N	122°05'44.38" W	102	TDL and UV-DOAS Source

For the MRC refinery fence-line system, all designated air monitoring equipment collects data on five-minute averages. These devices will meet the minimum of data completeness criteria, as defined in BAAQMD's correspondence to MRC dated December 22, 2022, further explained as:

Quarterly % Completeness = ([Hours in the calendar quarter with hour complete % ≥ 75%] / [Total hours in the calendar quarter]) × 100.

Here, an "hour" represents a distinct clock hour (0 - 23) on any given day, as opposed to a rolling 60-minute period. This method of data completeness assessment aligns with the guidelines in Attachment 3 of BAAQMD's letter, titled "Refinery Fenceline H_2S TDL Monitoring System Specifications" from 12/22/22. A complete description of the BAAQMD data reporting and completeness requirements are included as appendices to this document. After undergoing automated data Quality Assurance/Quality Control (QA/QC), the monitoring stations' data will be accessible to the public in real-time via a designated website. This live page will be a part of a comprehensive site that offers supplementary resources for data interpretation. The integration of open-path H_2S systems was completed and put into operation on January 1, 2023.

Tables 1.2 and 1. provide an overview of the gases covered in the fence-line program, the detection technologies employed, and the lower and upper quantification limits (LoQ and UQL) attainable under optimal conditions.

Table 1.2 – Quantification Limits for Gases Monitored by Open-Path Systems

	Path 1		**Path 2**		**Path 3**		**Path 4**	
Distance (m)	**445**		**810**		**825**		**435**	
Gas	**LoQ** (ppb)	**UDL** (ppb)	**LoQ** (ppb)	**UDL** (ppb)	**LoQ** (ppb)	**UDL** (ppb)	**LoQ** (ppb)	**UDL** (ppb)
Benzene	0.9	5,483	0;9	3,012	0.8	2,958	0.9	5,609
Ethyl Benzene	15	5,483	12	3,012	12	2,958	15	5,609
Hydrogen Sulfide*	3.0	5,000	3.0	5,000	3.0	5,000	3.0	5,000
Sulfur Dioxide	4.0	2,202	2.2	1,210	2.2	1,188	4.1	2,253
Toluene	1.8	2,742	1.7	1,506	1.7	1,479	1.8	2,805
Xylene	1.0	2,742	0.8	1,506	0.8	1,479	1.0	2,805

* The BAAQMD requirement for the LoQ of the H_2S includes the requirement that the systems report a value between 3 and 25 ppb under optimal environmental conditions. For the TDL air monitoring system, ideal conditions include clear air, non-condensing atmosphere, relative humidity less than 90%, and stable optical alignment.

Table 1.3 – Detection Limits for Gases Monitored by Point Source Samplers

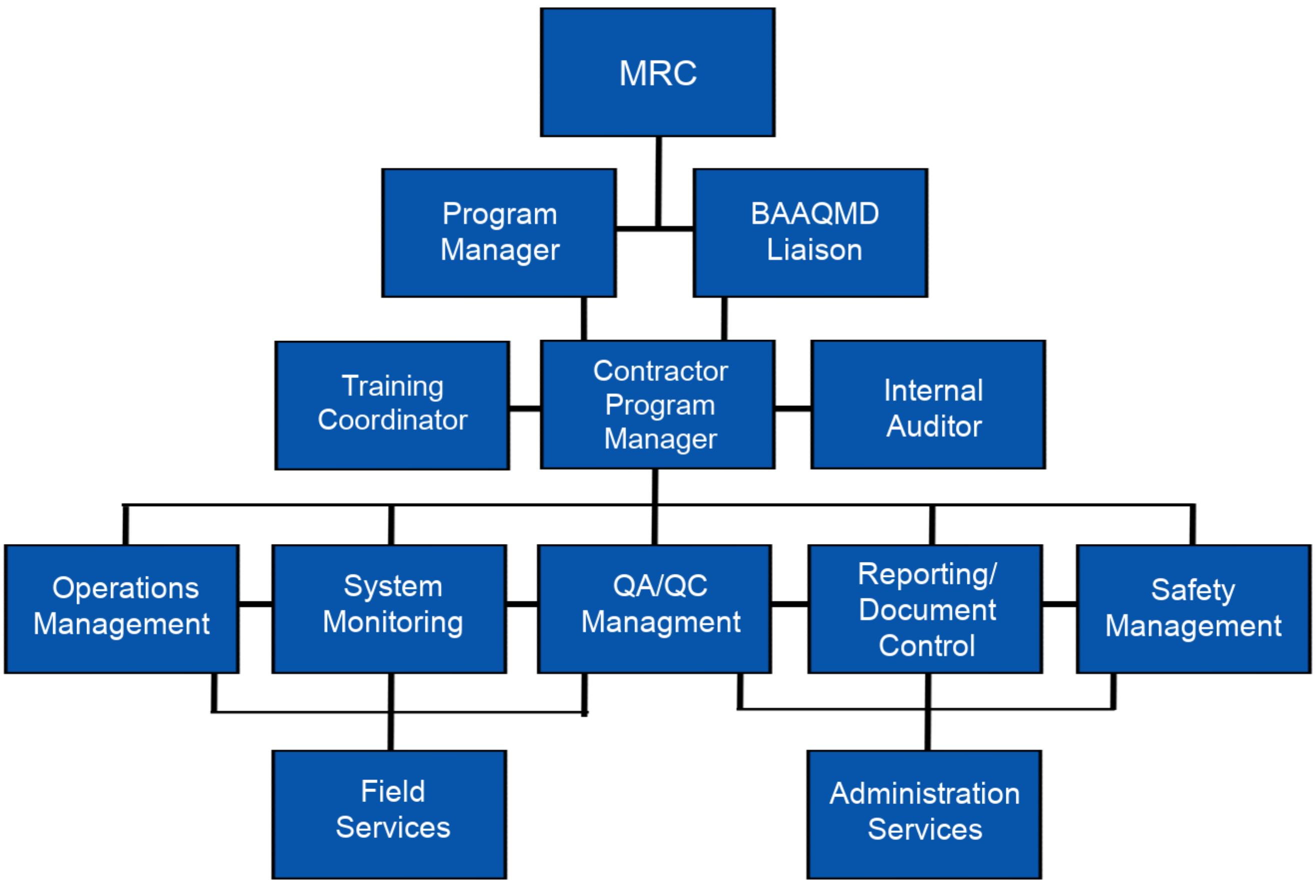
Point Source Monitor	**Detection Limits**	
	MDL (ppb)	**UDL** (ppb)
Total Alkanes	75	4,200
Total Organics	10	100,000

Section 2 – Project Management

Fence-Line Monitoring Task Organization

The operational framework of the program is established between MRC and the contractor, Argos Scientific Inc. (Argos), which holds the responsibility for the systems' operation and maintenance. The organizational structure for the MRC Monitoring Program is shown in Figure 2.1. Table 2.1 lists key personnel from the refinery, air district, and contractor, detailing their respective names, roles, and responsibilities within the MRC fence-line program.

Figure 2.1 – MRC Fence-line Air Monitoring Program Organization Chart



Organization	Roles	Responsibilities
Bay Area Air Quality Management District	BAAQMD Liaison, Rule 1215	Review the QAPP and make sure regulations are met for Rule 1215
Martinez Refining Company	Rule 1215 Liaison	Review/approve and submit reports to BAAQMD
Martinez Refining Company	Rule 1215 Program Manager	Overall system operation and maintenance. Contract management and procurement
Argos Scientific, Inc.	Contractor Program Manager	Primary interface between MRC and Argos / Overall Program Management
Argos Scientific, Inc.	Senior Manager Monitoring	Ensure data and notifications meet requirements of the QAPP
Argos Scientific, Inc.	Senior Operations Manager	Ensure system operations meet the requirements of the QAPP
Argos Scientific, Inc.	Senior Quality Assurance Manager/Data Processing Manager	Ensures QA/QC meets requirements of the QAPP
Argos Scientific, Inc.	Senior Manager Reporting/ Document Control	Ensure contractor reporting requirements of the QAPP are met. Ensure that documents associated with the QAPP are controlled.
Argos Scientific, Inc.	Lead Internal Auditor	Independently ensures monitoring program follows the QAPP
Argos Scientific, Inc.	Safety Officer	Ensure contractor safety per the contract with MRC
Argos Scientific, Inc.	FTIR/OGD Technical Expert	Ensures technology is operated in compliance with the QAPP
Argos Scientific, Inc.	UV Technical Expert	Ensures technology is operated in compliance with the QAPP

Organization	Roles	Responsibilities
Argos Scientific, Inc.	TDL Technical Expert	Ensures technology is operated in compliance with the QAPP
Argos Scientific, Inc.	Field Technician	Execute routine and non-routine site work according to the QAPP
Argos Scientific, Inc. or Qualified Contractor	Field Technician	Execute routine and non-routine site work according to the QAPP
Argos Scientific, Inc.	Training Coordinator	Ensures all staff have appropriate training per the QAPP
Argos Scientific, Inc.	Senior Manager Administrative Support	Manages administration tasks, including assisting other departments

Contractor Personnel Qualification and Training

Management and the operators of the monitoring equipment shall be trained in their area of focus, including but not limited to data management, QA/QC, the operation, maintenance, and operational verification of the equipment, as well as have resources to troubleshoot any technical issues. As necessary, all personnel will undergo specific annual refresher training in their areas of focus. Training for equipment operators will be provided by the technical experts who have undergone vendor-specific training for each analyzer. The Training Coordinator will document and verify staff have successfully completed the training. The following are the basic skills of each of the personnel:

<u>Contractor Program Manager</u> - Primary interface between MRC and Argos / Overall Program Management.

Responsibilities

- Ensures compliance with contract and QAPP.
- Contract review with client.
- Ensures continuous improvement within quality system.
- Advocates to client on any improvements that require additional budget.
- Manages overall program.

<u>Senior Manager Monitoring</u> - Ensure data and notifications meet the requirements of the QAPP.

Responsibilities

- Data processing and daily validation and compilation of resultant reports.
- Daily, monthly, and calibration data, including data preparation for reports.

- Follow guidelines from the reporting department to ensure reports are completed promptly and within quality guidelines.
- Verify gas detections for approval by the Program Manager.
- Manages notification system for equipment operation.

Operations Manager - Ensure system operations meet the requirements of the QAPP.

Responsibilities

- Work with system manager and field services to maintain a schedule of site work for the technical teams.
- Maintain a workflow system to manage the progress and completion of projects in a systematic and transparent manner.
- Keep management team updated with any changes in schedules.
- Ensure that sufficient stock of the consumables required for the work is available.
- Ensure the quality of all reports.
- Act as a Technical Signatory and sign reports.

Senior Quality Assurance Manager/Data Processing Manager - Ensures QA/QC meets requirements of the QAPP

Responsibilities

- Oversee the quality process.
- Update quality system documentation.
- Manage the corrective action process.
- Analyse data to facilitate continuous improvement.

Senior Manager Reporting and Document Control – Ensure contractor reporting requirements of the QAPP are met. Ensure that documents associated with the QAPP are controlled.

Responsibilities

- Work with internal auditing to standardize the reporting process while working to improve it.
- Manage and review routine reports and filings.
- Review, store, distribute, and track company documents.
- Ensure coordination with change order originators and approvers.
- Issue controlled document numbers.
- Archive records.
- Distribute controlled files to MRC as required in the QAPP.
- Records management of paper files.
- Ensure adherence to deadlines.

Lead Internal Auditor – Independently ensures monitoring program complies with the QAPP.

Responsibilities

- Coordinates and executes internal audits.
- Ensures continuous improvement of the quality system.
- If needed, arranges and coordinates for 3rd party audits.
- Coordinates annual management review of QAPP.

Safety Officer – Safety Officers are responsible for planning, implementing, and overseeing company employees' safety at work. Their main duty is to ensure that the company complies and adheres to the client Health and Safety guidelines.

Responsibilities

- Plan and implement health and safety policies and programs.
- Advise and lead employees on various safety-related topics.
- Review existing policies and procedures and make changes as necessary.
- Conduct risk assessment.
- Enforce preventative measures.
- Check if all the employees are acting in adherence with rules and regulations.
- Prepare reports on accidents and violations and determine causes and institute corrective actions.

Field Technicians - Execute routine and non-routine site work according to the QAPP.

Responsibilities

- Perform routine maintenance and quality checks as required, and record data and events in accordance with these tasks.
- Perform routine site visits to perform QA/QC or maintenance.
- Perform minor onsite repairs.
- Inform superiors when consumable purchases and instrument maintenance are required.
- Monitor alarms and work with the Operations Manager to troubleshoot and resolve them in a timely manner.
- Align open path systems.
- Assist the Operations Manager with instrument commissioning and any other duties that are required.

Technical Expert – Evaluates methods, QA/QC, preventative maintenance, and calibration of instruments and equipment at regular intervals and makes changes to the QAPP as necessary; coordinates proper installation and qualification of new instruments; engages in troubleshooting and repair of equipment including requalification.

Responsibilities

- Troubleshoots and repairs instruments, including coordination of vendor calls, with proper documentation and follow-through to return instruments to active service with proper re-qualification.
- Assists in writing and developing standard operating procedures (SOPs) associated with instrumentation and equipment. Revise SOPs as necessary and directed.
- Assist in training technical staff in instrument operations, SOPs, and proper documentation associated with instruments and equipment.
- Coordinates qualification of instrument operator personnel and supports individual training needs.
- Evaluate any instrument-specific method changes.

Training Coordinator – Ensures all staff have appropriate training per the QAPP.

Responsibilities

- Identify training needs.
- Based on research, plan and implement training programs that will prepare employees for the next step of their career paths.
- Recruit trainers.
- Make training schedules.
- Build quarterly and annual training program.
- Oversee employee attendance and performance.

- Track employee success and progress.
- Manage the production of program marketing material in collaboration with the marketing team.
- Communicate all the training programs on a timely basis.

Senior Manager Administrative Support – Manages administration tasks, including assisting other departments.

Responsibilities

- Responsible for inventory management.
- Oversee logistics records.
- Reporting assistance.
- Refinery training coordination with Safety Officer Adhere to all the rules and regulations.

Section 3 – Description of Hardware and Technology

Sample Analysis

Samples will be collected using UV-DOAS air monitors for the measurement of benzene, ethylbenzene, sulfur dioxide, toluene, and xylene. Extractive FTIRs will be used for the measurement of total alkanes. Organic Gas Detectors will be used for total organics. TDLs will be used for the measurement of H_2S. Each analyzer has a vendor-specific method for collecting and quantifying data. A description of each specific analytic method is listed below:

Open-path UV-DOAS

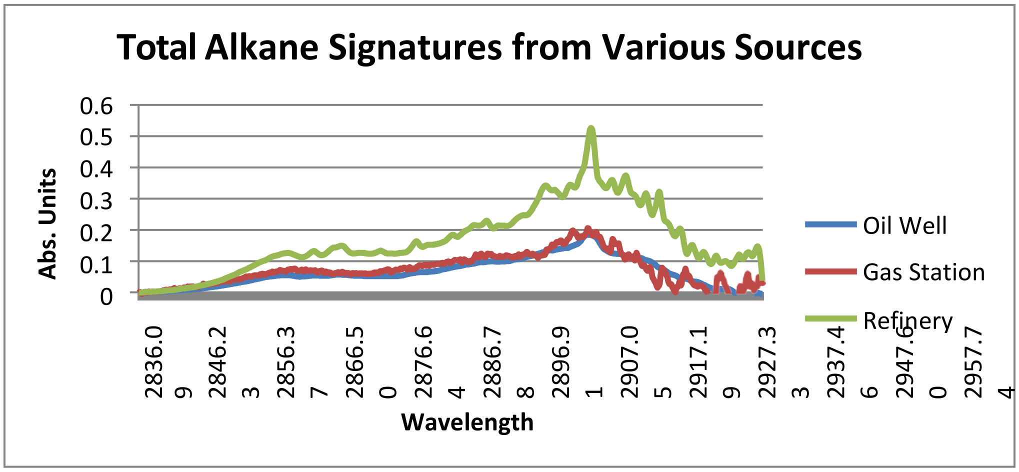
The UV-DOAS air monitoring system utilizes ultraviolet light beams for real-time detection of gases including benzene, toluene, ethylbenzene, xylene, and sulfur dioxide. This system projects an ultraviolet light beam in open air towards a detector situated at the opposite end of the beam's path. The system identifies gases by examining the wavelengths of UV light that have been absorbed by the gases present in the light beam. The amount of gas in the air is proportional to the amount of light absorbed at specific wavelengths.

To quantify data, the system employs a multivariate analytical method, which is critical in avoiding false gas detections. Every target gas is associated with a spectral library spanning its concentration range. Each target gas has a spectral library of gases covering the concentration range of the analyzer. It also includes libraries of potential interfering gases such as oxygen and ozone. Moreover, the system is equipped for in-field data and quality assurance verifications using a sealed gas cell.

Extractive FTIR

The FTIR air-monitoring system is a point sample air monitor that can be used for fence-line monitoring applications. The unit has the capability to detect total non-methane hydrocarbons on a real-time basis while minimizing the impact of gases that interfere with alkane measurement such as water vapor and methane gas. The analytical method employed by the FTIR is a multiple regression technique that separates the total amount of light absorbance by the various gases and outputs a result for each gas. In the case of alkanes, this includes the contribution of interfering gases such as water vapor and methane. The system also has the ability to distinguish between various sources of alkanes. Figure 3.1 shows the different types of spectral signatures for various sources of alkanes. The system has the ability to undergo data and quality assurance checks in the field by monitoring known ambient gases or by using gas standards. Total alkanes (regardless of source) will be displayed on the website, however, during the monthly QA/QC process, the data may be identified as not originating from the refinery depending on its spectral signature. The methodology to identify sources involves collecting the spectral features for alkanes when the wind direction is from different sources i.e., various refinery process areas, local highways, and other industrial facilities. Once the data is collected, the resulting absorbance spectra can be converted into a qualitative library spectrum that can be inserted in the analytic software which then analyses the data. The results of the analysis will include residuals that can be used to identify specific sources.

Figure 3.1 - Spectral Signature of Alkanes from Various Sources



Open-path TDL

The AirOptic open-path H_2S tunable diode laser (TDL) monitoring system is a monostatic system that uses mid-infrared laser light to scan across a narrow band of the infrared spectrum where gases such as H_2S, water, and methane absorb light. The system utilizes wavelength modulation to enhance signal-to-noise characteristics to reach path-average limits of quantification (LoQs) in a range of 3 to 25 ppb with an upper detection limit of 5,000 ppb. Real-time LoQs are calculated using methods described in Master SOP-[Instrument]-001 SOC. The system continuously tracks and logs the measurement and spectral signature of H_2S, water, and methane in the gas sample. It then employs a [redacted] routine to model their infrared light absorption. To determine the concentration of H_2S in the gas sample, [redacted] The system uses a [redacted] [redacted] that allows the system to remain in optical alignment with no major adjustments.

The data output includes the quantified results of all gases in the light spectra, which can be used as real-time performance checks. For example, quantified results for methane should be above the natural ambient atmospheric background level of 1.72 ppm. Since the system quantifies methane in real-time, along with moisture and other interferent gases, the verification of methane above natural ambient levels will be used as a real-time data quality check. Should methane concentrations drop below traditional ambient levels (currently 1.72 ppm), the data will be flagged for review. In addition to the measurement of ambient gases such as methane and water, other data quality checks are employed to evaluate each data point on a real-time basis. A complete summary of the real-time checks is included in Master SOP-[Instrument]-002 DVC.

The system uses removable H_2S calibration gas cells to perform “bump” and calibration checks that use the same optical path used for atmospheric quantification of H_2S. The cells provide a safe, effective way to determine measurement quality parameters including system precision and accuracy. “Bump” tests will be performed at least monthly: meeting the precision and accuracy requirements of no greater than 15%, with at least a 3-point calibration check performed at least quarterly with different concentrations to the “bump” test concentrations. This also needs to meet the precision and accuracy requirements of no greater than 15%. The following are the key performance parameters of the instrument and will be verified at least quarterly:

- Detection Limit Range: 3-25 ppb under varied operational conditions, with precision and accuracy within 15%.
- LoQ verification for gas concentrations under 25 ppb.
- Average Path-Averaged Detection Limit: 15 ppb.
- Repeatable Detection Limit: 25 ppb when light transmission is greater than 1%.
- Path-averaged Range: 3-5000 ppb (considering the above caveats).

Organic Gas Detector

- Organic Gas Detectors are based on the principle of photoionization and are referred to as Photoionization Detectors (PIDs). The system functions by introducing an ambient air sample into a chamber where it is subjected to ultraviolet light from a specialized lamp. Should the sample contain an organic gas, it will ionize upon interacting with the UV light. The ionized gas is then quantifiable using a gas detector. A primary strength of the PID air monitoring system is its remarkable sensitivity, allowing for the detection of organic gases at minute concentrations. However, the system's limitation lies in its inability to distinguish between different organic gas types present in the air. Furthermore, while it cannot detect C2-C3 hydrocarbons, it remains effective in identifying the majority of gases related to refining.

Meteorological Station

- The East Side Meteorological Station will provide real-time wind direction to the website. Meteorological instruments will be operated according to the EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV PSD Measurement Quality Objectives.

- Workstations
- The analyzers use Microsoft Windows based computer workstations to collect, analyze, and transmit data. The workstations will be industrial-grade computer workstations.
- Loggers
- The outputs of the analyzers are collected by Linux-based dataloggers that buffer and transmit the data to Cloud-Based Data Storage.
- Routers
- Computer routers will be used to network the analyzers together so the information from each system can be transmitted to the Internet.
- Remote Restart Equipment
- Equipment with internet-based remote restart capabilities will be integrated into vital components of the monitoring system. This ensures that, in the event of an error status, the equipment can be remotely shut down and reactivated to resolve the issue.
- Cloud-based Data Storage
- Data from the monitoring network will be stored on a cloud-based storage system with data backup capability. The data set encompasses raw data, inclusive of raw spectral details, relevant flagging, and documented actions aligned with the pertinent SOPs. The finalized data will be provided to BAAQMD upon their request.

Section 4 – Quality Management System

The overall goals of the fence-line monitoring program are referred to as "Data Quality Objectives" or "DQOs." The specific DQOs for the monitoring program at MRC ensure all the data, both real-time and QA/QC, meets the quality standards for presentation to the public and the BAAQMD. Data checks are formulated around EPA Quality Assurance/Quality Control protocols published in documents such as:

Environmental Technology Verification (ETV) Protocol for Optical Remote Sensors
https://archive.epa.gov/nrmrl/archive-etv/web/pdf/01_vp_openpath.pdf

EPA – Compendium Method TO-16
https://www3.epa.gov/ttn/amtic/files/ambient/airtox/to-16r.pdf

EPA – FTIR Guidance Document
https://www3.epa.gov/ttn/amtic/files/ambient/longpath/r-96-040.pdf

Throughout the measurement process, focus is placed on specific elements of the monitoring program. These are the critical elements:

- System operation
- Data Validation
- Monthly and quarterly system challenges
- Instrument Operation and Maintenance

System Operation Check (MSOP-[Instrument]-001 SOC)

The objective of the System Operation Checks (SOC) is to continuously monitor the system in real-time to confirm the analyzer's functionality, ensuring the generation of valid data. If any check indicates a possible performance discrepancy, a notification is sent to the designated support team for evaluation and necessary corrective measures. SOC flags can be generated by the instrument itself, by monitoring site parameters such as Internet connectivity, as well as evaluating the data external events such as weather-related issues. Specific SOCs are listed in Table 4 and are detailed in the instrument-specific System Operations Checks procedures.

Data Validation Checks (MSOP-[Instrument]-002-DVC)

The purpose of the Data Validation Check (DVC) is to ensure that any data meets appropriate data quality standards. DVCs are performed in real-time, daily, and anytime a data point is outside of normal parameters. Specific DVCs are listed in Table 4 and are detailed in the instrument-specific Data Validation Checks procedures.

System Challenge Checks (MSOP-[Instrument]-003 SCC)

The purpose of the System Challenge Checks (SCC) is to verify the air monitoring systems are meeting their operational performance requirement. The tests are performed by inserting a known concentration of gas into the beam path and measuring the system's response. Specific SCCs are listed in Table 4.1 and are detailed in the instrument-specific System Challenge Check procedures.

Operation and Maintenance Checks (MSOP-[Instrument]-004 OAM)

The purpose of the is to ensure the systems are being operated and maintained per the manufacturer's recommended standards. Specific OMCs are listed in Table 4.1 and are detailed in the instrument-specific Operation Maintenance Check procedures.

Checks are performed on a routine basis based on the application. For each check, specific "Measurement Quality Objectives" or "MQOs" have been developed. MQOs are defined as the specific performance criteria to evaluate whether the objective is met. When each of the MQOs is satisfied, this assures that the overall goals of the monitoring program (the Data Quality Objectives or DQOs) are being met. Should any of these MQOs not be satisfied, a root cause analysis will be conducted, followed by the initiation and documentation of a corrective action plan to address the problem. Each MQO will undergo assessment and, when required, revisions during the Internal System Audit Plan and the Annual Management Review. A synopsis of the MQOs for every instrument, data quality metrics, and program management procedures can be found in the subsequent tables.

Table 4.1 – Summary of Data Quality Objectives for Air Monitoring System

System Operation Checks	Check	Frequency	MQO
Instrument Malfunction Error Code	If a malfunction error code occurs, generate a system performance flag, and notify on-call support.	Continuous	Check Error Code Status
Hardware Failure Flags	If the last data point in the database is more than 20 minutes old, generate a hardware failure flag and notify on-call support.	Continuous	Check time of last data point collected
Internet/Data Failure Flag	Check to see if more than one analyzer is not reporting data.	Continuous	Check to see if multiple instruments are not reporting data
Environmental Conditions Flags	Check to see if light signal or other operational parameters are impacted by environmental factors such as humidity, temperature etc.	Continuous	If ambient parameters are outside of optimal equipment operations range, then generate a flag

Data Validation Checks	Check	Frequency	MQO
Instrument Output Statistics	Check output statistics generated by the manufacturer's software.	Real-time	Check operational parameters provided by the manufacturer, check ambient gases, and light signal
System output statistics	Check output statistics generated by the logging software.	Real-time	Check real-time LoQs, concentration to sigma ratio correlation coefficient
Quantitative Detection Validity Check	Determine if the detects identified valid meet quantification checks.	Daily	Perform independent validation of gas detects
Senior Review	Evaluate data for systems trends.	Monthly	Evaluate long-term performance trends
MDL Check	Determine the MDL of the analyzer with the calibration cell inserted into the unit.	Anytime a significant change in the hardware occurs- monthly bump test, quarterly challenges	Calculated detection limits must be less than limits specified in Tables 1.2 and 1.3.
Precision Check	Insert a known concentration of a gas into the calibration cell and measure precision.	Anytime a significant change in the hardware occurs- monthly bump test, quarterly challenges	Measured precision must be less than or equal to 15%
Accuracy Check	Insert a known concentration of a gas into the calibration cell and measure the accuracy.	Anytime a significant change in the hardware occurs- monthly bump test, quarterly challenges	Measured accuracy must be less than or equal to 15%
Linearity Check	Insert a known concentration of a gas into the calibration cell and measure the linearity.	Anytime a significant change in the hardware occurs- monthly bump test, quarterly challenges	R^2 for linear regression of data points must be greater than 0.9
Corrective Action	Calibration parameters are checked for failure.	Anytime a significant change in the hardware occurs- monthly bump test, quarterly challenges	Implement maintenance, root cause analysis, and recalibrate.

Check Type	Check	Frequency	MQO
Routine Operation	Follow the manufacturer-recommended operational procedures.	Continuous	Documentation demonstrating operational procedures are being followed.
Routine Maintenance Checks	Follow the manufacturer-recommendation for maintenance procedures.	Continuous	Documentation demonstrating routine procedures are being followed.
Non-routine Maintenance Checks	Follow the manufacturer-recommendation for maintenance procedures.	Continuous	Documentation demonstrating non-routine procedures are being followed.

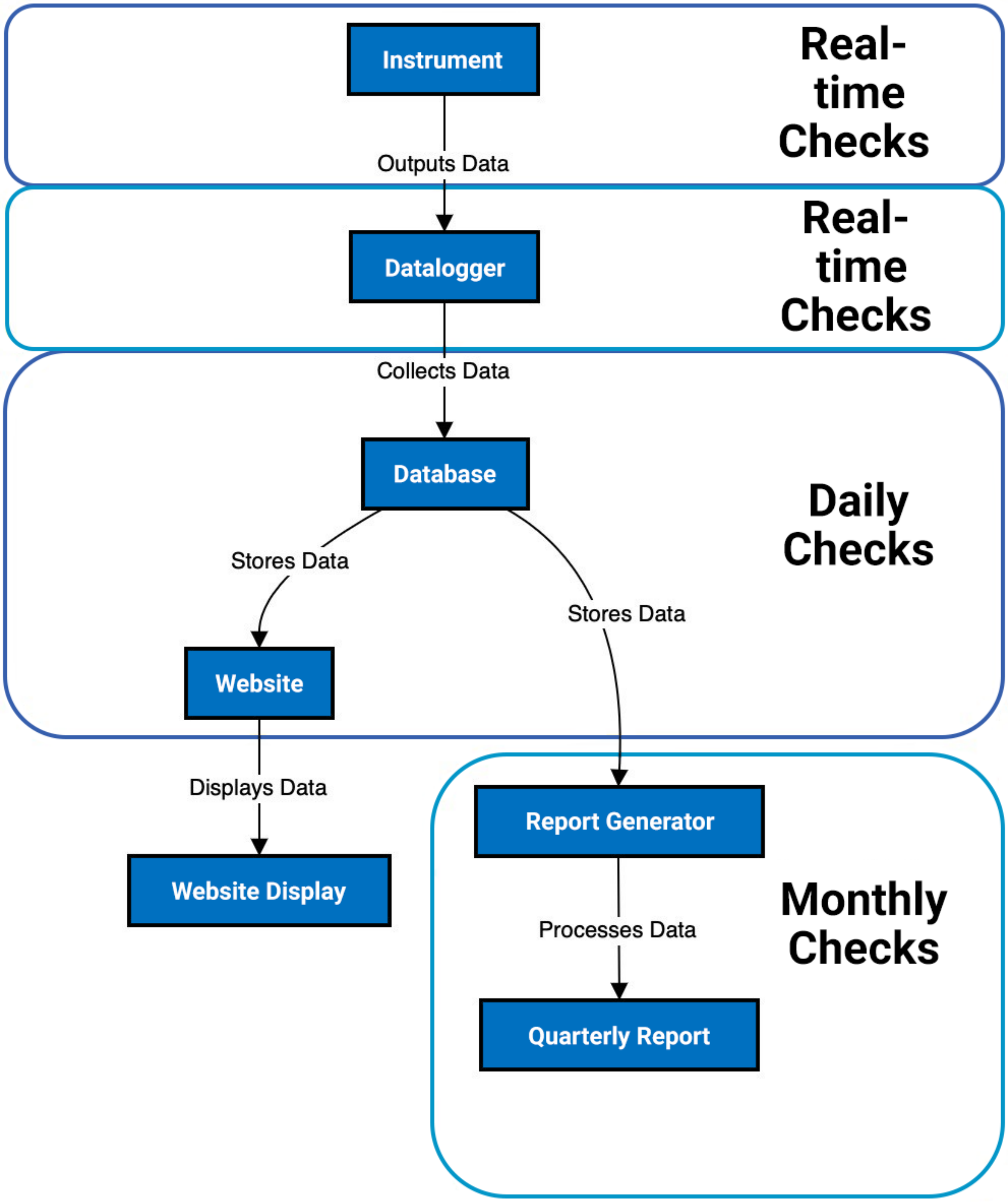
Section 5 – Data Management

Data Validation Process

The general flow of the validation of data for all instruments is shown in Figure 5.1 below. The data flow for each system is unique because each instrument has its own way of processing data. An example of how the TDL data is processed from the instrument to the website is shown in Appendix C. More detailed information on the validations performed at the specific steps (real-time, daily, monthly, and quarterly) is shown in the sections below.

Instrument-specific validation checks for each instrument are included in the Master SOP- Data Validation Checks **(MSOP-[Instrument]-002 DVC)**

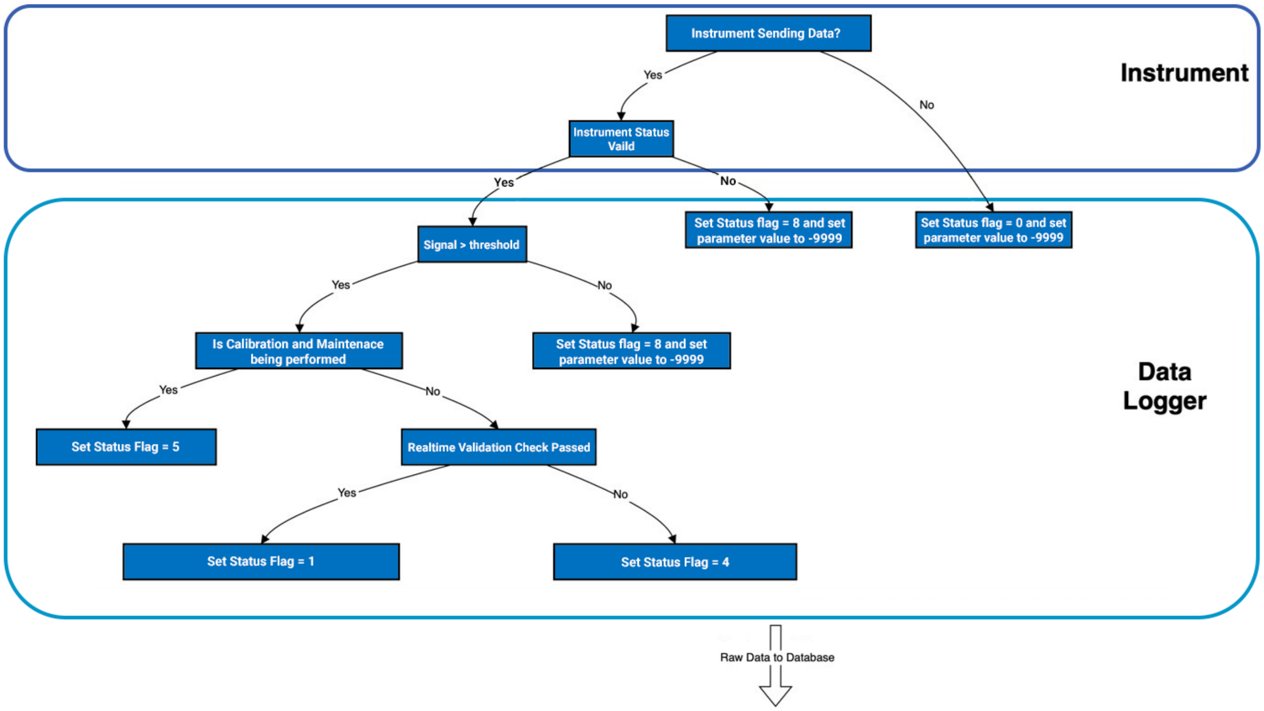
Figure 5.1: General process flow for Data Validation



Real-time (Instrument and Data Logger)

The handling of data is shown in Figure 5.2 below for the data collected during **Site Level Real-time data Validation.**

Figure 5.2: Site Level Realtime Validation Decision Tree



Following the data flow in Figure 5.2 above, if the logger is receiving data from the instrument no further action is required. If no data has been received, the data is flagged as missing and the values reported to the database set to -9999 for that timestamp and the status flag is changed to 0 to indicate missing data and troubleshooting is performed.

Upon receiving data from the instrument, the status flag from the instrument is checked. If the instrument status is valid according to the manufacturer's specifications, the instrument is operating correctly according to the instrument manufacturer, no further action is required. Where the status is not valid according to the manufacturer's specifications, the data is flagged as 8 and the value is set to –9999 and troubleshooting is performed.

Once it has been determined that the instrument is correctly operating an assessment of the light signal received from the instrument is made. If the light signal is above the system's low signal threshold value, the logger will perform further validation checks contained in the Master SOP – Data Validation Checks (**MSOP-[Instrument]-002-DVC)**. If the light signal is below the low signal threshold value in the Master SOP – Data Validation Checks (**MSOP-[Instrument]-002-DVC)**, data is flagged with a status of 8 and the parameter value is set to -9999 for that timestamp, and troubleshooting is performed.

If the light signal is above the instrument's threshold value, an assessment is made as to whether calibration or maintenance is taking place on site. If the instrument is in calibration or maintenance mode, the data is flagged with a status of 5 and the values from the instrument are recorded and sent to the database. If not, the below steps apply. If the instrument is not in calibration or maintenance mode, the data passes through a real-time validation check that is detailed in the Master SOP – Data Validation Checks (**MSOP-[Instrument]-002-DVC)**. Quality assurance parameters set in the logger are implemented to make an assessment as to whether a value above the detection threshold is valid. The validation check consists of the assessment checks that are supplied by the manufacturer and reviewed by the data analyst during monthly bump checks and quarterly calibration checks.

If the data successfully meets the validation criteria specified in the Master SOP – Data Validation Checks (**MSOP-[Instrument]-002 DVC)**, data is recorded with a status of 1, indicating a valid data point. However, if the validation check fails, the data is flagged with a value of 4, indicating that the data needs further evaluation during daily and weekly validation checks before deciding if the datapoint is valid or not. Data review steps are provided below. Every 5 minutes the data logger will write the data from the datalogger to a raw database table. Data is reported to the real-time website from this raw database table as described in Section 8.

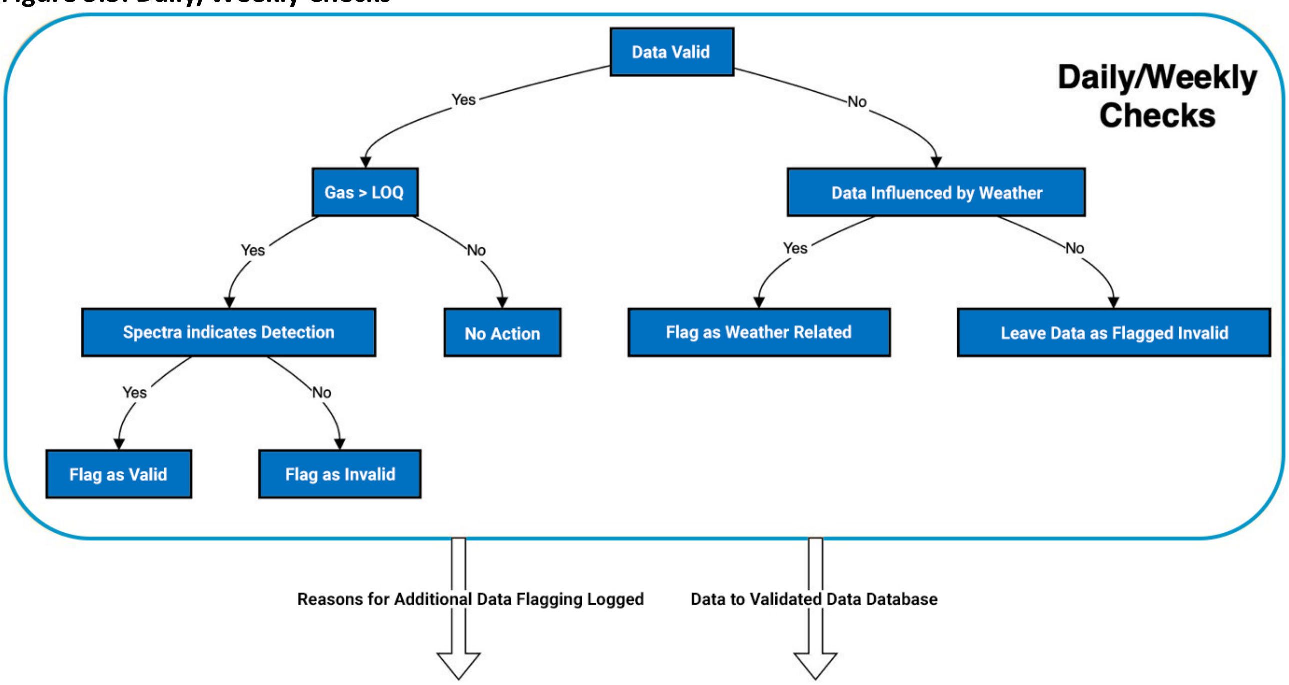
Daily/Weekly Validation Checks of Recorded Data

Further checks are made on the data by an Argos' data analyst on a daily and weekly basis. The aim of the analysis is to:

- Assess if possible weather-related effects occurred.
- Validate any possible detections.
- Invalidate data detections.
- Evaluate invalid data that has failed the real-time check above and is marked for further review and validation as described in the Sections below.

The process followed is shown in Figure 5.3 below.

Figure 5.3: Daily/Weekly Checks



During this process the raw dataset from the previous 24 hours or 7 days is evaluated, and status flags are adjusted:

- A data analyst will review data that has failed the real-time data check, as outlined above, and perform a raw spectral data check to determine validity. Evaluate data that is flagged status = 8 to see if this real-time flagging was caused by the influence of weather. This is defined as:
    - Light signal above the low signal threshold value
    - Precipitation is detected or the Relative Humidity is > 89 %

Once this dataset has been through this process it is uploaded to a validated data database that is used for reporting.

The raw data is not adjusted. All changes made between the raw and validated datasets are logged in a daily/weekly validation report and the process review documented.

Monthly Checks

At this level of data validation data is reviewed by a project management level staff member to ensure all above processes have been followed and is finalized for inclusion into the quarterly reporting format that is required by the BAAQMD. This report consists of three sections:

- Cover letter detailing to MRC:
  - Performance of each instrument against the onstream efficiency requirement of 90 % calculated according to the BAAQMD reporting procedure.
  - Data on monthly bump tests.
  - Data on quarterly calibrations (if applicable).
  - Description of corrections made to data due to QA.
- Five-minute average data in the format prescribed by the BAAQMD.
- Hourly completeness data in the format prescribed by the BAAQMD.

In order to achieve this a validated report generation application is run on the validated data set to provide the data in the BAAQMD format. This is then validated by a senior data analyst who performs the following checks. For each instrument the 5-minute average data is then checked by a senior data analyst against the following:

- Compare the data to the data trends for the month.
- Perform a check on a sample of data following the process in Figure 5.3 above.
- Validate any adjustments made due to QA.
- Log any further changes made to the validated data set.
- Review the log of data adjustments and send the report to Project Management staff for final review.

For each instrument, the hourly completeness data is checked by a senior data analyst against the following:

- Validate weather-related flags and calculations.
- Validate any data that has an hourly completeness between 65 and 80 %.
- Verify downtime where QA and Maintenance took place.
- Calculate the completeness.
- Send a report to Project Management staff for final review.

For the cover letter:

- Review the QA report.
- Review the completeness calculations.
- Review the log of data adjustments.
- Send report to Project Management staff for final review.

Section 6 – Instrument Maintenance

Instrument maintenance and repair interventions are carried out as required, guided by ongoing assessment of instrument error signals and data trends identified in the above data review steps. In addition to service and repair calls conducted on an as-needed basis, as identified in the above data review steps, preventive maintenance is conducted based on the schedules provided by the instrument manufacturer or further outlined in the Master Instrument SOP. Instrument-specific parameters are included in each system's Master Instrument SOP.

Section 7 – Document Control

Document Control will include the following elements to update and control documents to ensure the latest versions of documents are available. A new document number will be generated, and project management staff will review and approve all changes and sign the new document as approved and notify all users that a new version is available and archive previous versions.

Records of data flagging, reviews, and other related actions will be consistently stored as additional databases, with rationale for data changes/actions documented with associated data including which staff member made those changes and on what date.

Overall document control (outside of the data review outlined above) will include:

- Electronic copies of controlled documents include:
  - Manuals, policies, procedures, and work instructions as locked PDF documents.
  - Forms, templates, and checklists as locked PDFs or saved as Word or Excel templates (depending on application and use).
  - Registers, plans, and databases that are password protected.
  - Reports provided to MRC and BAAQMD

Section 8 – Website and Dashboard Management

The real-time Website is operated and maintained by Argos who will be solely responsible for its content. This section addresses the methods used to provide information to the public including message board updates, notification of significant events, data reporting, learning center section, and a contact page. The website is found at https://www.fenceline.org/martinez. The website defaults to the Real-Time Data Tab. The website has the following tabs:

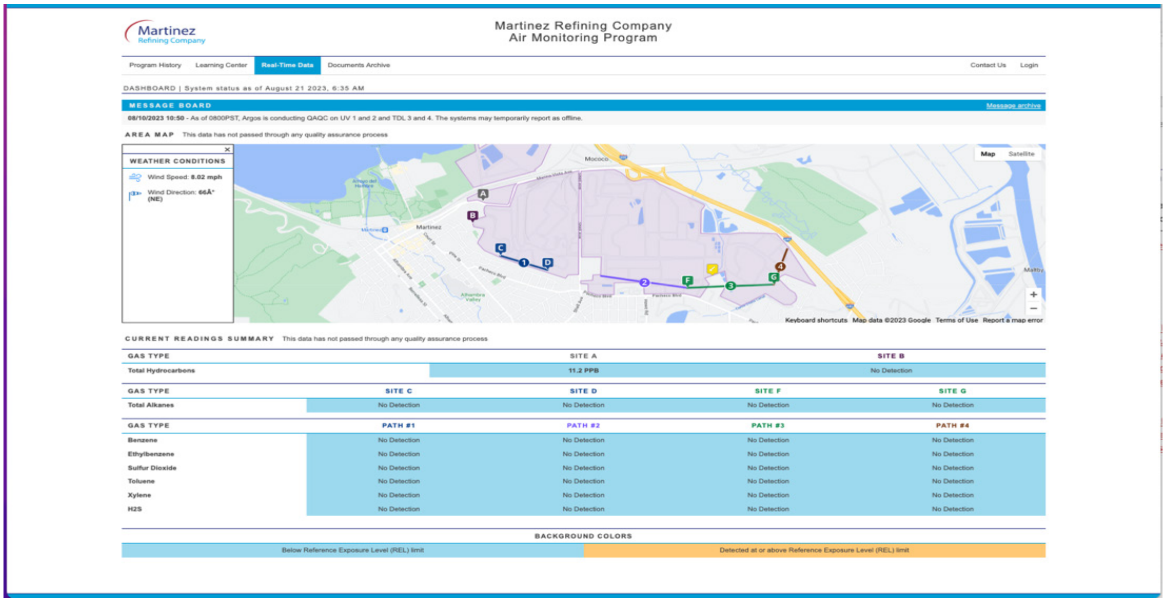
- Program History
- Learning Centre
- Real-time-Data
- Documents Archive

The Program history tab has the following text: "*On April 20, 2016, the Bay Area Air Quality Management District (BAAQMD) adopted Regulation 12 Rule 15 which requires Bay Area refineries to develop and submit an Air Monitoring Plan for APCO approval to establish and operate a fence-line monitoring system. The plan can be found in the Documents Archive of this website. Additional information can also be found in the Learning Center.*"
How the rest of the sections of the website are managed is described below.

Real-Time Data

As can be seen in Figure 8.1 below, the website displays the raw data received from the on-site loggers that are stored in the database. In addition, the website also receives data from Western Weather through an API.

Figure 8.1: Realtime-Data Tab (Landing Page)



This part of the website is managed through display rules based on the underlying data in the database and described below in Table 8.1. There is a message board used to inform the public of any maintenance, QA, or other issues occurring at the site. There is a notification system that sends out notifications to two different mailing groups:

- Maintenance notifications regarding instrument QA and downtime
- Gas Exceedance Notifications that show any values above the BAAQMD guideline values

Gas values shown on the website are managed programmatically using a set of rules that are based on the status flag values assigned to the real-time during the Data Management process described in Section 5. How data is displayed is summarized in **Table 8.1 below:**

Table 8.1: Website Data Display Rules

Value Displayed on Website	Database Rule Applied
No Detection	Data < LOQ in Table 1.2 and Status Flag = 1
“Value Displayed in ppb”	Data > LOQ in Table 1.2 and Status Flag = 1
“Low Signal”	Signal for Instrument below low signal threshold
“Offline”	Status Flag = 8
“QA/Maintenance”	Status Flag = 5
“Under Review”	“Status Flag = 4”

If the data on the website indicates an offline or low signal status for longer than 30 minutes, an email is sent to the maintenance notifications group so that the issue can be remotely diagnosed. If necessary, a technician is sent to the site to resolve the issue. If the value for a particular parameter is above the BAAQMD threshold values, the gas exceedance notification group is notified, and a data analyst is assigned to investigate the exceedance. These mailing lists are managed according to the requirements of the site.

If there is any maintenance or quality assurance being performed on-site, or if there are any significant events or equipment downtime that need to be communicated to the public, these are displayed on a message board on this page of the website. The messages on the message board are controlled by accessing a password-protected portal that allows for the composition of the message and the appropriate message is uploaded by appropriate Argos staff.

Learning Center

The Learning Center section of the website contains definitions of acronyms used on the website, chemical definitions, a description of the instruments used on site, and the minimum detection limits of each of the instruments. The content of this page is managed by Argos and can be updated through a password-protected secure portal.

Documents Archive

As mentioned above, the Documents Archive section of the website contains the current Fence Line Air Monitoring Plan, QAPP and other documents. All documents can be uploaded as required through a secure, password-protected portal by Argos.

Contacts

The Contacts section of the webpage allows the public to contact appropriate Argos staff with any message. This message is then reviewed and acted upon by appropriate Argos staff, who can then take action as agreed upon by MRC.

Section 9 - Reporting

Data from the fence-line monitors will be transmitted to an internet website where the near-real- time results can be viewed by the public. Data generated by the fence-line monitoring equipment undergoes review throughout the measurement and reporting process as described above. This process incorporates automated QA/QC evaluations prior to the data being displayed on the real-time website. Under normal circumstances, a 5-minute average measurement will appear on the website within 10 minutes of the end of the measurement period. However, the data uploaded may be impacted by internet traffic and additional review. An automated system conducts the Quality Assurance checks before the data is reported to the website as described above. Additional data review is conducted by data analysts and Project Management staff to validate/invalidate data as described in Section 5 above. The website will also make available a rolling 24-hour trend of the 5-minute data for each compound reported.

The website will report LoQ’s in real-time. A description of the instrument specific methods for determining MDLs and LoQs are provided in their respective Master Instrument SOP for **System Challenge Checks** (MSOP-[Instrument]-003-SCC). When data falls below the LoQ, the website will display the accurately calculated LoQ and indicate "<MDL of [calculated LoQ]” In instances where the light signal is below set parameters set in the associated Data Validation Checks (**MSOP-[Instrument]-002 DVC)**, the website will report the LoQ and also state that light level is too low to accurately measure compound concentrations.

Quarterly reports will be provided to the BAAQMD within 60 days after the end of each calendar quarter. The quarterly report format is consistent with guidance issued as part of Attachments 2 and 3 of the BAAQMD Letter “Refinery Fenceline H_2S TDL Monitoring System Specifications” dated 12/22/22. The specific format is found in NEWSOP3A and provided below. MRC is committed to providing the BAAQMD with one-hour average concentration data in a tabular format, using a comma-separated value (CSV) file. This file will adhere to the format specified by the BAAQMD, encompassing signal intensity, LoQ calculations, and all pertinent data and documentation for any invalidated, flagged, or otherwise qualified data entries. BAAQMD retains the discretion to share the one-hour average data with the public, either via the BAAQMD website or through public records inquiries. Prior to official report submission, MRC will promptly furnish any requested data to BAAQMD. Should any data be invalidated or excluded, MRC will provide the data and appropriate documentation in the Quarterly Report to BAAQMD. The validity of such actions will be in compliance with the appropriate SOPs and all other relevant documents and can be independently verified by BAAQMD based on the available data described above.

Appendix A - Required Procedures for Quarterly Reporting

All quarterly reports submitted following the date of this letter must meet the following specifications:

1. Quarterly reports must be submitted to the Air District within 60 days following the end of each calendar quarter.
2. Assign a unique identification number to each instrument or system that generates fence-line air monitoring data; add the unique IDs to the tables in the AMP and QAPP that identify the corresponding fence-line monitoring equipment.
3. Report all fence-line monitoring concentration data as 5-minue averages.
4. Submit the following data for all instrument/parameter combinations to the Air District in a single comma-separated value (CSV) data file using the template provided by the Air District with the following fields:

   a. facility_name – the name of the facility where the equipment is located
   b. instrument_id – the unique identification number assigned to the instrument described above
   c. instrument – a short descriptive name for the instrument associated with the reported unique ID (e.g., "H2S TDL", "OGD1", "OGD2", etc.)
   d. parameter – the name of the pollutant being measured and reported
   e. date – the date of measurement, reported in Pacific Standard Time and formatted as "yyyy-mm- dd"
   f. time – the hour of the day and the beginning of the five-minute period over which measurements were collected and averaged, reported in Pacific Standard Time (without any adjustments for daylight saving time) and formatted as "hh:mm" using 24-hour notation, where hh is the number of full hours (00 – 23) that have passed since midnight; for example, a 5-minute average concentration based on measurements collected between 1:10 pm and 1:15 pm should have a time stamp of "13:10"
   g. mean_concentration – the arithmetic mean pollutant concentration measured over the corresponding averaging period; for measurements below the LOQ, the mean concentration must be reported as a numeric value based on the actual values returned by the instrument during the corresponding averaging period
   h. units_of_measure – the units of measure corresponding to the reported mean pollutant concentration
   i. averaging_period – the averaging period (in minutes) for the reported mean pollutant concentration; this should be "5" unless otherwise approved by the Air District and specified in the QAPP
   j. observation_count – the number of values that comprise the reported mean concentration
   k. validity_indicator – an indicator ("Y" or "N") representing whether the reported mean concentration represents a valid air measurement; types of invalid data include but are not limited to data affected by instrument malfunction, environmental conditions, or data collected during a QC verification procedure
   l. error_codes – one or more error codes (as specified in the QAPP) explaining the reason for invalid or missing data; multiple codes should be separated by a semicolon without spaces, and the field should be left blank for valid data
   m. max_value – the maximum concentration measured during the corresponding averaging period, reported in the same units of measure as the mean concentration
   n. required_loq – the required LOQ for the corresponding instrument, reported in the same units of measure as the mean concentration
   o. real time_loq – the real-time average LOQ for the corresponding averaging period, reported in the same units of measure as the mean concentration

p. signal – the average measured light signal for the corresponding averaging period
q. signal units – the units of measure for the corresponding light signal

5. For every instrument/parameter combination, the data file outlined above must contain a record for every 5-minute period in every hour for the entire quarter. Where pollutant measurements are missing:

    a. The following fields should be populated with their respective values:

    i. facility name
    ii. instrument id
    iii. instrument
    iv. parameter
    v. date
    vi. time
    vii. error codes

    b. All other fields should be populated with a value of "NA"

6. Provide the information related to data completeness as further outlined in attachment 3.
7. Identify all monthly bump tests and quarterly calibration checks performed in the quarter, including failed bump tests and calibration checks; for each bump test and calibration check, specify: the system or equipment in question, the type of test or check performed, the beginning date and time, the ending date and time, and the date and time the equipment resumed normal operation. A failure to meet the specifications during two or more bump tests in any quarter, or four bump tests in any 12-month period, will result in a violation of the accuracy or precision specifications (as applicable) and QAPP requirements. Any such occurrence will invalidate all data prior to the failed bump test going back to the last passing bump test, and invalidated data will count against data completeness requirements.
8. Report the results of all bump tests and calibration checks, including the associated accuracy and precision measurements; for any bump test or calibration check that yields accuracy and precision measurements outside of the stated specifications, including a root cause analysis and a narrative description of the maintenance or repairs performed to return the system to proper operation.
9. Describe any corrections made to any data to account for the effects of gas cells or other equipment on light transmission; such corrections must be consistent with the procedures explained in QAPP.

Appendix B - Required Procedures for Assessing and Reporting Quarterly Data Completeness

1. For all instrument/parameter combinations, calculate the data completeness statistics below for each hour of the calendar quarter and include the results in the respective quarterly report to the Air District; provide the information in a single CSV data file for all instruments/parameters using the template provided by the Air District.
2. In the cover letter that accompanies the quarterly report, include the results of the following calculation based on data for the respective quarter along with a statement as to whether MRC met the required 90% completeness threshold:
   a. Quarterly % Completeness = [count of hours in the calendar quarter where hr_complete_pct ≥ 75%] [count of all hours in the calendar quarter] × 100
3. For every hour of the calendar quarter where data has been excluded due to adverse atmospheric or environmental conditions, MRC's quarterly report must include meteorological data and a narrative explanation sufficient to justify invalidation of the data. If MRC fails to adequately substantiate the exclusion of any data due to adverse atmospheric or environmental conditions, the Air District will consider the respective hour of data to be missing and will recalculate the Quarterly % Completeness statistic for purposes of determining compliance with the data completeness requirement.
4. Data completeness statistics:

   b. possible -The maximum number of 5-minute average concentrations that can be measured in a given hour and logged in the DMS; because data are reported in Pacific Standard Time, this should always be equal to 12
   c. captured -The actual number of 5-minute average concentrations that were measured in a given hour and logged in the DMS; for each hour, this value should equal the count of reported 5-minute average concentrations where the validity indicator field is equal to "Y" or "N"
   d. missing -The number of possible 5-minute average concentrations not measured or logged in the DMS in a given hour; for each hour, this value should equal the count of reported 5-minute periods where the mean concentration field is reported as "NA"
      i. missing = possible – captured
   e. missing_pct -The percentage of missing 5-minute average concentrations in a given hour relative to the possible number of average concentrations missing_pct = (missing / possible) x 100
   f. In all cases, an "hour" refers to an individual clock hour (0 - 23) of a particular day rather than a rolling 60-minute period.
   g. Field definitions and formatting for the facility_name, instrument_id, instrument, parameter, date, and hour columns in the provided template should be consistent with specifications.
   h. invalid_total -The number of invalid (for any reason) 5-minute average concentrations measured and logged in the DMS in a given hour; for each hour, this value should equal the count of reported 5-minute average concentrations where the validity indicator field is equal to "N"
   i. invalid_total_pct -The percentage of invalid (for any reason) 5-minute average concentrations measured and logged in the DMS in a given hour
      i. invalid_total_pct = (invalid_total / possible) x 100
   j. invalid_environmental - The number of invalid 5-minute average concentrations in a given hour due to adverse atmospheric or environmental conditions; for each hour, this value should equal the count of reported 5-minute average concentrations where the validity indicator field is equal to "N" and where the

error_codes field contains one or more error codes documented in the QAPP and associated with adverse atmospheric or environmental conditions

k. invalid_other -The number of invalid 5-minute average concentrations in a given hour due to anything other than adverse atmospheric or environmental conditions; this may include, but is not limited to, planned or unplanned maintenance; for each hour, this value should equal the count of reported 5-minute average concentrations where the validity indicator field is equal to "N" and where the error_codes field contains one or more error codes documented in the QAPP and not associated with adverse atmospheric or environmental conditions

l. invalid_other_pct -The percentage of invalid 5-minute average concentrations in a given hour due to anything other than adverse atmospheric or environmental conditions
    i. invalid_other_pct = (invalid_other / possible) x 100

m. expected -The number of possible 5-minute average concentrations in a given hour, adjusted for periods of low visibility during adverse atmospheric or environmental conditions
    i. expected = possible – invalid_environmental

n. valid -The number of valid 5-minute average concentrations measured and logged in the DMS in a given hour; for each hour, this value should equal the count of reported 5-minute average concentrations where the validity_indicator field is equal to "Y"

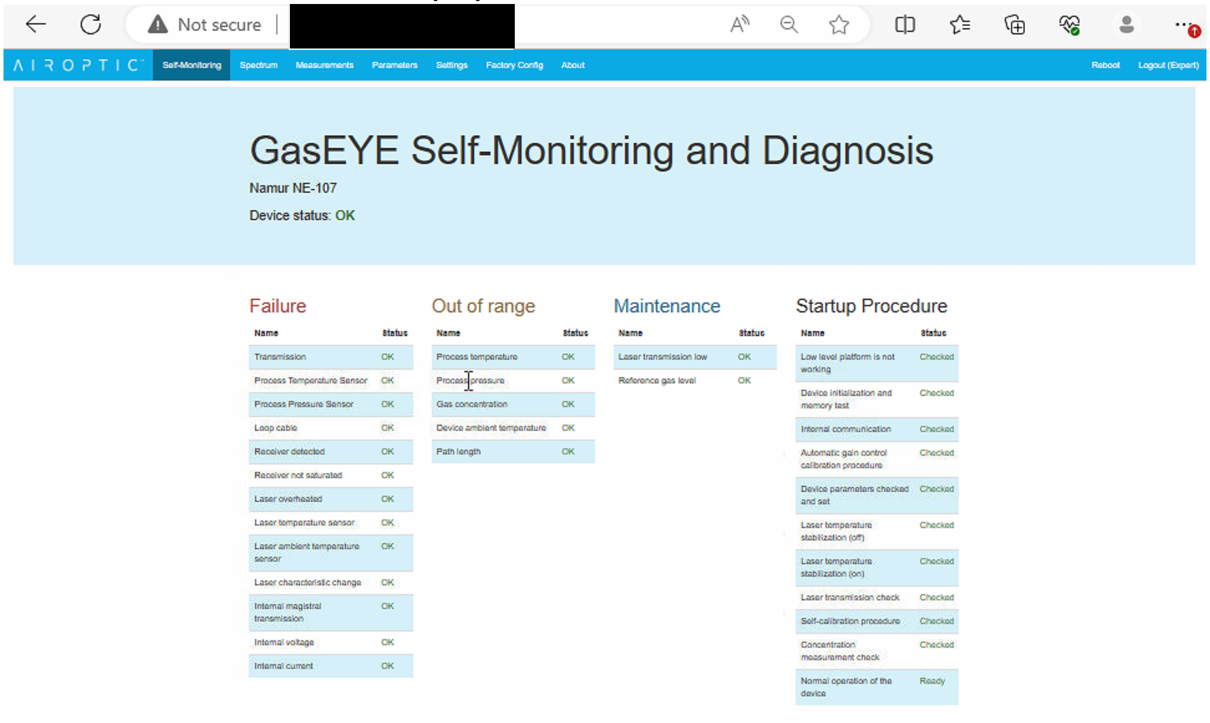
o. valid_pct -The percentage of valid 5-minute average concentrations in a given hour relative to the possible number of 5-minute concentrations
    i. valid_pct = (valid / possible) x 100

p. hr_complete_pct -The percentage of valid 5-minute average concentrations in a given hour relative to the expected number of data points
    i. hr_complete_pct = (valid / expected) x 100

Appendix C

1. In order to illustrate the flow of data through the automatic data validation process, data is shown going from the instrument to the database. From there it is shown on the website. To illustrate this the following was performed. The TDL instrument at Path 4 was taken offline prior to 5.50am on the 22nd of August. It was then put back online and was producing data from 5:51am onwards. Below is an example of that data flow for TDL Path 4. The first figure seen below, Figure 1, shows the status of the TDL instrument as it is running. You can see that the device status shows OK here and all the self-checks have been passed, under these conditions the instrument will output data with a status flag = 6

Figure 1: TDL Path 4 Status 05:53AM 08/22/2023



2. Figure 2, below, shows the concentrations of the various pollutants measured by the TDL. The H_2S one second value at the time of taking this screenshot on the instrument was 0.14 ppm (H2S GAS 101). On the logger (Figure 3), this is logged as the parameter h2s4 where the prefix 4 shows the path number (TDL Path 4). The display on the logger shows the 10 second average of the values from the instrument. When this sample was logged, the 10 second average for this period was 0.13 ppm (Figure 3) at timestamp 05:53:40.

Figure 2: Data Output of TDL Path 4 (1second resolution)

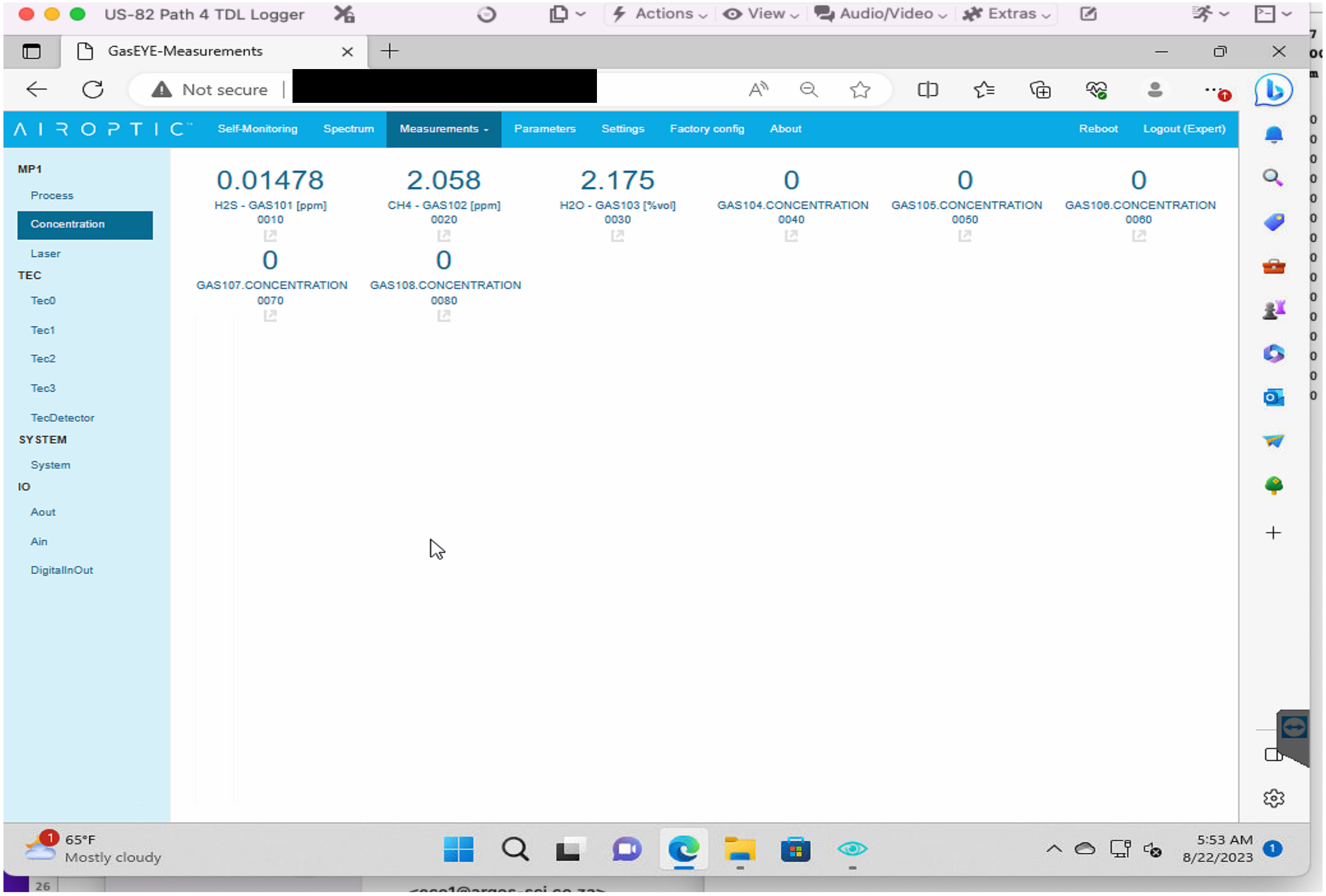
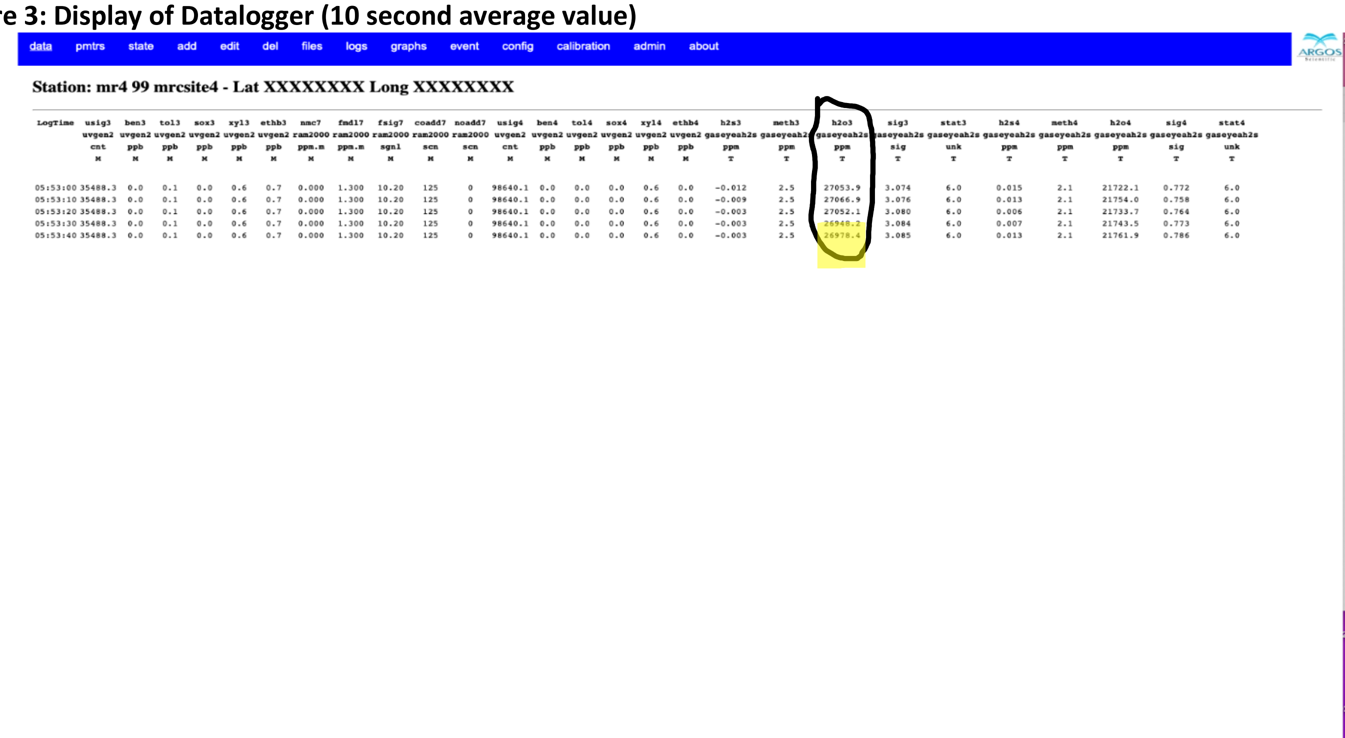


Figure 3: Display of Datalogger (10 second average value)



Station: mr4 99 mrcsite4 - Lat XXXXXXXX Long XXXXXXXX

LogTime	usig3 uvgen2 cnt M	ben3 uvgen2 ppb M	tol3 uvgen2 ppb M	sox3 uvgen2 ppb M	xyl3 uvgen2 ppb M	ethb3 uvgen2 ppb M	nmc7 ram2000 ppm.m M	fmdl7 ram2000 ppm.m M	fsig7 ram2000 sgnl M	coadd7 ram2000 scn M	noadd7 ram2000 scn M	usig4 uvgen2 cnt M	ben4 uvgen2 ppb M	tol4 uvgen2 ppb M
05:53:00	35488.3	0.0	0.1	0.0	0.6	0.7	0.000	1.300	10.20	125	0	98640.1	0.0	0.0
05:53:10	35488.3	0.0	0.1	0.0	0.6	0.7	0.000	1.300	10.20	125	0	98640.1	0.0	0.0
05:53:20	35488.3	0.0	0.1	0.0	0.6	0.7	0.000	1.300	10.20	125	0	98640.1	0.0	0.0
05:53:30	35488.3	0.0	0.1	0.0	0.6	0.7	0.000	1.300	10.20	125	0	98640.1	0.0	0.0
05:53:40	35488.3	0.0	0.1	0.0	0.6	0.7	0.000	1.300	10.20	125	0	98640.1	0.0	0.0

LogTime	sox4 uvgen2 ppb M	xyl4 uvgen2 ppb M	ethb4 uvgen2 ppb M	h2s3 gaseyeah2s ppm T	meth3 gaseyeah2s ppm T	h2o3 gaseyeah2s ppm T	sig3 gaseyeah2s sig T	stat3 gaseyeah2s unk T	h2s4 gaseyeah2s ppm T	meth4 gaseyeah2s ppm T	h2o4 gaseyeah2s ppm T	sig4 gaseyeah2s sig T	stat4 gaseyeah2s unk T
05:53:00	0.0	0.6	0.0	-0.012	2.5	27053.9	3.074	6.0	0.015	2.1	21722.1	0.772	6.0
05:53:10	0.0	0.6	0.0	-0.009	2.5	27066.9	3.076	6.0	0.013	2.1	21754.0	0.758	6.0
05:53:20	0.0	0.6	0.0	-0.003	2.5	27052.1	3.080	6.0	0.006	2.1	21733.7	0.764	6.0
05:53:30	0.0	0.6	0.0	-0.003	2.5	26948.2	3.084	6.0	0.007	2.1	21743.5	0.773	6.0
05:53:40	0.0	0.6	0.0	-0.003	2.5	26978.4	3.085	6.0	0.013	2.1	21761.9	0.786	6.0

3. Figure 4 below shows the output of the one second data that is collected from the logger and stored in the database. For the period highlighted on the logger above, when the concentration was an average of 0.13 ppm for 10 seconds as shown on the logger display, the one second data between 5:53:31 AM and 5:53:40 AM also averages 0.13 ppm and matches the datalogger display. The pollutant tag (h2s4) in the database matches with the pollutant tag on the logger (h2s4). The instrument is operating

correctly (Figure 1) and has an instrument status of 6 which is shown by the parameter stat4 (Figure 3) on the data logger, the status in the database is 1 as per the data handling procedures in Section 5 above.

Figure 4: One Second H_2S for Path 4 TDL transmitted to database.

sampledate	pollutant	value	status
2023-08-22 05:53:30	h2s4	0.009	1
2023-08-22 05:53:31	h2s4	0.01	1
2023-08-22 05:53:32	h2s4	0.01	1
2023-08-22 05:53:33	h2s4	0.011	1
2023-08-22 05:53:34	h2s4	0.012	1
2023-08-22 05:53:35	h2s4	0.012	1
2023-08-22 05:53:36	h2s4	0.013	1
2023-08-22 05:53:37	h2s4	0.013	1
2023-08-22 05:53:38	h2s4	0.014	1
2023-08-22 05:53:39	h2s4	0.014	1
2023-08-22 05:53:40	h2s4	0.014	1
NULL	NULL	NULL	NULL

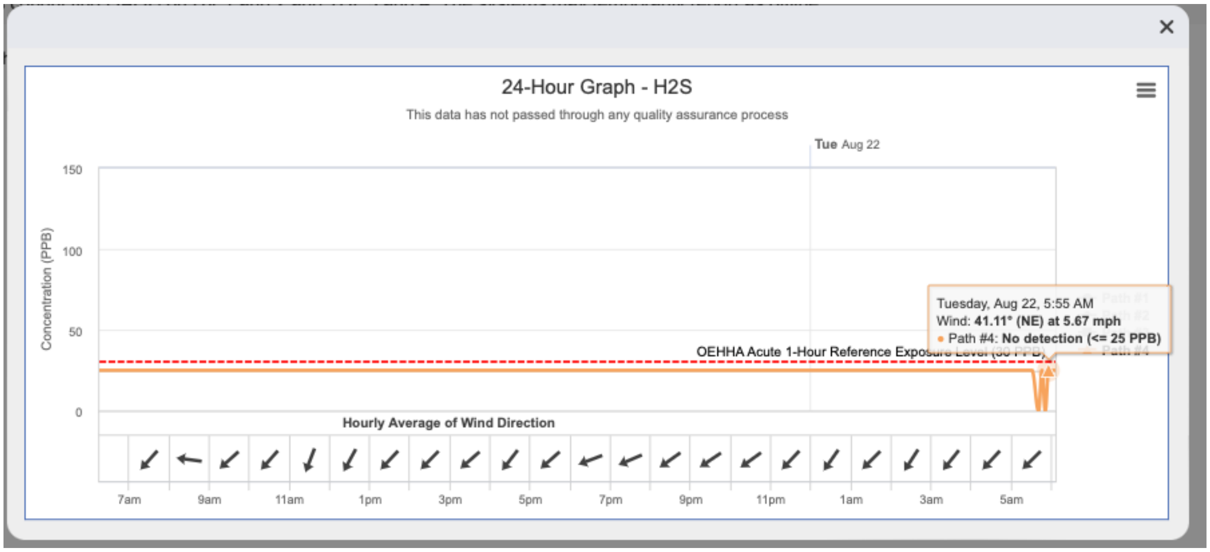
4. Data used for display to the public website is in 5-minute average form. In Figure 5 below, the 5-minute averages for H_2S at TDL Path 4 from 5.50am to 6am are shown. At 5.50am the instrument was taken offline for this demonstration. The status flag value is set to 5 as per the process outlined in Section 5. After that, the H_2S averages are 18.5 ppb and 16.8 ppb. When the data is stored as 5-minute values in the database, it's stored as ppb values and not ppm values.

Figure 5: Five Minute Averaged H_2S Data for Path 4 TDL Stored in Database

sampledate	pollutant	value	status
2023-08-22 05:50:00	h2s4	0	0
2023-08-22 05:55:00	h2s4	18.5	1
2023-08-22 06:00:00	h2s4	16.8	1
NULL	NULL	NULL	NULL

5. Figure 6 below shows the data shown on the website in one of the charts on the real-time data view. Where the graph is highlighted for Path 4 at 5.55am the website shows the wind direction, the wind speed, and it shows that there was No Detection and that the value was less than 25 ppb. The value in the database at that time was 18.5 ppb, which is less than 25 ppb. At just before 5.55am on the graph there was a dip in the graph to Zero. This indicates where the instrument was off-line.

Figure 6: Website View of Data



System Operations Checks of Open-path TDL Air Monitoring System:

Overview:

The purpose of the System Operation Checks (SOC) is to continuously check the system in real-time to ensure the analyzer is working in a manner to produce valid data. If a check occurs that indicates a potential performance issue, a message is sent to the on-call support team to evaluate the issue and perform corrective actions as needed. SOC flags can be generated by the instrument itself, by monitoring site parameters such as Internet connectivity, as well as evaluating the data for external events such as weather-related issues. The specific SOCs for the open-path TDLs are listed in Table 1.

Table 1 summarizes the specific SOPs used to address each SOC.

System Operating checks	Check	Frequency	MQO
Instrument Malfunction Error Code	If a malfunction error code occurs, a validated detection of H2S occurs, or an environmental issue is detected: generate a system performance flag and notify on-call support	Continuous	Check Error Code Status
Hardware Failure Flags	If the last data point in the database is more than 20 minutes old, generate a hardware failure flag and notify on-call support.	Continuous	Check the time of the last data point collected
Internet/Data Failure Flag	Check to see if more than one analyzer is not reporting Data	Continuous	Check to see if multiple instruments are not reporting data

Environmental Conditions Flags	Check to see if a light signal or other operational parameters are impacted by environmental factors such as humidity, temperature, etc.	Continuous	If ambient parameters are outside of the optimal equipment operation range, then generate a flag
Data Validation of a Detect	If the detection of gas meets all of the continuous data validation checks, notify on-call support for review.	Continuous	Check Data Validity Flags

Argos and, where appropriate, refinery staff, are notified via email if any equipment is operating outside the set operational parameters. They are set to notify Argos and refinery staff when the possibility of poor system performance or communication may affect data or data collection. Argos staff review data generated associated with the identified issue and begin a troubleshooting process outlined in the Argos Alarm Response Procedures Guide. If the issue cannot be corrected through this troubleshooting process, a work order is produced to direct field staff to correct the issue. The specific SOPs for each of the system checks are listed below.

Contents

SOP - Instrument Malfunction Error Code

Scope

The fence line monitoring system has the following alarms set up to automatically monitor the operation of the system:

1. A validated gas detection of Hydrogen Sulfide (H_2S) occurs.
2. System Fault Alarm:
   a. If the signal strength drops below a pre-set threshold:
      i. Open-path TDL - Light transmission falls below 0.05%
   b. If internet communication is lost
   c. If a field monitoring computer workstation is down

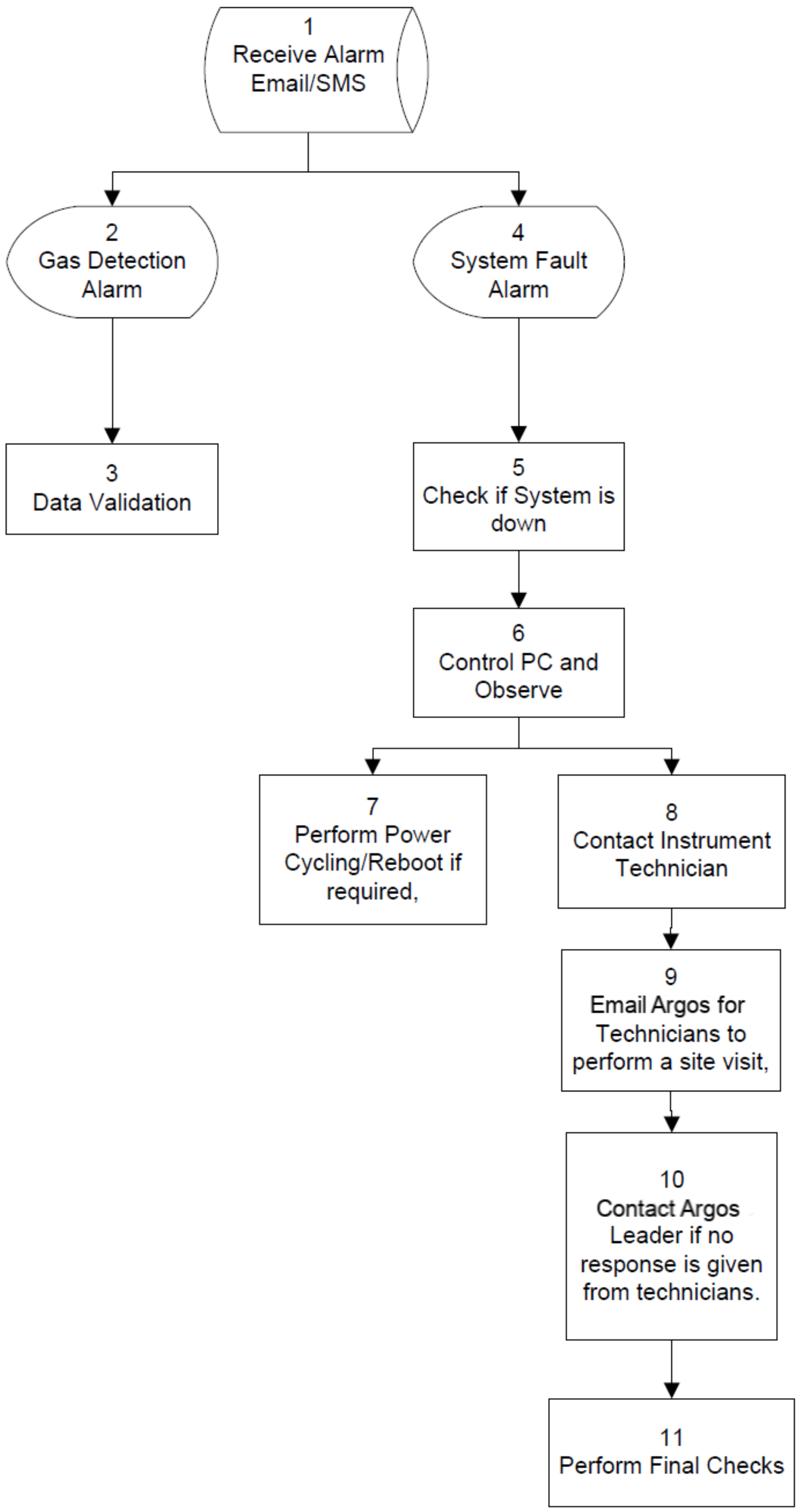
Responsibility and Authority

- ### Operational Technicians / Contract Technicians
  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
  - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments, and undertake corrective action where necessary.

- ### Data Technician and Technical Manager
  - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
  - A record of the station visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- ### Technical Manager
  - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – General Alarm Response Procedure



Procedure

1. An e-mail or SMS message is sent out to concerned parties as specified below:
    - Gas Alarm results are communicated to Argos and the refinery.
    - System down alarms are communicated to Argos and the refinery.
2. If an alarm is received that the gas detection level is over the Limit of Quantification, then:
    - A remote technician validates the raw data and logs any adjustments made to the system.
3. If an alarm is received concerning a system fault specified, and depending on the fault reported, the procedure is followed as per documentation:
    - A remote technician checks to see if the system is down, and then he/she:
        - Takes control of on-site computers using the Argos remote access system to observe probable causes through observation and depending on findings will either:
            - Re-initialize any data acquisition software: or
            - Perform a power cycling/ reboot, if the system is shut down due to a power outage or an update cycle; or
            - If the fault cannot be fixed by the steps above the fault is escalated to an Operational Technician.
            - If the fault persists, an e-mail is sent to Argos for an Operational Technician callout on-site. Together with remote technician support, an Operational Technician creates a work plan (work order) and visits the site, and checks the system for:
                - Alignment.
                - Instruments not operating.
        - If, after one hour from the callout, no updates from on-site technicians have occurred, an e-mail is escalated to Argos Project Management staff to notify of the delay in the execution of a site visit.
        - Once the fault is found and corrected, an on-site technician contacts the remote technician to conduct a verification of proper instrument operation as outlined in appropriate SOPs that will ensure that setup was done correctly, and the system is working properly.
        - The remote technician checks the following before logging out of the remote computer:
        - Signal strength
            - Open-path TDL - Light transmission is above 0.1. %
        - That a background has been collected before going live.
        - Data is reported to the website.

Records

Argos Work Order

IMS-QLT-MAN-010

FLM-QLT-FOR-001

References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Baird	Quentin Hurt	Don Gamiles
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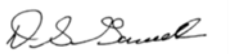
Date	May 2019	13 June 2019	29 August 2022
Final approval signature			

SOP - Hardware Failure Flags

Scope

In the event of a field monitoring computer malfunctions, Argos Scientific will be notified via e-mail, and refinery personnel will be notified via email or text of the condition. Argos will begin the process of troubleshooting and an Argos Operational Technician will attempt to restart the workstation.

Responsibility and Authority

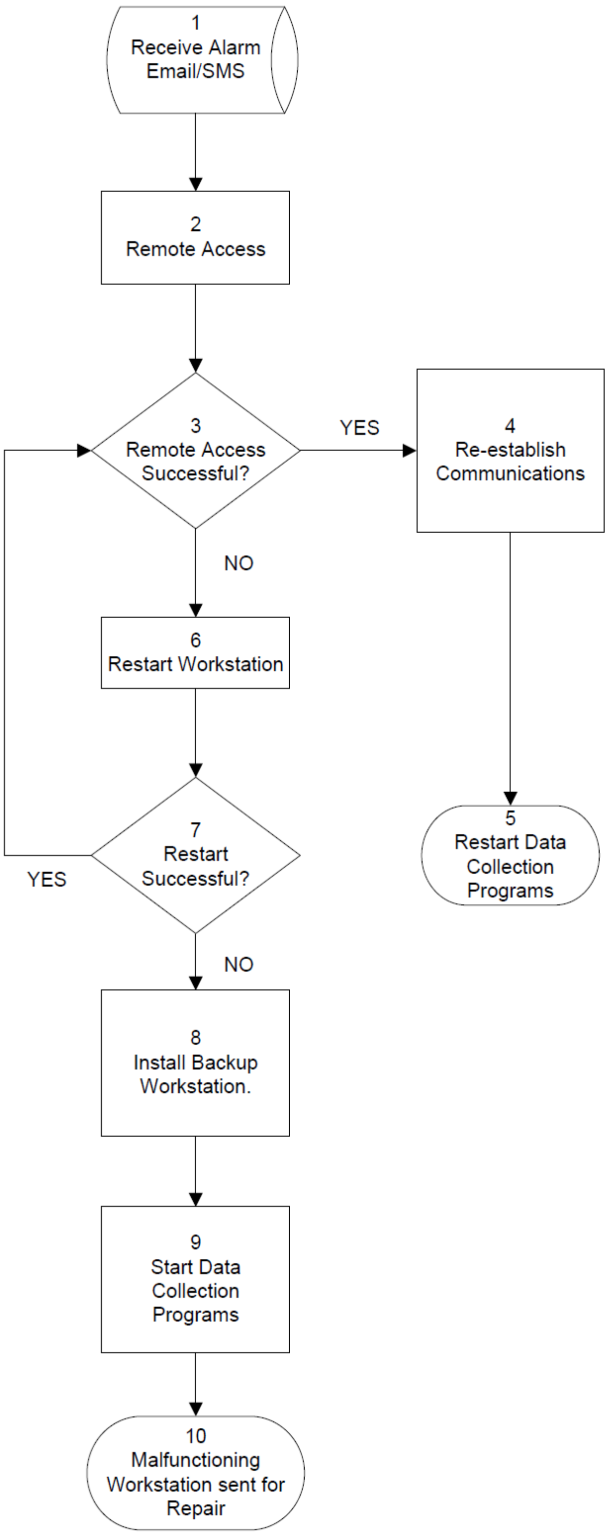
- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Field Data Workstation Malfunction

Process flow: Field Monitoring Computer Workstation Down



Procedure

1. A remote technician will attempt to remotely access the computer using the Argos remote access system.

2. If remote access was successful, then:
   - Re-establish communications; then,
   - Restart all data collection programs.
3. If Argos cannot establish a remote connection, then an Argos Operational Technician or a qualified subcontractor will be dispatched to restart the system.
4. If the computer restart is successful, then all data collection programs will be restarted.
5. If restarting the computer is not possible, then the Operational Technician will install the backup field monitoring computer workstation.
6. The remote technician will start all data acquisition programs on that computer.
7. The malfunctioning workstation will be sent to Argos for repair.
8. The *Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001* will be updated.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
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Date	May 2019	13 June 2019	08/28/22
Final approval signature			

SOP - Internet/Data Failure Flag

Scope

Site is connected to a database via an internet connection. When communication is lost, Argos Scientific is notified via email and the situation is monitored until the internet reconnects. Refinery personnel will be notified via SMS or e-mail notification. If the notification is received, Argos will respond to the notification as soon as possible.

Responsibility and Authority

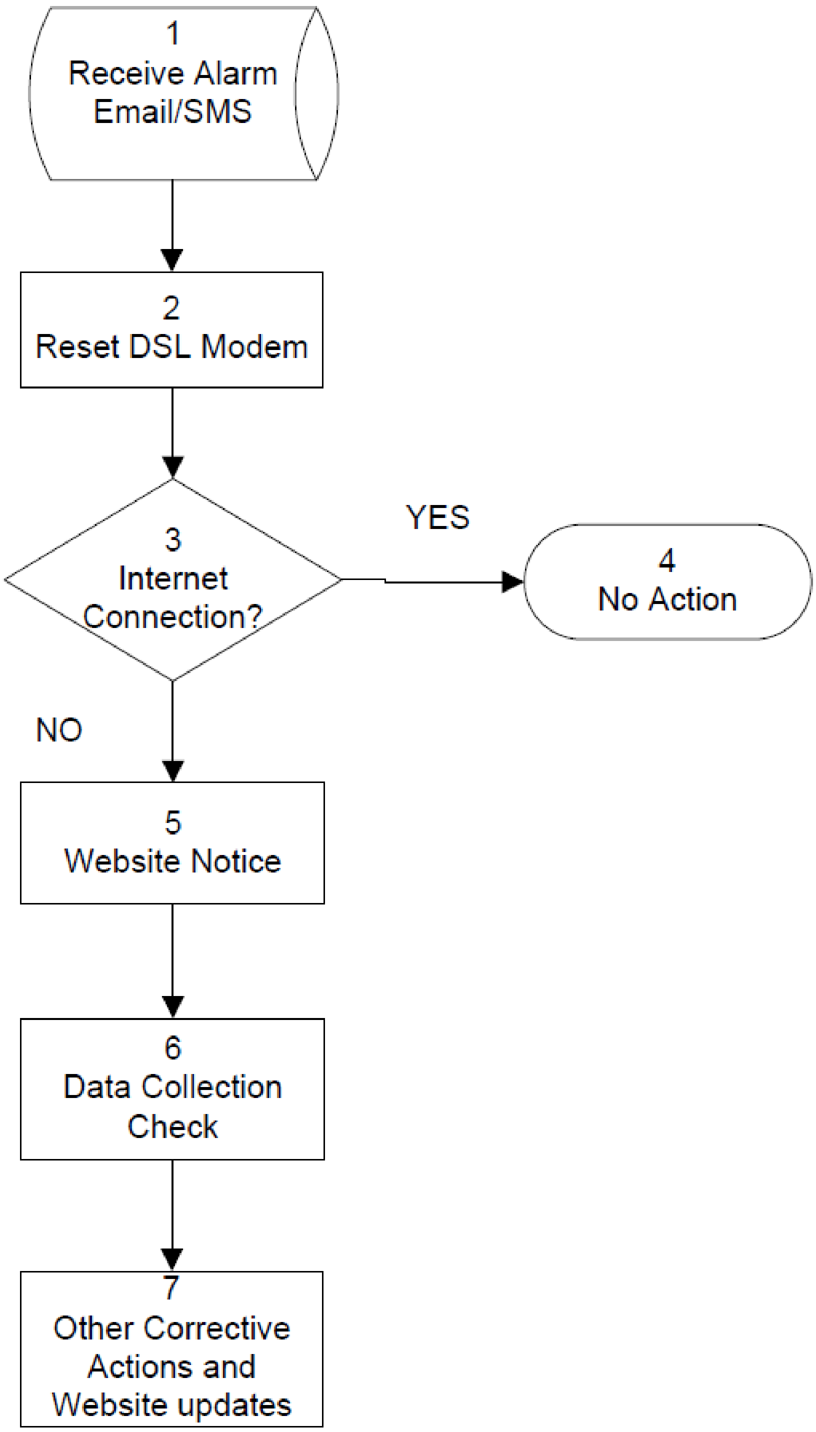
- Operational Technicians / Contract Technicians
  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
  - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
  - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
  - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
  - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Loss of Internet Communication

Process Flow: Internet Communication is Lost



Procedure

1. Argos will begin the process of troubleshooting and an Argos Operational Technician will attempt to reconnect to the Internet by resetting the modem located at the monitoring station.
2. The internet connection will be checked and, if:
    - The connection has been re-established, then no further action is needed;
    - The connection has not been re-established, then the following actions will be taken:
        - Argos will post a note to the message board of the real-time website stating that the Internet connection has been lost and actions are in place to re-establish the connection; then,
        - The Argos Operational Technician will go to all of the monitoring systems to make sure they are still collecting data and finally,
        - The real-time website will be updated as the corrective action(s) are taken.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence line Monitoring.

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
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Date	May 2019	13 June 2019	09 September 2019
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SOP - Environmental Conditions Flags

Scope

If the signal strength drops below a pre-set threshold, Argos Scientific will be notified via e-mail and refinery personnel will be notified via page or e-mail of the event. Upon receiving this notification, Argos will access the instruments to determine if the loss of signal is due to weather (e.g., fog, rain etc.), obstruction by trees, light sources wearing out, or misalignment of optics.

Responsibility and Authority

- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

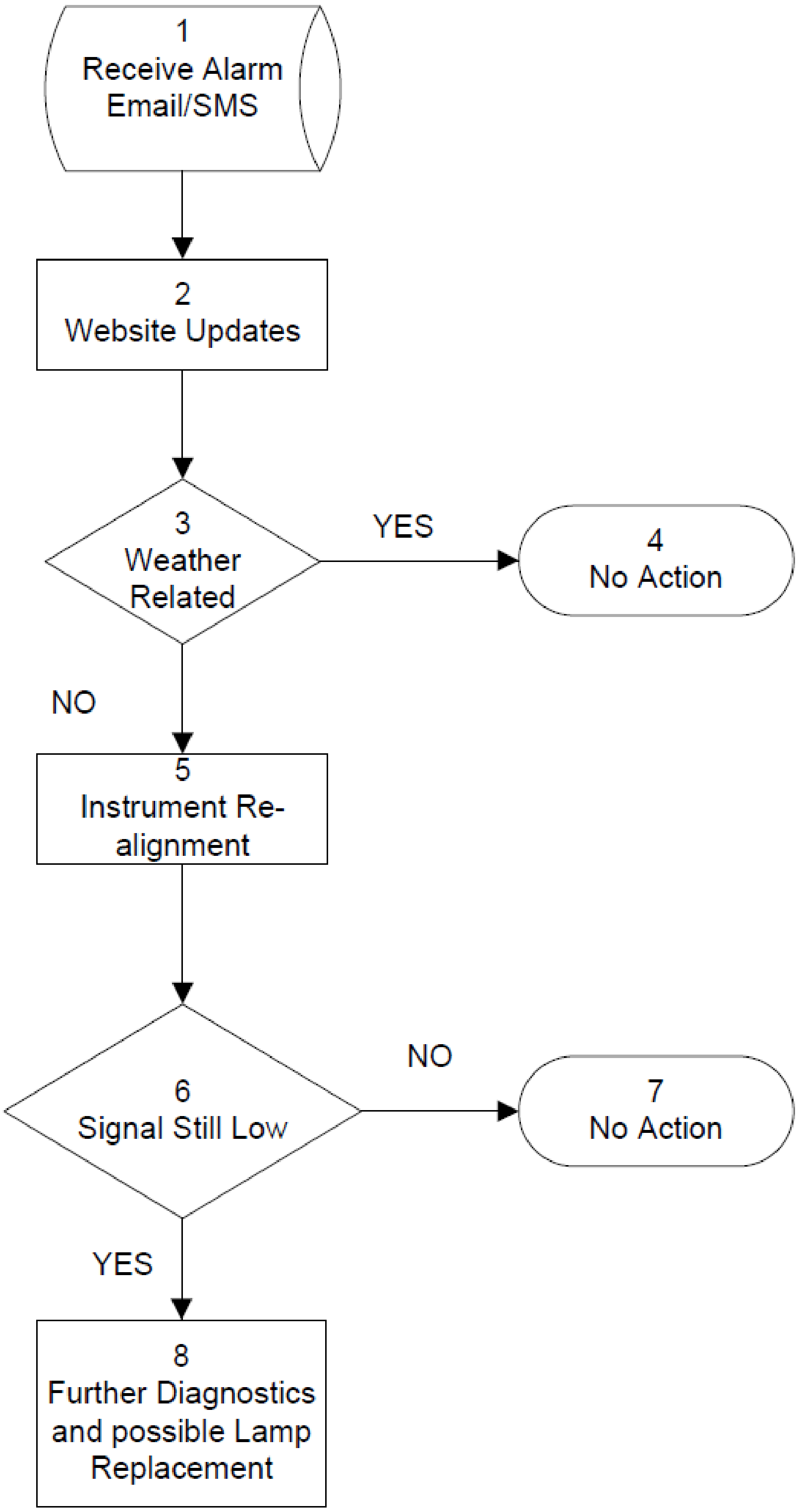
- Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit in order to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized

to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Operational Event Scenario 2

Process Flow: An Open-path Instrument (UV) has Low Signal



Procedure

1. If the signal strength drops below a pre-set threshold (0.1 %), Argos will be notified via e-mail and refinery personnel will be notified via SMS or e-mail of the event. Upon receiving this notification, Argos will access the instruments remotely via the Argos remote access system to determine if the loss of signal is due to weather (e.g., fog, rain etc.), obstruction by trees, light sources wearing out, or misalignment of optical components.
2. The real-time website message board will be updated to indicate which instrument has low signal. Data from that monitoring station will be flagged accordingly.
3. If the notification is weather related, then no additional action will be taken.
4. If the notification may be due to an instrument misalignment, then an Argos Operational Technician will be deployed to re-align the system.
5. If after the system has been re-aligned:
    - The signal strength is no longer low, then no further action is needed;
    - The signal strength is still consistently low, then further diagnostics are required, including replacement of light sources.
6. Once the TDL signal has been optimized by alignment an on-site technician contacts the remote technician to conduct a verification of proper instrument operation as outlined in appropriate SOPs that will ensure that setup was done correctly, and the system is working properly.
7. The remote technician checks the following before logging out of the remote computer:
    1. Signal strength
    2. Open-path TDL - Light transmission is above 0.1. %
    3. That a background has been collected before going live.
    4. Data is reported to the website.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Critical Spares Tracking List, FLM-QLT-REG-001
- Non-conformance/Improvement form, IMS-QLT-FOR-001

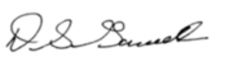
References

- Operations Guidance Document for *Refinery*: Fence-line Monitoring

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	August 2022	August 2022	August 2022
Final approval signature			

SOP - Data Validation Flags

Scope

The fence line monitoring system has the following alarms set up to automatically monitor the operation of the system to flag and report when a validated gas detection of Hydrogen Sulfide (H_2S) occurs.

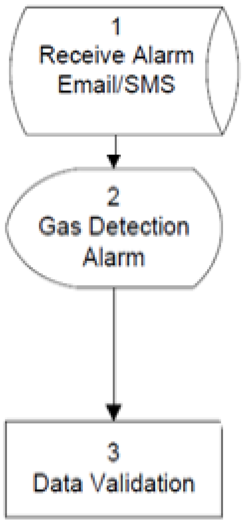
Responsibility and Authority

- Operational Technicians / Contract Technicians
  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
  - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
  - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
  - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
  - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Validated Detection and Procedure



Procedure

1. An e-mail or SMS message is sent out to concerned parties as specified below
    - Gas Alarm results are communicated to Argos and the refinery.
2. If an alarm is received that the gas detection level is over the Limit of Quantification, then the following steps occur:
3. On-call support is contacted, and the following parameters are checked:
4. [redacted], produced by the software, should be [redacted].
5. Maximum peak value at the H_2S spectra center, spanning points 29 through 35.
6. The ratio of the measured concentration of the gas to the standard deviation of the measurement (concentration to sigma ratio) was greater than 3.
7. Ambient methane concentration greater than 1.9 ppm.
8. If these checks are invalid, the data point is flagged for further review.
9. If all the checks are validated, then [redacted]
    - [redacted]
    - [redacted]

Records

IMS-QLT-MAN-010

FLM-QLT-FOR-001

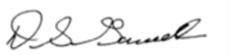
References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	29 August 2022
Final approval signature			

H_2S Data Validation

Overview:

The purpose of the Data Validation Check (DVC) is to ensure that any data that has not been flagged as invalid meets appropriate data quality standards. DVCs are performed in real-time, on a daily basis, and anytime a data point is outside of normal parameters. The specific DVC for the open-path TDLs are shown in Table 1.

Table 1 – H_2S Data Validation Checks

Check Type	Check	Frequency	MQO
Instrument Output Statistics	Check output statistics generated by the manufacturer's software	Real-time	Check output statistics [redacted] max-peak centerpoint, H_2O concentration, methane concentration, and light signal
System output statistics	Check output statistics generated by the logging software	Real-time	Check real-time MDLs, concentration to sigma ratio correlation coefficient
Quantitative Detection Validity Check	Determine if the detects identified meet valid quantification checks	Daily	Perform independent validation of H_2S detects
Review of Monthly Bump Check and Quarterly Calibration Check	Determine if the calibration check data meets precision and accuracy checks	Monthly and Quarterly	Insert NIST traceable gas standards into the beam path and measure the response
Senior Review	Evaluate data for systems trends	Monthly	Evaluate long-term performance trends

The SOPs for real-time validation of H_2S are included in (MSOP-001-TDL SCC) and are therefore not listed in the Table of Contents for this MSOP.

Contents

SOP - Quantitative Detection Daily Validation Checks

Scope

This describes the process where the Remote Technician does a manual check on the raw data collected in the last 24 hours. Items that are checked are:

- Assess possible Weather-related effects that occurred.
- Validate any possible detections.
- Invalidate data detections that do not meet quality assurance parameters.
- Any data that needs to be flagged according to the following flagging conventions:

Flagging Code	Flagging Convention
0	Missing
1	Valid
4	Data For Review
5	QA/Maintenance
8	Low Signal/Offline

Responsibility and Authority

1. Operational Technicians/Contract Technicians

- It is the responsibility of all Technicians/Contract Technicians to log on to the computer or logbook daily or as and when required, to download the previous day's work activities.

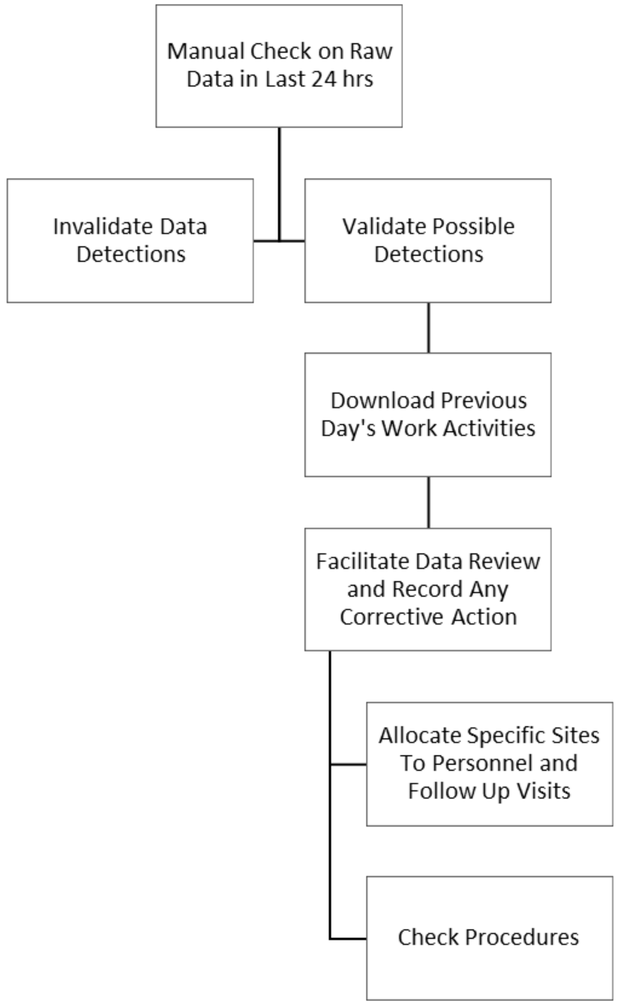
2. Data Technician and Technical Manager

- It is the responsibility of these staff to login onto the computer or logbook to facilitate data review and record any corrective action that needs to be taken.

3. Technical Manager

- The Technical Manager is responsible for allocating specific tasks to personnel and following up that tasks are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Daily Manual Validation of Field Data



Procedure

1. Check LoQ to ensure data meets BAAQMD LoQ requirements for H_2S.
2. Check values against Argos Data Dashboard for the system being checked.
3. Check for gases that are above LoQ thresholds meet the required data validation parameters these are:
   - [redacted], produced by the software, [redacted].
   - Maximum peak value at the H_2S spectra center, spanning points 29 through 35.
   - The ratio of the measured concentration of the gas to the standard deviation of the measurement (concentration to sigma ratio) was greater than 3.
   - Ambient methane concentration greater than 1.9 ppm.
4. Check data points marked as invalid against data validation parameters.
5. Check when humidity is above 90% and light signal below 0.1% transmission.
6. Check LoQ should always be more than the mean concentration for non-detects.
7. Check the completeness report.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
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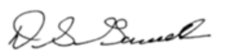
Final approval signature			

SOP - Monthly Validation of H_2S Data

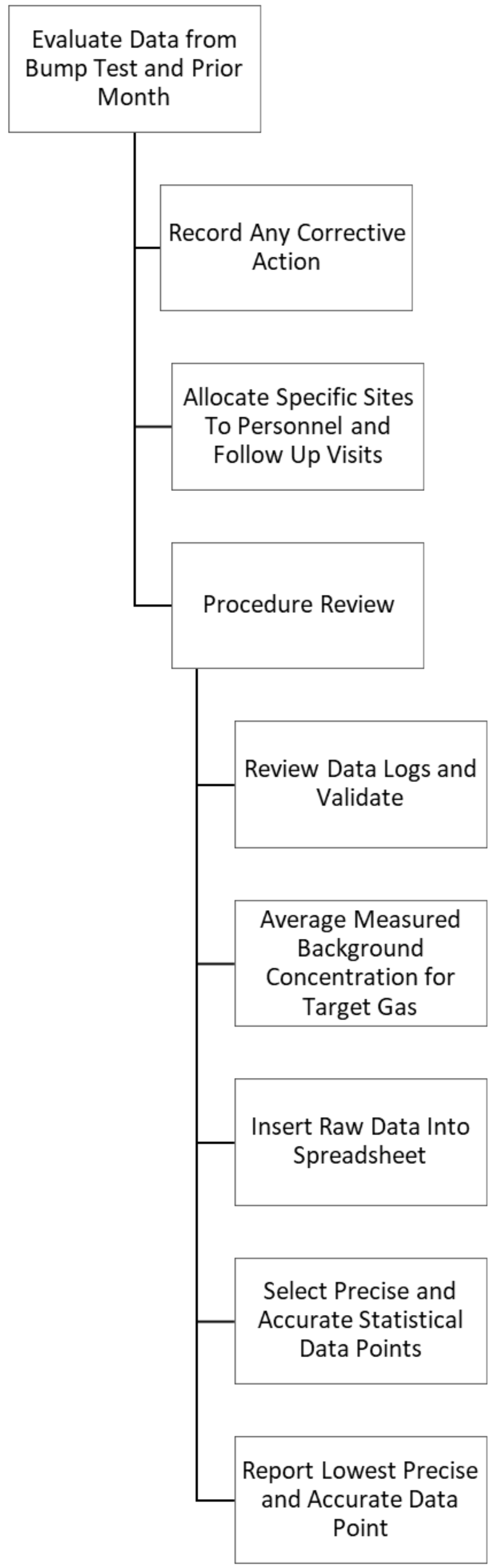
Scope

This process describes how a Data Analyst reviews the QA'd data from the bump test and the dataset for the prior month to ensure they are ready for inclusion in the Quarterly Data Reports. Items that are checked are:

Responsibility and Authority

8. Operational Technicians/Contract Technicians
   - It is the responsibility of all Technicians/Contract Technicians to log on to the computer or logbook on a daily or as and when required, basis to download the previous day's work activities with a record of the station visit, dated and time-stamped and traceable to the operator performing the calibration checks.
9. Data Technician and Technical Manager
   - It is the responsibility of these staff to login onto the computer or logbook to facilitate data review and record any corrective action that needs to be taken.
10. Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Monthly Validation of Field Data



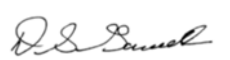
Procedure

1. Review data logs from Operational Technicians to validate the start and stop times for gas calibration.
2. Using the prior five-minute data set, average the measured background concentration for the target gas. Use this concentration as the background offset for the calibration data.
3. Insert the raw data into the spreadsheet that calculates the precision and accuracy.
4. Select the data points that have both precision and accuracy statistics that are below 15%.
5. Report the data point that has the lowest combined levels of precision and accuracy.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP - Senior Analyst Validation Checks of H_2S Data

Scope

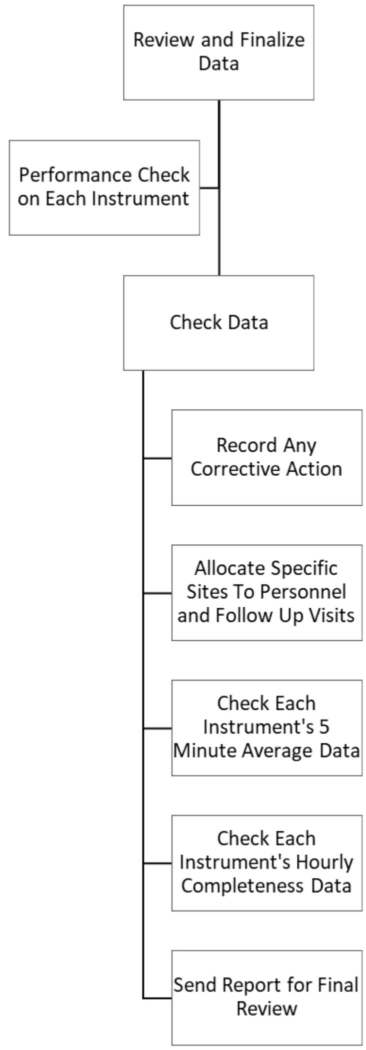
At this level of data validation data is reviewed by a project management level staff member to ensure all above processes have been followed and is finalized for inclusion into the quarterly reporting format that is required by the BAAQMD. The data to be checked include:

- Performance of each instrument against the onstream efficiency requirement of 90 % calculated according to the BAAQMD reporting procedure.
- Data on monthly bump tests.
- Data on quarterly calibrations (if applicable).
- Description of corrections made to data due to QA.
- Five-minute average data in the format prescribed by the BAAQMD.
- Hourly completeness data in the format prescribed by the BAAQMD.

Responsibility and Authority

- Data Technician and Technical Manager
    - It is the responsibility of these staff to evaluate the prior month's data set for the above flags and to login onto the computer or logbook to record any corrective action that needs to be taken.
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Senior Manual Validation of Field Data

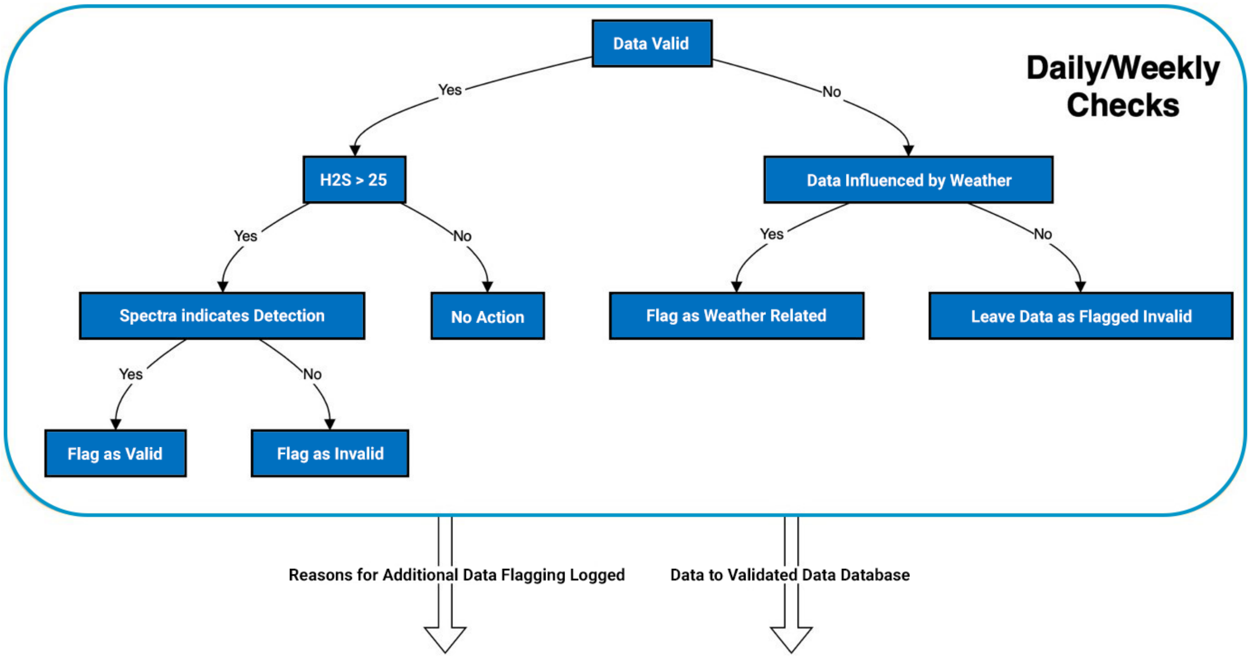


Procedure

A validated report generation application is run on the validated data set to provide the data in the BAAQMD format. This is then validated by a senior data analyst who performs the following checks:

For each instrument the 5-minute average data is checked against the following:

- Compare the data to the data trends for the month.
- Perform a check on a sample of data following the process in the figure below.



- Validate any adjustments made due to QA.
- Log any further changes made to the validated data set.
- Review the log of data adjustments.
- Send report to Project Management staff for final review.

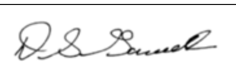
For each instrument the hourly completeness data is checked by a senior data analyst against the following:

- Validate weather related flags and calculations.
- Validate any data that has a completeness between less than 75 %.
- Verify downtime where QA and Maintenance took place.
- Calculate the completeness.
- Send report to Project Management staff for final review.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

System Challenges of Open-path TDL Air Monitoring System

Overview:

The purpose of the system challenge is to verify the TDL air monitor can meet the BAAQMD requirements specified in the letter dated December 22, 2023. Specifically, the letter states the following:

"For reference, the minimum detection limit (MDL) of a measurement process is defined as the lowest concentration of the analyte that can be reliably detected (i.e., distinguished from zero), and the LOQ is the lowest concentration at which the analyte can not only be reliably detected but at which predefined goals for accuracy and precision are met. The accuracy and precision specifications of 15% must be met at each calibration point. Failure to meet these specifications must trigger repair, maintenance, and root cause analysis, followed by repeat calibration checks until a passing calibration check is completed."

The Limits of Quantification (LoQ) for the TDL air monitoring system are calculated in real-time by evaluating five data quality parameters produced by the manufacturer's data analytic software along with standard statistical tests of the real-time data. The five data quality parameters produced by the system software are:

- [redacted] produced by the software [redacted] for a valid detection.
- Maximum peak value at the H_2S spectra center should be between points 29 through 35 on the data output graph.
- The measured ambient methane concentration is greater than 1.9 ppm.
- The measured ambient water concentration should trend the meteorological station data.
- Ratio of the measured concentration of the gas to the standard deviation of the measurement (concentration to Detection Limit) greater than 3.

In addition to these checks, a final check occurs by performing [redacted] on the spectral data generated by the TDL to a NIST traceable reference library. The H_2S is determined to be present in the data if [redacted]. A detection is deemed valid when all five parameters are met and [redacted].

In addition to the real-time checks, the Limit of Quantification (LoQ) is regularly established through monthly bump checks and quarterly span checks, by introducing a known quantity of gas. The LoQ is verified by ensuring the quantified concentration aligns with BAAQMD's precision and accuracy standards. Any data points exceeding the LoQ are flagged and then undergo review by a specialized data analyst within 24 hours of detection. To affirm the appropriate Levels of Quantification (LoQ), the TDLs undergo a monthly system challenge with H_2S gas that is traceable to NIST standards, within a range set by the BAAQMD for the required monthly bump check tests. This data is reviewed in a manner that includes evaluating the check for the BAAQMD requirements for precision and accuracy as well as the internal QA/QC checks. Table 1 presents the concentration ranges and the measurement frequency for the various tests.

Table 1 – Gas Concentrations for Calibration Tests

Check Type	Frequency	Concentration Low (ppb)	Concentration High (ppb)
Bump Check	Monthly	60	100
Low Conc Check	Monthly	20	40
Calibration Low	Quarterly	40	60
Calibration Mid	Quarterly	250	360
Calibration High	Quarterly	725	900

The specific SCCs for the open-path TDLs are listed in Table 2.

TABLE 2 – SCCS FOR THE OPEN-PATH TDLS

Check Type	Check	Frequency	MQO
MDL Check	Determine the MDL of the analyzer with the calibration cell inserted into the unit	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Calculated detection limits must be less than 25 ppb.
Precision Check	Insert a known concentration of a gas into the calibration cell and measure precision	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Measured precision must be Less than or equal to 15%
Accuracy Check	Insert a known concentration of a gas into the calibration cell and measure accuracy	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Measured accuracy must be Less than or equal to 15%
Linearity Check	Insert a known concentrations of a gas into the calibration cell and measure the linearity	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	R^2 for linear regression of data points must be greater than 0.9
Corrective Action	Calibration parameters are checked for failure	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Implement maintenance, and root cause analysis, and recalibrate.

The Standard Operating Procedures associated with the quantitative gas checks are found below.

Contents

SOP - Minimum Detection Limit (MDL) Determination for Open-Path H_2S Monitoring System

Scope

With no gas present in the light beam, a series of 26 spectra are collected using the appropriate averaging time (e.g., 5 min). The spectra are used to quantify the Hydrogen Sulfide (H_2S) measured in the beam path. The resulting 25 spectra are analyzed for the target gas. The MDL is defined as two times the standard deviation of the calculated concentrations. This method can be used in conjunction with lowering light transmission at the source to determine MDLs at specific signal strengths.

Responsibility and Authority

- Technical Manager and Data Technician
  - All technical procedures used must be fully validated before being used for monitoring.
  - Assess all deviations from expected outputs and decide on the acceptance and non-acceptance thereof.
  - Must report substantial deviations from expected outputs.

Frequency

Detection limits will be calculated and recorded in real time. In addition, detection limits will be validated on a quarterly basis by checking the detection limits by hand.

Procedure

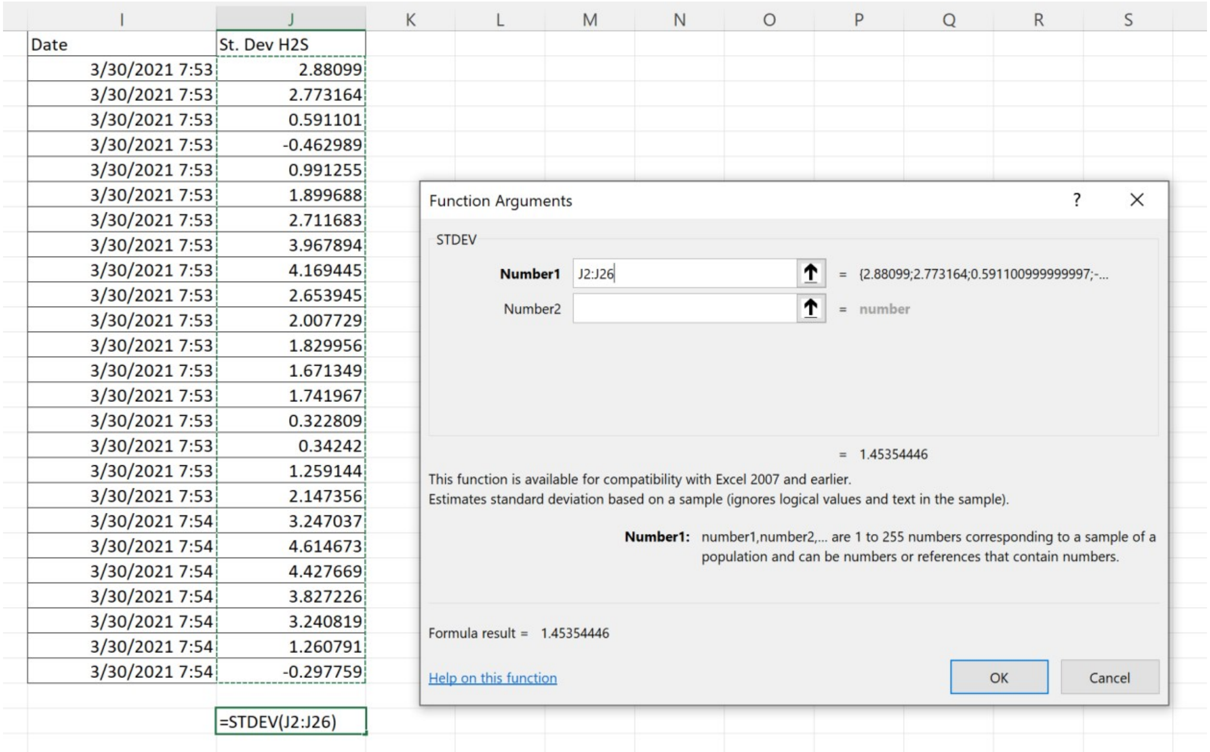
Select a period when the target compound is not present such as when the wind direction dictates that the monitor is upwind from the source of the target gas. There should also be enough wind speed to be confident that general dispersion of a target gas in all directions is not occurring (e.g., greater than 1 mph).

3.1. Open data summary file containing the reported concentration of H_2S.

3.2 Once opened, choose a folder from a date corresponding to a period of time when the wind direction was satisfactory (i.e., wind not blowing from the source of target gas). Choose 26 consecutive data points from the desired time period.

Date	H2S
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.46299
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
3/30/2021 7:53	2.711683
3/30/2021 7:53	3.967894
3/30/2021 7:53	4.169445
3/30/2021 7:53	2.653945
3/30/2021 7:53	2.007729
3/30/2021 7:53	1.829956
3/30/2021 7:53	1.671349
3/30/2021 7:53	1.741967
3/30/2021 7:53	0.322809
3/30/2021 7:53	0.34242
3/30/2021 7:53	1.259144
3/30/2021 7:53	2.147356
3/30/2021 7:54	3.247037
3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.29776
3/30/2021 7:54	-0.06576

3.3 Calculate the standard deviation of the 25 concentration values using the standard deviation function in Excel:



Date	St. Dev H2S
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.462989
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
3/30/2021 7:53	2.711683
3/30/2021 7:53	3.967894
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3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.297759
	=STDEV(J2:J26)

Alternatively, calculation can be completed by determining the average ($\overline{x}$) of the column of the selected chemical concentrations and the standard deviation (σ) according to the equation:

$$\sigma = \sqrt{\frac{\sum(x - \overline{x})^2}{n-1}}$$

where:

$\bar{x}$ = average reported concentration from the 25 calculated absorbance spectra

x = concentration reported in individual absorbance spectrum

n = number of data points

Finally, calculate 2x the standard deviation of the calculated concentrations to arrive at the Minimum Detection Limit (MDL).

Date	St. Dev H2S
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.462989
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
3/30/2021 7:53	2.711683
3/30/2021 7:53	3.967894
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3/30/2021 7:53	0.322809
3/30/2021 7:53	0.34242
3/30/2021 7:53	1.259144
3/30/2021 7:53	2.147356
3/30/2021 7:54	3.247037
3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.297759
St. Dev.	**1.5**
2 x St. Dev.	**2.9**
Average	**2.2**

Records

• MDL Spreadsheet inside the Verification Summary

• Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

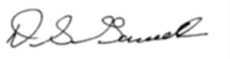
• Argos Scientific Operations Manual for Open-path Air Monitoring System

• Environmental Technology Verification Programme (Advanced Monitoring Systems Pilot) – Test/QA Plan for Verification of Optical Open Path Monitors

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Precision

Scope and Application

Frequency

Quarterly

Description

The precision of the monitor is a quantification of its ability to make repeatable measurements when challenged with the same gas sample inserted in the beam using a sample cell.

Measurement Quality Objective

The objective is to determine the precision of the TDL air monitoring system and compare the measured result to historical measurements. If the results differ in a statistically significant manner, corrective actions will be initiated. The procedure for determining the precision of the TDL is as follows:

H_2S gas will be introduced into the multi-pass cell and 25 single-beam spectra of the target gas will be obtained. The collected spectra will be analyzed for the target gas. The relative standard deviation of this set of measurements is the precision at the target gas concentration and is given by the following formula:

$$RSD = \left|\frac{\sigma}{\overline{\overline{T}}}\right| \cdot 100$$

Where RSD is the Relative Standard Deviation

Acceptance Criteria

The MQO will be met if the measured precision meets the requirements in Table 1.

Corrective Action

If the system fails the precision check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue. Beam spectra are then used to create absorption spectra, using each single beam spectrum.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Accuracy

Scope and Application

This document refers to an accuracy check for open-path air monitoring system for the continuous measurement of gases in the ambient air along an open path. It includes specific reference to the open-path monitor accuracy check described in EPA documents (e.g., Environmental Technology Verification (ETV) Protocol for Optical Open-Path Monitors (Section 5.5.4), Method TO-16). The relevant EPA documents describe the general procedure to determine instrument accuracy relative to a known concentration of target gas inserted into the beam path.

Frequency

Quarterly

Description

The accuracy of the monitors will be evaluated for target gases by inserting a calibration gas into the beam path with a known concentration of a target gas and comparing the calibration gas concentration to the concentration measured by the monitor.

Measurement Quality Objective

The objective is to determine the accuracy of the air monitoring system and compare the measured result to historical measurements. If the results differ in a statistically significant manner, corrective actions will be initiated. The procedure for measuring the accuracy of the is as follows:

The relative accuracy (A) of the monitor with respect to the reference gas is assessed using the following formula:

$$A = \frac{|\overline{R} - \overline{T}|}{\overline{R}} \cdot 100$$

Where:

A = accuracy of each measurement

$\overline{R}$ = the average value of the reference gas

$\overline{T}$ = the average value of the measurements

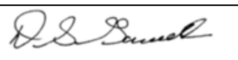
Acceptance Criteria

The MQO will be met if the measured accuracy is within 15% of the expected value.

Corrective Action

If the system fails the accuracy check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Linearity

Scope and Application

This document refers to a three-point linearity check using open-path air monitoring systems for the continuous measurement of ambient air along an open path. This document includes specific reference to open-path monitor linearity checks described in EPA documents (e.g., Environmental Technology Verification (ETV) Protocol for Optical Open-Path Monitors (Section 5.5.4), Method TO-16). This procedure specifically refers to the linearity of the monitor for a specific target gas over a range of concentrations. This is referred to as the "concentration linearity".

Frequency

Quarterly

Description

Using the method outlined in the relevant EPA document for open-path air monitoring systems, the lower detection limit (LDL) will be measured for the Open-path air monitoring system.

Measurement Quality Objective

Detection limits are determined using the method outlined in the appropriate SOP. The detection limits are calculated by removing the target gas from the optical path of the monitor and measuring the detection limit. The MQO will be considered to have been met if the calculated detection limits are less than or equal to the detection described in the appropriate documentation.

Acceptance Criteria

This MQO will be considered to have been met if the values in Table 1 are met.

Corrective Action

If the system fails the detection limit check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

Sampling Procedures

Instrument Operation

Measurement Quality Objectives

Procedure: The general procedure for determining the concentration linearity is as follows:

Determining the concentration linearity of the instrument requires challenging the monitor with at least three varying concentrations of the target gas. At each of these concentrations, a measurement of the target gas concentration is made using the standard analytical software. The results of each measured quantity are plotted against the known concentration values on a scatterplot. A linear regression or best fit calculation is performed for the resulting line. A corresponding correlation coefficient (R2) is calculated which measures how close the data are to the straight or fitted line. The concentration linearity of the instruments will be archived and used for comparison purposes. An instrument's linearity should not be statistically significantly different from prior quarterly checks and should not vary in a systematic way over time.

Details of the specific steps involved in carrying out this procedure are given below.

1. Open the vendor-specific continuous monitoring software.

2. Select the target gas/gases present in the sealed cell used in the linearity check.

3. If possible, set the light signal to be approximately equal to 75% of the full-scale value for the air monitor.

4. Confirm that the wind direction indicates that no target gas is present in the beam path (i.e., the instrument is upwind of the source), or otherwise confirm the current concentration of target gas in the air (subtracted from the final reading).

5. Insert the cell into the beam path and collect a background i.e., clean air sample for five minutes.

6. Fill the calibration cell with the first calibration gas containing the target gas at concentration c1. Check "Alignment" to confirm that the signal is still within the appropriate range. Collect a data sample for five minutes. This concentration will be referred to as c1.

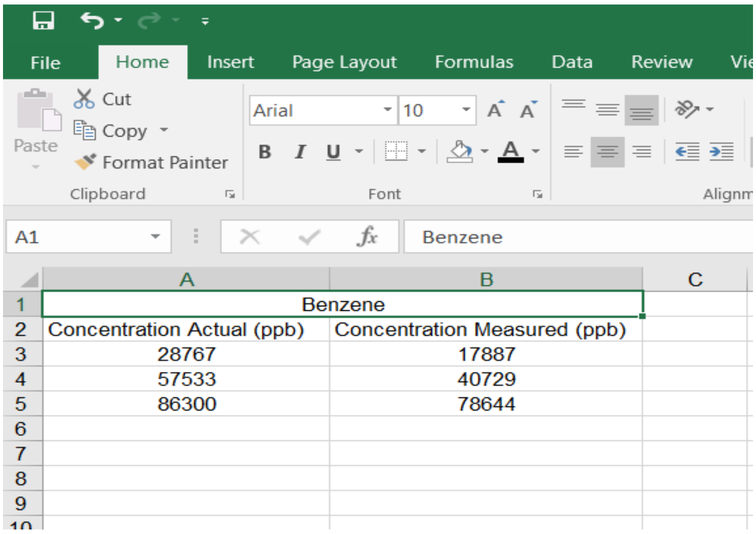
7. Repeat the data collections described in Step 6 two additional times with gas concentrations listed in Table 1. For each data collection, leave the gas cell in the beam path for five minutes. The two concentrations will be referred to c2 and c3.

8. Purge the flow through the cell with nitrogen and collect spectra for an additional five minutes. These spectra will represent the background levels of the target compound.

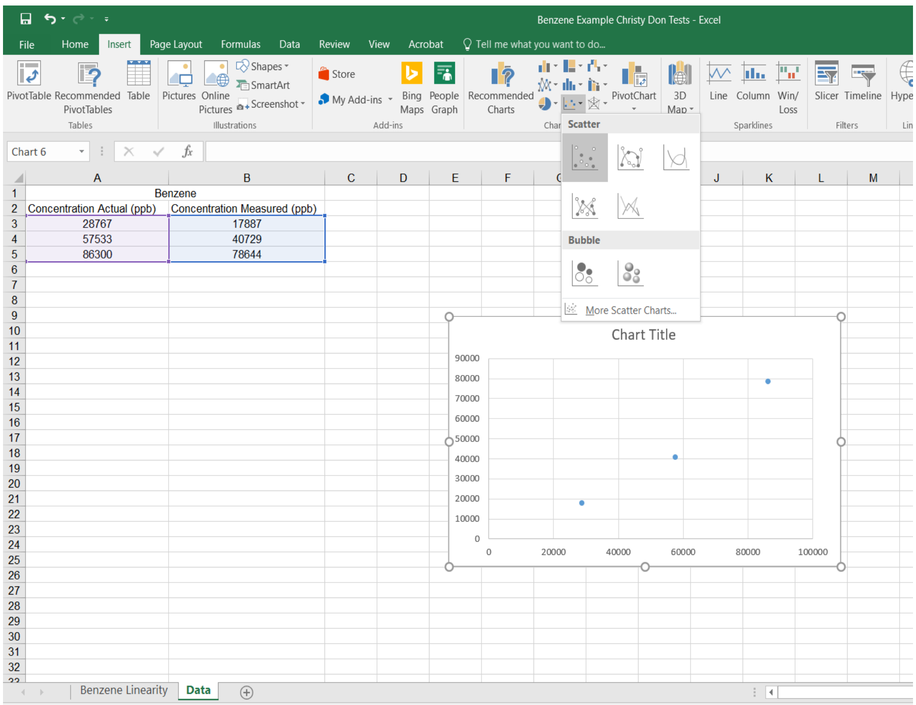
9. Using the procedure to determine the optimal precision and accuracy for each concentration, record the lowest combination of measurement error for each gas concentration.

10.

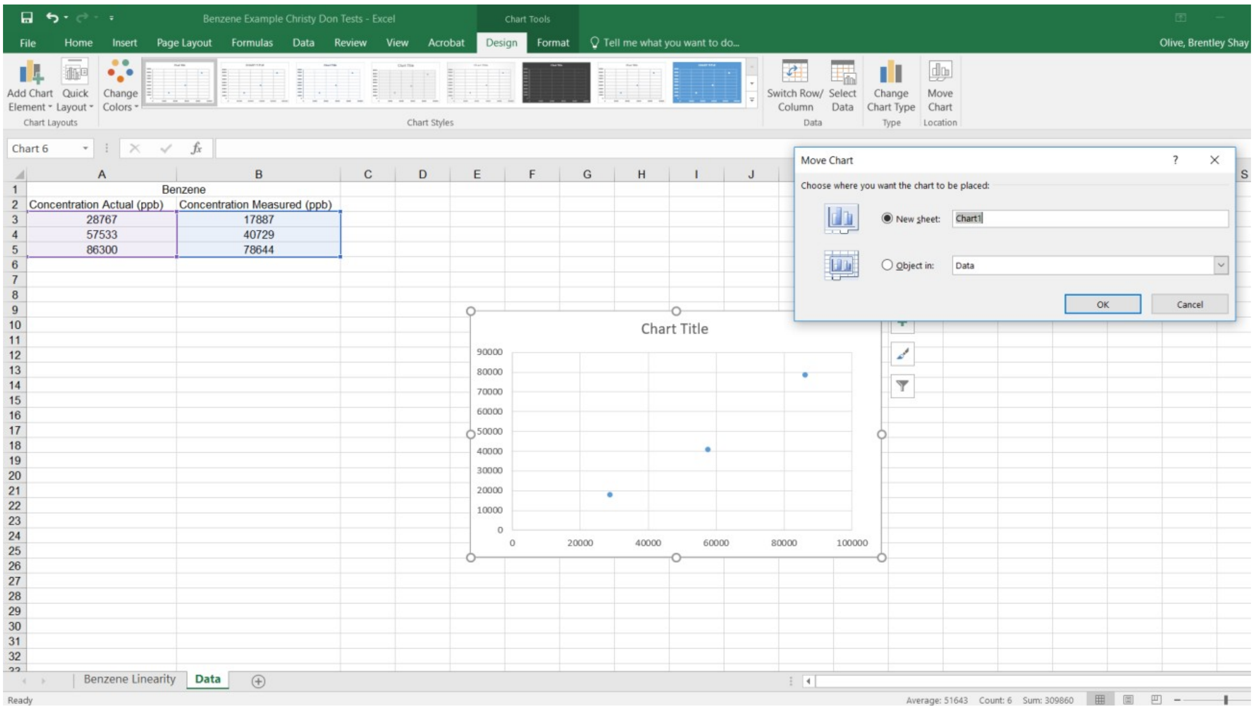
11. Open Excel. In a new Excel worksheet, create two columns, one for the actual c1, c2, and c3 cell concentrations and one for the measured results. By default, Excel will plot the column to the left on the x-axis (independent variable), and the column to the right on the y-axis (dependent variable).



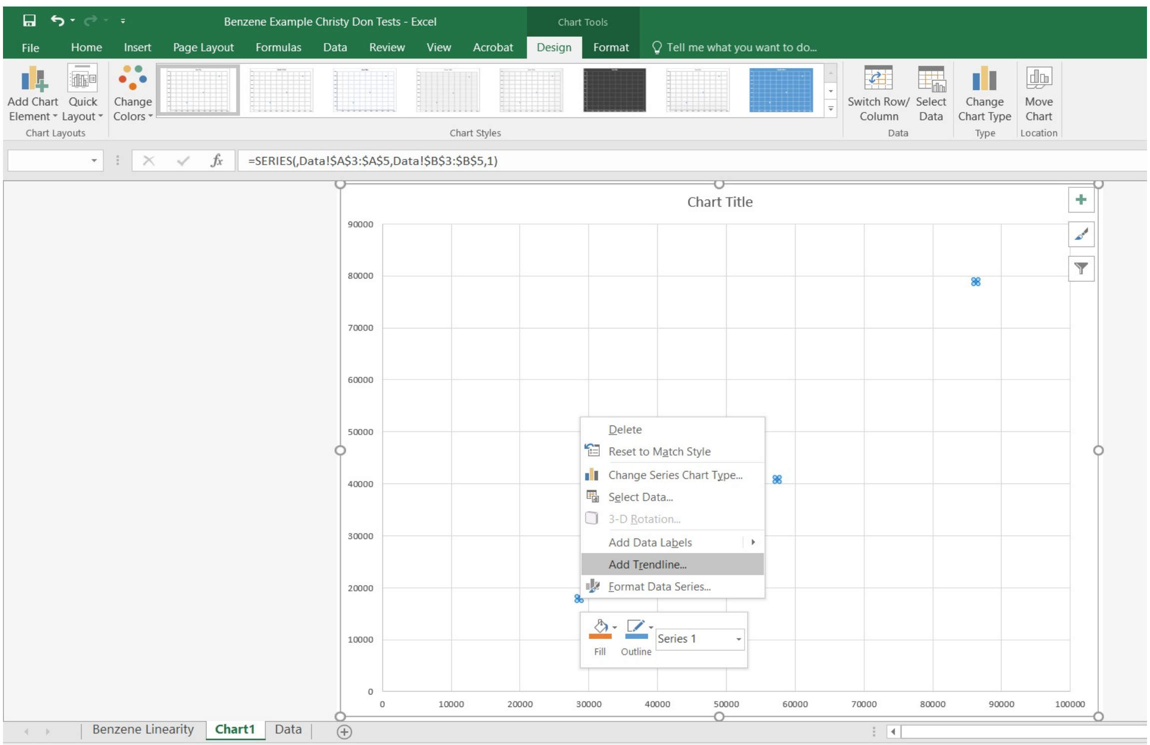
12. Highlight the two columns and choose "Insert", "Scatter".



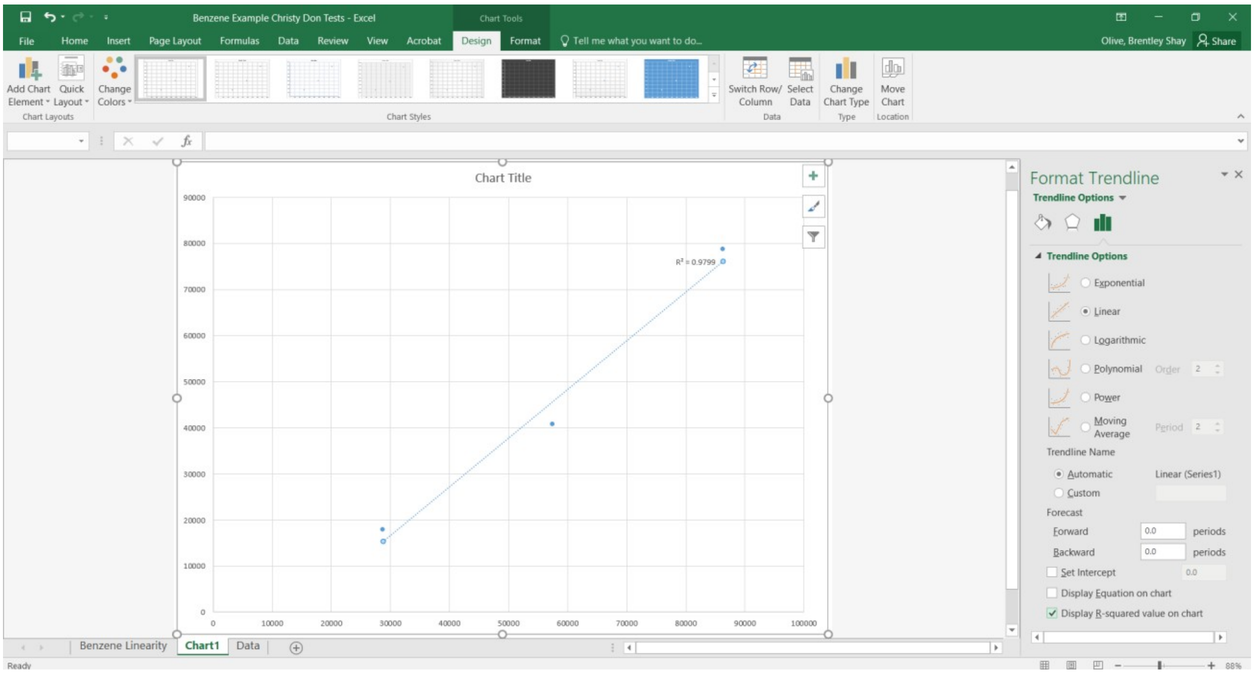
13. A scatterplot will be inserted into the active spreadsheet tab. If desired, the newly created graph can be selected, and by clicking "Move Chart", the graph will be moved to a new tab and enlarged.



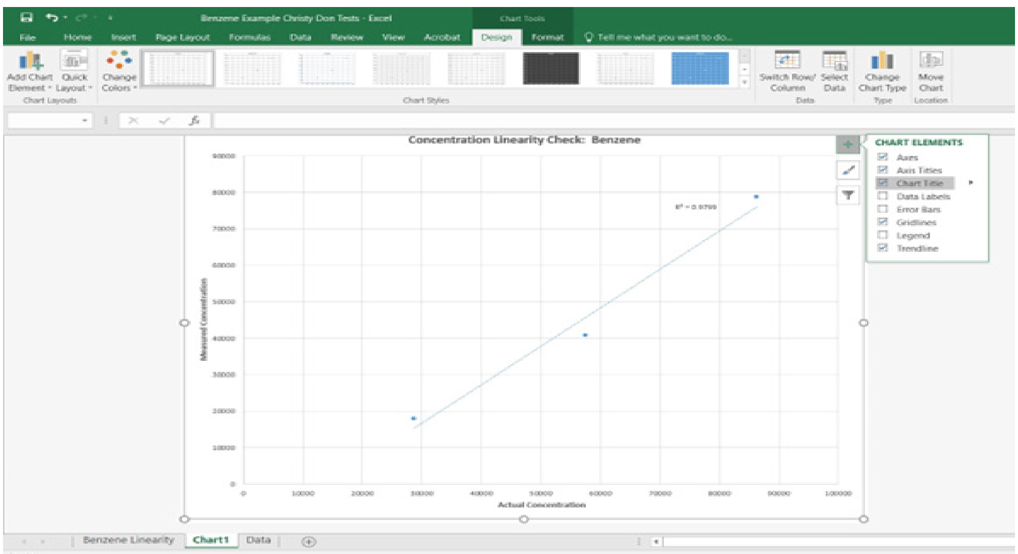
14. Right click on any of the plotted points and select "Add Trendline".



15. An option bar will appear on the right-hand side of the screen. If not selected by default, select “linear” from the list of options, and check the box for “Display R-squared value on chart”. An R-squared value of 1 equates to a perfect linear correlation. In general, values at or above 0.9 are desirable when a linear instrument response is assumed to be the case. The PLS software can compensate for non-linear instrument responses at higher concentrations when reference spectra at corresponding concentrations are collected and entered into the algorithm.



16. Additional options can be selected such as displaying the straight-line equation on the chart, as well as adding axis titles, adjusting gridlines, and formatting the plot area by either double clicking or right-clicking on various options.



Record and archive the R-squared value for the specific concentration linearity check. Compare the results to previous checks to determine if there is a significant difference in instrument performance as compared to past linearity checks.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP - Corrective Action Procedure

Purpose

The purpose of the Continual Improvement and Non-conforming Work Procedure is to encourage the ongoing re-assessment and improvement of the business Management System and to define the parameters and procedures by which such changes are considered and documented.

This procedure describes the process and responsibilities for the identification, control, follow-up and close out of improvements and non-conformities identified in the business's management and technical system.

Scope

This procedure applies to formal non-conformities identified at any management system audit and all processes, external or internal, where improvements or non-conformances are or can be raised and have to be actioned.

Definitions/Abbreviations/Acronyms

Non-conformance	:	Non-fulfilment of a requirement.
Requirement	:	A need or expectation that is stated, generally implied, or obligatory.
Correction	:	Action taken to eliminate a detected non-conformity.
Corrective Action	:	Action taken to eliminate the cause of a detected non-conformance or other undesirable situation in the management system or process, so as to prevent recurrence.

Preventive Action	:	Action taken to determine and eliminate the causes of a potential non-conformance or other undesirable potential situation to prevent occurrence.
Improvement	:	Action taken to improve an otherwise satisfactory process or system.
Management Team	:	Includes the Managing Director, Manager and General Managers or authorised designates
Root Cause analysis	:	A root cause analysis is conducted to determine the real cause (not symptoms or explanations) of non-conformities. The root cause is the reason why a problem started in the first place.

Responsibility and Authority

- The **Project Manager** is responsible for the implementation of this procedure.
- The **Management Team** or designates have the responsibility and authority to ensure that all non-conformances are processed, and corrective action is implemented, effective, and managed to completion within the predetermined time limit.
- The Management Team has the authority and responsibility to handle and control the non-conforming work, halt work where applicable, determine when test/calibration reports are finalized and authorise the resumption of work.
- All employees are required to report non-conforming work and assist in the investigation and close-out of non-conformances.

  Note: where a job title is mentioned, the action can also be performed by the authorised designate(s). Refer to the Authority Matrix (IMS-QLT-REG-009) for details.

General

- Non-conformances may be the result of the following, but are not limited to:
  - Failure of the business and its personnel to comply with the requirements of the quality management system, standards, and regulations.
  - Failure of test/calibration/verification data to meet required standards.
  - Failure of resources (e.g., equipment, people, etc.) to meet performance or other specified requirements.
- Any employee may initiate a non-conformance, improvement, or preventive action by following these steps:

- Create a detailed description of the non-conformance, improvement, or preventive action (see Appendix 1 for guidelines).
- Notify the Assistant and line management.

Control of Non-Conforming Work

- The Management Team shall evaluate the significance of the non-conforming work to make a decision about its acceptability. The decision shall be based on scientific knowledge and the relevant requirements of the specific methods.
- If the Management Team deem it necessary, work shall be halted, and determine when test/calibration reports are finalized.
- The root cause shall be determined, and relevant corrective and preventive action shall be implemented to correct the nature of the non-conformance. All decisions shall be documented and retained within the relevant project file.
- A non-conformance shall be registered in the Non-Conformance and Audit Register (IMS-QLT-REG-002) and documented on the Non-Conformance and Improvement Report (IMS-QLT-FOR-001).
- The Management Team shall ensure that the client is notified about the non-conformance and any associated corrective action.
- In the event where a test/calibration report has been issued with a non-conformance, the test/calibration report shall be recalled, and an amended test/calibration report shall be issued.
- The Management Team shall authorise the resumption of work upon the implementation of the corrective action.

Corrective Action

1.1. NEED FOR CORRECTIVE ACTION

- Corrective action requires careful consideration to determine the root cause of a non-conformance and may involve a team.
- Corrective action includes measures to immediately address the problem (correction) and to see that they do not recur.
- Corrective action shall be taken in the event of the following, but not limited to:
  - Non-conformance creates an unacceptable risk to the business.
  - Correction is not enough to prevent recurrence of a non-conformance.
  - Non-conformance adversely affects the business's ability to demonstrate competence.

1.2. CORRECTIVE ACTION PROCESS

- The business adheres to the following steps for implementing corrective action when non-conformances from its policies and procedures are detected within the management system or technical operations. These steps include:
  - Registration of non-conformances, improvements or preventive actions in the *Non-Conformance and Audit Register (IMS-QLT-REG-002)*. *(Note: A unique number is assigned to each non-conformance).*
  - Document the non-conformance on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
  - An Impact Assessment shall be conducted to determine if a full root cause investigation is required. This shall be recorded on the *Non-Conformance and Audit Register (IMS-QLT-REG-002)* and indicated on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
  - The Impact Assessment is conducted by the Manager and verified by an impartial source, e.g., a member of the Management Team.
  - The Project Manager in consultation with the Line Manger(s) shall assign the non-conformance to a designated person.
  - The designated person in conjunction with a team will initiate an investigation to determine the root cause(s) of the problem if required (see Appendix 2 for guidelines on root cause analysis) and compile an action plan to correct and prevent the problem from being repeated.
  - Risks identified during the investigation of the non-conformance shall be indicated in the risk register and reviewed on an annual basis.
  - The Risk Register will be updated and reviewed by the Management Team.
  - The action plan shall be submitted to the Project Manager within two weeks from the date of initiation of the non-conformance.
  - The Management Team and the designated person shall monitor the investigation process.
  - Following the implementation of the corrective actions, the final close-out date shall be indicated on the *Non-Conformance and Audit Register (IMS-QLT-REG-002)*, and the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)* plus corresponding evidence of corrective actions sent to the Manager to verify the actions taken.
  - For internal audits/non-conformances, the Project Manager/Line Manager(s) shall verify the corrective action on the close-out date or within one week of the final close-out date.
  - If the corrective actions are reviewed and found to be unsatisfactory, this is to be indicated on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001),* and the designated person shall review the root cause and revise the corrective actions.

- Once the corrective actions have been verified by the Project Manager/Line Manager(s), the verification date is recorded on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)* and *Non-Conformance and Audit Register (IMS-QLT-REG-002)*.
- Evaluation of the effectiveness of the corrective actions shall be scheduled on the *Internal Audit Schedule (IMS-QLT-REG-007)* approximately one month after the corrective action verification date. Should this evaluation not be possible within the designated timeframe, justification shall be provided on the Non-Conformance Register. The Management Team or Project Manager shall evaluate the effectiveness of the corrective actions. This shall be recorded on the Non-Conformance/Improvement Report, and in the event that the corrective actions have not had the desired effect, a new non-conformance shall be raised.

- All evidence of investigations of non-conformances shall be filed in either hard copy or electronic copy.

  Note: *The time-frame for external audit findings to be investigated and corrective actions implemented shall be dependent on the requirements of the accreditation body or auditing organization; internal audit findings shall be investigated, and an action plan shall be developed to ensure corrective actions are implemented within an agreed upon timeframe. The action plan shall be compiled and submitted within two weeks from the initiation of the audit finding.*

Preventative Action Improvements

1.3. GENERAL

- Preventive action is a proactive process whereby improvements and potential sources of non-conformances are identified internally. These may be technical or concern the quality management system itself.
- Action plans are developed, implemented, and monitored to reduce the likelihood of the occurrence of non-conformances and to take advantage of the opportunities for improvement and to ensure that they are effective.
- Every employee shall attempt to identify improvements and potential sources of non-conformances, either operational or concerning the management system.

1.4. SOURCES OF PREVENTIVE/IMPROVEMENT ACTION

- The business continually improves the effectiveness of its management system by identifying opportunities for prevention or improvement via the use of any or all the following:
  - *Health and Safety (IMS-SFT-POL-001)* and *Quality Policy (IMS-QLT-POL-001)*
  - *Code of Integrity (IMS-QLT-POL-002)*
  - *Business objectives for the various businesses* (which are reviewed regularly)

- Audit results
- Analysis of data
- Corrective and preventive actions
- Management review
- Project planning
- Customer feedback
- Training
- Maintenance
- Employee feedback and performance reviews
- Meetings

Note: Preventive action must be taken after the trend analysis of root causes identified during the Management Review process to ensure that they are not repeated.

Preventive and improvement action can further be indicated in the Risk Register.

1.5. PREVENTIVE/IMPROVEMENT ACTION PROCESS

- When preventive/improvement action or risks are identified, the individual shall ensure that it is reported to the Project Manager and shall be recorded on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
- The Management Team shall be responsible for implementing and monitoring the action plan to ensure that the appropriate actions are taken within a reasonable time frame and that resulting changes are effective.
- Records of the continual improvement process shall be maintained and controlled by the Manager.

Records

- Non-conformances from audits as well as internally identified by employees.
- Evidence of investigations of root causes.
- Evidence of implementation of corrective actions.
- Non-Conformance and Audit Register (IMS-QLT-REG-002).
- Non-Conformance/Improvement Report (IMS-QLT-FOR-001).
- Risk Registers.

References

- ISO 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories.
- X-Lab Root Cause Analysis Training, Aleesha Sewpersad, January 2020.
- IMS-QLT-REG-007 Authority Matrix

Replacement

This document replaces IMS-QLT-MAN-010, Revision 03 dated 2 July 2020.

Approval

	PREPARED BY:	UPDATED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Management Team	Don Gamiles
Title	Manager	Managing Director	N/A	President
Date	17 January 2017	11 May 2020	3 June 2020	3 June 2020
Final approval signature				

Appendix 1: Guidelines for describing non-conformances, etc.

1.6. The description must be:

- Clear and understandable – make sure everyone can understand the description.
- Concise – only include what is necessary.
- Correct – make sure all the information provided is right.
- Complete and detailed: make sure all the necessary information is provided (What, When, Where, Who)

1.7. The description should contain reference to the relevant clause in a standard or section in a procedure, if applicable.

1.8. The description should contain metrics where applicable, e.g., Z-scores, QC data.

1.9. Examples:

- Example 1: Incorrect description:
  Original statement: "The LGC Aquacheck PT (Round 28-AR0792) indicated questionable results for the Total Solids – Z-score 2.24".

  Correct statement: "The LGC LGC Air Stack Emissions for PT (Round 28-AR0792) indicated questionable results for the dust analysis – Z-score 2.24".

- Example 2: Description too vague:
  Original statement: "Decision rules have not been defined internally or with the customer."

  Better statement: "Decision rules regarding the inclusion of uncertainty of measurement when reporting results against specifications and standards have not been defined internally or with the customer. ISO 17025:2017 Clause 7.1.3"

- Example 3: Description incomplete:
  Original Statement "SABS Group 2 - February 2019 - Unacceptable results for Nitrate, and Hexavalent Chromium."

  Better statement: "SABS Group 2 PT (Water) - February 2019 - Unacceptable results for Nitrate by DA (-3.98; -3.43; -5.06) and Hexavalent Chromium by DA (132.02)".

Appendix 2: Guidelines for root cause analysis

1.10. Put together a team to do the root cause analysis. This should include anyone involved in the problem and its resolution.

1.11. Identify the problem.

- This can be taken from the Non-compliance Report (NCR) finding statement, provided that has been properly described.

1.12. Investigate the problem.

- What happened?
- Where did it happen? Physical location, stage of process, environment
- When did it happen? Has it happened before? When did it start?
- Who was involved? Who reported the problem? Who is impacted (staff/project/job)?
- What is the extent of the problem? How serious is the problem? Is it specific to a section/process? Is it throughout? How many projects/jobs are affected?
- How did it happen? How was it discovered? Equipment, maintenance, reagents, quality control, records, methods, procedures, training, etc.

1.13. Identify the root cause(s).

- There may be more than one root cause for the problem.
- These can generally be assigned to one of the following categories:
  - MAN (anyone involved with the process)
  - METHODS/SYSTEMS (how the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations, and laws)
  - MACHINE/EQUIPMENT (any equipment, computers, tools etc. required to accomplish the job)
  - MATERIALS (raw materials, parts, pens, paper, etc. used to produce the final product)
  - MEASUREMENT (data generated from the process used to evaluate its quality)
  - ENVIRONMENT (the conditions, such as location, time, temperature, and culture in which the process operates)
- For each question answered above, that identified something that was wrong, ask "why?" at least 5 times (5 Whys Process). Eventually, the answer to the question will not change and this last unique answer is likely the root cause.
- Once identified, for each root cause ask:
  - Is this root cause really the cause of the problem?

- Is this root cause necessary for the problem to occur?
- Is this root cause alone sufficient to cause the problem?

- If the answer to any of these questions is "no", the true root cause has not been identified or additional root causes need to be found.
- If not already done, assign the root cause to one of the categories listed above.

1.14. Develop an action plan(s) to resolve the root cause(s).

- Decide what needs to be done to remove the problem permanently.
- Plan how this is to be implemented.
- Set a completion date.

1.15. Document all of the above on the non-conformance/improvement report and submit this to the Management Team for review and approval.

- Make sure all the evidence from the investigation is attached.

1.16. Implement the approved plan(s) within the completion date.

1.17. Monitor the situation to decide if the problem has been eliminated.

1.18. Retain evidence of the implementation and monitoring.

System Challenges of Open-path TDL Air Monitoring System Operation and Maintenance

Overview

The purpose of the document is to present the specific operation and maintenance procedures needed to maintain compliance with BAAQMD Rule 12-15.

The specific procedures used to perform these checks are as follows:

Check Type	Check	Frequency	MQO
Routine Operation	Follow the manufacturer recommended operational procedures	Continuous	Documentation demonstrating operational procedures are being followed.
Planned Maintenance Checks	Follow the manufactures recommendation for maintenance procedures	Monthly and Quarterly	Documentation demonstrating routine procedures are being followed.
Non-Planned Maintenance Checks	Follow the manufacturer recommendation for maintenance procedures	As Needed	Documentation demonstrating non-routine procedures are being followed.

The Standard Operating Procedures associated with the Operation and Maintenance of the Open-path TDLs are found below.

Contents

Planned Maintenance

Scope

This procedure describes the actions and communication that takes place when a system is undergoing routine maintenance, QA/QC checks, or field repair. In regards to the open-path TDL air monitoring system, the following routine maintenance checks occur:

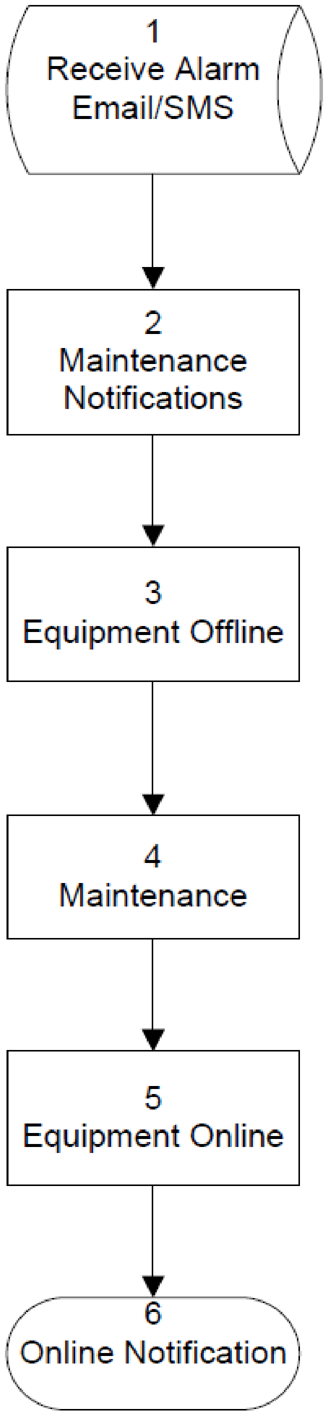
Activity	Monthly	Quarterly	Annually
Visually inspect the system.	✓		
Confirm the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well.	✓		
Download data from detector hard drive and delete old files to free space, if needed.	✓		
Ensure there are no obstructions between the detector and the light source.	✓		
Verify system settings.	✓		
Clean optics on detector and retroreflector.	✓		
Realign system after service.	✓		
Check system performance indicators.	✓		
Annual Service Check			✓

Responsibility and Authority

- ### Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments, and undertake corrective action where necessary.
- ### Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit in order to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR- 001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.
- Flow Chart – Planned Maintenance

Process Flow: Planned Maintenance



Procedures

1. In the event a system is undergoing routine maintenance, QA/QC checks, or field repair, the following actions will be taken:
   - The refinery will be notified of the activity by E-mail.
   - A remote Argos Technician will take the unit off-line through the Argos Remote Access system, so that the data is not transmitted to the real-time website.
   - When the activities are complete, the systems will be brought back on-line, and the following actions will be performed:
     - The field technicians will optimize the signal of the system and leave the system in alignment mode.
     - A remote technician will collect a new background file.
     - A remote technician will start the system.
     - The remote technician will wait for one 5-minute scan to complete to ensure that the system is operating correctly.
2. The refinery will be notified that the system is back online, and the real-time website will be updated with the same notification.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence-line Monitoring

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019
Final approval signature			

Unplanned Maintenance

Scope

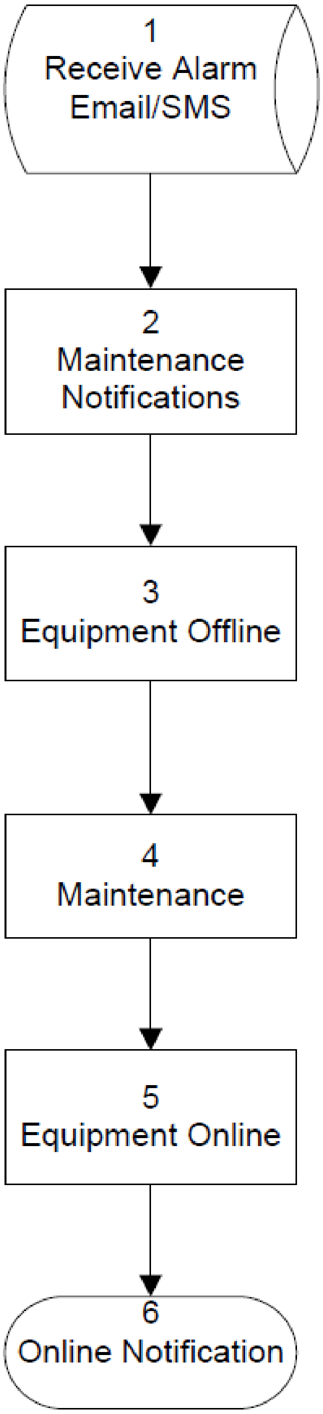
This procedure describes the actions and communication that takes place when a system undergoes non-routine maintenance.

Responsibility and Authority

- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites when an equipment call-out occurs and undertake corrective action where necessary.
- Remote Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each event and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR- 001)*
- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Planned Maintenance

Process Flow: Unplanned Maintenance



Procedure

- In the event a system undergoes non-routine maintenance

    - An alarm notification will be sent to the on-call staff who will initiate a work order to identify and correct the issue.
    - The refinery will be notified of the activity by E-mail.
    - A remote Argos Technician will take the unit off-line remotely, so that the erroneous data is not transmitted to the real-time website.
    - The corrective action plan will occur using the work order process.
    - When the activities are complete, the systems will be brought back on-line, and the following actions will be performed:
        - The field technicians will optimize the signal of the system and leave the system in alignment mode.
        - A remote technician will collect a new background file.
        - A remote technician will start the system.
        - The remote technician will wait for one 5-minute scan to complete to ensure that the system is operating correctly.
- The refinery will be notified that the system is back on-line, and the real-time website will be updated with the same notification.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001

References

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019

Final approval signature	

General Operation of Open-path TDL Air Monitoring System

Scope

This document refers to the procedure to perform startup operations for the AirOptic Open-path TDL air monitoring system. This procedure will allow to reach a signal level of greater 1% return light signal for the system.

Software Applications

The following applications are needed to perform startup and light signal optimization:

- Air Optic Gas Sense Software
- Argos Grafana Real-time Dashboard

Hardware Requirements

The following hardware is needed for this application:

- Air Optic GasEye Open-path TDL
- 10 inch retroreflector cube

Procedure

4.1 Connect Laptop to TDL

- Plug in the TDL power cable to 110v power outlet to power on the system.

- Connect the laptop to the TDL ethernet outlet.

[redacted]

4.2 -

4.2 Verify the IP address from the label on the TDL.

[redacted]

- Type in credentials to login. [redacted]

[redacted]

4.3 Setting Parameters for alignment.

- Under Parameters →MP1→ Process set the value of **"MEAS.PATH_LENGTH_CH_1_(m)"** to two times the distance between the TDL and reflector. i.e., the reflector is 400 meters away from the TDL, set the value to 800.

[redacted]

- Under Parameters →SCAN→ Scan0 set the value of **"SCAN0.TRANS_THRESHOLD"** to 0.0001.

[redacted]

- Under Parameters →FIT→ FIT403 toggle **"FIT403.SCALAR_COR_ENABLE"** to Off.

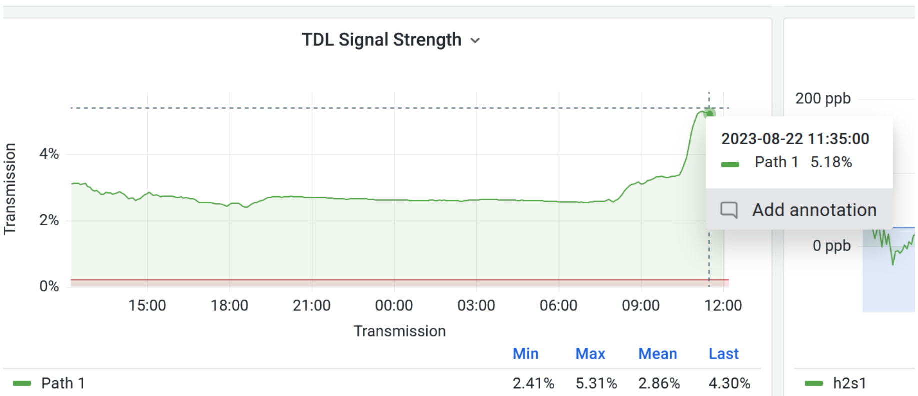
4.3 – System Alignment

- Align the receiver by gently moving the receiver up/down or right/left using the cranks located in the tripod below the receiver box and observing the maximum light intensity value.

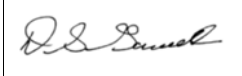
- Maximize light signal above 5% light transmission

4.4 – System Check

- Access the Argos Grafana dashboard and confirm the light transmission signal is greater than 5%.



Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019
Final approval signature			

System Operations Checks of Organic Gas Detector (OGD) Air Monitoring System:

Overview:

The purpose of the System Operation Checks (SOC) is to continuously check the system in real-time to ensure the analyzer is working in a manner to produce valid data. If a check occurs that indicates a potential performance issue, a message is sent to the on-call support team to evaluate the issue and perform corrective actions as needed. SOC flags can be generated by the instrument itself, by monitoring site parameters such as Internet connectivity, as well as evaluating the data for external events such as weather-related issues. The specific SOCs for the OGDs are listed in Table 1.

Table 1 summarizes the specific SOPs used to address each SOC.

System Operating checks	Check	Frequency	MQO
Instrument Malfunction Error Code	If a malfunction error code occurs, a validated detection of OGD occurs, or an environmental issue is detected: generate a system performance flag and notify on-call support	Continuous	Check Error Code Status
Hardware Failure Flags	If the last data point in the database is more than 20 minutes old, generate a hardware failure flag and notify on-call support.	Continuous	Check the time of the last data point collected
Internet/Data Failure Flag	Check to see if more than one analyzer is not reporting Data	Continuous	Check to see if multiple instruments are not reporting data

Environmental Conditions Flags	Check to see if a light signal or other operational parameters are impacted by environmental factors such as humidity, temperature, etc.	Continuous	If ambient parameters are outside of the optimal equipment operation range, then generate a flag
Data Validation of a Detect	If the detection of gas meets all of the continuous data validation checks, notify on-call support for review.	Continuous	Check Data Validity Flags

Argos and, where appropriate, refinery staff, are notified via email if any equipment is operating outside the set operational parameters. They are set to notify Argos and refinery staff when the possibility of poor system performance or communication may affect data or data collection. Argos staff review data generated associated with the identified issue and begin a troubleshooting process outlined in the Argos Alarm Response Procedures Guide. If the issue cannot be corrected through this troubleshooting process, a work order is produced to direct field staff to correct the issue. The specific SOPs for each of the system checks are listed below.

Contents

SOP - Instrument Malfunction Error Code

Scope

The fence line monitoring system has the following alarms set up to automatically monitor the operation of the system:

1. A validated gas detection of volatile organic compounds (VOCs)
2. System Fault Alarm:
    a. If the system generates a operational fault alarm.
    b. If internet communication is lost
    c. If a field monitoring computer workstation is down

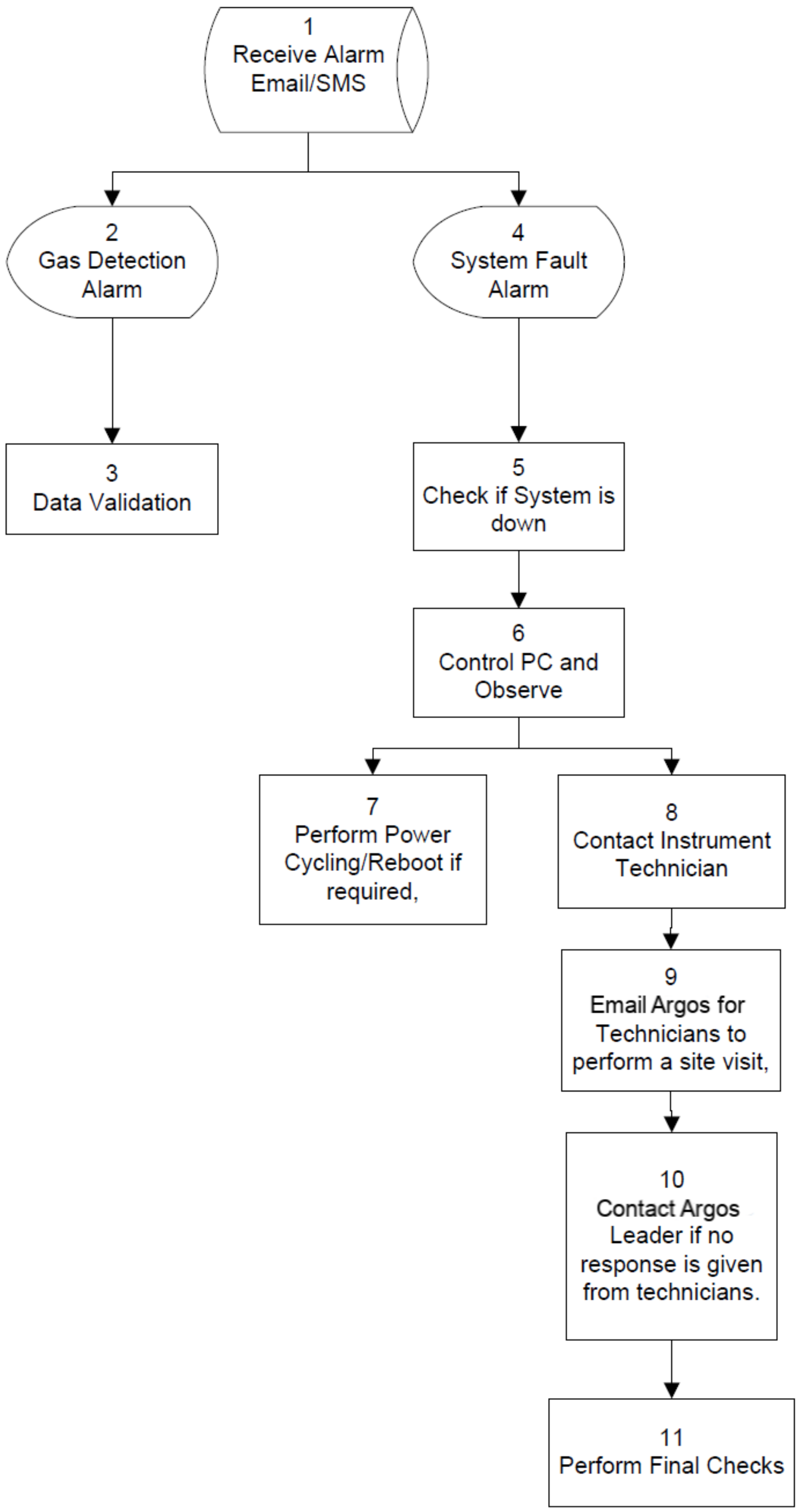
Responsibility and Authority

- ### Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments, and undertake corrective action where necessary.

- ### Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- ### Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – General Alarm Response Procedure



Procedure

1. An e-mail or SMS message is sent out to concerned parties as specified below:
    - Gas Alarm results are communicated to Argos and the refinery.
    - System down alarms are communicated to Argos and the refinery.
2. If an alarm is received that the gas detection level is over the Limit of Quantification, then:
    - A remote technician validates the raw data and logs any adjustments made to the system.
3. If an alarm is received concerning a system fault specified, and depending on the fault reported, the procedure is followed as per documentation:
    - A remote technician checks to see if the system is down, and then he/she:
        - Takes control of on-site computers using the Argos remote access system to observe probable causes through observation and depending on findings will either:
            - Re-initialize any data acquisition software: or
            - Perform a power cycling/ reboot, if the system is shut down due to a power outage or an update cycle; or
            - If the fault cannot be fixed by the steps above the fault is escalated to an Operational Technician.
            - If the fault persists, an e-mail is sent to Argos for an Operational Technician callout on-site. Together with remote technician support, an Operational Technician creates a work plan (work order) and visits the site, and checks the system for:
                - Instruments not operating.
        - If, after one hour from the callout, no updates from on-site technicians have occurred, an e-mail is escalated to Argos Project Management staff to notify of the delay in the execution of a site visit.
        - Once the fault is found and corrected, an on-site technician contacts the remote technician to conduct a verification of proper instrument operation as outlined in appropriate SOPs that will ensure that setup was done correctly, and the system is working properly.
        - The remote technician checks the following before logging out of the remote computer:
        - Signal strength
            - OGD - Light signal flag is good
        - Data is reported to the website.

Records

Argos Work Order

IMS-QLT-MAN-010

FLM-QLT-FOR-001

References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	29 August 2022
Final approval signature			

SOP - Hardware Failure Flags

Scope

In the event of a field monitoring computer malfunctions, Argos Scientific will be notified via e-mail, and refinery personnel will be notified via email or text of the condition. Argos will begin the process of troubleshooting and an Argos Operational Technician will attempt to restart the workstation.

Responsibility and Authority

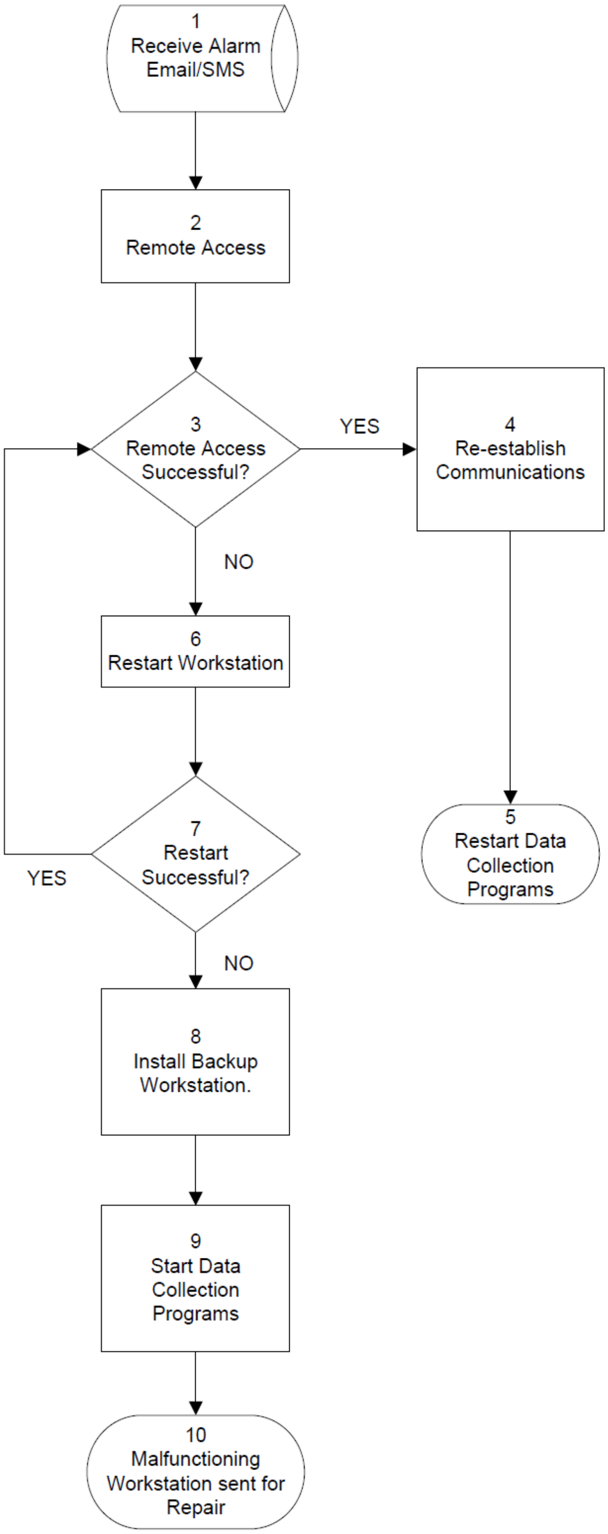
- ### Operational Technicians / Contract Technicians
  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
  - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- ### Data Technician and Technical Manager
  - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
  - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- ### Technical Manager
  - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Field Data Workstation Malfunction

Process flow: Field Monitoring Computer Workstation Down



Procedure

1. A remote technician will attempt to remotely access the computer using the Argos remote access system.

2. If remote access was successful, then:
   - Re-establish communications; then,
   - Restart all data collection programs.
3. If Argos cannot establish a remote connection, then an Argos Operational Technician or a qualified subcontractor will be dispatched to restart the system.
4. If the computer restart is successful, then all data collection programs will be restarted.
5. If restarting the computer is not possible, then the Operational Technician will install the backup field monitoring computer workstation.
6. The remote technician will start all data acquisition programs on that computer.
7. The malfunctioning workstation will be sent to Argos for repair.
8. The *Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001* will be updated.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

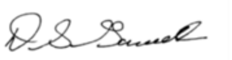
References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	08/28/22
Final approval signature			

SOP - Internet/Data Failure Flag

Scope

Site is connected to a database via an internet connection. When communication is lost, Argos Scientific is notified via email and the situation is monitored until the internet reconnects. Refinery personnel will be notified via SMS or e-mail notification. If the notification is received, Argos will respond to the notification as soon as possible.

Responsibility and Authority

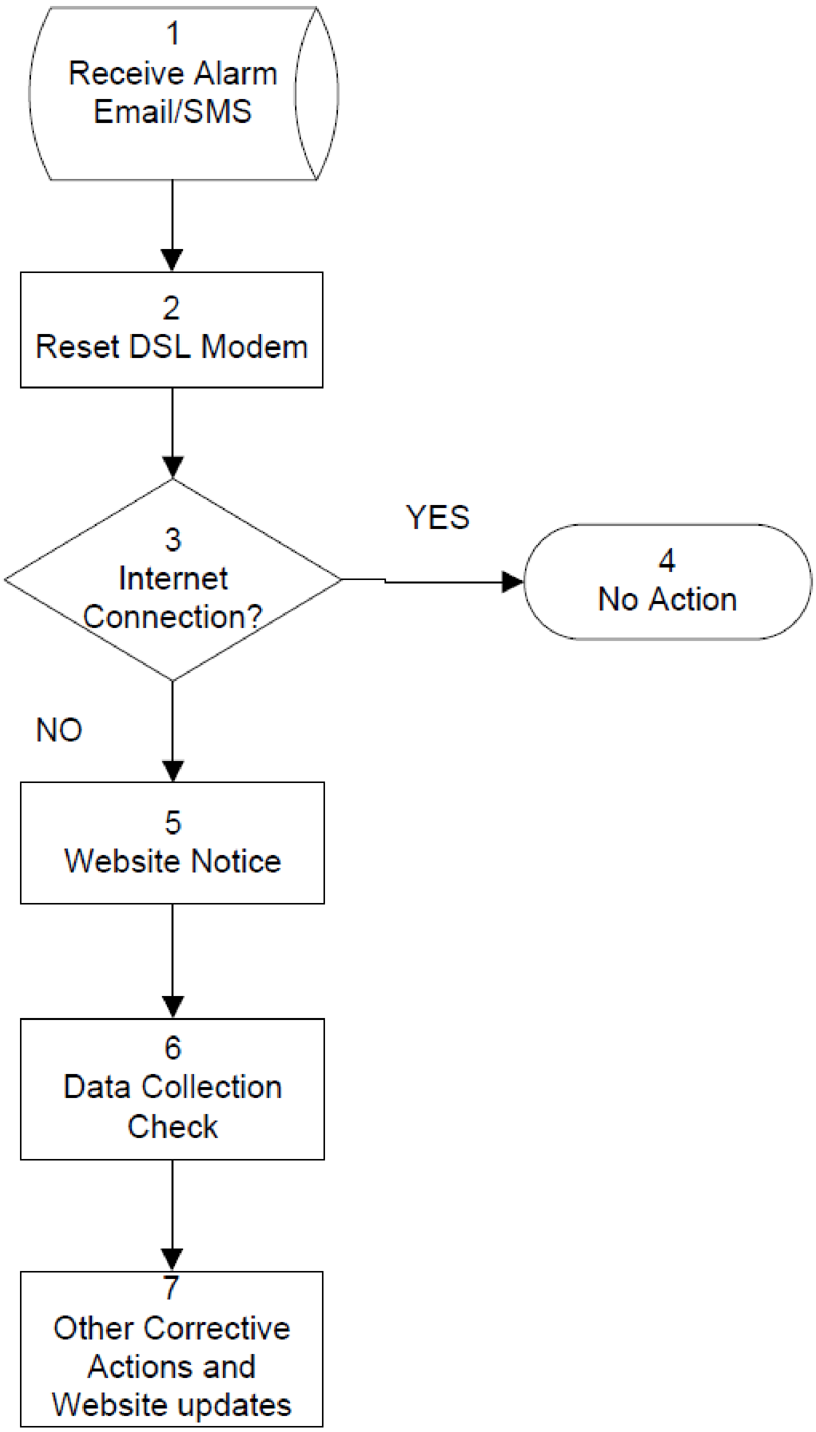
- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Loss of Internet Communication

Process Flow: Internet Communication is Lost



Procedure

1. Argos will begin the process of troubleshooting and an Argos Operational Technician will attempt to reconnect to the Internet by resetting the modem located at the monitoring station.
2. The internet connection will be checked and, if:
    - The connection has been re-established, then no further action is needed;
    - The connection has not been re-established, then the following actions will be taken:
        - Argos will post a note to the message board of the real-time website stating that the Internet connection has been lost and actions are in place to re-establish the connection; then,
        - The Argos Operational Technician will go to all of the monitoring systems to make sure they are still collecting data and finally,
        - The real-time website will be updated as the corrective action(s) are taken.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence line Monitoring.

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019
Final approval signature			

SOP - Environmental Conditions Flags

Scope

If the weather related flag occurs, Argos Scientific will be notified via e-mail and refinery personnel will be notified via page or e-mail of the event. Upon receiving this notification, Argos will access the instruments to determine if the loss of signal is due to weather (e.g., fog, rain etc).

Responsibility and Authority

- Operational Technicians / Contract Technicians
  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
  - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

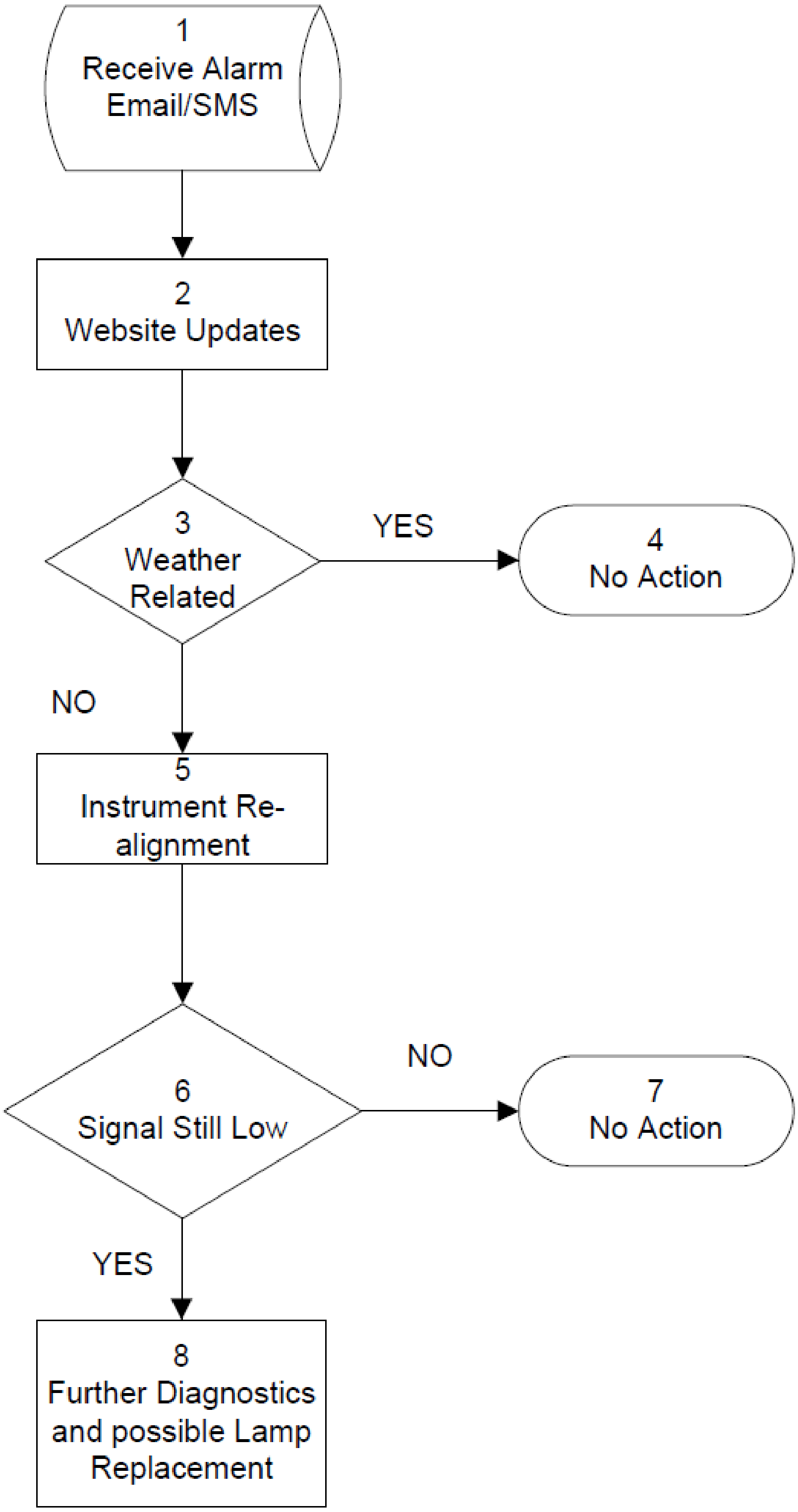
- Data Technician and Technical Manager
  - It is the responsibility of these staff to login onto the computer during each visit in order to facilitate data manipulation and record any corrective action that needs to be taken.
  - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
  - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective

action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Operational Event Scenario 2

Process Flow: An OGD has Low Signal



Procedure

1. If the signal strength flag is enabled, Argos will be notified via e-mail and refinery personnel will be notified via SMS or e-mail of the event. Upon receiving this notification, Argos will access the instruments remotely via the Argos remote access system to determine if the loss of signal is due to weather (e.g., fog, rain etc.).
2. The real-time website message board will be updated to indicate which instrument has low signal. Data from that monitoring station will be flagged accordingly.
3. If the notification is weather related, then no additional action will be taken.
4. The remote technician checks the following before logging out of the remote computer:
    1. OGD - Light signal flag is good
    2. Data is reported to the website.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Critical Spares Tracking List, FLM-QLT-REG-001
- Non-conformance/Improvement form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence-line Monitoring

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	August 2022	August 2022	August 2022
Final approval signature			

SOP - Data Validation Flags

Scope

The fence line monitoring system has the following alarms set up to automatically monitor the operation of the system to flag and report when a validated gas detection of VOCs occurs.

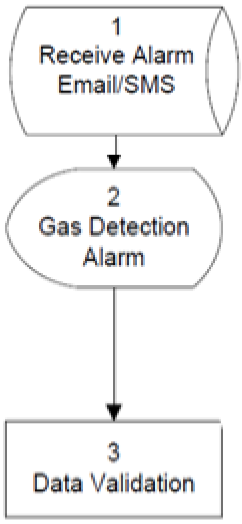
Responsibility and Authority

- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Validated Detection and Procedure



Procedure

1. An e-mail or SMS message is sent out to concerned parties as specified below
    - Gas Alarm results are communicated to Argos and the refinery.
2. If an alarm is received that the gas detection level is over the Limit of Quantification, then the following steps occur:
3. On-call support is contacted, and the following parameters are checked:
4. No system error code is present.
5. No weather-related events.
6. If these checks are invalid, the data point is flagged for further review.

Records

IMS-QLT-MAN-010

FLM-QLT-FOR-001

References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	29 August 2022
Final approval signature			

Organic Gas Detection (OGD) Total Volatile Chemicals (VOCs) Data Validation

Overview:

The purpose of the Data Validation Check (DVC) is to ensure that any data that has not been flagged as invalid meets appropriate data quality standards. DVCs are performed in real-time, on a daily basis, and anytime a data point is outside of normal parameters. The specific DVC for the OGD's are shown in Table 1.

Table 1 – VOCS Data Validation Checks

Check Type	Check	Frequency	MQO
Instrument Output Statistics	Check output statistics generated by the manufacturer's software	Real-time	Check output signals from sensor
System output statistics	Check output statistics generated by the logging software	Real-time	Check real-time MDLs, concentration to sigma ratio correlation coefficient
Quantitative Detection Validity Check	Determine if the detects identified meet valid quantification checks	Daily	Perform independent validation of VOCs detects
Review of Monthly Bump Check	Determine if the calibration check data meets precision and accuracy checks	Monthly	Insert NIST traceable gas standards into the beam path and measure the response
Senior Review	Evaluate data for systems trends	Monthly	Evaluate long-term performance trends

The SOPs for real-time validation of VOCS are included in (MSOP-001-TDL SCC) and are therefore not listed in the Table of Contents for this MSOP.

Contents

SOP - Quantitative Detection Daily Validation Checks

Scope

This describes the process where the Remote Technician does a manual check on the raw data collected in the last 24 hours. Items that are checked are:

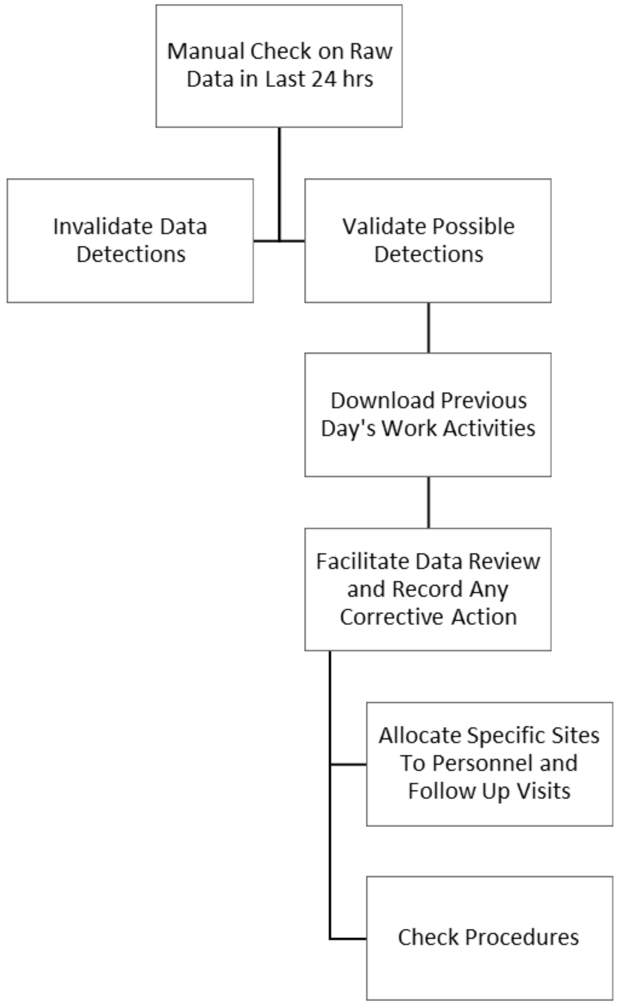
- Assess possible Weather-related effects that occurred.
- Validate any possible detections.
- Invalidate data detections that do not meet quality assurance parameters.
- Any data that needs to be flagged according to the following flagging conventions:

Flagging Code	Flagging Convention
0	Missing
1	Valid
4	Data For Review
5	QA/Maintenance
8	Low Signal/Offline

Responsibility and Authority

1. Operational Technicians/Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to log on to the computer or logbook daily or as and when required, to download the previous day's work activities.
2. Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer or logbook to facilitate data review and record any corrective action that needs to be taken.
3. Technical Manager
    - The Technical Manager is responsible for allocating specific tasks to personnel and following up that tasks are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Daily Manual Validation of Field Data



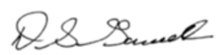
Procedure

1. Check LoQ to ensure data meets BAAQMD LoQ requirements for VOCs.
2. Check values against Argos Data Dashboard for the system being checked.
3. Check for gases that are above LoQ thresholds meet the required data validation parameters these are:
    - The measurement standard deviation is greater than 6.
    - Ambient methane concentration greater than 1.9 ppm.
4. Check data points marked as invalid against data validation parameters.
5. Check when humidity is above 90% and light signal below 4 volts transmission.
6. Check LoQ should always be more than the mean concentration for non-detects.
7. Check the completeness report.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP - Monthly Validation of VOCs Data

Scope

This process describes how a Data Analyst reviews the QA'd data from the bump test and the dataset for the prior month to ensure they are ready for inclusion in the Quarterly Data Reports. Items that are checked are:

Responsibility and Authority

8. Operational Technicians/Contract Technicians

- It is the responsibility of all Technicians/Contract Technicians to log on to the computer or logbook on a daily or as and when required, basis to download the previous day's work activities with a record of the station visit, dated and time-stamped and traceable to the operator performing the calibration checks.

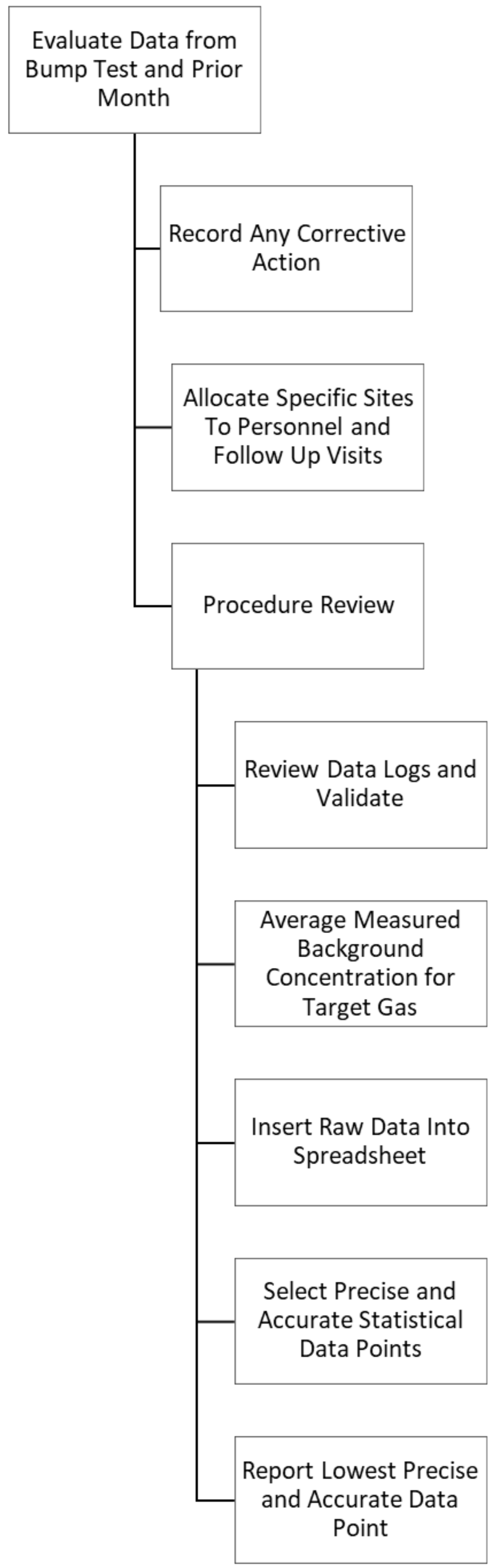
9. Data Technician and Technical Manager

- It is the responsibility of these staff to login onto the computer or logbook to facilitate data review and record any corrective action that needs to be taken.

10. Technical Manager

- The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Monthly Validation of Field Data



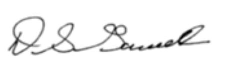
Procedure

1. Review data logs from Operational Technicians to validate the start and stop times for gas calibration.
2. Using the prior five-minute data set, average the measured background concentration for the target gas. Use this concentration as the background offset for the calibration data.
3. Insert the raw data into the spreadsheet that calculates the precision and accuracy.
4. Select the data points that have both precision and accuracy statistics that are below 15%.
5. Report the data point that has the lowest combined levels of precision and accuracy.

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP - Senior Analyst Validation Checks of VOCs Data

Scope

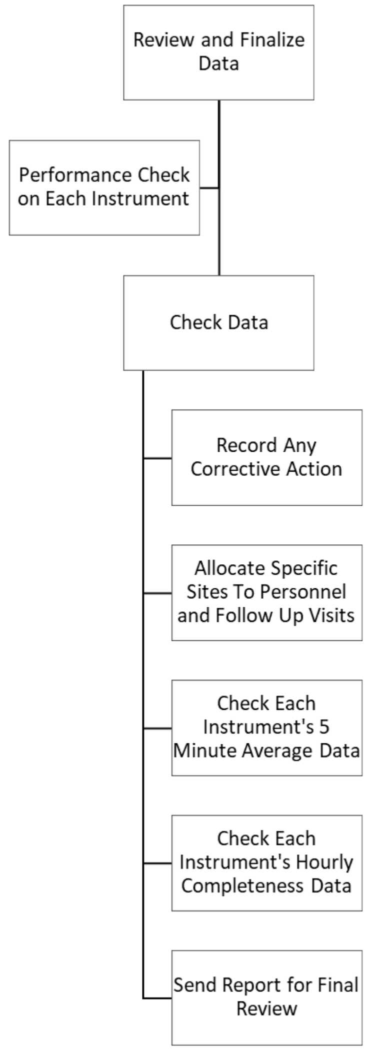
At this level of data validation data is reviewed by a project management level staff member to ensure all above processes have been followed and is finalized for inclusion into the quarterly reporting format that is required by the BAAQMD. The data to be checked include:

- Performance of each instrument against the onstream efficiency requirement of 90% calculated according to the BAAQMD reporting procedure.
- Data on monthly bump tests.
- Description of corrections made to data due to QA.
- Five-minute average data in the format prescribed by the BAAQMD.
- Hourly completeness data in the format prescribed by the BAAQMD.

Responsibility and Authority

- Data Technician and Technical Manager
    - It is the responsibility of these staff to evaluate the prior month's data set for the above flags and to login onto the computer or logbook to record any corrective action that needs to be taken.
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Senior Manual Validation of Field Data

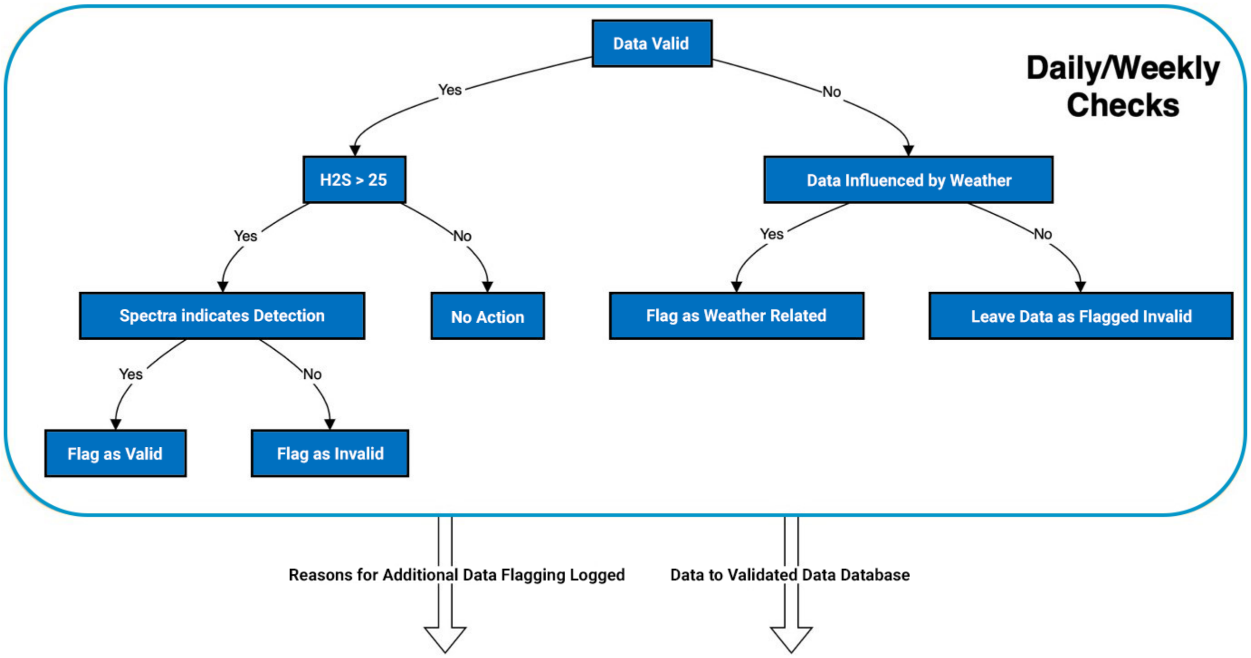


Procedure

A validated report generation application is run on the validated data set to provide the data in the BAAQMD format. This is then validated by a senior data analyst who performs the following checks:

For each instrument the 5-minute average data is checked against the following:

- Compare the data to the data trends for the month.
- Perform a check on a sample of data following the process in the figure below.



- Validate any adjustments made due to QA.
- Log any further changes made to the validated data set.
- Review the log of data adjustments.
- Send report to Project Management staff for final review.

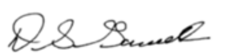
For each instrument the hourly completeness data is checked by a senior data analyst against the following:

- Validate weather related flags and calculations.
- Validate any data that has a completeness between less than 75%.
- Verify downtime where QA and Maintenance took place.
- Calculate the completeness.
- Send report to Project Management staff for final review.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

System Challenges of Organic Gas Detector (OGD) Air Monitoring System

Overview:

The purpose of the system challenge is to verify the OGD air monitor which detections alkanes meet the BAAQMD requirements specified in the letter dated December 22, 2023. Specifically, the letter states the following:

"For reference, the minimum detection limit (MDL) of a measurement process is defined as the lowest concentration of the analyte that can be reliably detected (i.e., distinguished from zero), and the LOQ is the lowest concentration at which the analyte can not only be reliably detected but at which predefined goals for accuracy and precision are met. The accuracy and precision specifications of 15% must be met at each calibration point. Failure to meet these specifications must trigger repair, maintenance, and root cause analysis, followed by repeat calibration checks until a passing calibration check is completed."

The Limits of Quantification (LoQ) for the OGD air monitoring system are calculated in real-time by evaluating data quality parameters produced by the manufacturer's data analytic software along with standard statistical tests of the real-time data. The data quality parameters produced by the system software are:

- The measured ambient ozone concentration tracks the local air monitoring stations.

Correlation coefficient for the measurement is greater than 0.7.

In addition to the real-time checks, the Limit of Quantification (LoQ) is regularly established through quarterly bump check, by introducing a known quantity of gas. The LoQ is verified by ensuring the quantified concentration aligns with BAAQMD's precision and accuracy standards. Any data points exceeding the LoQ are flagged and then undergo review by a specialized data analyst within 24 hours of detection. Table 1 presents the concentration ranges and the measurement frequency for the various tests.

Table 1 – Gas Concentrations for Calibration Tests

Check Type	Frequency
Bump Check	Quarterly

The current calibration concentrations for the gas standards are shown in Table 2

	Expected Isobutylene (ppb)
OGD A	10
OGD B	10

The specific SCCs for the open-path OGDs are listed in Table 2.

TABLE 2 – SCCS FOR THE OPEN-PATH OGDS

Check Type	Check	Frequency	MQO
MDL Check	Determine the MDL of the analyzer with the calibration gas inserted into the unit	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Calculated detection limits must be less than 25 ppb.
Precision Check	Insert a known concentration of a gas into the system and measure precision	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Measured precision must be Less than or equal to 15%
Accuracy Check	Insert a known concentration of a gas into the system and measure accuracy	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Measured accuracy must be Less than or equal to 15%
Corrective Action	Calibration parameters are checked for failure	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Implement maintenance, and root cause analysis, and recalibrate.

The Standard Operating Procedures associated with the quantitative gas checks are found below.

Contents

SOP - Minimum Detection Limit (MDL) Determination for OGD Monitoring System

Scope

With no gas present in the light beam, a series of 26 spectra are collected using the appropriate averaging time (e.g., 5 min). The spectra are used to quantify the alkanes measured in the beam path. The resulting 25 spectra are analyzed for the target gas. The MDL is defined as two times the standard deviation of the calculated concentrations. This method can be used in conjunction with lowering light transmission at the source to determine MDLs at specific signal strengths.

Responsibility and Authority

- Technical Manager and Data Technician
  - All technical procedures used must be fully validated before being used for monitoring.
  - Assess all deviations from expected outputs and decide on the acceptance and non-acceptance thereof.
  - Must report substantial deviations from expected outputs.

Frequency

Detection limits will be calculated and recorded in real time. In addition, detection limits will be validated on a quarterly basis by checking the detection limits by hand.

Procedure

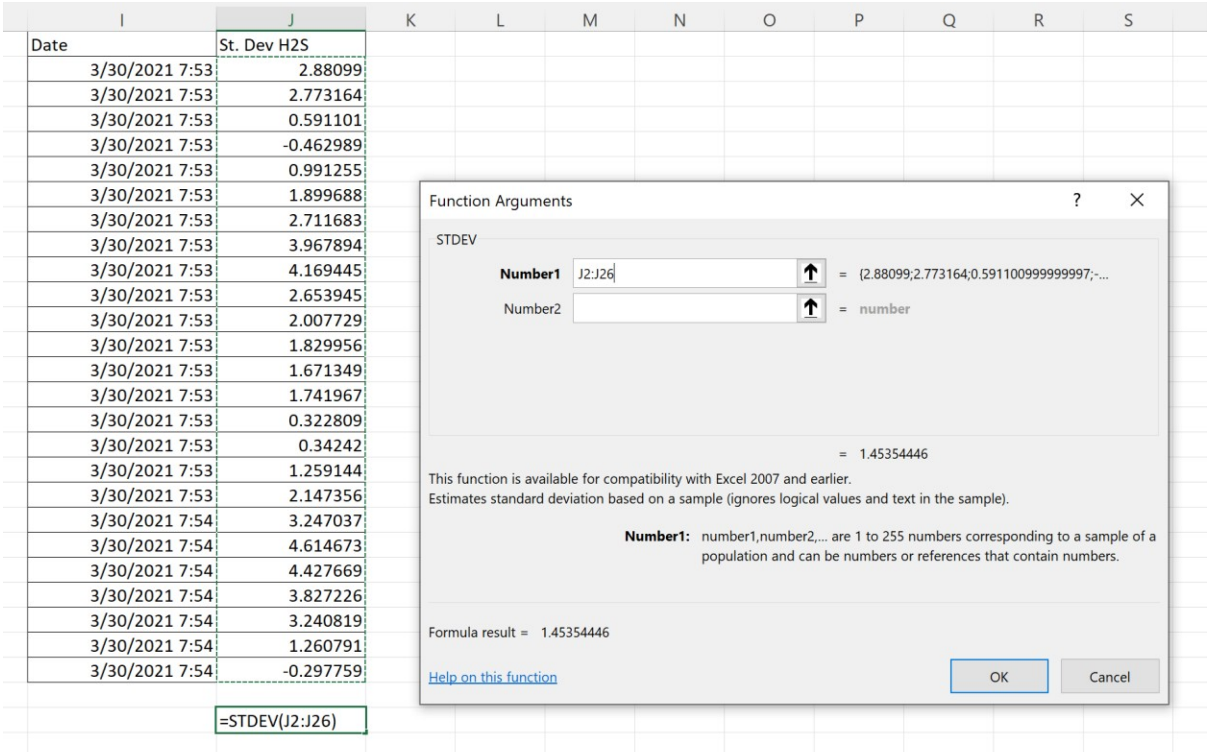
Select a period when the target compound is not present such as when the wind direction dictates that the monitor is upwind from the source of the target gas. There should also be enough wind speed to be confident that general dispersion of a target gas in all directions is not occurring (e.g., greater than 1 mph).

3.1. Open data summary file containing the reported concentration of alkanes.

3.2 Once opened, choose a folder from a date corresponding to a period of time when the wind direction was satisfactory (i.e., wind not blowing from the source of target gas). Choose 26 consecutive data points from the desired time period.

Date	Alkanes
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.46299
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
3/30/2021 7:53	2.711683
3/30/2021 7:53	3.967894
3/30/2021 7:53	4.169445
3/30/2021 7:53	2.653945
3/30/2021 7:53	2.007729
3/30/2021 7:53	1.829956
3/30/2021 7:53	1.671349
3/30/2021 7:53	1.741967
3/30/2021 7:53	0.322809
3/30/2021 7:53	0.34242
3/30/2021 7:53	1.259144
3/30/2021 7:53	2.147356
3/30/2021 7:54	3.247037
3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.29776
3/30/2021 7:54	-0.06576

3.3 Calculate the standard deviation of the 25 concentration values using the standard deviation function in Excel:



Alternatively, calculation can be completed by determining the average ($\overline{x}$) of the column of the selected chemical concentrations and the standard deviation (σ) according to the equation:

$$\sigma = \sqrt{\frac{\sum(x-\overline{x})^2}{n-1}}$$

where:

$\bar{x}$ = average reported concentration from the 25 calculated absorbance spectra

x = concentration reported in individual absorbance spectrum

n = number of data points

Finally, calculate 2x the standard deviation of the calculated concentrations to arrive at the Minimum Detection Limit (MDL).

Date	St. Dev Alkanes
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.462989
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
3/30/2021 7:53	2.711683
3/30/2021 7:53	3.967894
3/30/2021 7:53	4.169445
3/30/2021 7:53	2.653945
3/30/2021 7:53	2.007729
3/30/2021 7:53	1.829956
3/30/2021 7:53	1.671349
3/30/2021 7:53	1.741967
3/30/2021 7:53	0.322809
3/30/2021 7:53	0.34242
3/30/2021 7:53	1.259144
3/30/2021 7:53	2.147356
3/30/2021 7:54	3.247037
3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.297759
St. Dev.	**1.5**
2 x St. Dev.	**2.9**
Average	**2.2**

Records

- MDL Spreadsheet inside the Verification Summary
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

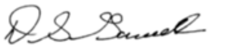
References

- Argos Scientific Operations Manual for Open-path Air Monitoring System
- Environmental Technology Verification Programme (Advanced Monitoring Systems Pilot) – Test/QA Plan for Verification of Optical Open Path Monitors

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Precision

Scope and Application

Frequency

Quarterly

Description

The precision of the monitor is a quantification of its ability to make repeatable measurements when challenged with the same gas sample inserted in the instrument using a sample cell.

Measurement Quality Objective

The objective is to determine the precision of the OGD air monitoring system and compare the measured result to historical measurements. If the results differ in a statistically significant manner, corrective actions will be initiated. The procedure for determining the precision of the OGD is as follows:

Alkane gas will be introduced into the multi-pass cell and 25 single-beam spectra of the target gas will be obtained. The collected spectra will be analyzed for the target gas. The relative standard deviation of this set of measurements is the precision at the target gas concentration and is given by the following formula:

$$RSD = \left|\frac{\sigma}{\overline{\overline{T}}}\right| \cdot 100$$

Where RSD is the Relative Standard Deviation

Acceptance Criteria

The MQO will be met if the measured precision meets the requirements in Table 1.

Corrective Action

If the system fails the precision check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue. Beam spectra are then used to create absorption spectra, using each single beam spectrum.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Accuracy

Scope and Application

This document refers to an accuracy check for air monitoring system for the continuous measurement of gases in the ambient air along an open path. Relevant EPA documents describe the general procedure to determine instrument accuracy relative to a known concentration of target gas inserted into the beam path.

Frequency

Quarterly

Description

The accuracy of the monitors will be evaluated for target gases by inserting a calibration gas into the instrument with a known concentration of a target gas and comparing the calibration gas concentration to the concentration measured by the monitor.

Measurement Quality Objective

The objective is to determine the accuracy of the air monitoring system and compare the measured result to historical measurements. If the results differ in a statistically significant manner, corrective actions will be initiated. The procedure for measuring the accuracy of the is as follows:

The relative accuracy (A) of the monitor with respect to the reference gas is assessed using the following formula:

$$A = \frac{|\overline{R} - \overline{T}|}{\overline{R}} \cdot 100$$

Where:

A = accuracy of each measurement

$\overline{R}$ = the average value of the reference gas

$\overline{T}$ = the average value of the measurements

Acceptance Criteria

The MQO will be met if the measured accuracy is within 15% of the expected value.

Corrective Action

If the system fails the accuracy check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP - Corrective Action Procedure

Purpose

The purpose of the Continual Improvement and Non-conforming Work Procedure is to encourage the ongoing re-assessment and improvement of the business Management System and to define the parameters and procedures by which such changes are considered and documented.

This procedure describes the process and responsibilities for the identification, control, follow-up and close out of improvements and non-conformities identified in the business's management and technical system.

Scope

This procedure applies to formal non-conformities identified at any management system audit and all processes, external or internal, where improvements or non-conformances are or can be raised and have to be actioned.

Definitions/Abbreviations/Acronyms

Non-conformance	:	Non-fulfilment of a requirement.
Requirement	:	A need or expectation that is stated, generally implied, or obligatory.
Correction	:	Action taken to eliminate a detected non-conformity.

Corrective Action	:	Action taken to eliminate the cause of a detected non-conformance or other undesirable situation in the management system or process, so as to prevent recurrence.
Preventive Action	:	Action taken to determine and eliminate the causes of a potential non-conformance or other undesirable potential situation to prevent occurrence.
Improvement	:	Action taken to improve an otherwise satisfactory process or system.
Management Team	:	Includes the Managing Director, Manager and General Managers or authorised designates
Root Cause analysis	:	A root cause analysis is conducted to determine the real cause (not symptoms or explanations) of non-conformities. The root cause is the reason why a problem started in the first place.

Responsibility and Authority

- The **Project Manager** is responsible for the implementation of this procedure.
- The **Management Team** or designates have the responsibility and authority to ensure that all non-conformances are processed, and corrective action is implemented, effective, and managed to completion within the predetermined time limit.
- The Management Team has the authority and responsibility to handle and control the non-conforming work, halt work where applicable, determine when test/calibration reports are finalized and authorise the resumption of work.
- All employees are required to report non-conforming work and assist in the investigation and close-out of non-conformances.

  Note: where a job title is mentioned, the action can also be performed by the authorised designate(s). Refer to the Authority Matrix (IMS-QLT-REG-009) for details.

General

- Non-conformances may be the result of the following, but are not limited to:
  - Failure of the business and its personnel to comply with the requirements of the quality management system, standards, and regulations.
  - Failure of test/calibration/verification data to meet required standards.
  - Failure of resources (e.g., equipment, people, etc.) to meet performance or other specified requirements.

- Any employee may initiate a non-conformance, improvement, or preventive action by following these steps:
  - Create a detailed description of the non-conformance, improvement, or preventive action (see Appendix 1 for guidelines).
  - Notify the Assistant and line management.

Control of Non-Conforming Work

- The Management Team shall evaluate the significance of the non-conforming work to make a decision about its acceptability. The decision shall be based on scientific knowledge and the relevant requirements of the specific methods.
- If the Management Team deem it necessary, work shall be halted, and determine when test/calibration reports are finalized.
- The root cause shall be determined, and relevant corrective and preventive action shall be implemented to correct the nature of the non-conformance. All decisions shall be documented and retained within the relevant project file.
- A non-conformance shall be registered in the Non-Conformance and Audit Register (IMS-QLT-REG-002) and documented on the Non-Conformance and Improvement Report (IMS-QLT-FOR-001).
- The Management Team shall ensure that the client is notified about the non-conformance and any associated corrective action.
- In the event where a test/calibration report has been issued with a non-conformance, the test/calibration report shall be recalled, and an amended test/calibration report shall be issued.
- The Management Team shall authorise the resumption of work upon the implementation of the corrective action.

Corrective Action

1.1. NEED FOR CORRECTIVE ACTION

- Corrective action requires careful consideration to determine the root cause of a non-conformance and may involve a team.
- Corrective action includes measures to immediately address the problem (correction) and to see that they do not recur.
- Corrective action shall be taken in the event of the following, but not limited to:
  - Non-conformance creates an unacceptable risk to the business.
  - Correction is not enough to prevent recurrence of a non-conformance.

- Non-conformance adversely affects the business's ability to demonstrate competence.

1.2. CORRECTIVE ACTION PROCESS

- The business adheres to the following steps for implementing corrective action when non-conformances from its policies and procedures are detected within the management system or technical operations. These steps include:
  - Registration of non-conformances, improvements or preventive actions in the *Non-Conformance and Audit Register (IMS-QLT-REG-002)*. *(Note: A unique number is assigned to each non-conformance).*
  - Document the non-conformance on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
  - An Impact Assessment shall be conducted to determine if a full root cause investigation is required. This shall be recorded on the *Non-Conformance and Audit Register (IMS-QLT-REG-002)* and indicated on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
  - The Impact Assessment is conducted by the Manager and verified by an impartial source, e.g., a member of the Management Team.
  - The Project Manager in consultation with the Line Manger(s) shall assign the non-conformance to a designated person.
  - The designated person in conjunction with a team will initiate an investigation to determine the root cause(s) of the problem if required (see Appendix 2 for guidelines on root cause analysis) and compile an action plan to correct and prevent the problem from being repeated.
  - Risks identified during the investigation of the non-conformance shall be indicated in the risk register and reviewed on an annual basis.
  - The Risk Register will be updated and reviewed by the Management Team.
  - The action plan shall be submitted to the Project Manager within two weeks from the date of initiation of the non-conformance.
  - The Management Team and the designated person shall monitor the investigation process.
  - Following the implementation of the corrective actions, the final close-out date shall be indicated on the *Non-Conformance and Audit Register (IMS-QLT-REG-002)*, and the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)* plus corresponding evidence of corrective actions sent to the Manager to verify the actions taken.
  - For internal audits/non-conformances, the Project Manager/Line Manager(s) shall verify the corrective action on the close-out date or within one week of the final close-out date.

- If the corrective actions are reviewed and found to be unsatisfactory, this is to be indicated on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001),* and the designated person shall review the root cause and revise the corrective actions.
- Once the corrective actions have been verified by the Project Manager/Line Manager(s), the verification date is recorded on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)* and *Non-Conformance and Audit Register (IMS-QLT-REG-002)*.
- Evaluation of the effectiveness of the corrective actions shall be scheduled on the *Internal Audit Schedule (IMS-QLT-REG-007)* approximately one month after the corrective action verification date. Should this evaluation not be possible within the designated timeframe, justification shall be provided on the Non-Conformance Register. The Management Team or Project Manager shall evaluate the effectiveness of the corrective actions. This shall be recorded on the Non-Conformance/Improvement Report, and in the event that the corrective actions have not had the desired effect, a new non-conformance shall be raised.

- All evidence of investigations of non-conformances shall be filed in either hard copy or electronic copy.

Note: *The time-frame for external audit findings to be investigated and corrective actions implemented shall be dependent on the requirements of the accreditation body or auditing organization; internal audit findings shall be investigated, and an action plan shall be developed to ensure corrective actions are implemented within an agreed upon timeframe. The action plan shall be compiled and submitted within two weeks from the initiation of the audit finding.*

Preventative Action Improvements

1.3. GENERAL

- Preventive action is a proactive process whereby improvements and potential sources of non-conformances are identified internally. These may be technical or concern the quality management system itself.
- Action plans are developed, implemented, and monitored to reduce the likelihood of the occurrence of non-conformances and to take advantage of the opportunities for improvement and to ensure that they are effective.
- Every employee shall attempt to identify improvements and potential sources of non-conformances, either operational or concerning the management system.

1.4. SOURCES OF PREVENTIVE/IMPROVEMENT ACTION

- The business continually improves the effectiveness of its management system by identifying opportunities for prevention or improvement via the use of any or all the following:

- *Health and Safety (IMS-SFT-POL-001)* and *Quality Policy (IMS-QLT-POL-001)*
- *Code of Integrity (IMS-QLT-POL-002)*
- *Business objectives for the various businesses* (which are reviewed regularly)
- Audit results
- Analysis of data
- Corrective and preventive actions
- Management review
- Project planning
- Customer feedback
- Training
- Maintenance
- Employee feedback and performance reviews
- Meetings

Note: Preventive action must be taken after the trend analysis of root causes identified during the Management Review process to ensure that they are not repeated.

Preventive and improvement action can further be indicated in the Risk Register.

1.5. PREVENTIVE/IMPROVEMENT ACTION PROCESS

- When preventive/improvement action or risks are identified, the individual shall ensure that it is reported to the Project Manager and shall be recorded on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
- The Management Team shall be responsible for implementing and monitoring the action plan to ensure that the appropriate actions are taken within a reasonable time frame and that resulting changes are effective.
- Records of the continual improvement process shall be maintained and controlled by the Manager.

Records

- Non-conformances from audits as well as internally identified by employees.
- Evidence of investigations of root causes.
- Evidence of implementation of corrective actions.
- Non-Conformance and Audit Register (IMS-QLT-REG-002).
- Non-Conformance/Improvement Report (IMS-QLT-FOR-001).

- Risk Registers.

References

- ISO 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories.
- X-Lab Root Cause Analysis Training, Aleesha Sewpersad, January 2020.
- IMS-QLT-REG-007 Authority Matrix

Replacement

This document replaces IMS-QLT-MAN-010, Revision 03 dated 2 July 2020.

Approval

	PREPARED BY:	**UPDATED BY:**	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Baird	Quentin Hurt	Management Team	Don Gamiles
Title	Manager	Managing Director	N/A	President
Date	17 January 2017	11 May 2020	3 June 2020	3 June 2020
Final approval signature				

Appendix 1: Guidelines for describing non-conformances, etc.

1.6. The description must be:

- Clear and understandable – make sure everyone can understand the description.
- Concise – only include what is necessary.
- Correct – make sure all the information provided is right.
- Complete and detailed: make sure all the necessary information is provided (What, When, Where, Who)

1.7. The description should contain reference to the relevant clause in a standard or section in a procedure, if applicable.

1.8. The description should contain metrics where applicable, e.g., Z-scores, QC data.

1.9. Examples:

- Example 1: Incorrect description:
  Original statement: “The LGC Aquacheck PT (Round 28-AR0792) indicated questionable results for the Total Solids – Z-score 2.24”.

  Correct statement: “The LGC LGC Air Stack Emissions for PT (Round 28-AR0792) indicated questionable results for the dust analysis – Z-score 2.24”.

- Example 2: Description too vague:
  Original statement: “Decision rules have not been defined internally or with the customer.”

  Better statement: “Decision rules regarding the inclusion of uncertainty of measurement when reporting results against specifications and standards have not been defined internally or with the customer. ISO 17025:2017 Clause 7.1.3”

- Example 3: Description incomplete:
  Original Statement “SABS Group 2 - February 2019 - Unacceptable results for Nitrate, and Hexavalent Chromium.”

  Better statement: “SABS Group 2 PT (Water) - February 2019 - Unacceptable results for Nitrate by DA (-3.98; -3.43; -5.06) and Hexavalent Chromium by DA (132.02)”.

Appendix 2: Guidelines for root cause analysis

1.10. Put together a team to do the root cause analysis. This should include anyone involved in the problem and its resolution.

1.11. Identify the problem.

- This can be taken from the Non-compliance Report (NCR) finding statement, provided that has been properly described.

1.12. Investigate the problem.

- What happened?
- Where did it happen? Physical location, stage of process, environment
- When did it happen? Has it happened before? When did it start?
- Who was involved? Who reported the problem? Who is impacted (staff/project/job)?
- What is the extent of the problem? How serious is the problem? Is it specific to a section/process? Is it throughout? How many projects/jobs are affected?
- How did it happen? How was it discovered? Equipment, maintenance, reagents, quality control, records, methods, procedures, training, etc.

1.13. Identify the root cause(s).

- There may be more than one root cause for the problem.
- These can generally be assigned to one of the following categories:
  - MAN (anyone involved with the process)
  - METHODS/SYSTEMS (how the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations, and laws)
  - MACHINE/EQUIPMENT (any equipment, computers, tools etc. required to accomplish the job)
  - MATERIALS (raw materials, parts, pens, paper, etc. used to produce the final product)
  - MEASUREMENT (data generated from the process used to evaluate its quality)
  - ENVIRONMENT (the conditions, such as location, time, temperature, and culture in which the process operates)
- For each question answered above, that identified something that was wrong, ask “why?” at least 5 times (5 Whys Process). Eventually, the answer to the question will not change and this last unique answer is likely the root cause.
- Once identified, for each root cause ask:
  - Is this root cause really the cause of the problem?

    - Is this root cause necessary for the problem to occur?
    - Is this root cause alone sufficient to cause the problem?
  - If the answer to any of these questions is “no”, the true root cause has not been identified or additional root causes need to be found.
  - If not already done, assign the root cause to one of the categories listed above.

1.14. Develop an action plan(s) to resolve the root cause(s).

  - Decide what needs to be done to remove the problem permanently.
  - Plan how this is to be implemented.
  - Set a completion date.

1.15. Document all of the above on the non-conformance/improvement report and submit this to the Management Team for review and approval.

  - Make sure all the evidence from the investigation is attached.

1.16. Implement the approved plan(s) within the completion date.

1.17. Monitor the situation to decide if the problem has been eliminated.

1.18. Retain evidence of the implementation and monitoring.

System Challenges of Organic Gas Detector (OGD) Air Monitoring System Operation and Maintenance

Overview

The purpose of the document is to present the specific operation and maintenance procedures needed to maintain compliance with BAAQMD Rule 12-15.

The specific procedures used to perform these checks are as follows:

Check Type	Check	Frequency	MQO
Routine Operation	Follow the manufacturer recommended operational procedures	Continuous	Documentation demonstrating operational procedures are being followed.
Planned Maintenance Checks	Follow the manufactures recommendation for maintenance procedures	Monthly and Quarterly	Documentation demonstrating routine procedures are being followed.
Non-Planned Maintenance Checks	Follow the manufacturer recommendation for maintenance procedures	As Needed	Documentation demonstrating non-routine procedures are being followed.

The Standard Operating Procedures associated with the Operation and Maintenance of the Organic Gas Detectors are found below. In general, the message board of the website will be updated to inform the public that maintenance activities will be taking place.

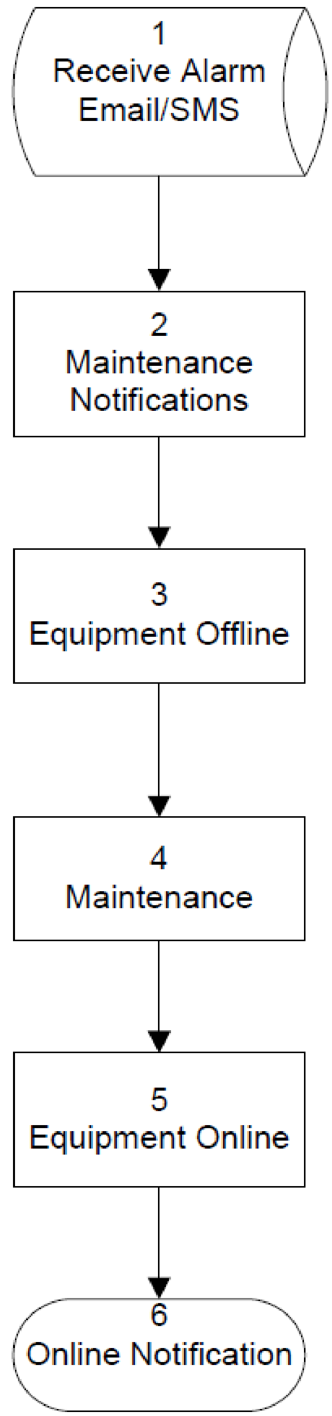
Contents

Planned Maintenance

Responsibility and Authority

- ### Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments, and undertake corrective action where necessary.
- ### Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit in order to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR- 001)*
- ### Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.
- ### Flow Chart – Planned Maintenance

Process Flow: Planned Maintenance



Procedures

1. In the event a system is undergoing routine maintenance, QA/QC checks, or field repair, the following actions will be taken:
   - The refinery will be notified of the activity by E-mail.

- A remote Argos Technician will take the unit off-line through the Argos Remote Access system, so that the data is not transmitted to the real-time website.
- When the activities are complete, the systems will be brought back on-line, and the following actions will be performed:
    - The field technicians will check the system as defined in the manufacturers instrument manual.
    - A remote technician will start the system.
    - The remote technician will wait for one 5-minute scan to complete to ensure that the system is operating correctly.

2. The refinery will be notified that the system is back online, and the real-time website will be updated with the same notification.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence-line Monitoring

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019
Final approval signature			

Unplanned Maintenance

Scope

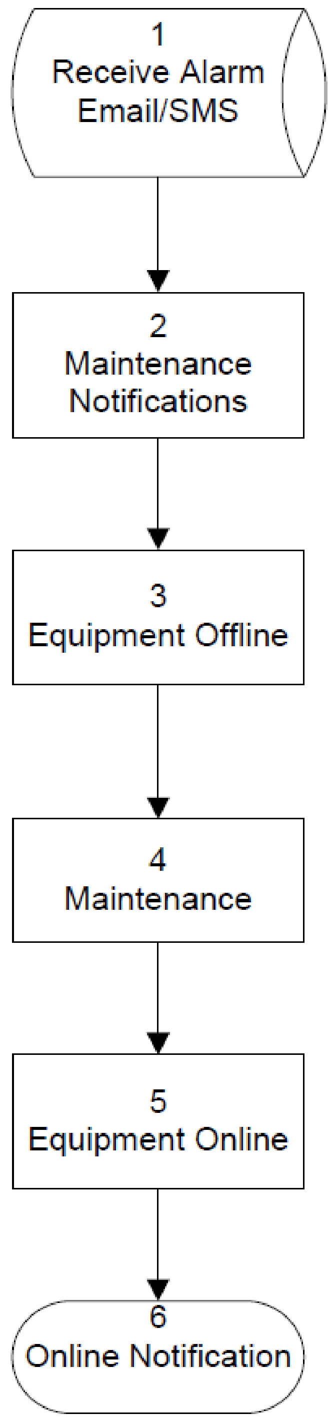
This procedure describes the actions and communication that takes place when a system undergoes non-routine maintenance.

Responsibility and Authority

- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites when an equipment call-out occurs and undertake corrective action where necessary.
- Remote Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each event and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR- 001)*
- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Planned Maintenance

Process Flow: Unplanned Maintenance



Procedure

- In the event a system undergoes non-routine maintenance

  - An alarm notification will be sent to the on-call staff who will initiate a work order to identify and correct the issue.
  - The refinery will be notified of the activity by E-mail.
  - A remote Argos Technician will take the unit off-line remotely, so that the erroneous data is not transmitted to the real-time website and the message board updated to reflect maintenance activities are taking place.
  - The corrective action plan will occur using the work order process.
  - When the activities are complete, the systems will be brought back on-line, and the following actions will be performed:
    - The field technicians will optimize the signal of the system and leave the system in alignment mode.
    - A remote technician will collect a new background file.
    - A remote technician will start the system.
    - The remote technician will wait for one 5-minute scan to complete to ensure that the system is operating correctly.
- The refinery will be notified that the system is back on-line, and the real-time website will be updated with the same notification.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001

References

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019

SEC Millenium
Hydrocarbon Gas Detector

Instruction and Operation Manual

Sensor Electronics Corporation 5500 Lincoln Drive
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(952) 938-9617
Email: sales@sensorelectronic.com Web site www.sensorelectronics.com

Part Number 71-4000 Version 040109

Sensor Electronics Corporation

Sensor Electronics Corporation (SEC) designs and manufactures innovative fixed system gas detection equipment, for combustible gases, oxygen, carbon dioxide and toxic gases.

Commitment

Our quality and service are uncompromising. We back each of our products with a two-year warranty on all materials and workmanship. We offer technical support, user training and on-site service and maintenance of equipment to meet the needs of our customers.

Gas Detection Service

Individually designed maintenance packages are available for specific customer needs. Service begins with verification of the system installation that includes an initial system check and calibration. We then offer customer training programs (on-site and at factory) to insure that technical personnel fully understand operation and maintenance procedures. When on-the-spot assistance is required, service representatives are available to handle any questions or problems immediately.

Warranty

Sensor Electronics Corporation (SEC) warrants products manufactured by SEC to be free from defects in workmanship and materials for a period of two (2) years from date of shipment from the factory. Any parts returned freight pre-paid to the factory and found defective within the warranty would be repaired or replaced, at SEC's option. SEC will return repaired or replaced equipment pre-paid lowest cost freight. This warranty does not apply to items, which by their nature are subject to deterioration or consumption in normal service. Such items may include:
Fuses and Batteries.
Warranty is voided by abuse including rough handling, mechanical damage, alteration or repair. This warranty covers the full extent of SEC liability and SEC is not responsible for removal, replacement costs, local repair costs, transportation costs or contingent expenses incurred without prior written approval. Sensor Electronics Corporation's obligation under this warranty shall be limited to repair or replacement of any product that has been returned to Sensor Electronics Corporation for warranty consideration. This warranty is expressly in lieu of any and all other warranties expressed or implied, and all other obligations or liabilities on the part of Sensor Electronics Corporation including but not limited to, the fitness for a particular purpose. In no event shall Sensor Electronics Corporation be liable for direct, incidental, or consequential loss or damage of any kind connected with the use of it's products or failure to function or operate properly.

Year 2000 Compliance

All Sensor Electronics products have been tested and are certified by Sensor Electronics to accurately process date/time and date/time related data from, into and between the 20th and 21st centuries. Sensor Electronics products neither contain nor create any logical or mathematical inconsistency, will not malfunction, and will not cease to function when processing date/time data.
Please contact Sensor Electronics for further information.

Table of Contents

I. SPECIFICATIONS

Model:
Sensor Electronics Corporation SEC MILLENIUM Infrared Hydrocarbon Gas Detector

Available gases:

Methane	Hexane	Jet A
Ethane	Diesel	Ethanol
Ethylene	Gasoline	Methanol
Ethylene Oxide	Green Earth	Butane
Propane	DF 2000	Hexane

Please note *that this list is not all-inclusive. The SEC MILLENIUM can be calibrated for most hydrocarbons, provided a calibration gas is available. For more please contact Sensor Electronics Corporation.*

Part Number: 142-0280

Detection Method:
Diffusion
Optional sample draw (requires a minimum of 1 liter per minute flow rate)

Output (analog):
4-20 mA (Source type), max. 1000 Ohm load at 24 VDC supply voltage

Response Time:
T50 < 5
seconds T90
< 10 seconds

Construction:
316 stainless steel.
Class 1, Division 1, Groups B, C and D

Accuracy:
+/- 3% LFL, 0 to 50% LFL (Lower Flammable Limit)
+/- 5% LFL, 51 to 100% LFL

Operating Temperature Rating:
-40° to +70°C at 0 to 99% RH (non-condensing)

Operating Voltage:
24 VDC Operating range: 18 to 32 VDC measured at the detector head

Power Consumption: 5 Watts Max.

Max. Current Draw: (at 24
VDC) Average: 210 mA
Peak: 400 mA

Approvals: CSA, For -40C to +50C operation, Performance Tested

Installation Category: Cat. I, Pollution Degree 2

II GENERAL DESCRIPTION

CONVENTIONS

The following conventions are used in this manual.

⚠ Warning Statement

⎓ VDC (DC

Voltage)

SEC MILLENIUM

The SEC MILLENIUM Infrared gas detector is a microprocessor based intelligent gas detector that continuously monitors combustible hydrocarbon gases and vapors within the Lower Flammable Limit (LFL).

The SEC MILLENIUM is ideally suited for use in harsh environments and where the cost of required maintenance for conventional catalytic detectors is prohibitive. The SEC MILLENIUM Infrared gas detector will perform reliably in the presence of silicone and other catalytic poisoning agents and can also operate in oxygen free environments or where high background gas levels are present. There are no known poisons that affect this technology.

The SEC MILLENIUM is a stand-alone device providing a continuous 4 to 20 mA output.

Features

- Requires no routine calibration to ensure proper operation.
- Continuous self-test automatically indicates a fault, with fail to safe operation.
- A multi-layered filtering system protects optics from dirt and water ingress.
- Straight optical path eliminates the need for mirrors or reflective surfaces, such as mirrors or beam splitters.
- Performs well in the presence of high concentrations or constant background levels of hydrocarbons and

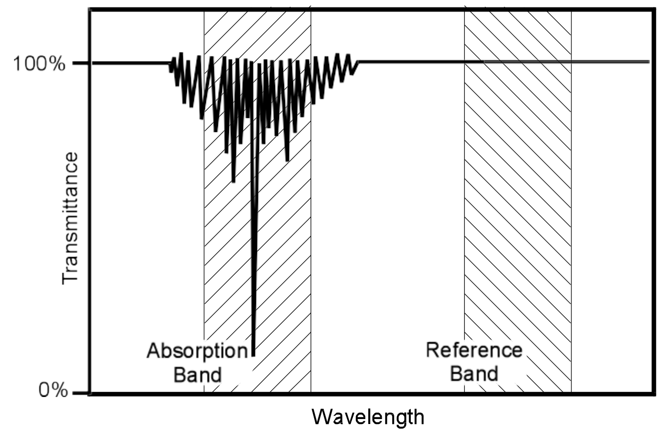
in oxygen depleted atmospheres.

- Highly resistant to poisoning and etching.
- Standard 4 to 20 mA output (current source)
- Explosion proof housing designed for harsh environments.
- Smart Calibration AutoAC™ circuit.

Infrared Detection Technology

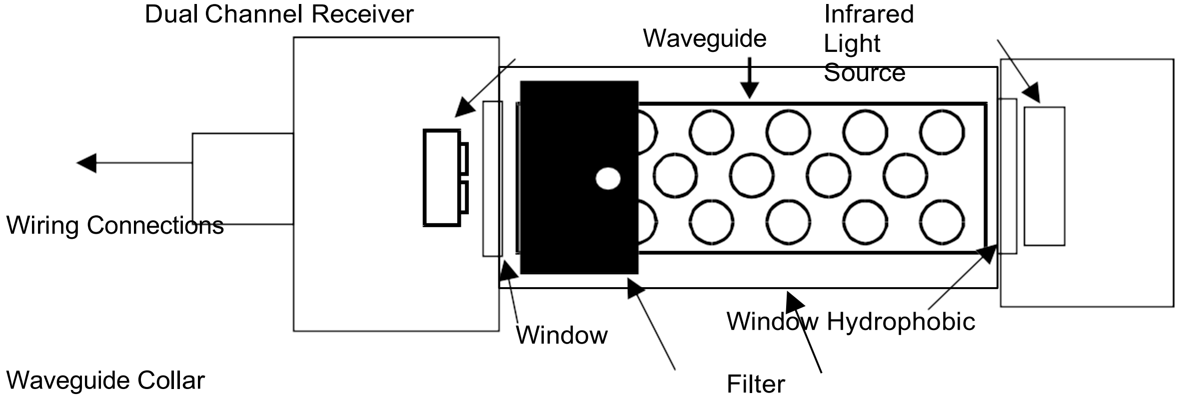
The SEC MILLENIUM Infrared gas detector uses infrared absorption technology for detecting combustible hydrocarbon gases. Gases absorb infrared light only at certain wavelengths. The concentration of a gas can be measured by the difference of two channels (wavelengths), a reference and a measurement channel. The SEC MILLENIUM uses a collimated infrared light source that passes through a waveguide, at the end of the waveguide is a dual channel receiver. The dual channel receiver measures the intensity of two specific wavelengths, one at an absorption wavelength and another outside of the absorption wavelength. The gas concentration is determined by a comparison of these two values.

Infrared Absorption Spectrum for Methane



The dual channel receiver is a single wafer, double filtered, dual receiver with an internal optical barrier. The elements are perfectly matched resulting in overall stability and superior performance throughout the entire temperature range.

Dual Channel Receiver



Using a dual channel receiver there is no need to use any special lenses or beam splitters to achieve the different measurement bands.

The SEC MILLENIUM utilizes a unique patent pending feature, the AutoAC™ circuit. The AutoAC™ circuit is an automatic analog control circuit, which allows the SEC MILLENIUM to be calibrated for any combustible hydrocarbon, provided that a calibration quality level of the gas is available. This eliminates setting dipswitches or changing out sensors for different types of hydrocarbons, simply calibrate the unit with a calibration gas of the specific gas to be detected.

The optics can be easily disassembled for cleaning. This does not require powering the unit down and does not compromise the units' explosion proof rating. The device will self compensate for dirty optics until a point in which the optical surfaces are completely obscured.

There are no consumable components contained in this product.

III. OPERATION

Installation and Startup

Warning: The user shall be made aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

The first step in the installation process is to establish a mounting location for the SEC MILLENIUM. Select a location that is typical of the atmosphere to be monitored or close to the anticipated source of a dangerous gas.

It is very important that the SEC MILLENIUM be properly located to enable it to provide maximum protection. The most effective number and placement of sensors vary depending on the conditions of the application. When determining where to locate sensors the following factors should be considered.

- What are the characteristics of the gas that is to be detected? Is it lighter or heavier than air? If it is lighter than air the sensor should be placed above the potential gas leak. Place the sensor close to the floor for gases that are heavier than air or for vapors resulting from flammable liquid spills. Note that air currents can cause a gas that is heavier than air to rise. In addition, if the temperature of the gas is hotter than ambient air or mixed with gases that are lighter than air, it could also rise.

- How rapidly will the gas diffuse into the ambient air? Select a location for the sensor that is close to the anticipated source of a gas leak.

- Wind or ventilation characteristics of the immediate area must also be considered. Movement of air may cause gas to accumulate more heavily in one area than in another. The detector should be placed in the areas where the most concentrated accumulation of gas is anticipated. For outdoor applications with strong wind conditions, it may require the sensors to be mounted closer together and on the down wind side, to the anticipated area of a gas leak. Also take into consideration for indoor applications, the fact that many ventilation systems do not operate continuously.

- The sensor should be accessible for maintenance.

- Excessive heat or vibration can cause premature failure of any electronic device and should be avoided if possible.

- Follow all national and local installation codes and practices.

The SEC MILLENIUM has a ¾” NPT threaded connector for mounting the detector to a junction box. SEC can provide a junction box with terminals for this purpose.

A user-supplied junction box can be used providing it has the appropriate sized NPT conduit entries. The junction box must be suitable for use in the application and location in which it is being installed. After the device has been installed, a calibration is required. Refer to the Calibration section of this manual.

Wiring connections

Red wire: 18 to 32 VDC ⎓
Black wire: DC Common

Blue wire: 4 to 20 mA output
White wire: Smart Calibration Wire (data wire)
Earth Ground: Male 10-32 Stud on SEC Millenium cap, see figure 1.

Wire sizing:
0 to 500 feet, recommended wire gauge size 16
AWG 501 to 1000 feet, recommended wire gauge
size 14 AWG

Shielded cable is recommended. Wiring should be installed in medal conduit with no other cabling in the same conduit.

Warm-up
When power is applied to the detector, it enters a one (1) minute warm-up mode. The output current will be
0.8 mA during the warm up time period. At the end of the warm-up period with no faults present, the detector automatically enters the normal operating mode (4 mA). If a fault is present after warm-up, the detector current output will indicate a fault. See the following chart for fault code status.

Normal

In the normal operating mode, the 4 to 20 mA signal levels correspond to the detected gas concentration. The detector continuously checks for system faults or initiation of calibration and automatically changes to the appropriate mode.

The 4 to 20 mA output of the SEC MILLENIUM is a non-isolated current source.

Current Output and Corresponding Status

Current Output	Status.
0-20 mA	Normal measuring mode
0.0 mA	Unit Fault
0.2 mA	Reference channel fault
0.4 mA	Analytical channel fault
0.8 mA	Unit warm up
1.0 mA	Optics fault
1.2 mA	Zero drift fault
1.6 mA	Calibration fault
2.0 mA	Unit spanning
2.2 mA	Unit zeroing
4.0 mA	Zero gas level (0%LEL)
5.6 mA	(10%LEL)
8.0 mA	(25%LEL)
12 mA	(50%LEL)
16 mA	(75%LEL)
20 mA	Full scale (100% LEL)
20.1- 23 mA	Over-range (> 100% LEL)

Once the fault is cleared the SEC MILLENIUM will atomatically resume normal operation.

IV. CALIBRATION

SEC MILLENIUM

The SEC MILLENIUM is factory calibrated zeroed and spanned. *Unlike catalytic sensors it does not require routine span gas calibration to ensure proper operation.*

The SEC MILLENIUM can be calibrated for almost any hydrocarbon using a calibration gas of the hydrocarbon that is to be detected (target gas). The SEC MILLENIUM is required to be spanned with gas only one time with the target gas. Typically this is done at the factory, but it is possible to field span the device by connecting the SEC MILLENIUM to a computer and using a software package provided by SEC. Please contact the factory for further details.

A typical field calibration only requires the use of zero air (or 99.99% nitrogen). *If the sensor is located in an area that is known to be free of the hydrocarbon gases then ambient air can be used as a zero reference.*

If zero air is used for the calibration, there is a fitting on the bottom of the sensor for a 1/8" ID tubing connection.

Before beginning calibration use the SEC MILLENIUM Insulation Tube to cover outer cylinder holes and connect a clean air source to the sensor's calibration port for a minimum of 3 minutes. To enter into the calibration mode the calibration wire must be connected to negative (common of the power supply) for ten
(10) seconds, upon release the sensor will automatically enter the zero calibration routine. The electronics will automatically adjust the sensor's signal to the new zero reference level. (Applying span gas is not necessary because of the SEC MILLENIUM's unique software algorithms). During the zero calibration routine, the current output of the SEC MILLENIUM will go to 2.2 mA. Although this can be accomplished manually, installation of a switch (contact closure) can accomplish the zeroing procedure. It is recommended that this switch be a momentary type switch to prevent it from inadvertently being left in the calibrate position. If after 20 seconds the calibration lead has not been removed from common, the SEC MILLENIUM will ignore the signal and continue operation as normal.

The SEC MILLENIUM can be spanned in the field if the customer wishes to change the target hydrocarbon gas. Please contact factory for additional equipment information and pricing for SEC PC IR Link Package)

V. MAINTENANCE

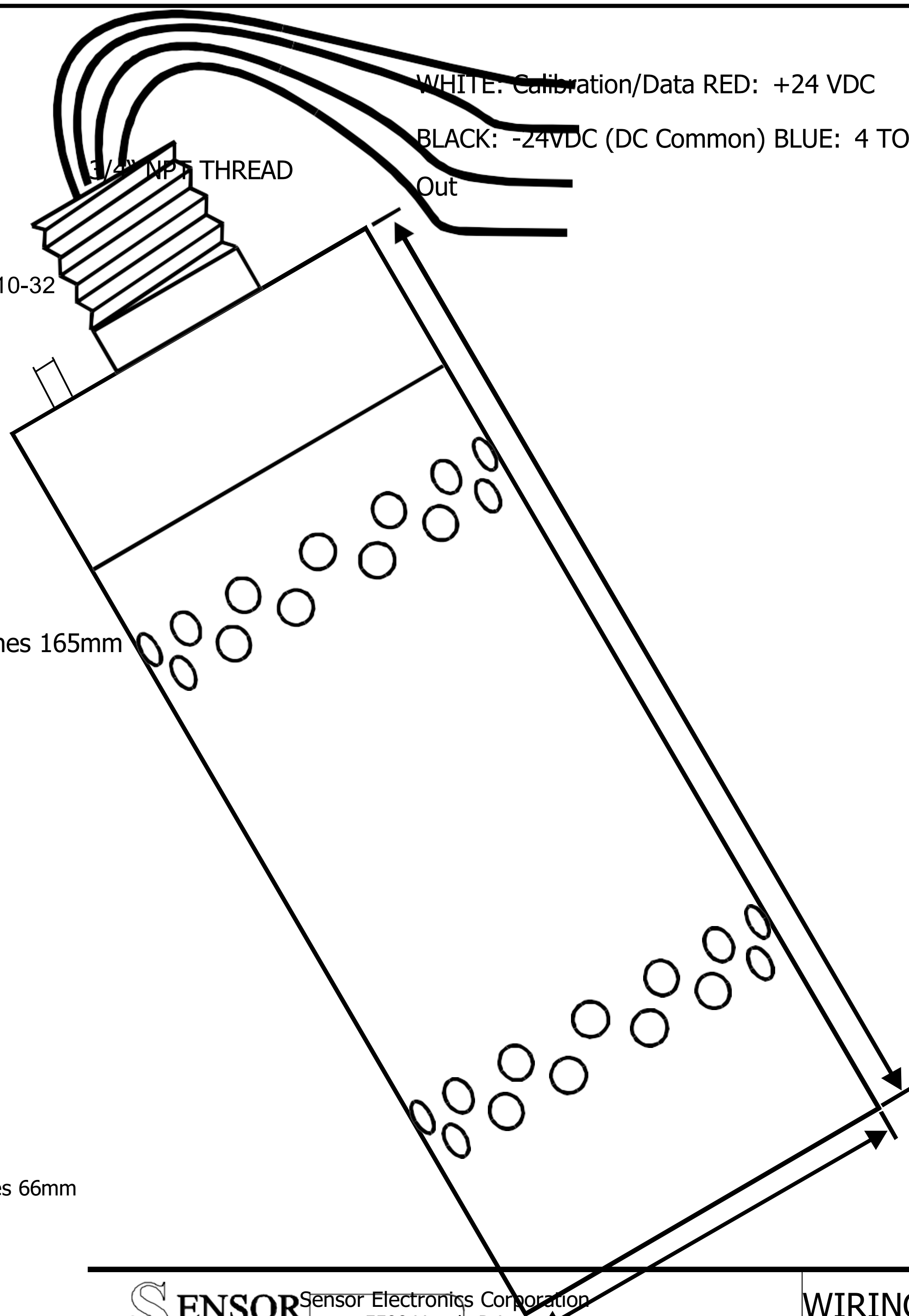
The SEC MILLENIUM does not normally require cleaning of the optics. However if the unit is operating in a very dirty or dusty environment the optical path might become obscured. If the obscuration is severe enough to affect the units accuracy, the unit will activate an "Optics Fault" will. To clear an Optics Fault, first try a calibration. If the calibration does not correct the fault condition, try to clean the optics. The outer barrel (tube with two sets of holes) can be removed (unscrewed) to inspect the cleanliness of the hydrophobic filter. The hydrophobic filter is a Teflon coated stainless steel mesh that keeps moisture and particulates out of the optical path. A setscrew holds the filter to the MILLENIUM's housing. Once the hydrophobic filter is removed, the internal waveguide tube should be inspected for cleanliness. The waveguide and waveguide collar can be removed by inserting rigid instruments such as Allen wrenches into one hole of the waveguide and one hole of the collar. Turning the two instruments in opposite directions will loosen the waveguide allowing the collar to be screwed down on to the waveguide until it can be removed from the SEC MILLENIUM housing. This will allow the windows of the SEC MILLENIUM to be cleaned. Dust can be removed using compressed air. Hard or oily deposits can be removed using

Isopropyl alcohol and cotton tipped swabs. Wipe any film or residue or film left by the alcohol on the windows with a clean dry cotton swab. The internal electro polished wave-guide tube can be cleaned the same way. Be careful not to leave any particles of the cleaning swab in the waveguide. The waveguide holes can collect pieces of the cleaning swab. After reassembling the unit (the waveguide and collar should be very tight to both ends of the SEC MILLLENIUM housing after installation. Once the unit is completely reassembled and power is reapplied, the SEC MILLENIUM must be calibrated. Refer to the calibration section of this manual.

VI. Parts List

Part Number	Description
142-0280	Replacement Sensor SEC MILLENIUM
190-1001	SEC 2001 Sensor Separation Kit
142-0877	SEC Insulation Tube
142-0497	SEC MILLENIUM Replacement
Hydrophobic Filter 142-0297	SEC MILLENIUM Wave Guide
Tube	
142-0570	SEC MILLENIUM Wave Guide Tube Collar
142-0636	SEC PC IR Link Kit

VII. Drawing Section



SENSOR ELECTRONICS CORPORATION

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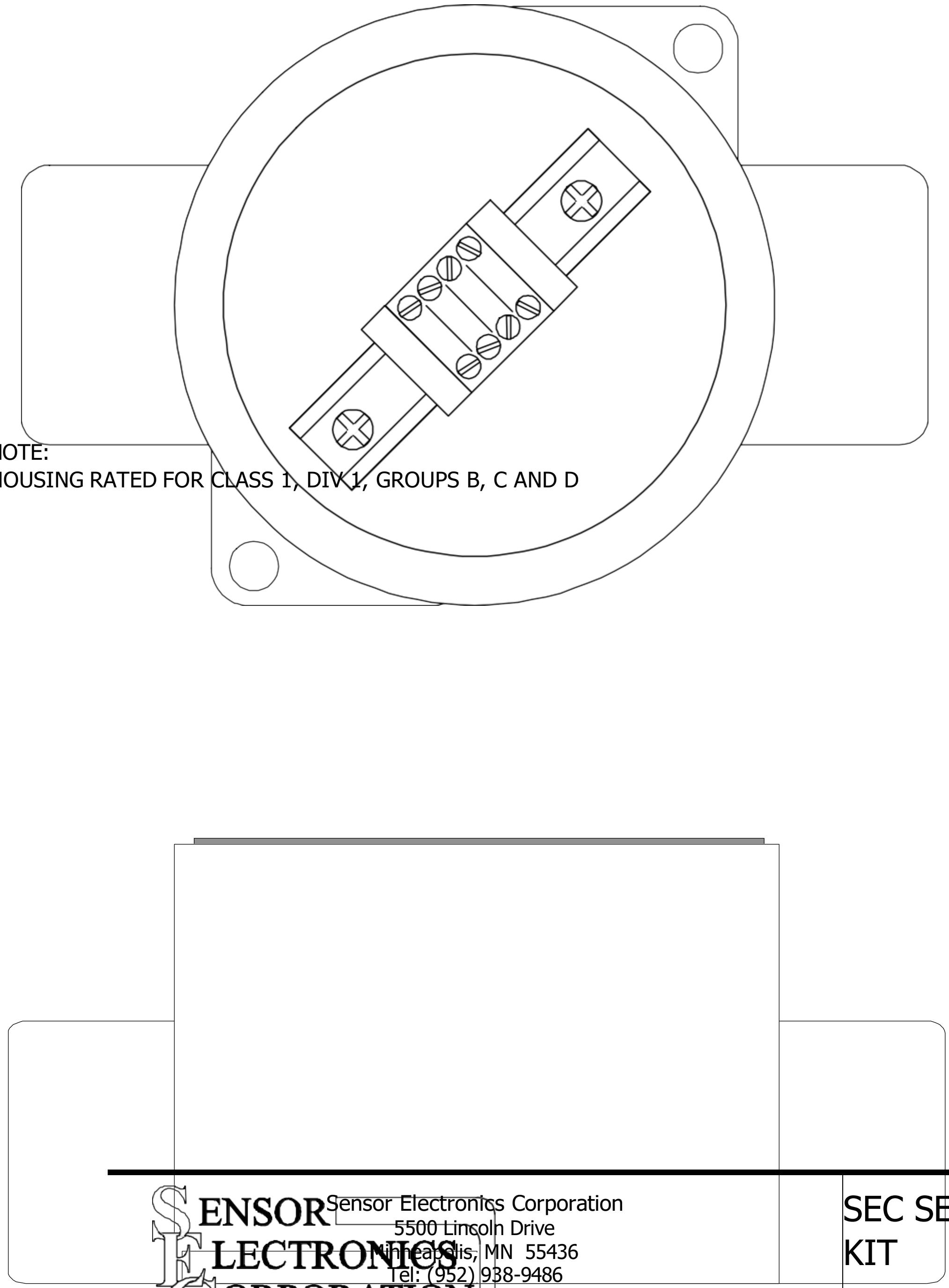
WIRING DIAGRAM
MILLENIUM SENSOR

FIGURE 1

WIRE ENTRY FOR RETURN TO SEC 2000
3/4 NPT

WIRE ENTRY FOR SENSOR 3/4 NPT



NOTE:
HOUSING RATED FOR CLASS 1, DIV 1, GROUPS B, C AND D

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SEC SENSOR SEPARATION KIT

FIGURE 2

System Operations Checks of Extractive FTIR Air Monitoring System:

Overview:

The purpose of the System Operation Checks (SOC) is to continuously check the system in real-time to ensure the analyzer is working in a manner to produce valid data. If a check occurs that indicates a potential performance issue, a message is sent to the on-call support team to evaluate the issue and perform corrective actions as needed. SOC flags can be generated by the instrument itself, by monitoring site parameters such as Internet connectivity, as well as evaluating the data for external events such as weather-related issues. In general, the message board on the website is updated to inform the public why instruments may be offline. The specific SOCs for the FTIRs are listed in Table 1.

Table 1 summarizes the specific SOPs used to address each SOC.

System Operating checks	Check	Frequency	MQO
Instrument Malfunction Error Code	If a malfunction error code occurs, a validated detection of FTIR occurs, or an environmental issue is detected: generate a system performance flag and notify on-call support	Continuous	Check Error Code Status
Hardware Failure Flags	If the last data point in the database is more than 20 minutes old, generate a hardware failure flag and notify on-call support.	Continuous	Check the time of the last data point collected
Internet/Data Failure Flag	Check to see if more than one analyzer is not reporting Data	Continuous	Check to see if multiple instruments are not reporting data

Environmental Conditions Flags	Check to see if a light signal or other operational parameters are impacted by environmental factors such as humidity, temperature, etc.	Continuous	If ambient parameters are outside of the optimal equipment operation range, then generate a flag
Data Validation of a Detect	If the detection of gas meets all of the continuous data validation checks, notify on-call support for review.	Continuous	Check Data Validity Flags

Argos and, where appropriate, refinery staff, are notified via email if any equipment is operating outside the set operational parameters. They are set to notify Argos and refinery staff when the possibility of poor system performance or communication may affect data or data collection. Argos staff review data generated associated with the identified issue and begin a troubleshooting process outlined in the Argos Alarm Response Procedures Guide. If the issue cannot be corrected through this troubleshooting process, a work order is produced to direct field staff to correct the issue. The specific SOPs for each of the system checks are listed below.

Contents

SOP - Instrument Malfunction Error Code

Scope

The fence line monitoring system has the following alarms set up to automatically monitor the operation of the system:

1. A validated gas detection of alkanes occurs.
2. System Fault Alarm:
    a. If the signal strength drops below a pre-set threshold:
        i. FTIR - Light transmission falls below 4 volts
    b. If internet communication is lost
    c. If a field monitoring computer workstation is down

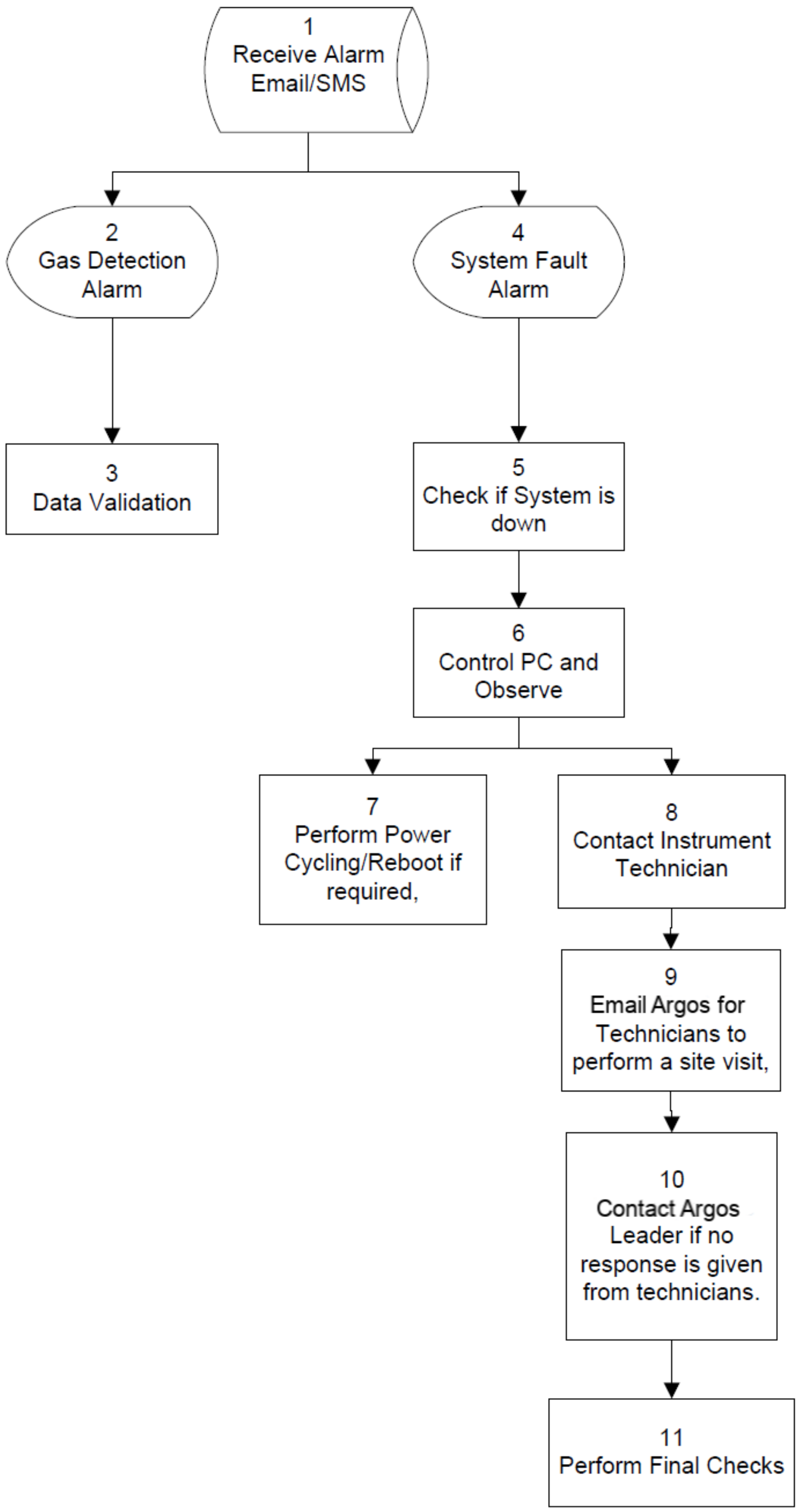
Responsibility and Authority

- ### Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments, and undertake corrective action where necessary.

- ### Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- ### Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – General Alarm Response Procedure



Procedure

1. An e-mail or SMS message is sent out to concerned parties as specified below:
    - Gas Alarm results are communicated to Argos and the refinery.
    - System down alarms are communicated to Argos and the refinery.
2. If an alarm is received that the gas detection level is over the Limit of Quantification, then:
    - A remote technician validates the raw data and logs any adjustments made to the system.
3. If an alarm is received concerning a system fault specified, and depending on the fault reported, the procedure is followed as per documentation:
    - A remote technician checks to see if the system is down, and then he/she:
        - Takes control of on-site computers using the Argos remote access system to observe probable causes through observation and depending on findings will either:
            - Re-initialize any data acquisition software: or
            - Perform a power cycling/ reboot, if the system is shut down due to a power outage or an update cycle; or
            - If the fault cannot be fixed by the steps above the fault is escalated to an Operational Technician.
            - If the fault persists, an e-mail is sent to Argos for an Operational Technician callout on-site. Together with remote technician support, an Operational Technician creates a work plan (work order) and visits the site, and checks the system for:
                - Alignment.
                - Instruments not operating.
        - If, after one hour from the callout, no updates from on-site technicians have occurred, an e-mail is escalated to Argos Project Management staff to notify of the delay in the execution of a site visit.
        - Once the fault is found and corrected, an on-site technician contacts the remote technician to conduct a verification of proper instrument operation as outlined in appropriate SOPs that will ensure that setup was done correctly, and the system is working properly.
        - The remote technician checks the following before logging out of the remote computer:
        - Signal strength
            - FTIR - Light transmission is above 4 volts
        - That a background has been collected before going live.
        - Data is reported to the website.

Records

Argos Work Order

IMS-QLT-MAN-010

FLM-QLT-FOR-001

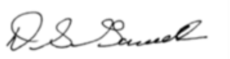
References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	29 August 2022
Final approval signature			

SOP - Hardware Failure Flags

Scope

In the event of a field monitoring computer malfunctions, Argos Scientific will be notified via e-mail, and refinery personnel will be notified via email or text of the condition. Argos will begin the process of troubleshooting and an Argos Operational Technician will attempt to restart the workstation.

Responsibility and Authority

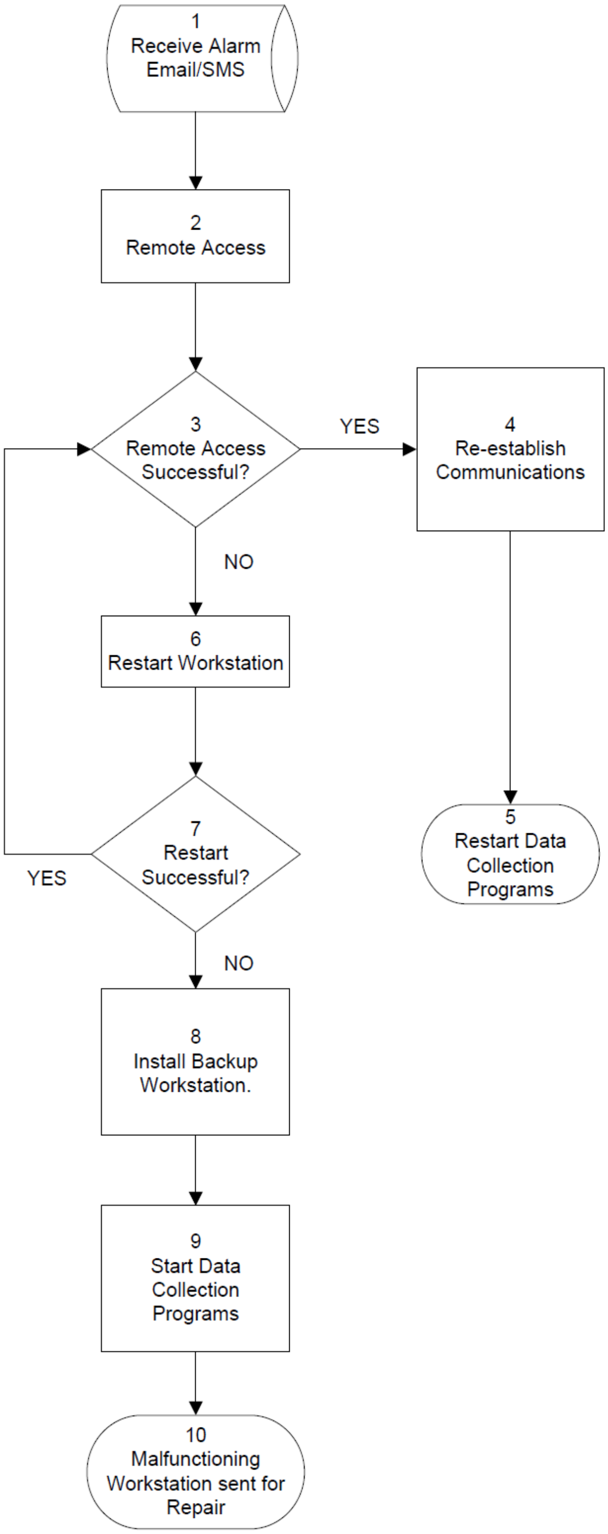
- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Field Data Workstation Malfunction

Process flow: Field Monitoring Computer Workstation Down



Procedure

1. A remote technician will attempt to remotely access the computer using the Argos remote access system.

2. If remote access was successful, then:
    - Re-establish communications; then,
    - Restart all data collection programs.
3. If Argos cannot establish a remote connection, then an Argos Operational Technician or a qualified subcontractor will be dispatched to restart the system.
4. If the computer restart is successful, then all data collection programs will be restarted.
5. If restarting the computer is not possible, then the Operational Technician will install the backup field monitoring computer workstation.
6. The remote technician will start all data acquisition programs on that computer.
7. The malfunctioning workstation will be sent to Argos for repair.
8. The *Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001* will be updated.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	08/28/22
Final approval signature			

SOP - Internet/Data Failure Flag

Scope

Site is connected to a database via an internet connection. When communication is lost, Argos Scientific is notified via email and the situation is monitored until the internet reconnects. Refinery personnel will be notified via SMS or e-mail notification. If the notification is received, Argos will respond to the notification as soon as possible.

Responsibility and Authority

- Operational Technicians / Contract Technicians
  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
  - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
  - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
  - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
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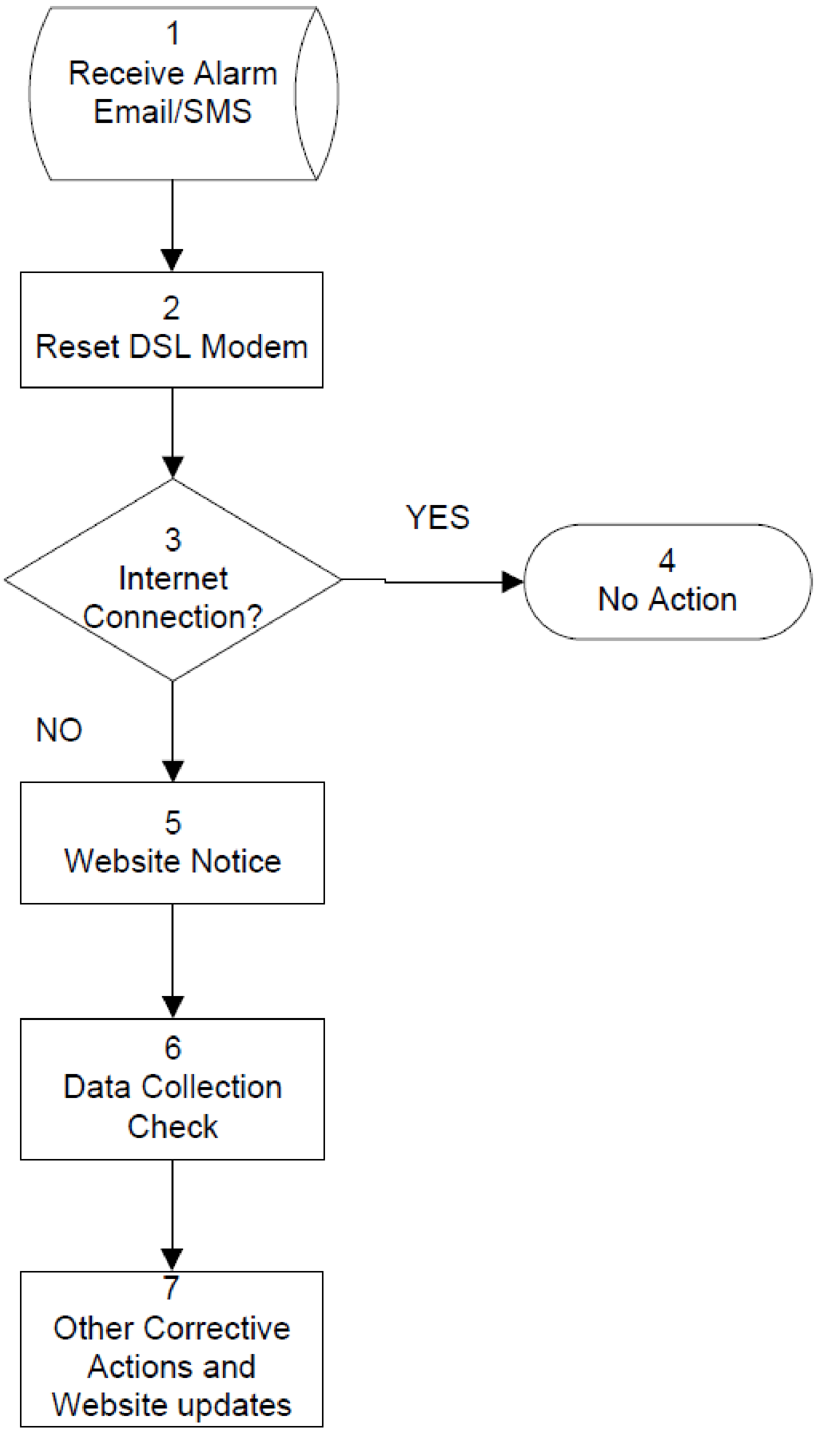
Flow Chart – Loss of Internet Communication

Process Flow: Internet Communication is Lost



Procedure

1. Argos will begin the process of troubleshooting and an Argos Operational Technician will attempt to reconnect to the Internet by resetting the modem located at the monitoring station.
2. The internet connection will be checked and, if:
    - The connection has been re-established, then no further action is needed;
    - The connection has not been re-established, then the following actions will be taken:
        - Argos will post a note to the message board of the real-time website stating that the Internet connection has been lost and actions are in place to re-establish the connection; then,
        - The Argos Operational Technician will go to all of the monitoring systems to make sure they are still collecting data and finally,
        - The real-time website will be updated as the corrective action(s) are taken.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence line Monitoring.

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019
Final approval signature			

SOP - Environmental Conditions Flags

Scope

If the signal strength drops below a pre-set threshold, Argos Scientific will be notified via e-mail and refinery personnel will be notified via page or e-mail of the event. Upon receiving this notification, Argos will access the instruments to determine if the loss of signal is due to weather (e.g., fog, rain etc.), obstruction by trees, light sources wearing out, or misalignment of optics.

Responsibility and Authority

- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

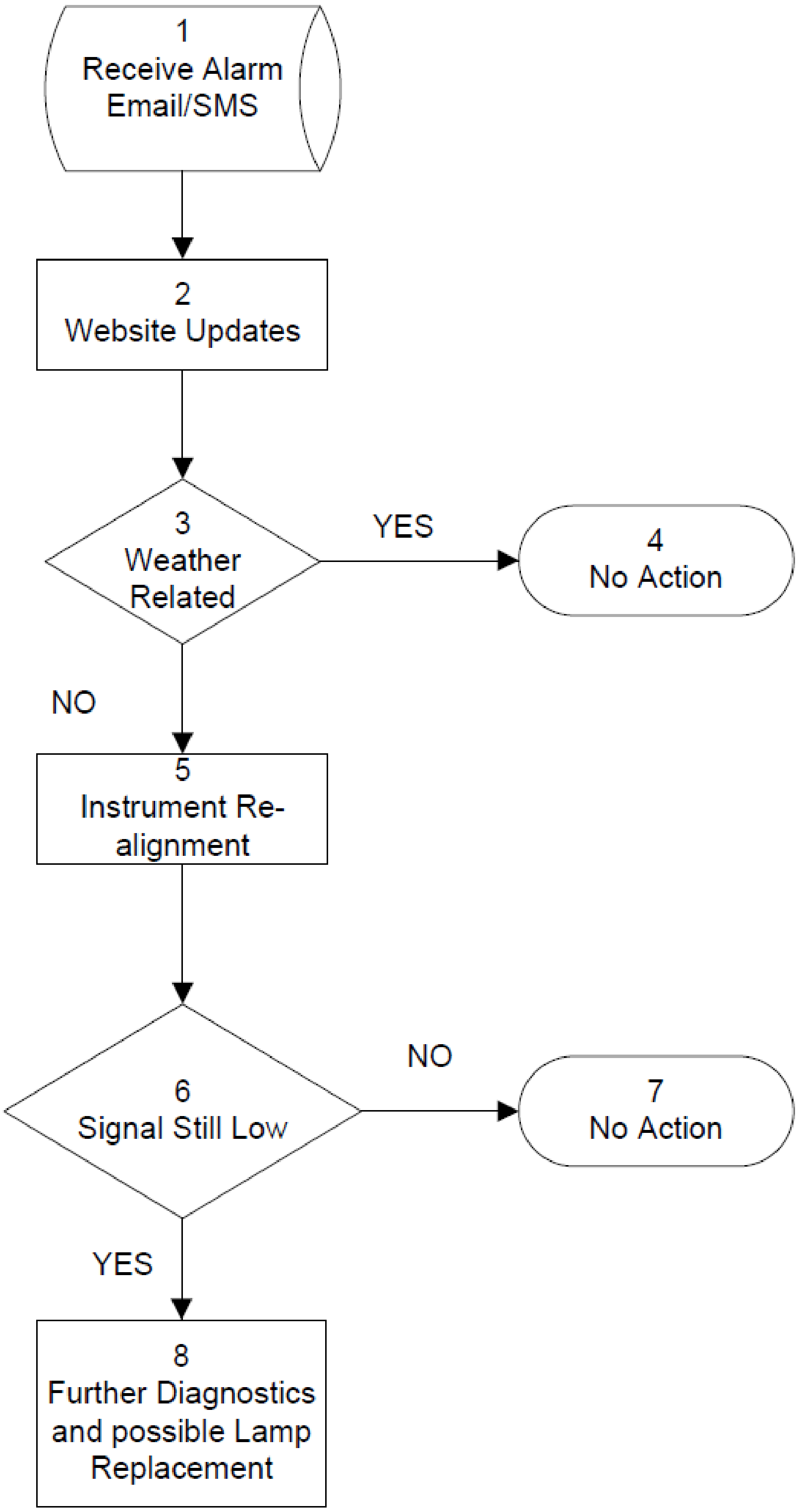
- Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit in order to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized

to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Operational Event Scenario 2

Process Flow: An FTIR has Low Signal



Procedure

1. If the signal strength drops below a pre-set threshold (4 volts), Argos will be notified via e-mail and refinery personnel will be notified via SMS or e-mail of the event. Upon receiving this notification, Argos will access the instruments remotely via the Argos remote access system to determine if the loss of signal is due to weather (e.g., fog, rain etc.), obstruction by trees, light sources wearing out, or misalignment of optical components.
2. The real-time website message board will be updated to indicate which instrument has low signal. Data from that monitoring station will be flagged accordingly.
3. If the notification is weather related, then no additional action will be taken.
4. If the notification may be due to an instrument misalignment, then an Argos Operational Technician will be deployed to re-align the system.
5. If after the system has been re-aligned:
   - The signal strength is no longer low, then no further action is needed;
   - The signal strength is still consistently low, then further diagnostics are required, including replacement of light sources.
6. Once the FTIR signal has been optimized by alignment an on-site technician contacts the remote technician to conduct a verification of proper instrument operation as outlined in appropriate SOPs that will ensure that setup was done correctly, and the system is working properly.
7. The remote technician checks the following before logging out of the remote computer:
   1. Signal strength
   2. FTIR - Light transmission is above 4 volts
   3. That a background has been collected before going live.
   4. Data is reported to the website.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Critical Spares Tracking List, FLM-QLT-REG-001
- Non-conformance/Improvement form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence-line Monitoring

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	August 2022	August 2022	August 2022
Final approval signature			

SOP - Data Validation Flags

Scope

The fence line monitoring system has the following alarms set up to automatically monitor the operation of the system to flag and report when a validated gas detection of alkanes occurs.

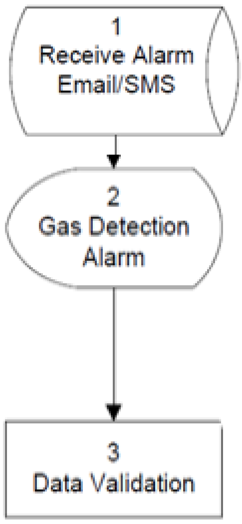
Responsibility and Authority

- Operational Technicians / Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
    - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments and undertake corrective action where necessary.

- Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer during each visit to facilitate data manipulation and record any corrective action that needs to be taken.
    - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR-001)*

- Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians. *Note: This will be carried out in accordance with the Continual Improvement Procedure, IMS-QLT-MAN-010.*

Flow Chart – Validated Detection and Procedure



Procedure

1. An e-mail or SMS message is sent out to concerned parties as specified below
    - Gas Alarm results are communicated to Argos and the refinery.
2. If an alarm is received that the gas detection level is over the Limit of Quantification, then the following steps occur:
3. On-call support is contacted, and the following parameters are checked:
4. The ratio of the measured concentration of the gas to the standard deviation of the measurement (concentration to sigma ratio) was greater than 3.
5. Ambient methane concentration greater than 1.9 ppm.
6. If these checks are invalid, the data point is flagged for further review.
7. If all the checks are validated, then a regression analysis of the field data to an alkane reference occurs.
    - If the regression correlation coefficient is above 0.7, then the data point is reported as valid.
    - If the regression correlation coefficient is less than 0.7, the data point is flagged for further review.

Records

IMS-QLT-MAN-010

References

N/A

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	29 August 2022
Final approval signature			

FTIR Alkane Data Validation

Overview:

The purpose of the Data Validation Check (DVC) is to ensure that any data that has not been flagged as invalid meets appropriate data quality standards. DVCs are performed in real-time, on a daily basis, and anytime a data point is outside of normal parameters. The specific DVC for the FTIR's are shown in Table 1.

Table 1 – ALKANE Data Validation Checks

Check Type	Check	Frequency	MQO
Instrument Output Statistics	Check output statistics generated by the manufacturer's software	Real-time	Check output statistics measurement standard deviation, dropped scans, and light signal
System output statistics	Check output statistics generated by the logging software	Real-time	Check real-time MDLs, concentration to sigma ratio correlation coefficient
Quantitative Detection Validity Check	Determine if the detects identified meet valid quantification checks	Daily	Perform independent validation of alkane detects
Review of Monthly Bump Check	Determine if the calibration check data meets precision and accuracy checks	Monthly	Insert NIST traceable gas standards into the beam path and measure the response
Senior Review	Evaluate data for systems trends	Monthly	Evaluate long-term performance trends

The SOPs for real-time validation of ALKANE are included in (MSOP-001-TDL SCC) and are therefore not listed in the Table of Contents for this MSOP.

Contents

SOP - Quantitative Detection Daily Validation Checks

Scope

This describes the process where the Remote Technician does a manual check on the raw data collected in the last 24 hours. Items that are checked are:

- Assess possible Weather-related effects that occurred.
- Validate any possible detections.
- Invalidate data detections that do not meet quality assurance parameters.
- Any data that needs to be flagged according to the following flagging conventions:

Flagging Code	Flagging Convention
0	Missing
1	Valid
4	Data For Review
5	QA/Maintenance
8	Low Signal/Offline

Responsibility and Authority

1. Operational Technicians/Contract Technicians

   - It is the responsibility of all Technicians/Contract Technicians to log on to the computer or logbook daily or as and when required, to download the previous day's work activities.

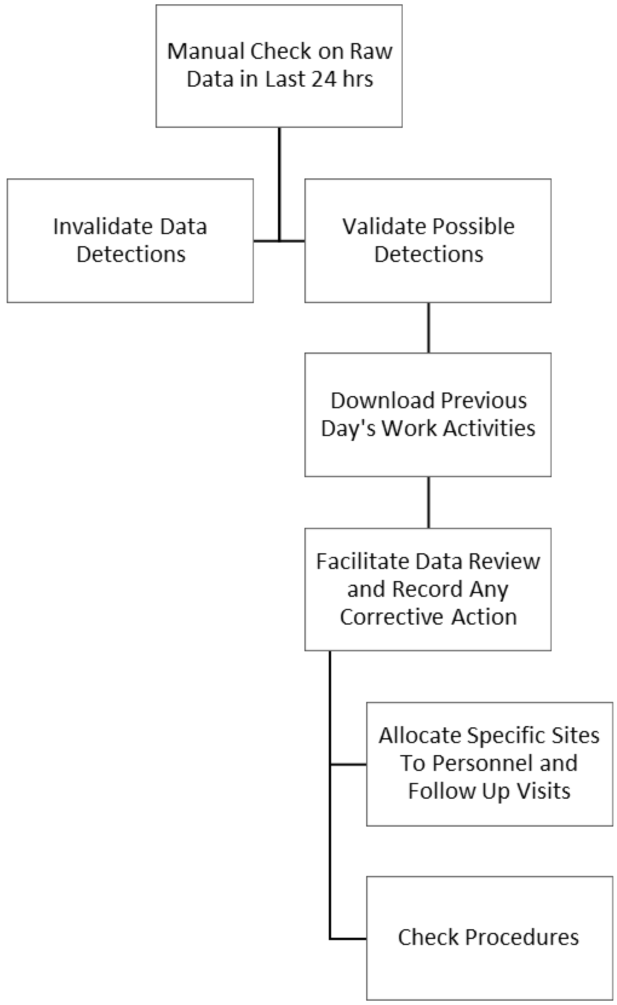
2. Data Technician and Technical Manager

   - It is the responsibility of these staff to login onto the computer or logbook to facilitate data review and record any corrective action that needs to be taken.

3. Technical Manager

   - The Technical Manager is responsible for allocating specific tasks to personnel and following up that tasks are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Daily Manual Validation of Field Data



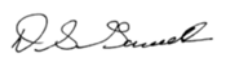
Procedure

1. Check LoQ to ensure data meets BAAQMD LoQ requirements for alkanes.
2. Check values against Argos Data Dashboard for the system being checked.
3. Check for gases that are above LoQ thresholds meet the required data validation parameters these are:
    - The measurement standard deviation is greater than 6.
    - Ambient methane concentration greater than 1.9 ppm.
4. Check data points marked as invalid against data validation parameters.
5. Check when humidity is above 90% and light signal below 4 volts transmission.
6. Check LoQ should always be more than the mean concentration for non-detects.
7. Check the completeness report.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP - Monthly Validation of Alkane Data

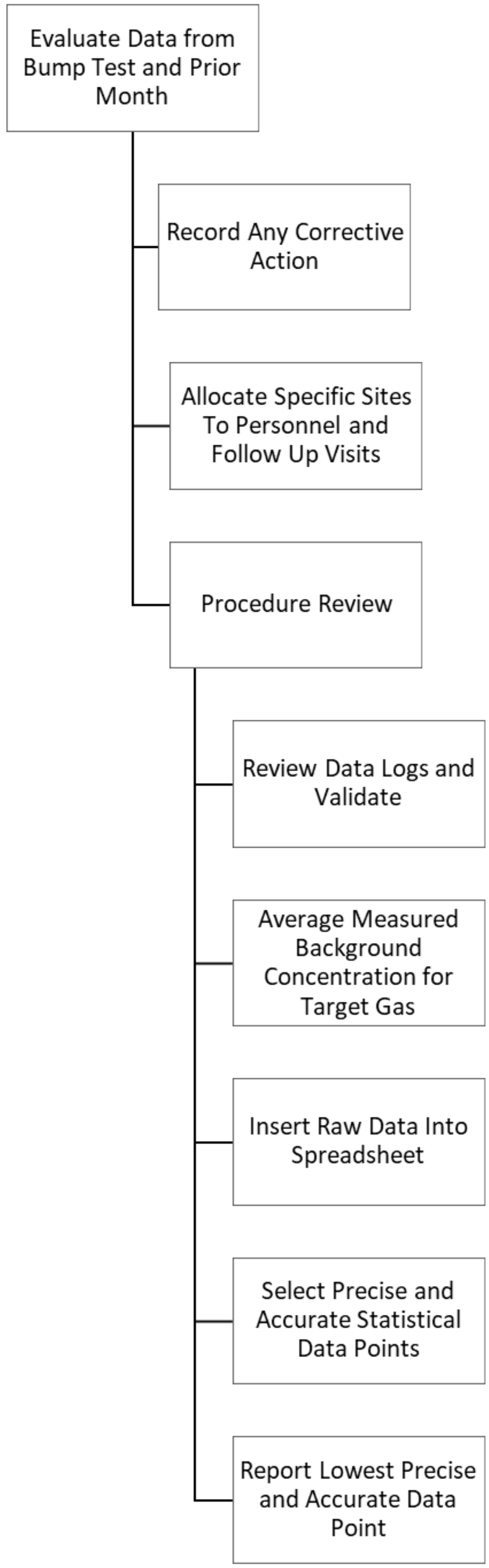
Scope

This process describes how a Data Analyst reviews the QA'd data from the bump test and the dataset for the prior month to ensure they are ready for inclusion in the Quarterly Data Reports. Items that are checked are:

Responsibility and Authority

8. Operational Technicians/Contract Technicians
    - It is the responsibility of all Technicians/Contract Technicians to log on to the computer or logbook on a daily or as and when required, basis to download the previous day's work activities with a record of the station visit, dated and time-stamped and traceable to the operator performing the calibration checks.
9. Data Technician and Technical Manager
    - It is the responsibility of these staff to login onto the computer or logbook to facilitate data review and record any corrective action that needs to be taken.
10. Technical Manager
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Monthly Validation of Field Data



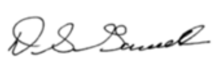
Procedure

1. Review data logs from Operational Technicians to validate the start and stop times for gas calibration.
2. Using the prior five-minute data set, average the measured background concentration for the target gas. Use this concentration as the background offset for the calibration data.
3. Insert the raw data into the spreadsheet that calculates the precision and accuracy.
4. Select the data points that have both precision and accuracy statistics that are below 15%.
5. Report the data point that has the lowest combined levels of precision and accuracy.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP - Senior Analyst Validation Checks of Alkane Data

Scope

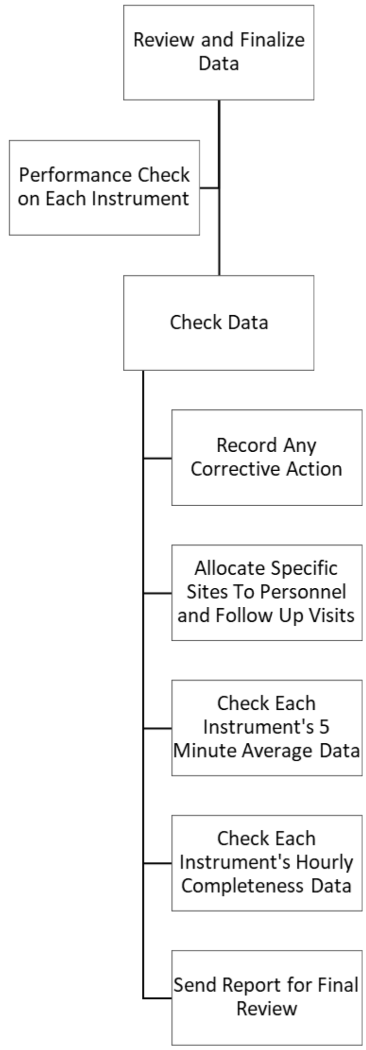
At this level of data validation data is reviewed by a project management level staff member to ensure all above processes have been followed and is finalized for inclusion into the quarterly reporting format that is required by the BAAQMD. The data to be checked include:

- Performance of each instrument against the onstream efficiency requirement of 90% calculated according to the BAAQMD reporting procedure.
- Data on monthly bump tests.
- Description of corrections made to data due to QA.
- Five-minute average data in the format prescribed by the BAAQMD.
- Hourly completeness data in the format prescribed by the BAAQMD.

Responsibility and Authority

- Data Technician and Technical Manager
    - It is the responsibility of these staff to evaluate the prior month's data set for the above flags and to login onto the computer or logbook to record any corrective action that needs to be taken.
    - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Senior Manual Validation of Field Data

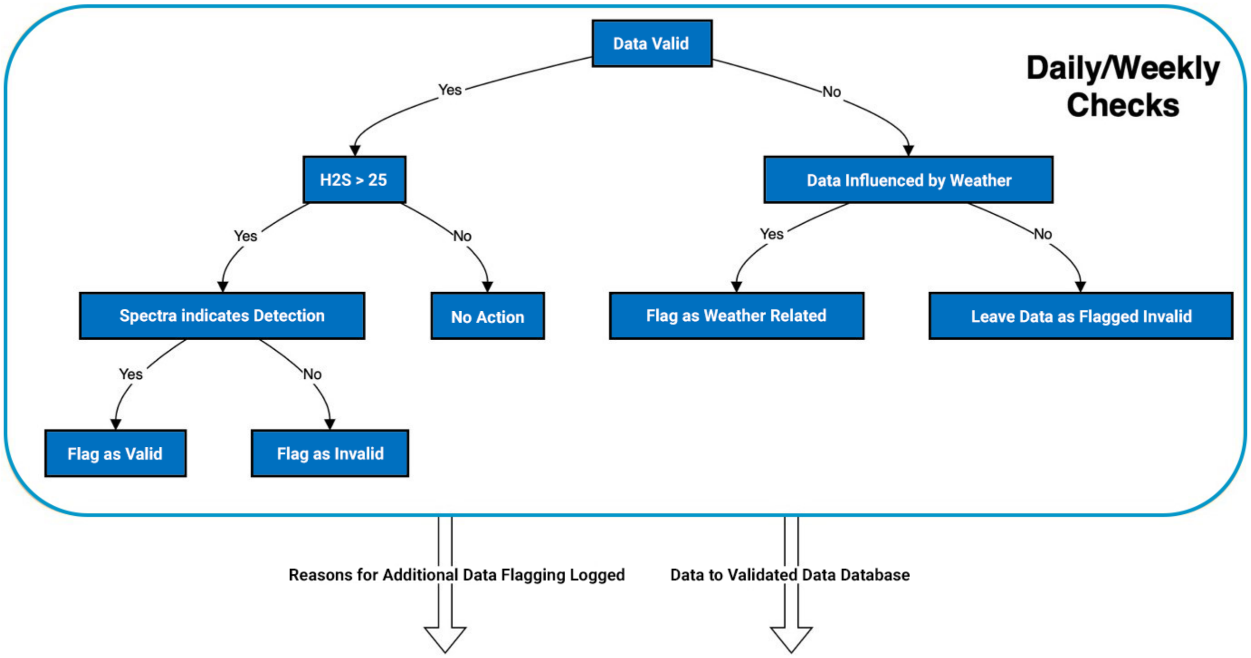


Procedure

A validated report generation application is run on the validated data set to provide the data in the BAAQMD format. This is then validated by a senior data analyst who performs the following checks:

For each instrument the 5-minute average data is checked against the following:

- Compare the data to the data trends for the month.
- Perform a check on a sample of data following the process in the figure below.



- Validate any adjustments made due to QA.
- Log any further changes made to the validated data set.
- Review the log of data adjustments.
- Send report to Project Management staff for final review.

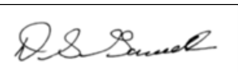
For each instrument the hourly completeness data is checked by a senior data analyst against the following:

- Validate weather related flags and calculations.
- Validate any data that has a completeness between less than 75%.
- Verify downtime where QA and Maintenance took place.
- Calculate the completeness.
- Send report to Project Management staff for final review.

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08 August 2022
Final approval signature			

System Challenges of FTIR Air Monitoring System

Overview:

The purpose of the system challenge is to verify the FTIR air monitor which detections alkane scan meet the BAAQMD requirements specified in the letter dated December 22, 2023. Specifically, the letter states the following:

"For reference, the minimum detection limit (MDL) of a measurement process is defined as the lowest concentration of the analyte that can be reliably detected (i.e., distinguished from zero), and the LOQ is the lowest concentration at which the analyte can not only be reliably detected but at which predefined goals for accuracy and precision are met. The accuracy and precision specifications of 15% must be met at each calibration point. Failure to meet these specifications must trigger repair, maintenance, and root cause analysis, followed by repeat calibration checks until a passing calibration check is completed."

The Limits of Quantification (LoQ) for the FTIR air monitoring system are calculated in real-time by evaluating data quality parameters produced by the manufacturer's data analytic software along with standard statistical tests of the real-time data. The data quality parameters produced by the system software are:

- The measured ambient ozone concentration tracks the local air monitoring stations.

Correlation coefficient for the measurement is greater than 0.7.

In addition to the real-time checks, the Limit of Quantification (LoQ) is regularly established through monthly bump checks and quarterly span checks, by introducing a known quantity of gas. The LoQ is verified by ensuring the quantified concentration aligns with BAAQMD's precision and accuracy standards. Any data points exceeding the LoQ are flagged and then undergo review by a specialized data analyst within 24 hours of detection. To affirm the appropriate Levels of Quantification (LoQ), the FTIRs undergo a monthly system challenge with alkane gas that is traceable to NIST standards, within a range set by the BAAQMD for the required monthly bump check tests. This data is reviewed in a manner that includes evaluating the check for the BAAQMD requirements for precision and accuracy as well as the internal QA/QC checks. Table 1 presents the concentration ranges and the measurement frequency for the various tests.

Table 1 – Gas Concentrations for Calibration Tests

Check Type	Frequency
Bump Check	Monthly
Low Conc Check	Monthly
Calibration Low	Quarterly
Calibration Mid	Quarterly
Calibration High	Quarterly

The current calibration concentrations for the gas standards are shown in Table 2

	Expected n-Hexane (ppb)
FTIR C	2100 ± 300
FTIR D	2100 ± 300
FTIR F	2100 ± 300
FTIR G	2100 ± 300

The specific SCCs for the open-path FTIRs are listed in Table 2.

TABLE 2 – SCCS FOR THE OPEN-PATH FTIRS

Check Type	Check	Frequency	MQO
MDL Check	Determine the MDL of the analyzer with the calibration gas inserted into the unit	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Calculated detection limits must be less than 25 ppb.
Precision Check	Insert a known concentration of a gas into the system and measure precision	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Measured precision must be Less than or equal to 15%
Accuracy Check	Insert a known concentration of a gas into the system and measure accuracy	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Measured accuracy must be Less than or equal to 15%
Linearity Check	Insert a known concentrations of a gas into the system and measure the linearity	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	R^2 for linear regression of data points must be greater than 0.9
Corrective Action	Calibration parameters are checked for failure	Anytime a significant change in the hardware occurs, Monthly bump test, quarterly challenges	Implement maintenance, and root cause analysis, and recalibrate.

The Standard Operating Procedures associated with the quantitative gas checks are found below.

Contents

SOP - Minimum Detection Limit (MDL) Determination for FTIR Monitoring System

Scope
With no gas present in the light beam, a series of 26 spectra are collected using the appropriate averaging time (e.g., 5 min). The spectra are used to quantify the alkanes measured in the beam path. The resulting 25 spectra are analyzed for the target gas. The MDL is defined as two times the standard deviation of the calculated concentrations. This method can be used in conjunction with lowering light transmission at the source to determine MDLs at specific signal strengths.

Responsibility and Authority
- Technical Manager and Data Technician
    - All technical procedures used must be fully validated before being used for monitoring.
    - Assess all deviations from expected outputs and decide on the acceptance and non-acceptance thereof.
    - Must report substantial deviations from expected outputs.

Frequency
Detection limits will be calculated and recorded in real time. In addition, detection limits will be validated on a quarterly basis by checking the detection limits by hand.

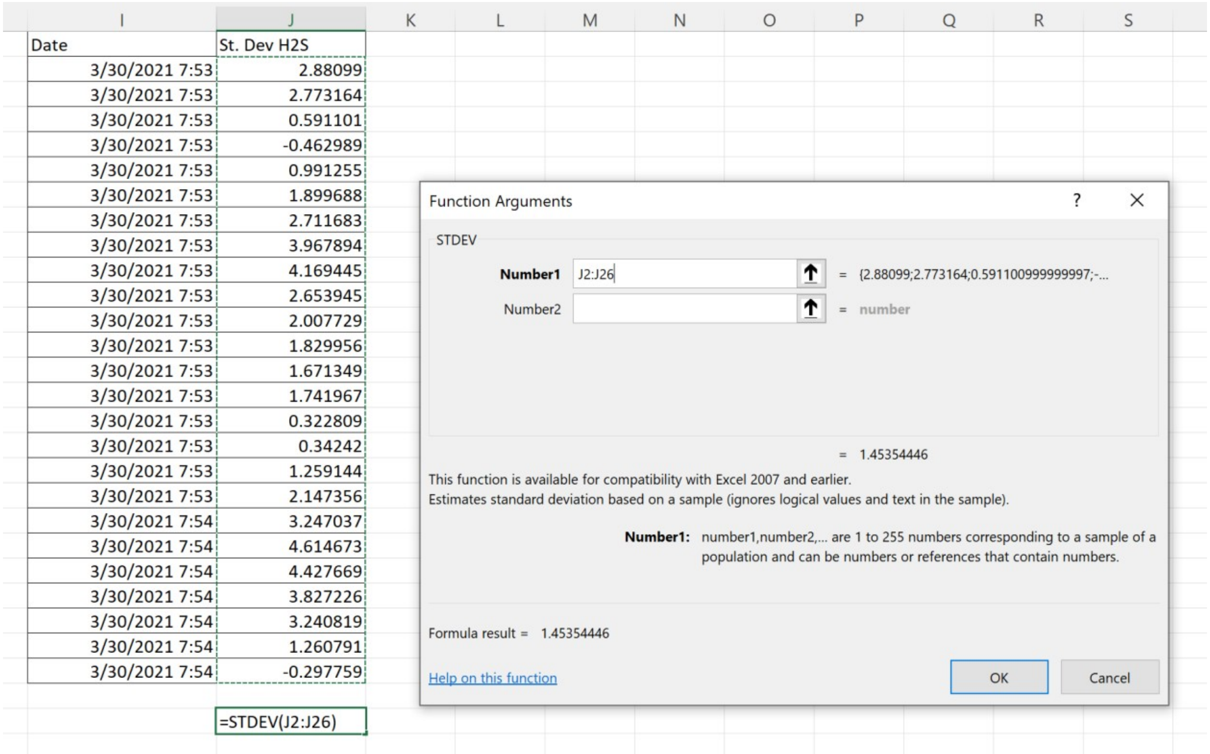
Procedure
Select a period when the target compound is not present such as when the wind direction dictates that the monitor is upwind from the source of the target gas. There should also be enough wind speed to be confident that general dispersion of a target gas in all directions is not occurring (e.g., greater than 1 mph).

3.1. Open data summary file containing the reported concentration of alkanes.

3.2 Once opened, choose a folder from a date corresponding to a period of time when the wind direction was satisfactory (i.e., wind not blowing from the source of target gas). Choose 26 consecutive data points from the desired time period.

Date	Alkanes
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.46299
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
3/30/2021 7:53	2.711683
3/30/2021 7:53	3.967894
3/30/2021 7:53	4.169445
3/30/2021 7:53	2.653945
3/30/2021 7:53	2.007729
3/30/2021 7:53	1.829956
3/30/2021 7:53	1.671349
3/30/2021 7:53	1.741967
3/30/2021 7:53	0.322809
3/30/2021 7:53	0.34242
3/30/2021 7:53	1.259144
3/30/2021 7:53	2.147356
3/30/2021 7:54	3.247037
3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.29776
3/30/2021 7:54	-0.06576

3.3 Calculate the standard deviation of the 25 concentration values using the standard deviation function in Excel:



Date	St. Dev H2S
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.462989
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
3/30/2021 7:53	2.711683
3/30/2021 7:53	3.967894
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3/30/2021 7:53	2.147356
3/30/2021 7:54	3.247037
3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.297759
	=STDEV(J2:J26)

Alternatively, calculation can be completed by determining the average ($\bar{x}$) of the column of the selected chemical concentrations and the standard deviation (σ) according to the equation:

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

where:

$\bar{x}$ = average reported concentration from the 25 calculated absorbance spectra

x = concentration reported in individual absorbance spectrum

n = number of data points

Finally, calculate 2x the standard deviation of the calculated concentrations to arrive at the Minimum Detection Limit (MDL).

Date	St. Dev Alkanes
3/30/2021 7:53	2.88099
3/30/2021 7:53	2.773164
3/30/2021 7:53	0.591101
3/30/2021 7:53	-0.462989
3/30/2021 7:53	0.991255
3/30/2021 7:53	1.899688
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3/30/2021 7:53	1.671349
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3/30/2021 7:53	0.322809
3/30/2021 7:53	0.34242
3/30/2021 7:53	1.259144
3/30/2021 7:53	2.147356
3/30/2021 7:54	3.247037
3/30/2021 7:54	4.614673
3/30/2021 7:54	4.427669
3/30/2021 7:54	3.827226
3/30/2021 7:54	3.240819
3/30/2021 7:54	1.260791
3/30/2021 7:54	-0.297759
St. Dev.	**1.5**
2 x St. Dev.	**2.9**
Average	**2.2**

Records

- MDL Spreadsheet inside the Verification Summary
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

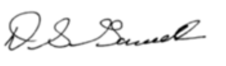
References

- Argos Scientific Operations Manual for Open-path Air Monitoring System
- Environmental Technology Verification Programme (Advanced Monitoring Systems Pilot) – Test/QA Plan for Verification of Optical Open Path Monitors

Replacement

This is a new document.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Don Gamiles
Title	Technical Manager	Managing Director	Technical Manager
Date	August 2022	August 2022	08 August 2022
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Precision

Scope and Application

Frequency

Quarterly

Description

The precision of the monitor is a quantification of its ability to make repeatable measurements when challenged with the same gas sample inserted in the beam using a sample cell.

Measurement Quality Objective

The objective is to determine the precision of the FTIR air monitoring system and compare the measured result to historical measurements. If the results differ in a statistically significant manner, corrective actions will be initiated. The procedure for determining the precision of the FTIR is as follows:

Alkane gas will be introduced into the multi-pass cell and 25 single-beam spectra of the target gas will be obtained. The collected spectra will be analyzed for the target gas. The relative standard deviation of this set of measurements is the precision at the target gas concentration and is given by the following formula:

$$RSD = \left|\frac{\sigma}{\overline{\overline{T}}}\right| \cdot 100$$

Where RSD is the Relative Standard Deviation

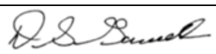
Acceptance Criteria

The MQO will be met if the measured precision meets the requirements in Table 1.

Corrective Action

If the system fails the precision check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue. Beam spectra are then used to create absorption spectra, using each single beam spectrum.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Accuracy

Scope and Application

This document refers to an accuracy check for open-path air monitoring system for the continuous measurement of gases in the ambient air along an open path. It includes specific reference to the open-path monitor accuracy check described in EPA documents (e.g., Environmental Technology Verification (ETV) Protocol for Optical Open-Path Monitors (Section 5.5.4), Method TO-16). The relevant EPA documents describe the general procedure to determine instrument accuracy relative to a known concentration of target gas inserted into the beam path.

Frequency

Quarterly

Description

The accuracy of the monitors will be evaluated for target gases by inserting a calibration gas into the beam path with a known concentration of a target gas and comparing the calibration gas concentration to the concentration measured by the monitor.

Measurement Quality Objective

The objective is to determine the accuracy of the air monitoring system and compare the measured result to historical measurements. If the results differ in a statistically significant manner, corrective actions will be initiated. The procedure for measuring the accuracy of the is as follows:

The relative accuracy (A) of the monitor with respect to the reference gas is assessed using the following formula:

$$A = \frac{|\overline{R} - \overline{T}|}{\overline{R}} \cdot 100$$

Where:

A = accuracy of each measurement

$\overline{R}$ = the average value of the reference gas

$\overline{T}$ = the average value of the measurements

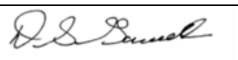
Acceptance Criteria

The MQO will be met if the measured accuracy is within 15% of the expected value.

Corrective Action

If the system fails the accuracy check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP for: Open-Path Air Monitoring Systems – Linearity

Scope and Application

This document refers to a three-point linearity check using open-path air monitoring systems for the continuous measurement of ambient air along an open path. This document includes specific reference to open-path monitor linearity checks described in EPA documents (e.g., Environmental Technology Verification (ETV) Protocol for Optical Open-Path Monitors (Section 5.5.4), Method TO-16). This procedure specifically refers to the linearity of the monitor for a specific target gas over a range of concentrations. This is referred to as the "concentration linearity".

Frequency

Quarterly

Description

Using the method outlined in the relevant EPA document for open-path air monitoring systems, the lower detection limit (LDL) will be measured for the Open-path air monitoring system.

Measurement Quality Objective

Detection limits are determined using the method outlined in the appropriate SOP. The detection limits are calculated by removing the target gas from the optical path of the monitor and measuring the detection limit. The MQO will be considered to have been met if the calculated detection limits are less than or equal to the detection described in the appropriate documentation.

Acceptance Criteria

This MQO will be considered to have been met if the values in Table 1 are met.

Corrective Action

If the system fails the detection limit check, the electronic records saved during the test will be sent to the equipment manufacturer or their representative to troubleshoot the issue.

Sampling Procedures

Instrument Operation

Measurement Quality Objectives

Procedure: The general procedure for determining the concentration linearity is as follows:

Determining the concentration linearity of the instrument requires challenging the monitor with at least three varying concentrations of the target gas. At each of these concentrations, a measurement of the target gas concentration is made using the standard analytical software. The results of each measured quantity are plotted against the known concentration values on a scatterplot. A linear regression or best fit calculation is performed for the resulting line. A corresponding correlation coefficient (R2) is calculated which measures how close the data are to the straight or fitted line. The concentration linearity of the instruments will be archived and used for comparison purposes. An instrument's linearity should not be statistically significantly different from prior quarterly checks and should not vary in a systematic way over time.

Details of the specific steps involved in carrying out this procedure are given below.

1. Open the vendor-specific continuous monitoring software.

2. Select the target gas/gases present in the sealed cell used in the linearity check.

3. If possible, set the light signal to be approximately equal to 75% of the full-scale value for the air monitor.

4. Confirm that the wind direction indicates that no target gas is present in the beam path (i.e., the instrument is upwind of the source), or otherwise confirm the current concentration of target gas in the air (subtracted from the final reading).

5. Insert the cell into the beam path and collect a background i.e., clean air sample for five minutes.

6. Fill the calibration cell with the first calibration gas containing the target gas at concentration c1. Check "Alignment" to confirm that the signal is still within the appropriate range. Collect a data sample for five minutes. This concentration will be referred to as c1.

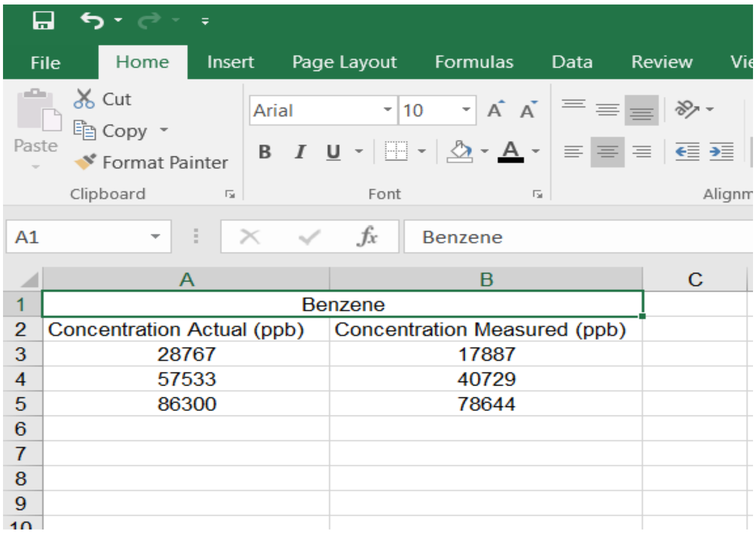
7. Repeat the data collections described in Step 6 two additional times with gas concentrations listed in Table 1. For each data collection, leave the gas cell in the beam path for five minutes. The two concentrations will be referred to c2 and c3.

8. Purge the flow through the cell with nitrogen and collect spectra for an additional five minutes. These spectra will represent the background levels of the target compound.

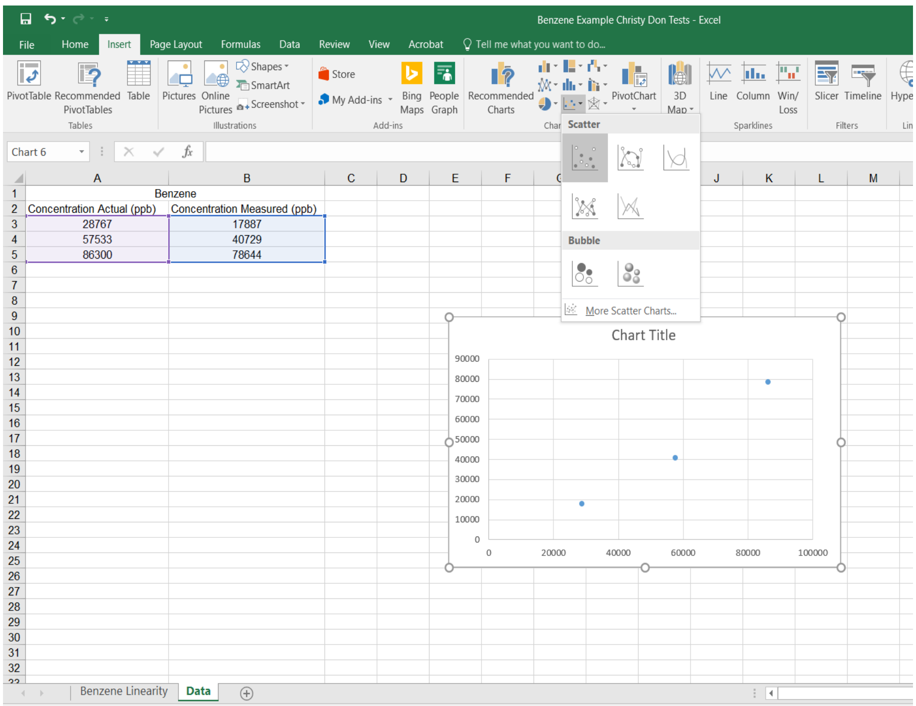
9. Using the procedure to determine the optimal precision and accuracy for each concentration, record the lowest combination of measurement error for each gas concentration.

10. Open Excel. In a new Excel worksheet, create two columns, one for the actual c1, c2, and c3 cell concentrations and one for the measured results. By default, Excel will plot the

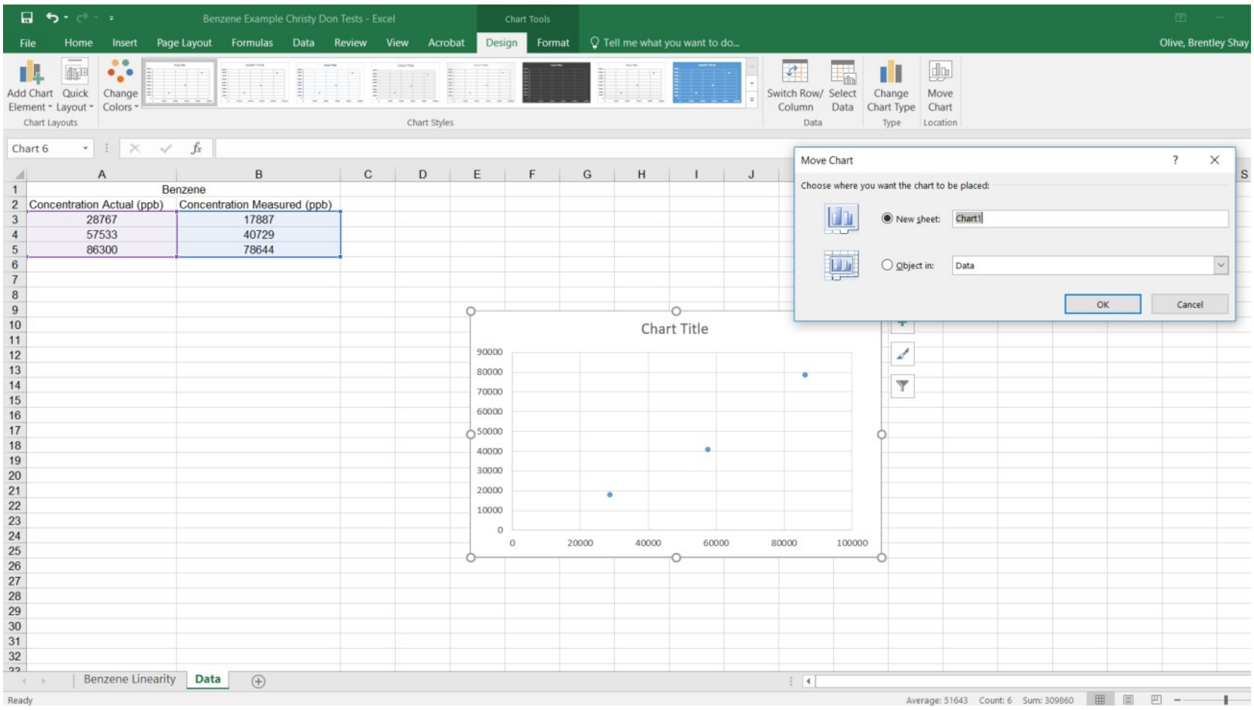
column to the left on the x-axis (independent variable), and the column to the right on the y-axis (dependent variable).



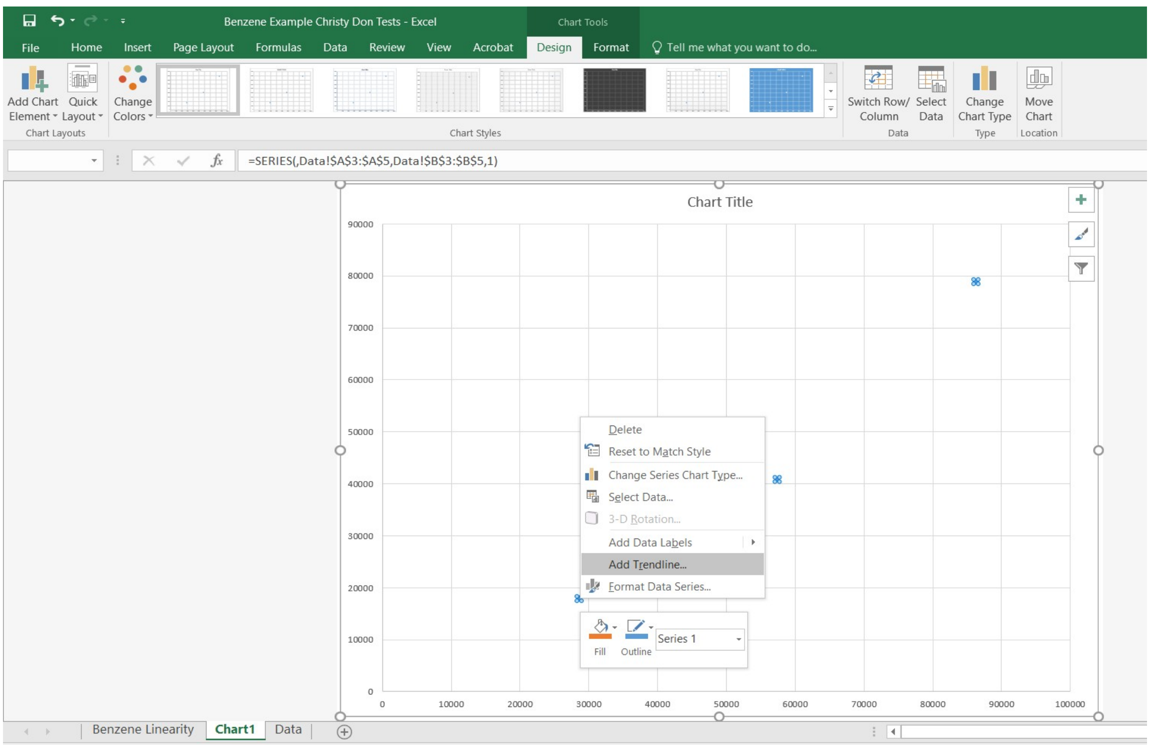
11. Highlight the two columns and choose “Insert”, “Scatter”.



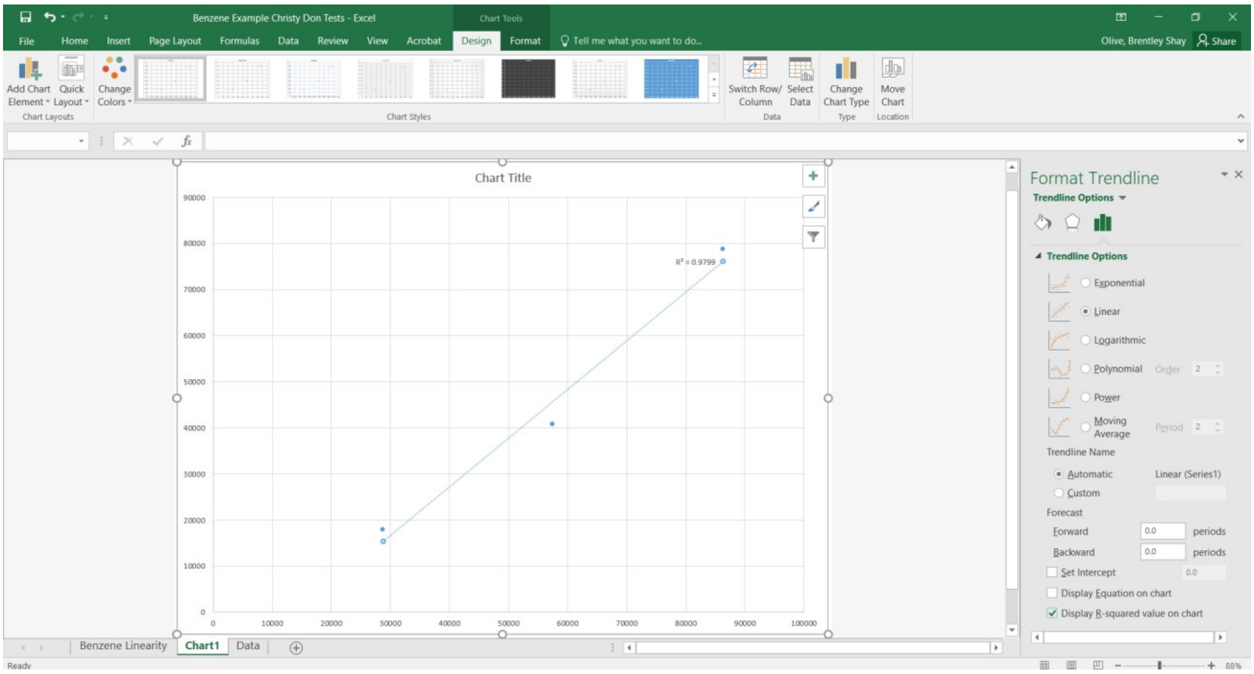
12. A scatterplot will be inserted into the active spreadsheet tab. If desired, the newly created graph can be selected, and by clicking "Move Chart", the graph will be moved to a new tab and enlarged.



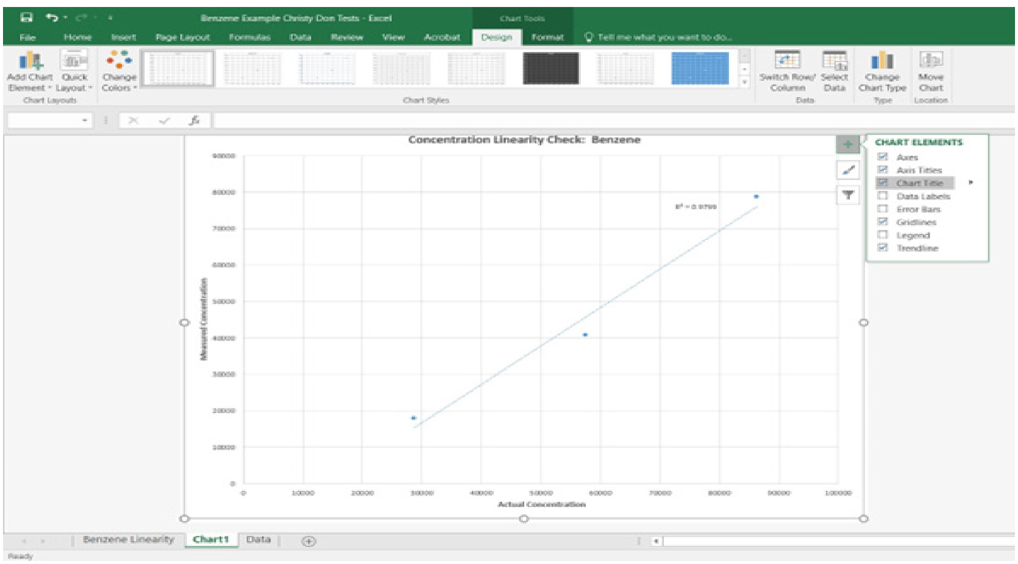
13. Right click on any of the plotted points and select "Add Trendline".



14. An option bar will appear on the right-hand side of the screen. If not selected by default, select “linear” from the list of options, and check the box for “Display R-squared value on chart”. An R-squared value of 1 equates to a perfect linear correlation. In general, values at or above 0.9 are desirable when a linear instrument response is assumed to be the case. The PLS software can compensate for non-linear instrument responses at higher concentrations when reference spectra at corresponding concentrations are collected and entered into the algorithm.



15. Additional options can be selected such as displaying the straight-line equation on the chart, as well as adding axis titles, adjusting gridlines, and formatting the plot area by either double clicking or right-clicking on various options.



Record and archive the R-squared value for the specific concentration linearity check. Compare the results to previous checks to determine if there is a significant difference in instrument performance as compared to past linearity checks.

Approval

	PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Wicking-Baird	Quentin Hurt	Donald Gamiles
Title	Technical Manager (AQM)	Technical Supervisor	Technical Manager (AQM)
Date	August 2022	August 2022	08/29/22
Final approval signature			

SOP - Corrective Action Procedure

Purpose

The purpose of the Continual Improvement and Non-conforming Work Procedure is to encourage the ongoing re-assessment and improvement of the business Management System and to define the parameters and procedures by which such changes are considered and documented.

This procedure describes the process and responsibilities for the identification, control, follow-up and close out of improvements and non-conformities identified in the business's management and technical system.

Scope

This procedure applies to formal non-conformities identified at any management system audit and all processes, external or internal, where improvements or non-conformances are or can be raised and have to be actioned.

Definitions/Abbreviations/Acronyms

Non-conformance	:	Non-fulfilment of a requirement.
Requirement	:	A need or expectation that is stated, generally implied, or obligatory.
Correction	:	Action taken to eliminate a detected non-conformity.
Corrective Action	:	Action taken to eliminate the cause of a detected non-conformance or other undesirable situation in the management system or process, so as to prevent recurrence.

Preventive Action	:	Action taken to determine and eliminate the causes of a potential non-conformance or other undesirable potential situation to prevent occurrence.
Improvement	:	Action taken to improve an otherwise satisfactory process or system.
Management Team	:	Includes the Managing Director, Manager and General Managers or authorised designates
Root Cause analysis	:	A root cause analysis is conducted to determine the real cause (not symptoms or explanations) of non-conformities. The root cause is the reason why a problem started in the first place.

Responsibility and Authority

- The **Project Manager** is responsible for the implementation of this procedure.
- The **Management Team** or designates have the responsibility and authority to ensure that all non-conformances are processed, and corrective action is implemented, effective, and managed to completion within the predetermined time limit.
- The Management Team has the authority and responsibility to handle and control the non-conforming work, halt work where applicable, determine when test/calibration reports are finalized and authorise the resumption of work.
- All employees are required to report non-conforming work and assist in the investigation and close-out of non-conformances.

  Note: where a job title is mentioned, the action can also be performed by the authorised designate(s). Refer to the Authority Matrix (IMS-QLT-REG-009) for details.

General

- Non-conformances may be the result of the following, but are not limited to:
  - Failure of the business and its personnel to comply with the requirements of the quality management system, standards, and regulations.
  - Failure of test/calibration/verification data to meet required standards.
  - Failure of resources (e.g., equipment, people, etc.) to meet performance or other specified requirements.
- Any employee may initiate a non-conformance, improvement, or preventive action by following these steps:

- Create a detailed description of the non-conformance, improvement, or preventive action (see Appendix 1 for guidelines).
- Notify the Assistant and line management.

Control of Non-Conforming Work

- The Management Team shall evaluate the significance of the non-conforming work to make a decision about its acceptability. The decision shall be based on scientific knowledge and the relevant requirements of the specific methods.
- If the Management Team deem it necessary, work shall be halted, and determine when test/calibration reports are finalized.
- The root cause shall be determined, and relevant corrective and preventive action shall be implemented to correct the nature of the non-conformance. All decisions shall be documented and retained within the relevant project file.
- A non-conformance shall be registered in the Non-Conformance and Audit Register (IMS-QLT-REG-002) and documented on the Non-Conformance and Improvement Report (IMS-QLT-FOR-001).
- The Management Team shall ensure that the client is notified about the non-conformance and any associated corrective action.
- In the event where a test/calibration report has been issued with a non-conformance, the test/calibration report shall be recalled, and an amended test/calibration report shall be issued.
- The Management Team shall authorise the resumption of work upon the implementation of the corrective action.

Corrective Action

1.1. NEED FOR CORRECTIVE ACTION

- Corrective action requires careful consideration to determine the root cause of a non-conformance and may involve a team.
- Corrective action includes measures to immediately address the problem (correction) and to see that they do not recur.
- Corrective action shall be taken in the event of the following, but not limited to:
  - Non-conformance creates an unacceptable risk to the business.
  - Correction is not enough to prevent recurrence of a non-conformance.
  - Non-conformance adversely affects the business's ability to demonstrate competence.

1.2. CORRECTIVE ACTION PROCESS

- The business adheres to the following steps for implementing corrective action when non-conformances from its policies and procedures are detected within the management system or technical operations. These steps include:
  - Registration of non-conformances, improvements or preventive actions in the *Non-Conformance and Audit Register (IMS-QLT-REG-002)*. *(Note: A unique number is assigned to each non-conformance).*
  - Document the non-conformance on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
  - An Impact Assessment shall be conducted to determine if a full root cause investigation is required. This shall be recorded on the *Non-Conformance and Audit Register (IMS-QLT-REG-002)* and indicated on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
  - The Impact Assessment is conducted by the Manager and verified by an impartial source, e.g., a member of the Management Team.
  - The Project Manager in consultation with the Line Manger(s) shall assign the non-conformance to a designated person.
  - The designated person in conjunction with a team will initiate an investigation to determine the root cause(s) of the problem if required (see Appendix 2 for guidelines on root cause analysis) and compile an action plan to correct and prevent the problem from being repeated.
  - Risks identified during the investigation of the non-conformance shall be indicated in the risk register and reviewed on an annual basis.
  - The Risk Register will be updated and reviewed by the Management Team.
  - The action plan shall be submitted to the Project Manager within two weeks from the date of initiation of the non-conformance.
  - The Management Team and the designated person shall monitor the investigation process.
  - Following the implementation of the corrective actions, the final close-out date shall be indicated on the *Non-Conformance and Audit Register (IMS-QLT-REG-002)*, and the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)* plus corresponding evidence of corrective actions sent to the Manager to verify the actions taken.
  - For internal audits/non-conformances, the Project Manager/Line Manager(s) shall verify the corrective action on the close-out date or within one week of the final close-out date.
  - If the corrective actions are reviewed and found to be unsatisfactory, this is to be indicated on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001),* and the designated person shall review the root cause and revise the corrective actions.

- Once the corrective actions have been verified by the Project Manager/Line Manager(s), the verification date is recorded on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)* and *Non-Conformance and Audit Register (IMS-QLT-REG-002)*.
- Evaluation of the effectiveness of the corrective actions shall be scheduled on the *Internal Audit Schedule (IMS-QLT-REG-007)* approximately one month after the corrective action verification date. Should this evaluation not be possible within the designated timeframe, justification shall be provided on the Non-Conformance Register. The Management Team or Project Manager shall evaluate the effectiveness of the corrective actions. This shall be recorded on the Non-Conformance/Improvement Report, and in the event that the corrective actions have not had the desired effect, a new non-conformance shall be raised.

- All evidence of investigations of non-conformances shall be filed in either hard copy or electronic copy.

  Note: *The time-frame for external audit findings to be investigated and corrective actions implemented shall be dependent on the requirements of the accreditation body or auditing organization; internal audit findings shall be investigated, and an action plan shall be developed to ensure corrective actions are implemented within an agreed upon timeframe. The action plan shall be compiled and submitted within two weeks from the initiation of the audit finding.*

Preventative Action Improvements

1.3. GENERAL

- Preventive action is a proactive process whereby improvements and potential sources of non-conformances are identified internally. These may be technical or concern the quality management system itself.
- Action plans are developed, implemented, and monitored to reduce the likelihood of the occurrence of non-conformances and to take advantage of the opportunities for improvement and to ensure that they are effective.
- Every employee shall attempt to identify improvements and potential sources of non-conformances, either operational or concerning the management system.

1.4. SOURCES OF PREVENTIVE/IMPROVEMENT ACTION

- The business continually improves the effectiveness of its management system by identifying opportunities for prevention or improvement via the use of any or all the following:
  - *Health and Safety (IMS-SFT-POL-001)* and *Quality Policy (IMS-QLT-POL-001)*
  - *Code of Integrity (IMS-QLT-POL-002)*
  - *Business objectives for the various businesses* (which are reviewed regularly)

- Audit results
- Analysis of data
- Corrective and preventive actions
- Management review
- Project planning
- Customer feedback
- Training
- Maintenance
- Employee feedback and performance reviews
- Meetings

Note: Preventive action must be taken after the trend analysis of root causes identified during the Management Review process to ensure that they are not repeated.

Preventive and improvement action can further be indicated in the Risk Register.

1.5. PREVENTIVE/IMPROVEMENT ACTION PROCESS

- When preventive/improvement action or risks are identified, the individual shall ensure that it is reported to the Project Manager and shall be recorded on the *Non-Conformance/Improvement Report (IMS-QLT-FOR-001)*.
- The Management Team shall be responsible for implementing and monitoring the action plan to ensure that the appropriate actions are taken within a reasonable time frame and that resulting changes are effective.
- Records of the continual improvement process shall be maintained and controlled by the Manager.

Records

- Non-conformances from audits as well as internally identified by employees.
- Evidence of investigations of root causes.
- Evidence of implementation of corrective actions.
- Non-Conformance and Audit Register (IMS-QLT-REG-002).
- Non-Conformance/Improvement Report (IMS-QLT-FOR-001).
- Risk Registers.

References

- ISO 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories.
- X-Lab Root Cause Analysis Training, Aleesha Sewpersad, January 2020.
- IMS-QLT-REG-007 Authority Matrix

Replacement

This document replaces IMS-QLT-MAN-010, Revision 03 dated 2 July 2020.

Approval

	PREPARED BY:	UPDATED BY:	REVIEWED BY:	APPROVED BY:
Name	Mark Baird	Quentin Hurt	Management Team	Don Gamiles
Title	Manager	Managing Director	N/A	President
Date	17 January 2017	11 May 2020	3 June 2020	3 June 2020
Final approval signature				

Appendix 1: Guidelines for describing non-conformances, etc.

1.6. The description must be:

- Clear and understandable – make sure everyone can understand the description.
- Concise – only include what is necessary.
- Correct – make sure all the information provided is right.
- Complete and detailed: make sure all the necessary information is provided (What, When, Where, Who)

1.7. The description should contain reference to the relevant clause in a standard or section in a procedure, if applicable.

1.8. The description should contain metrics where applicable, e.g., Z-scores, QC data.

1.9. Examples:

- Example 1: Incorrect description:
  Original statement: "The LGC Aquacheck PT (Round 28-AR0792) indicated questionable results for the Total Solids – Z-score 2.24".

  Correct statement: "The LGC LGC Air Stack Emissions for PT (Round 28-AR0792) indicated questionable results for the dust analysis – Z-score 2.24".

- Example 2: Description too vague:
  Original statement: "Decision rules have not been defined internally or with the customer."

  Better statement: "Decision rules regarding the inclusion of uncertainty of measurement when reporting results against specifications and standards have not been defined internally or with the customer. ISO 17025:2017 Clause 7.1.3"

- Example 3: Description incomplete:
  Original Statement "SABS Group 2 - February 2019 - Unacceptable results for Nitrate, and Hexavalent Chromium."

  Better statement: "SABS Group 2 PT (Water) - February 2019 - Unacceptable results for Nitrate by DA (-3.98; -3.43; -5.06) and Hexavalent Chromium by DA (132.02)".

Appendix 2: Guidelines for root cause analysis

1.10. Put together a team to do the root cause analysis. This should include anyone involved in the problem and its resolution.

1.11. Identify the problem.

- This can be taken from the Non-compliance Report (NCR) finding statement, provided that has been properly described.

1.12. Investigate the problem.

- What happened?
- Where did it happen? Physical location, stage of process, environment
- When did it happen? Has it happened before? When did it start?
- Who was involved? Who reported the problem? Who is impacted (staff/project/job)?
- What is the extent of the problem? How serious is the problem? Is it specific to a section/process? Is it throughout? How many projects/jobs are affected?
- How did it happen? How was it discovered? Equipment, maintenance, reagents, quality control, records, methods, procedures, training, etc.

1.13. Identify the root cause(s).

- There may be more than one root cause for the problem.
- These can generally be assigned to one of the following categories:
  - MAN (anyone involved with the process)
  - METHODS/SYSTEMS (how the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations, and laws)
  - MACHINE/EQUIPMENT (any equipment, computers, tools etc. required to accomplish the job)
  - MATERIALS (raw materials, parts, pens, paper, etc. used to produce the final product)
  - MEASUREMENT (data generated from the process used to evaluate its quality)
  - ENVIRONMENT (the conditions, such as location, time, temperature, and culture in which the process operates)
- For each question answered above, that identified something that was wrong, ask “why?” at least 5 times (5 Whys Process). Eventually, the answer to the question will not change and this last unique answer is likely the root cause.
- Once identified, for each root cause ask:
  - Is this root cause really the cause of the problem?

- Is this root cause necessary for the problem to occur?
- Is this root cause alone sufficient to cause the problem?

- If the answer to any of these questions is "no", the true root cause has not been identified or additional root causes need to be found.
- If not already done, assign the root cause to one of the categories listed above.

1.14. Develop an action plan(s) to resolve the root cause(s).

- Decide what needs to be done to remove the problem permanently.
- Plan how this is to be implemented.
- Set a completion date.

1.15. Document all of the above on the non-conformance/improvement report and submit this to the Management Team for review and approval.

- Make sure all the evidence from the investigation is attached.

1.16. Implement the approved plan(s) within the completion date.

1.17. Monitor the situation to decide if the problem has been eliminated.

1.18. Retain evidence of the implementation and monitoring.

System Challenges of FTIR Air Monitoring System Operation and Maintenance

Overview

The purpose of the document is to present the specific operation and maintenance procedures needed to maintain compliance with BAAQMD Rule 12-15.

The specific procedures used to perform these checks are as follows:

Check Type	Check	Frequency	MQO
Routine Operation	Follow the manufacturer recommended operational procedures	Continuous	Documentation demonstrating operational procedures are being followed.
Planned Maintenance Checks	Follow the manufactures recommendation for maintenance procedures	Monthly and Quarterly	Documentation demonstrating routine procedures are being followed.
Non-Planned Maintenance Checks	Follow the manufacturer recommendation for maintenance procedures	As Needed	Documentation demonstrating non-routine procedures are being followed.

The Standard Operating Procedures associated with the Operation and Maintenance of the FTIR are found below. In general, the message board on the website will be updated to inform the public that instruments are offline due to maintenance.

Contents

Planned Maintenance

Scope

This procedure describes the actions and communication that takes place when a system is undergoing routine maintenance, QA/QC checks, or field repair. In regards to the organic gas detector (FTIR) air monitoring system, the following routine maintenance checks occur:

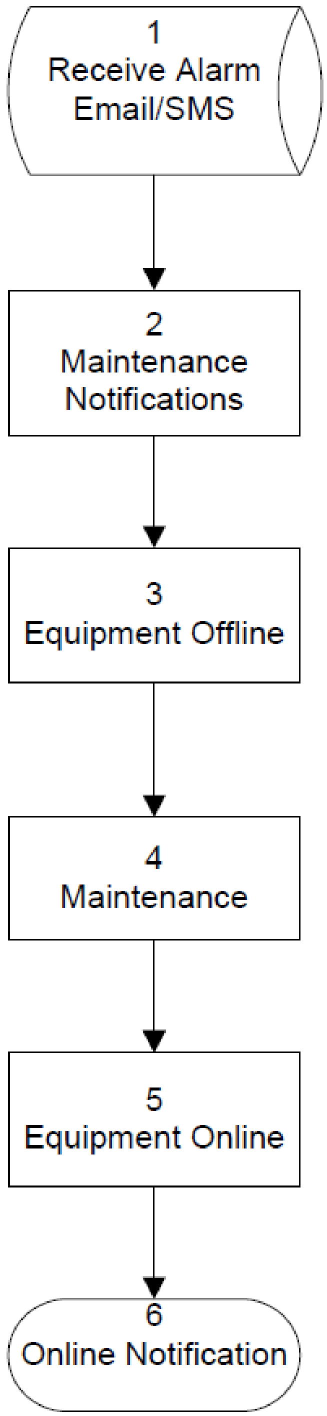
Activity	Monthly	Annually
Visually inspect the system.	✓	
Download data from detector hard drive and if needed delete old files to free space.	✓	
Check system performance indicators.	✓	
Annual Service Check		✓

Responsibility and Authority

- Operational Technicians / Contract Technicians
  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites on a weekly, monthly, or as and when required basis.
  - It is their responsibility to carry out the work necessary, maintain the site in a secure and clean condition, maintain instruments, and undertake corrective action where necessary.
- Data Technician and Technical Manager
  - It is the responsibility of these staff to login onto the computer during each visit in order to facilitate data manipulation and record any corrective action that needs to be taken.
  - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR- 001)*
- Technical Manager
  - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

- Flow Chart – Planned Maintenance

Process Flow: Planned Maintenance



Procedures

1. In the event a system is undergoing routine maintenance, QA/QC checks, or field repair, the following actions will be taken:

- The refinery will be notified of the activity by E-mail.
- A remote Argos Technician will take the unit off-line through the Argos Remote Access system, so that the data is not transmitted to the real-time website.
- When the activities are complete, the systems will be brought back on-line, and the following actions will be performed:
  - The field technicians will optimize the signal of the system and leave the system in alignment mode.
  - A remote technician will collect a new background file.
  - A remote technician will start the system.
  - The remote technician will wait for one 5-minute scan to complete to ensure that the system is operating correctly.

2. The refinery will be notified that the system is back online, and the real-time website will be updated with the same notification.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001
- Non-conformance/Improvement Form, IMS-QLT-FOR-001

References

- Operations Guidance Document for *Refinery*: Fence-line Monitoring

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019
Final approval signature			

Unplanned Maintenance

Scope

This procedure describes the actions and communication that takes place when a system undergoes non-routine maintenance.

Responsibility and Authority

- ### Operational Technicians / Contract Technicians

  - It is the responsibility of all Technicians/Contract Technicians to visit the allocated sites when an equipment call-out occurs and undertake corrective action where necessary.

- ### Remote Data Technician and Technical Manager

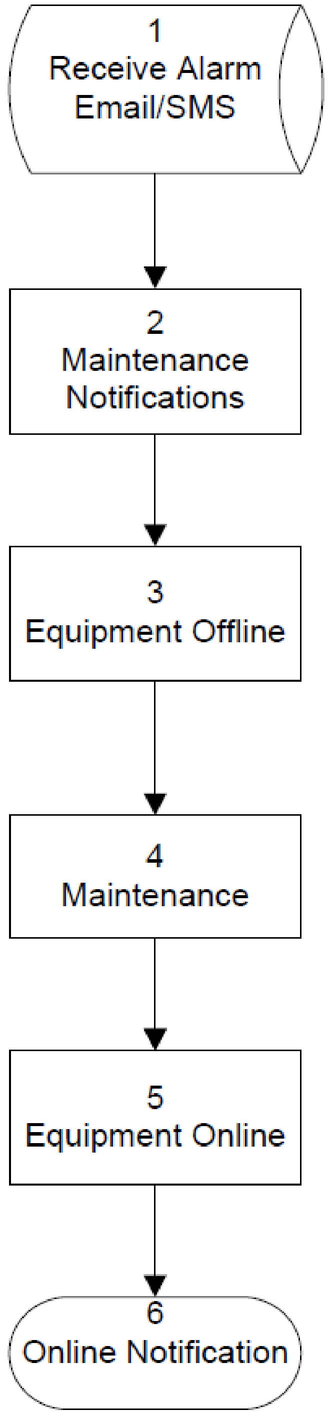
  - It is the responsibility of these staff to login onto the computer during each event and record any corrective action that needs to be taken.
  - A record of the station-visit and alarm, dated and time-stamped and traceable to the performing operator, via *Monthly System Down and Alarm Records Form, (FLM-QLT-FOR- 001)*

- ### Technical Manager

  - The Technical Manager is responsible for allocating specific sites to personnel and following up that visits are undertaken as required. The Technical Manager is authorized to take corrective and preventive action on any deficiencies indicated on any corrective action submitted by Technicians/Contract Technicians.

Flow Chart – Planned Maintenance

Process Flow: Unplanned Maintenance



Procedure

- In the event a system undergoes non-routine maintenance
- An alarm notification will be sent to the on-call staff who will initiate a work order to identify and correct the issue.
- The refinery will be notified of the activity by E-mail.
- A remote Argos Technician will take the unit off-line remotely, so that the erroneous data is not transmitted to the real-time website.
- The corrective action plan will occur using the work order process.
- When the activities are complete, the systems will be brought back on-line, and the following actions will be performed:
  - The field technicians will optimize the signal of the system and leave the system in alignment mode.
  - A remote technician will collect a new background file.
  - A remote technician will start the system.
  - The remote technician will wait for one 5-minute scan to complete to ensure that the system is operating correctly.

The refinery will be notified that the system is back on-line, and the real-time website will be updated with the same notification.

Records

- Monthly System Down and Alarm Records Form, FLM-QLT-FOR-001

References

Replacement

This is a new document.

Approval

	PREPARED BY:	**REVIEWED BY:**	**APPROVED BY:**
Name	Mark Wicking-Baird	Quentin Hurt	Mark Wicking-Baird
Title	Technical Manager	Managing Director	Technical Manager
Date	May 2019	13 June 2019	09 September 2019

RAM 2000
Remote Air Monitor

Second Generation (G2) Users Guide

Rev A: August 2010


RAM™
2000
Remote Air Monitor

The **RAM2000** product line is patented property of ITT Corporation. Exclusive rights have been granted under license to KASSAY FSI.

OVERVIEW OF THIS DOCUMENT

This documentation is a general guide to RAM2000™ G2 system. It is intended for trained personnel who will install, set up, and operate the system for open-path data collection, processing and quantitative analysis. ***The content within provides general information about basic system setup and is not a substitute for factory training. The manual does not provide information on specific methods, monitoring strategy, or analysis techniques. Users with technical questions should contact their RAM2000 representative.***

This document is supplemental to the original two (2) RAM2000 manuals:

RAM 2000™ Installation & Setup Manual published by: AIL Systems Inc. 07/30/04 (FSCM00752, DOC: 468467 Rev B)

RAM 2000™ System Operators Manual published by: AIL Systems Inc. 2/24/03 (FSC 0752 DOC: 467392 Rev C)

SECTION I: OVERVIEW of the RAM2000 Second Generation FTIR RAM2000 G2 INTRODUCTION

The RAM 2000™ is a real-time "Remote Air Monitor" (RAM) that identifies the presence and concentration of molecules in the atmosphere. The RAM2000 is a transceiver with a Fourier-transform InfraRed (FTIR) spectrometer attached to telescope optics to sample the open atmosphere.

Active measurements are made by directing a beam of modulated infrared energy from the monitor's telescope to a remote reflector placed up to 1000 meters away. The energy returns to the system back along the same beam path. Chemical molecules intercepted in the infrared beam path uniquely absorb some of that transmitted energy at known frequencies. An analysis of the absorption spectrum identifies the type and quantity of chemicals present.

The RAM 2000™ G2 is designed to operate continuously 24 hours a day, year round with minimum maintenance. Multiple beam paths can be monitored for more then 300 types of target chemicals.

The figure on the left depicts the RAM 2000™ G2 being used in a

typical monitoring scenario. A chemical source has created a plume of air drifting towards the houses in the community. The leaking drums could be representative of a chemical plant or any other source of volatile organic compounds (VOCs) in gaseous phase.

The RAM 2000™ projects a harmless IR beam through the plume. The beam is reflected back into the FTIR by the retro-reflector. The spectrum collected is analyzed at specific frequencies to determine the compounds present in the plume. An optional Meteorological (MET) station can be integrated to automatically store weather data measured during each FTIR sample.

The RAM2000 and Controlling Software RMMSoft have been deployed worldwide since 1995. The system features integrated accessories such as an autopositioner to shoot to multiple retro-reflectors, automatic liquid fill for Liquid Nitrogen MCT detector dewar, and weather station. The RAM2000 product line was the first open-path FTIR to complete the USEPA's Technology Verification Program (ETV).

G2 Design

The RAM2000 G2 system is the result of design improvements from ten years of experience with the first generation RAM2000.
The G2 includes two main components:

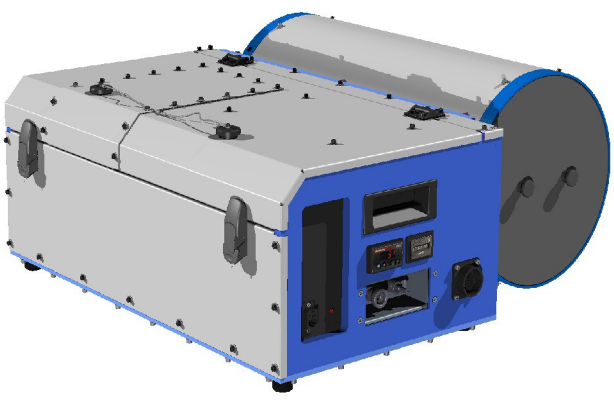
1) Configurable optical bench chassis, and,
2) Removable telescope assembly.

The arrangement allows the user to reconfigure the system depending on measurement objectives.

The G2 can be used for open-path (mono-static active, and bi-static active or passive) monitoring. The gas cell compartment allows for extractive monitoring applications.

Electromechanically, the G2 builds upon the proven features of the original system with external linear power supplies, thermally stabilized bench, scan indicator lamp, elapsed time meter, and RMMSoft software with patented algorithms. G2 Users can choose the LN2 filled detector dewar or a closed-loop sterling engine cryocooler. All G2 electronics have been updated with newly designed circuit boards and interface. The 16-Bit ADC has been replaced with an 18-bit ADC. The outdated fiber optic link has been replaced with an embedded controller and an Ethernet CAT5 cable interface. Optics can now be field-adjusted to improve performance. See Appendix A for a chart comparing the original and the G2 RAM2000 FTIR systems

The G2 is controlled by the award winning RMMSoft with patented signal processing algorithms such as adaptive background filtering and water-vapor-alignment. RMMSoft version 6 will continue to be improved and updated.



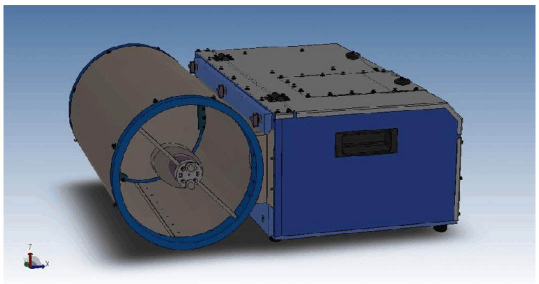
Overall, users familiar with the first RAM2000 system will find the G2 easy to operate since software features remain the same. Users will benefit greatly from the improved hardware design and appreciate the improved performance.

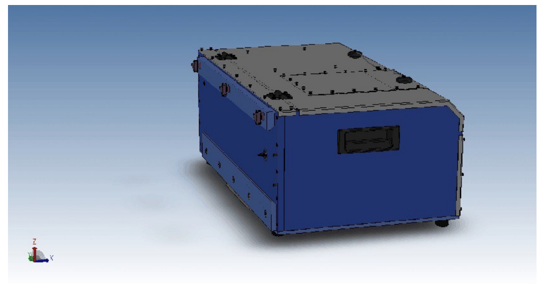
System with Telescope	L x W x H (inches)	Volume (cubic feet)	Weight (Lbs)
RAM2000 (Original)	33 x 12.5 x 23	5.5	110
RAM2000 G2	**25 x 27.5 x 11.5**	**4.5**	**85**

The proceeding paragraphs describe some of the RAM2000 G2 features in more detail.

Removable Telescope Assembly

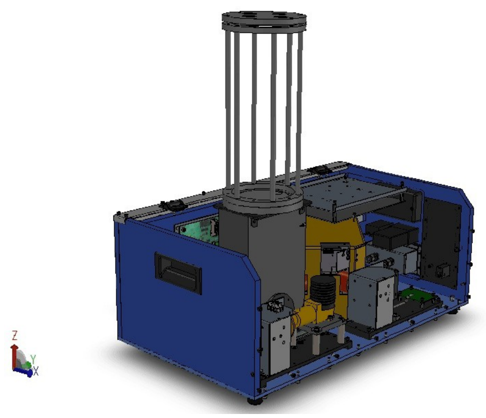
The telescope assembly can be easily removed or replaced with a different size telescope. The assembly slides on / off the optical bench along its dovetail plate and is fastened by tightening the three knobs of the dovetail clamp. The design makes the system easier to store and transport. The standard 10-inch Newtonian telescope allows for path ranges up to a kilometer . An oversize retro-reflector can be ordered to increase signal at long ranges.



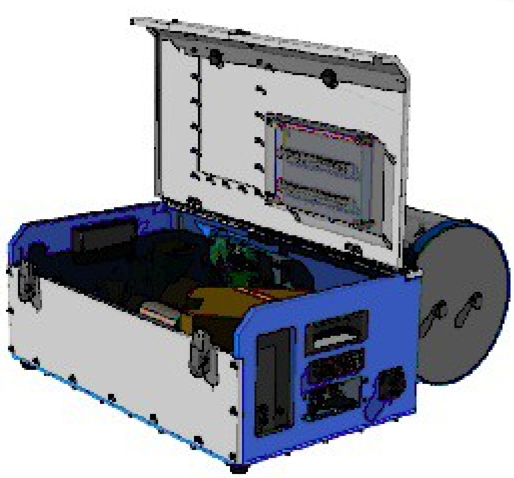


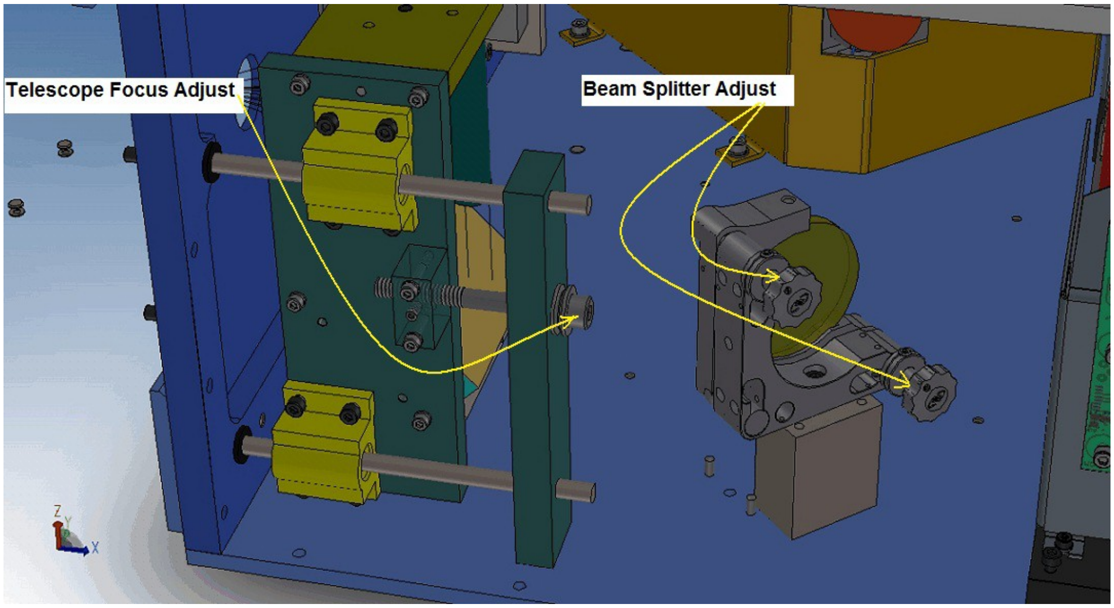
Internal Gas Cell Compartment

The system bench has a compartment for installing either 15cm (single pass,) or a multi-pass gas extraction cell. Simply remove the gas cell lid and insert the cell in the optical beam path. The gas cell can be installed with or without removing the telescope. For ***Compendium Method TO-16*** projects, a 15cm single pass cell can be installed in series with a the telescope to perform QA/QC. For extractive monitoring, a long path multi pass cell can be inserted in the same location. The second beam splitter can be rotated to redirect energy through either gas cell. Depicted below is the system with a 10-meter multi-pass cell installed.

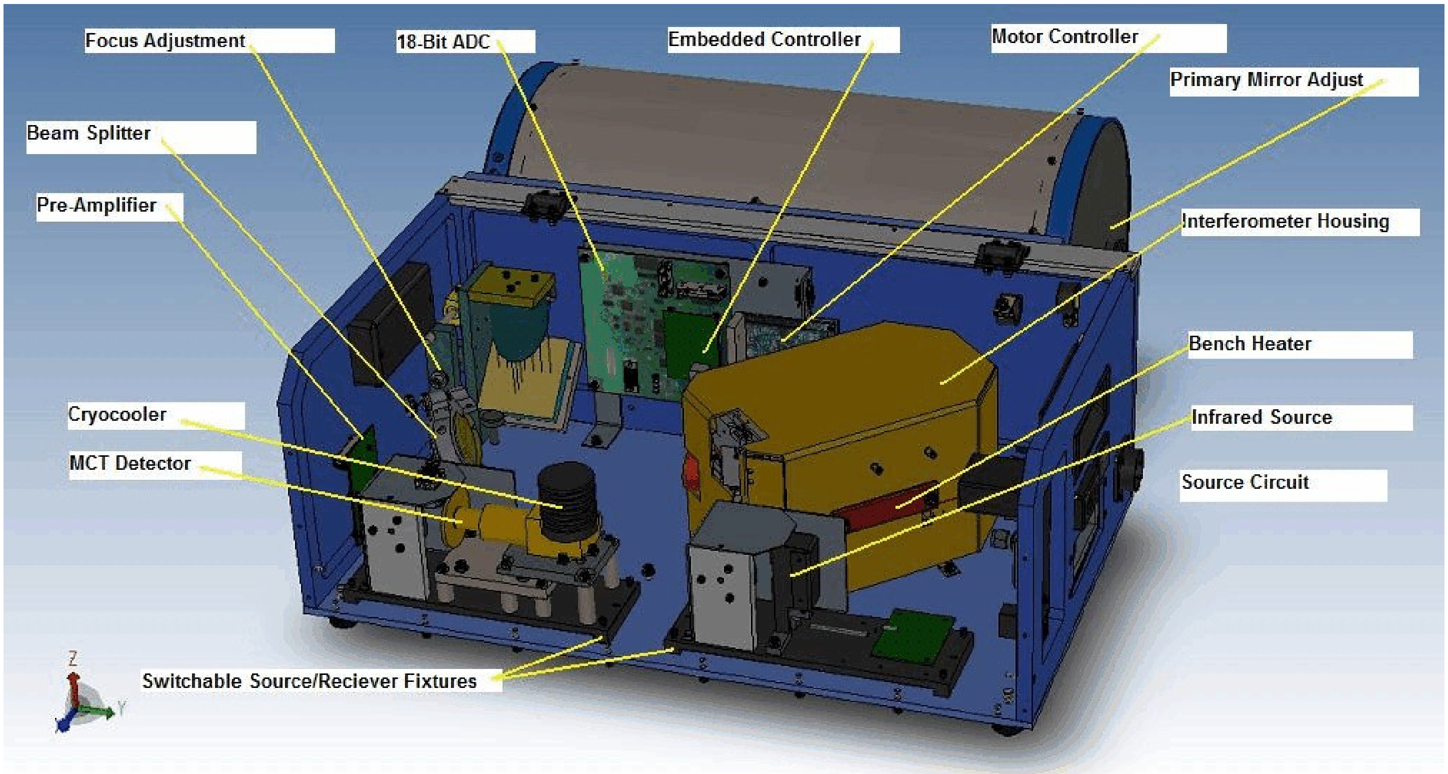


0




Telescope Focus Adjust
Beam Splitter Adjust

Internal Chassis Components



Pre-Amplifier Circuit

The redesigned pre-amplifier has is a full-range scale of 20 volts (ZPD P-P.) It is coupled between the ADC and MCT detector by shielded BNC cables to reduce noise. The gain settings are software controlled rather then manual hardware jumpers like the original system.

18-Bit ADC Circuit

The amplified detector signal is sampled by the improved 18-Bit ADC. The additional 2 bits improve the sampling accuracy over the original 16-bit ADC. The board features an integrated circuit to illuminate an LED lamp on the back of the RAM2000 which indicates each sampled scan (sweep) of the interferometer.

Embedded Controller Circuit

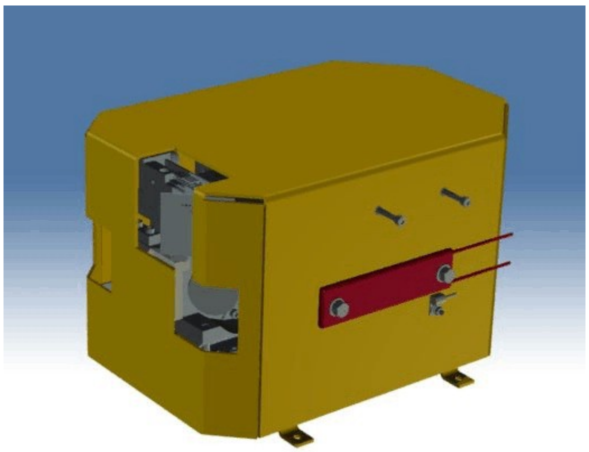
A programmable embedded controller is attached to the ADC board. The controller governs the ADC sampling using signals from the interferometer. The signal is digitized into an interferogram and the internal program sends the interferogram to the PC through an Ethernet CAT5 cable. Unlimited options are now available since the system can now be controlled over a network LAN / WAN. No data acquisition board needs to be installed in the PC. Additionally, no operating system drivers are required.

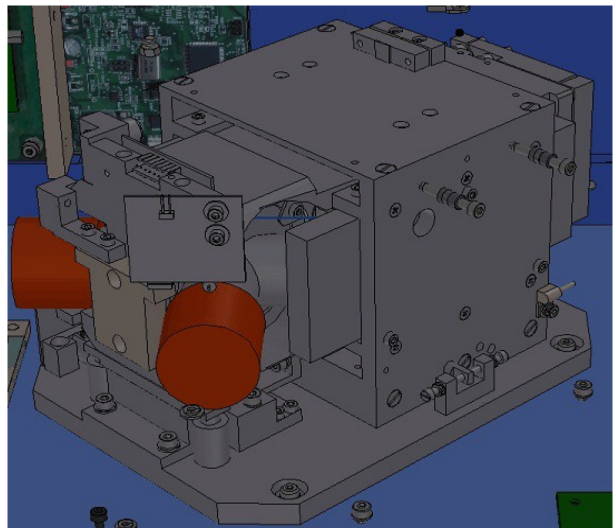
IR Source Circuit

The infrared source power is filtered through a circuit. The circuit produces a steady, even infrared signal to be propagated through the interferometer in the active mono-static open-path configuration. The circuit also extends the life of the IR source.

Interferometer

The interferometer is a Michelson design with increased throughput due to the larger diameter beam splitter. The beam splitter and compensator plate are constructed from ZnSe for durability. The sampling frequency is governed by a vertical-cavity surface emitting laser (VCSEL.) Compared to traditional HeNe lasers, VCSEL lasers are smaller, lighter, and less expensive. VCSELs do not require a high voltage power supply and do not get hot. The interferometer collects spectra at 0.5cm-1 resolution and uses the same reference library as the original RAM2000. The sweep rate for 0.5 cm resolution is approximately 1.7 seconds. The interferometer is thermally stabilized to improve stability and sampling accuracy. The sweep is governed by a programmable motor controller which can be factory adjusted to change sweep

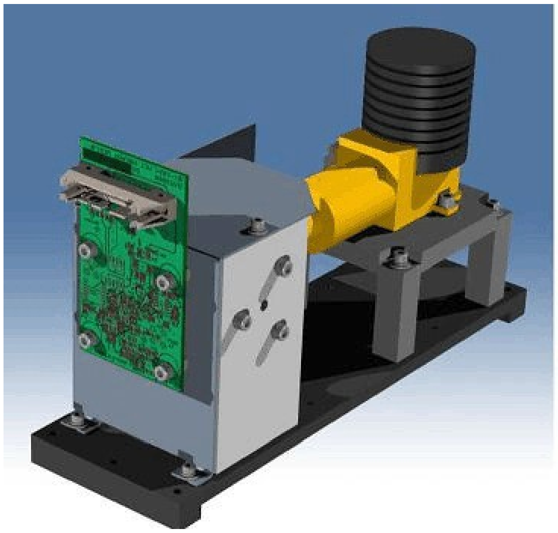


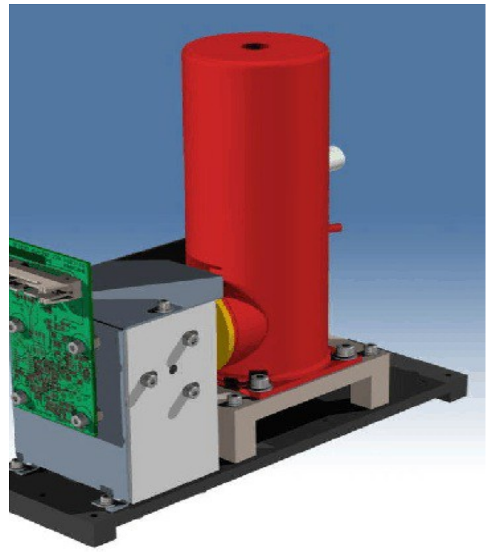


speed, distance, and direction.

Receiver / Detector Options

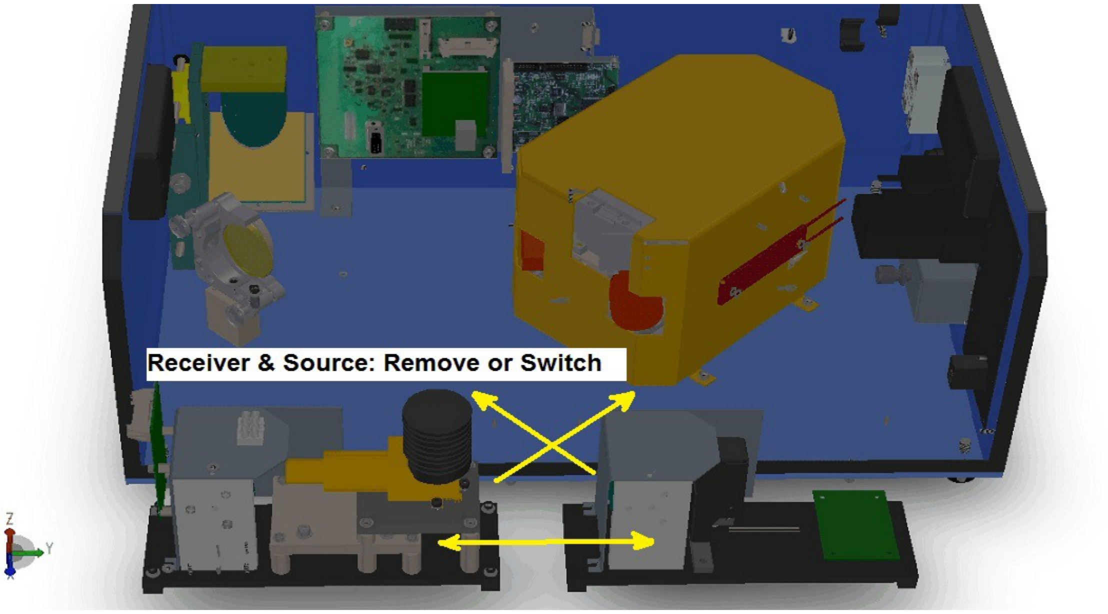
Two detector receivers options are available for purchase. An LN2-cooled manual filled dewar, or a closed-loop sterling engine cryocooler can be selected. The MCT detector is installed into the cold finger of the selected option. Receivers can be easily switched due to the common baseplate assembly.





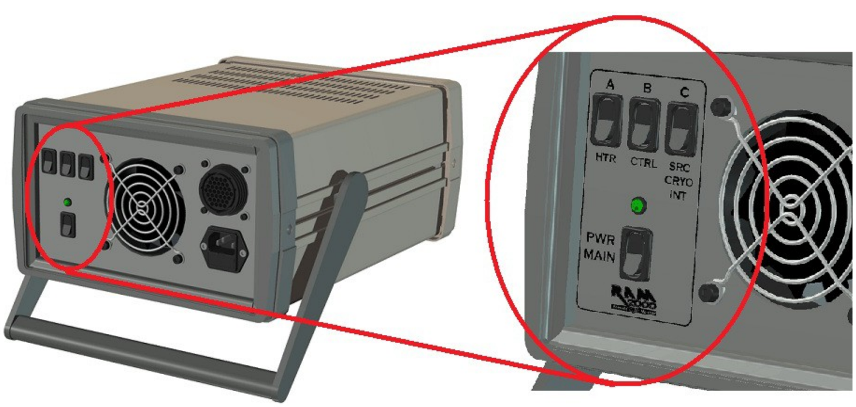
Switchable Components

The IR source and receiver (detector) assembly share the same baseplate and focus to allow for simple reconfiguration of beam path. For active mono-static monitoring, the IR source is projected into the interferometer. For passive monitoring, the user can remove the IR source assembly and move the receiver to the IR Source location. For mono-static/passive monitoring, the user can switch the receiver and detector assemblies.



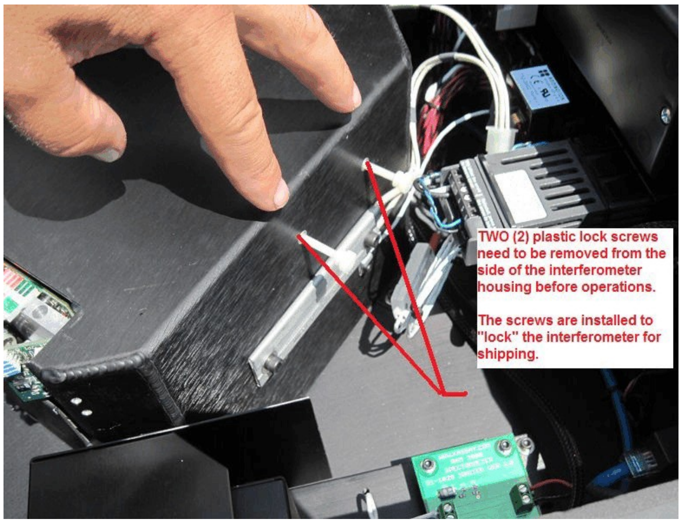
External Power Controller

The power supply has also been redesigned to be lighter and smaller. The suitcase enclosure is easily transportable and more protective then the original rack-mount design. Like the original system, the linear power supplies are external to the optical bench to isolate any potential mechanical, thermal, or electrical noise from entering the data spectrum. Three switches supply power to the heater assembly, embedded controller, IR Source, cryocooler, and Interferometer.



Section II: Set up of RAM2000 G2 hardware

The below procedures explain how to identify and set up hardware for open-path data collection. This procedure provides a general overview of hardware assembly procedure but is not a substitute for factory training. For software set up and general data collection techniques, consult the RMMSoft software user manual. If there are any questions, please contact the RAM2000 GII representative on the front cover of this document.



Warning !

Always confirm that the interferometer is unlocked ***before*** powering up the equipment. The Interferometer is shipped with two plastic screws to lock it in a safe position. The screws must be **removed** before operating the The interferometer can be accessed by opening the cover of the optical bench.

The screws are only hand-tightened

G2 Components

To begin collecting open path FTIR data, the following hardware components need to be assembled.

RAM2000 G2 bench chassis: The main spectrometer cabinet includes the electronics & optical assemblies. The G2 bench gets all power from the grey cable screwed into the rear bulkhead.

Telescope : The tube assembly with the 10-inch primary and 3-inch secondary mirror transmits the IR beam from the G2 bench. The dovetail plate connected to the telescope provides a rigid point for fastening the tube to the G2 bench. A bore sight scope is fastened to the top of the telescope tube to allow the user to align to the retro-reflector by eye.

Power Controller - Four power supplies wired to three toggle switches supply power to the G2 bench. The power controller has an AC line cord to plug the controller into standard USA 110VAC power input.

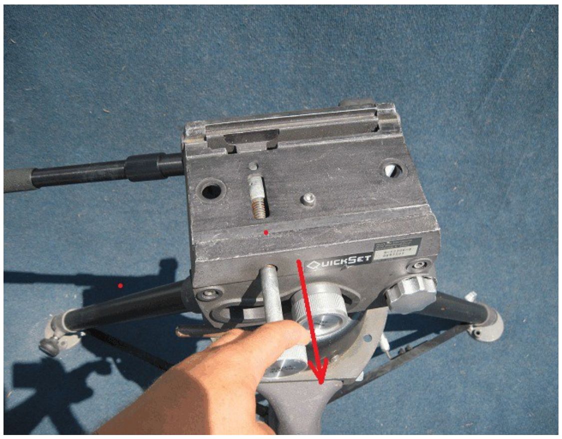
Line Cable - Includes 10-foot grey cable with circular male / female connectors. The cable is connected between the RAM2000 G2 rear bulkhead and the Power Controller.

PC - The portable computer (PC) controls the RAM2000 G2 system and has the the communication software the the operating software installed. (The PC is usually supplied by the customer.)

Retro-Reflector- A standard 37 cube retro-reflector array is supplied with each system.

Attach RAM2000 FTIR to tripod.

It is recommended that a second person assist when attaching the RAM2000 G2 bench to the tripod. The FTIR tripod head has a cleat fixture that receives the dovetail plate on the underside of the bench chassis.



Prepare the FTIR tripod to receive the RAM2000 by making sure that the tripod legs are fully opened and the head is level.

Tighten both elevation and azimuth adjustments so the head doesn't 'tilt' or 'pan' while attempting to fasten the FTIR.

Prepare the dovetail plate by loosening the plate lock knob on the tripod head. Turn the knob counter-clockwise until it is fully un-threaded from the hinged edge.

Once loose, pull the plate lock knob outward allow the locking edge to release to the cleat to the open position.

Grasp the RAM2000 by the two inset handles on each end. Tilt the dovetail into the fixed edge of the cleat first.

Position the RAM2000 down onto the tripod head allowing the locking edge of the cleat to close onto the dovetail plate. A "click" sound is usually audible.

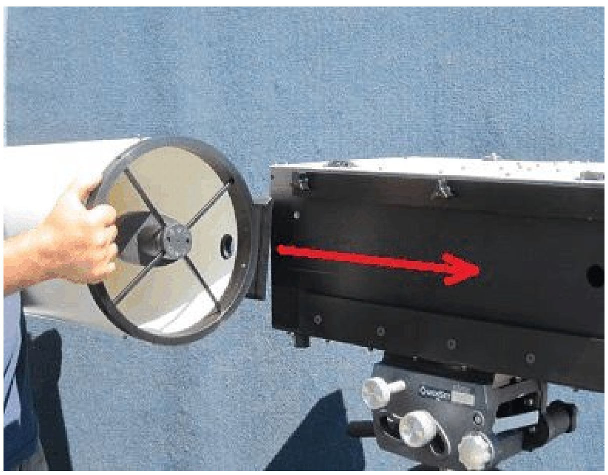
Warning: The dovetail plate is located at the center of mass when the telescope is connected. Therefore, when the telescope is NOT connected, be aware the the RAM2000 G2 is not balanced on the tripod.

Tighten the cleat / plate by turning the knob clockwise. Confirm that the dovetail plate is secure before letting go of the RAM2000 G2 FTIR. The plate knob has two mechanical actions. The twisted action tightens and loosens the plate when the dovetail is inserted. The linear action is spring loaded and only operable when the knob is completely un- threaded (counter-clockwise.)

Note: To remove the RAM2000, unscrew the knob, then pull out to release the mechanism. BE SURE TO HOLD THE RAM2000 SO IT WILL NOT FALL OFF THE TRIPOD**.**

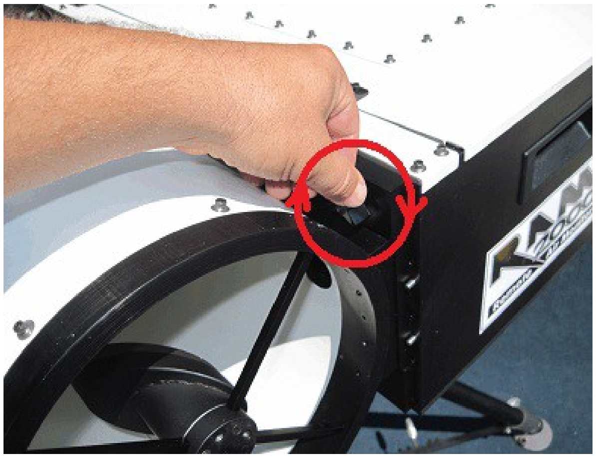
Attach Telescope

Prepare the RAM2000 bench to receive the telescope by loosening the three (3) plate knobs on the RAM2000 bench. Remove dust caps from both the FTIR bench and telescope if installed. Confirm correct telescope tube orientation by checking that the small hole in telescope tube wall will align over the small hole in the FTIR bench sidewall. Grasp the telescope assembly with two hands, making sure not to touch the secondary mirror with fingers.



The RAM2000 telescope will smoothly slide forward onto the FTIR bench. If the dovetail is binding in any way, do not force. Instead, make sure that the knobs are sufficiently loose.

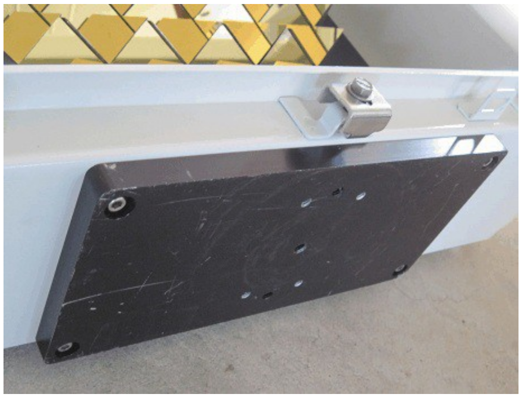
Slide the tube completely forward until it gently touches the two stop pins located at the end of the plate run. For best alignment, make sure that end of the dovetail plate is touching the two stop pins before tightening.



Evenly tighten the three knobs to draw the plate snug against the FTIR bench. It may be helpful to gently lift the telescope tube while evenly tightening the three knobs.

Attach Retro-reflector to tripod

Two (2) persons are recommended to fasten the retro-reflector to the tripod. Prepare the retro-reflector tripod by extending the three legs and ensuring the top plate is level and tight. Set the retro-reflector on top of the tripod head to align the bolt that threads up from the bottom. Hand tighten, then slide the retro toward the center of the tripod along the slot. Use a wrench to completely tighten the tripod head bolt



The bottom of the retro-reflector enclosure has an aluminum plate with a 3/8-16UNC threaded hole to receive the fastening bolt.

The tripod head has a slot to allow the 3/8-inch bolt to connect the tripod to the retro-reflector. The slot allows the user to slide the retro-reflector to the forward side of the the tripod head to give your hands more access to the bolt.

Set the retro-reflector housing on top of tripod head and insert the 3/8" bolt through the tripod head slot and thread into the retro plate. Once hand tight, slide the retro-reflector towards the center of the tripod head and tighten with a wrench.

The retro-reflector will need to be oriented towards the RAM2000 FTIR beam path. The tripod head has adjustments for both tilt and pan.

Connect Cables

Connect the grey cable between the RAM2000 G2 bulkhead and the power controller. The black end connectors are key slotted and can draw the connection tight into the receiving socket by rotating the outer ring clockwise. Be sure that cable orientation is male to female (pins to sockets.)

> WARNING: The power controller is wired to receive 110VAC. Plugging the controller into 220 V will cause damage to both the controller and the RAM2000 system. Contact KASSAY for different service options.

Fasten the CAT5 ethernet cable (yellow) between the RAM2000 bulkhead and PC. The CAT5 cable must be a “cross-over” type cable when connecting directly between the PC and RAM2000.

(Note: A regular CAT5 ethernet cable can be used if running through a network switch or router.)

Fasten the grey cable to the rear bulkhead.

Plug the AC line cord into the power controller and **110 AC .** The power controller houses all of the power supplies for the RAM2000 system. Both 110 Volts AC and 5, 12, DC power are carried by the grey cable to the RAM2000 electronics.

The “main” rocker switch allows power to the other three switches. The green LED light will indicate when the “main” is on. Switches A, B, & C need to be ‘on’ to collect data. Data can be collected immediately, but 30 to 60-minutes of warm up time is recommended.

The three switches in the power controller are as follows:

Switch ‘A’: HTR. Supplies 110V AC power to the interferometer heater assembly. This switch can also be left ‘on’ (‘B’ &‘C’ off) if the user wants to keep the interferometer warm.

Switch ‘B’: CTRL. This switch supplies 5V DC power to the RAM2000 ADC, pre-amp, and embedded conroller. This switch needs to be ‘on’ for the PC to communicate to the RAM2000.

Switch 'C': SRC /CRYO / INT. This switch supplies 12V DC power to the infrared source, cryocooler (if equipped) and interferometer motor.

(For LN2 dewara read document *'RAM2000 G2-LN2-fill.pdf*)

Turning on the RAM2000 G2 System

Once all of the hardware is connected as described above, the system can be powered on. It is recommended that the sequence of power up is as follows:

1) Turn power on to the computer ***(Fill LN2 dewars before this step if so equipped)***
2) Press the 'Main' switch on power controller
3) Press the 'on' all three rocker switches A, B, and C

When the power controller switch 'A' is turned on, the temperature controller on the rear bulk head of the RAM2000 G2 will display illuminated numbers. The numbers represent the actual and set point temperatures of the interferometer heater assembly. The programable temperature controller is set to hold the interferometer at 32 °C.

When power switch 'B' and 'C' are both on, the LED controller on the rear bulk head of the RAM2000 G2 will flash. The flashing lamp indicates that the interferometer is properly sweeping.

If equipped with cryocooler, when power switch 'C' is turned on, the cryocooler will be powered. The cryocooler will have a noticeable buzzing sound when operating. The buzzing sound will be loud for the first 1-2 minutes. Once the cryocooler cools the cold finger to the proper operating temperature, the buzzing sound will get noticeably quieter. The sound will equilibrate to a steady loudness.

Launch RMMSoft Software

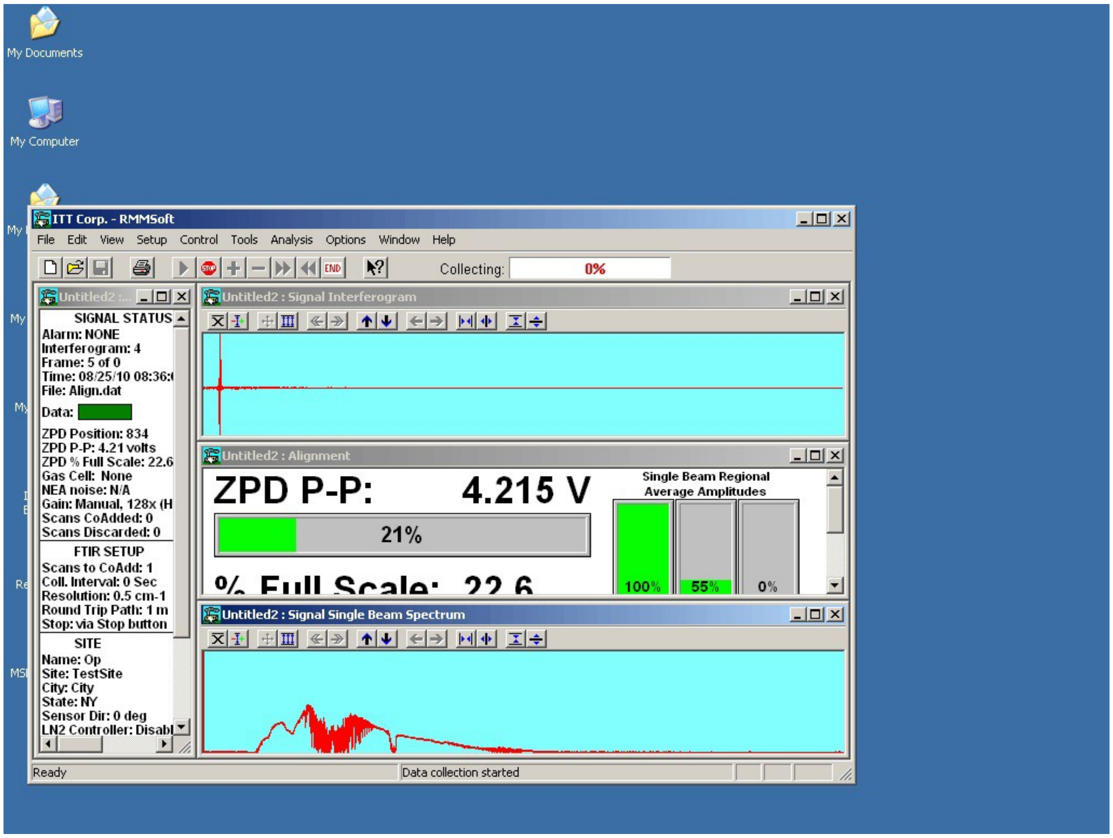
Once the FTIR is powered up, all data collection procedures are performed through the controlling software program *RMMSoft*$^{(TM)}$. To start the software double click on the *RMMSoft* icon located on the PC desktop.

The RAM2000 sensor will need to be directed towards the retro reflector to return infrared energy to the detector

RMMSoft(TM) will start

second screen, the TFTP server, will lay on top of the RMMSoft main screen. **Do not close the TFTP server screen.** Closing the TFTP server will prevent the RAM2000 from communicating to the PC. Just click on any grey area of the *RMMSoft*(TM) main screen to hide the TFTP server screen, or minimize the TFTP window.

The first operation in *RMMSoft*^(TM)^ is usually to align the RAM2000 G2 to the retro-reflector to get the maximum return signal. From the top menu bar select ***RUN>ALIGNMENT.*** A four panel screen will pop up with the peak to peak voltage (ZPD P-P) that is being returned to the detector.



NOTE: When collecting data, the user will need to step through the *FTIR Setup* Screen. Keep the following settings for all G2 systems:

1) The Gain setting should typically be left as **"manual"** and ***"40x - 60x" (goal is about 10 Volts)***

Refer to the **RAM2000 System Operators Manual** (Document Number 0752-467392 Rev: C) for additional information on how to use *RMMSoft*^(TM)^ to align, collect, and process data. (Page 28 of the manual starts the RMMSoft section)

For training or additional support Contact:

KASSAY FSI

internet: http://www.kassay.com email sperry@kassay

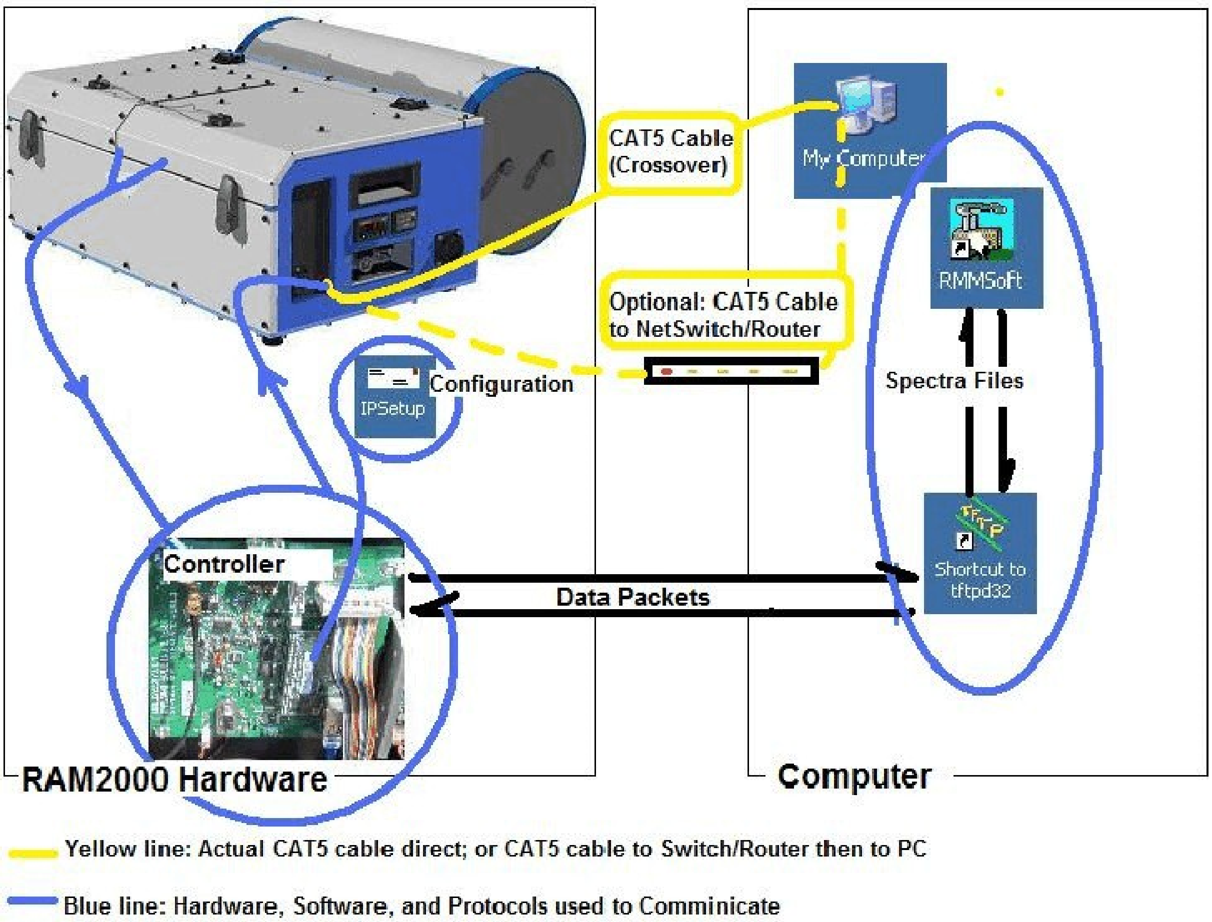
.com

phone: (732) - 979 - 5192

Section III - G2interface.

The GII system is shipped with a factory configured PC and installed software. The following section describes in general how to set up additional PC's.

The RAM2000 G2 system architecture differs from the original system in several ways. The communication link from the RAM2000 to the PC originates from the embedded system controller which is also referred to as a "netburner module." The controller captures the FTIR data and sends it to the PC through a CAT5 (ethernet) cable. "Hand-shaking" protocol between the two systems is accomplished through a TFTP communications link run by the host PC. The below diagram described the devices used to transfer data between the RAM2000 G2 and the PC. The yellow line represents the actual CAT5 cable. The blue line represents the hidden hardware/software used.



The system controller will read and write to the address defined by the TFTP host server. The TFTP server also directs the data to a directory within the host computer to store text and binary (spectra) files which are used by RMMSoft.

Once the interface system is established, there are many possibilities that can be achieved. The RAM2000 can now link to a LAN / WAN via net switches, routers, bridges, and even use wireless communication. No PC board or driver is required, and operating systems can be flexible.

SET UP a new PC interface

Setting up a new communication link between the RAM2000 G2 requires four steps:

- Determine the IP addresses
- Set the address of the embedded controller (netburner module)
- Set address and directory for the TFTP Server
- Set RMMSoft to communicate with the TFTP Server

Determine the IP address of the PC and gateway

To create a new connection, first determine the IP address of the PC. Both static and dynamic IP addresses are allowable. If routing the RAM2000 into a network switch or router, it is often desirable to set a static IP address for the PC so that the communication link doesn't change. Proper rules need to be followed for IP address assignment. The below example describes how to set up a new PC with a direct CAT5 crossover cable. A crossover cable is an Ethernet cable that is used to connect PC to PC directly. The same steps apply if connected through a network switch or router.

EXAMPLE:

To determine the IP address and the gateway of the PC, from the start menu choose "run," and type CMD <enter>

A DOS window will open. At the command prompt type ipconfig<enter> Write down the addresses to use later. Address values for PCs will differ from this example.

Setting up the RAM2000 G2 embedded system controller (IP Setup netburner module)

The controller can be found when connected to the PC by using a software utility program. The RAM2000 G2 system must be turned on (powered) for the IP address to be broadcast to the IP Setup software.

Click on the “IPSetup” icon on the desktop to start the controller software. The netburner IPSetup V2.0 window will open. If the RAM2000 is connected, a green symbol with the words “MOD5282[xx-xx-xx-xx-xx-xx] at [IP address]

If the RAM2000 G2 module is not powered up, or if there is some communication failure, it will not appear in the “Select a Unit” window. Press the “Search Again” button to keep checking.

[redacted]

In the example above [redacted]

To change the IP address of the netburner module, navigate to the "NDK" window and type in the new IP address, mask, or gateway values. Press "Set" and wait a few moments. Press the "Search Again" button to make sure the controller has now received those new values.

[redacted]

Once the netburner IP address is set, confirm that the data is pointed to the TFTP server. Press the "advanced.." button. An "Advanced Settings" portion will open up. In the TFTP Server box, enter the IP address of the PC. Keep all other parameters the same. Press "SET" to register the change. Then press "search" to make sure the module accepted the change.

[redacted]

The embedded controller (netburner module) values are now set.

Set up the TFTP Server

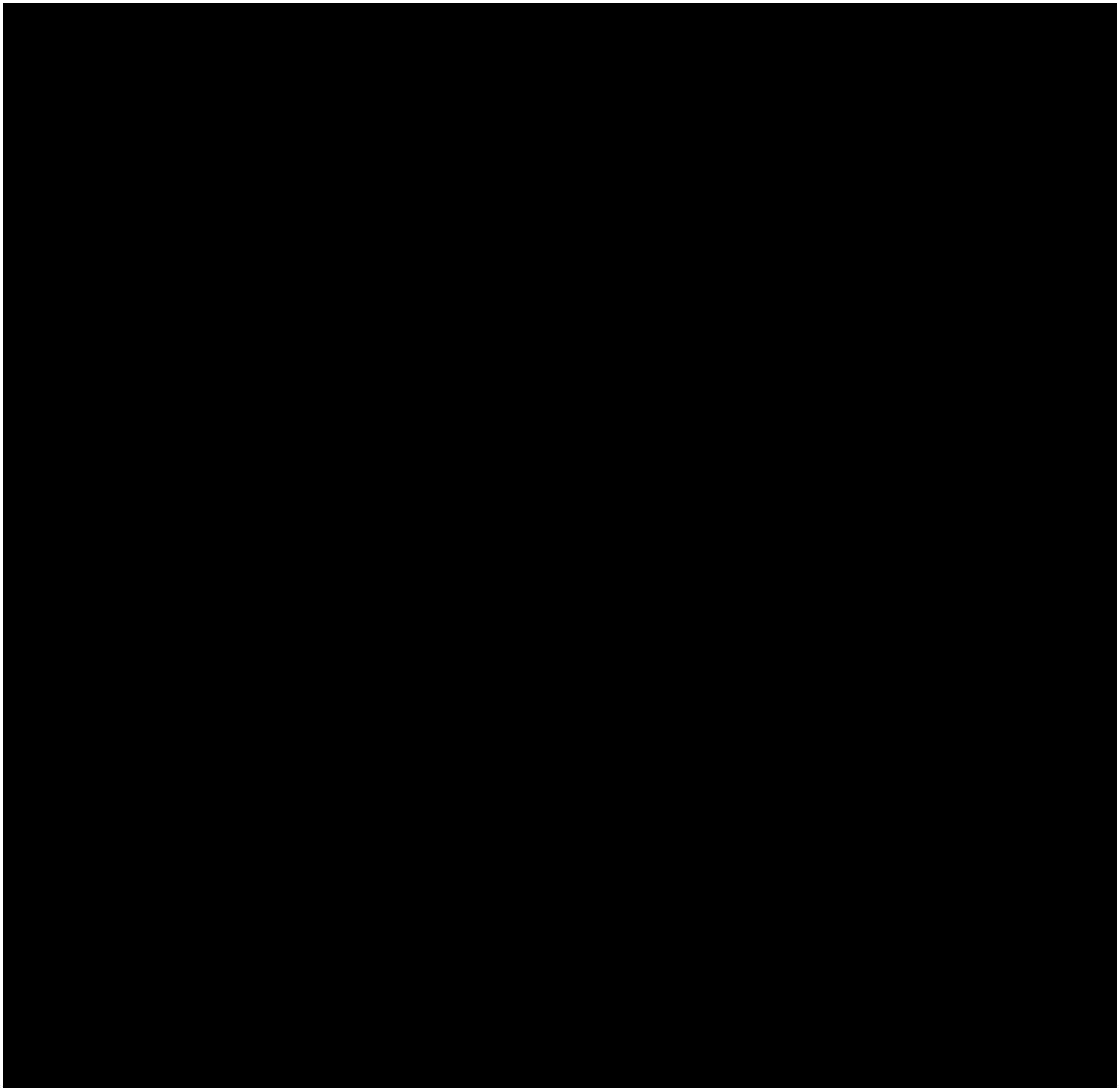
TFTP is an acronym for *Trivial File Transfer Protocol* which is a simple form of the very common FTP. TFTP protocol is used to transfer data between hosts on a network. Files are written to/from a remote server. Transfer of data from the RAM2000 controller begins with a request to read or write a file. If the TFTP server grants the request, then a connection is open between the RAM2000 controller and the PC. Both the RMMSoft PC and the RAM2000 send and receive acknowledgments. If a packet of data is lost or not received by the RMMSoft PC, then the data may be re-transmitted.

There are many available TFTP servers will work to perform this function. One “free” TFTP server that can used is TFTP32 by Phil Journan is used for this example. To start the TFTP server, click on the TFTP icon. The TFTP32 software will launch.

Once TFTP32 is started, it will attempt to communicate with RAM2000 G2 controller. The RAM2000 controller executes data collection commands stored in a file named “config.txt” which is continually sent from the PC. The “config.txt” file is stored in the RMMSoft root directory. If there is an incorrect IP address or data directory, the file transfer will fail.

To edit the TFTP32 parameters, select the “Settings” button from the TFTP32 main screen.

A Settings window will open, and the directory and IP address parameters can be edited. After editing the Setting for the correct IP and data directory, the TFTP server will need to be closed and then relaunched to register those changes.



When the TFTP and RAM2000 controller are set up correctly, a small placard will flash showing the transfer of the “config.txt” file from the PC to the RAM2000 controller. The correct directory and IP address will be presented in the proper places.

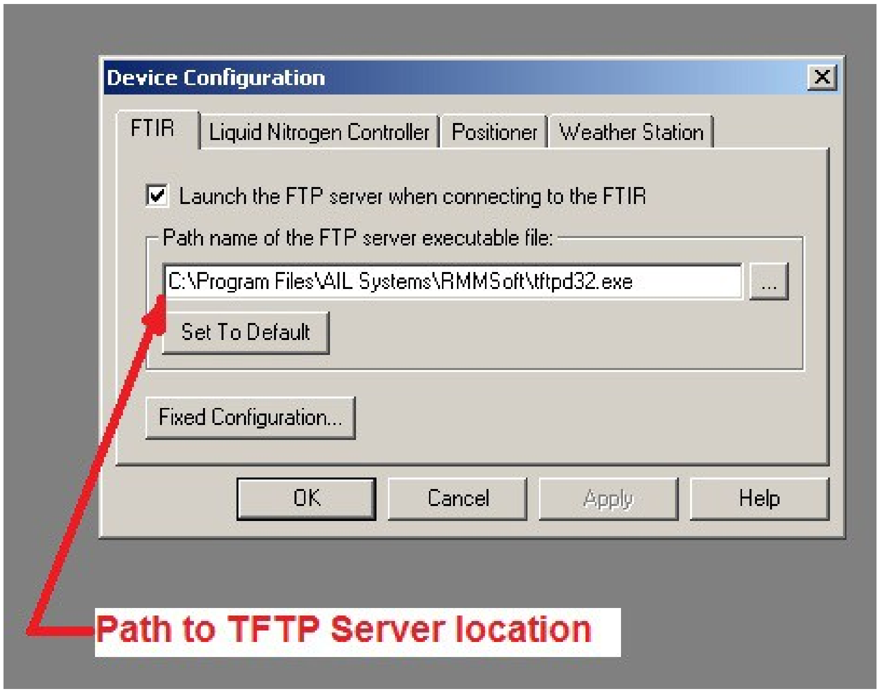
Setting up RMMSoft to communicate to the RAM2000 controller.

RMMSoft will automatically launch the TFTP server specified by the parameters set up in the RMMSoft TFTP options setup. To set the TFTP server, select RMMSoft from the Desktop by double clicking the RMMSoft icon.

Depending on the default settings, RMMSoft may attempt to launch the TFTP Server. If the TFTP Server path or addresses are incorrect, the communication will fail. For example, if the TFTP server is present, but the IP addresses are incorrect, then RMMSoft will report the following:

To set the TFTP server, choose the OPTIONS menu from the RMMSoft main page.

Under the "OPTIONS" menu select "DEVICE CONFIGURATION" to edit the parameters.



A window will open with the FTP server location. The FTP (TFTP) server can be located anywhere but usually stored in the C:\Program Files\AIL Systems\ RMMSoft directory. Select the option to; "Launch the FTP server when connecting to the FTIR." This will cause the TFTP server to automatically launch whenever RMMSoft is started.

Once the path and address is correct, a small window will flash each time the "Config.txt" file is successfully transferred.

Troubleshooting with MTTY

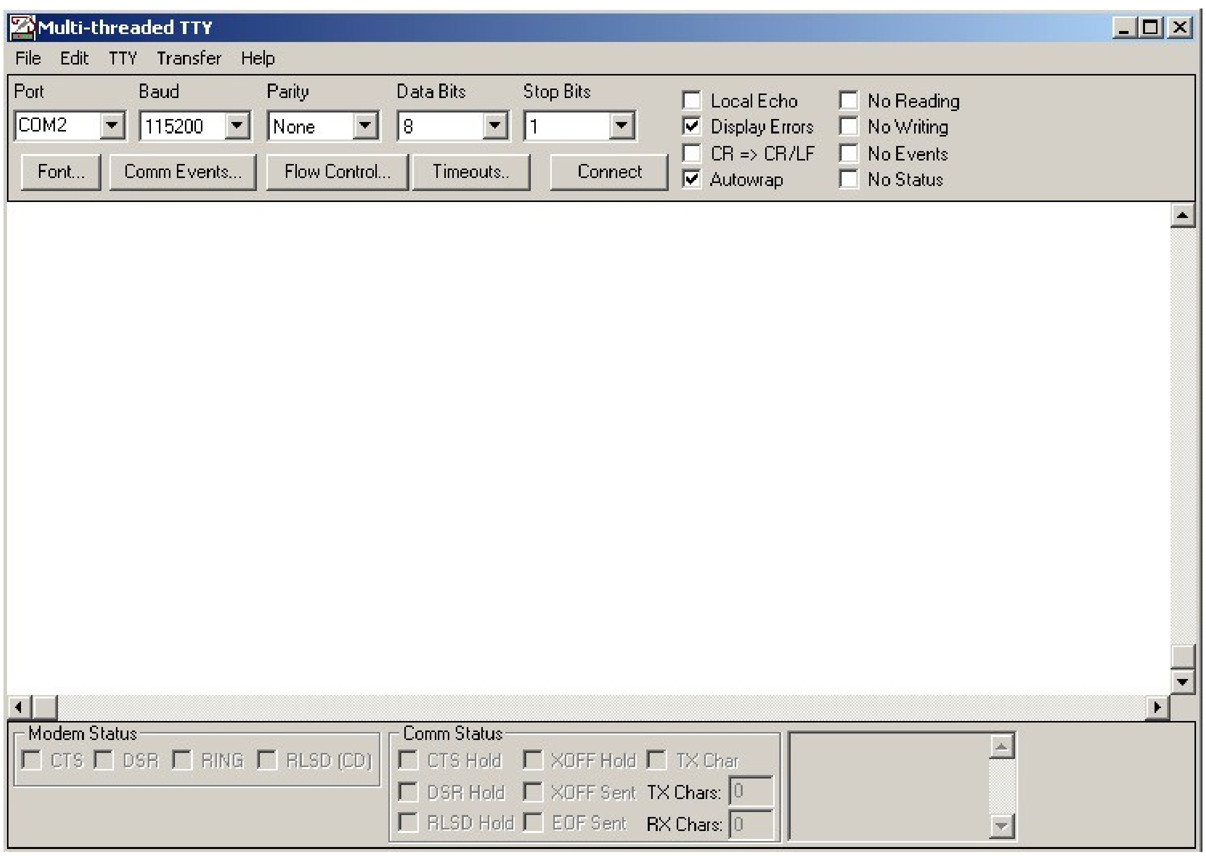
The RAM2000 G2 controller can be directly communicated to through an RS-232 cable and a terminal program named MTTY. Commands can be sent directly to the controller, without the use of RMMSoft. The controller firmware can also be updated through this connection.

In order to communicate through MTTY, the following must be confirmed:

- The RAM2000 needs to be powered
- The TFTP Server needs to be running with the proper IP addresses and directories
- The CAT5 cable needs to be connected between the RAM2000 and PC.
- An RS-232 cable needs to be connected between the controller board and the

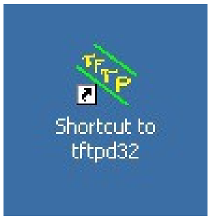
PC To open the terminal program click on the MTTY desktop icon.

A window will open with the blank MTTY. The window will be blank to start. Select the correct COM (1 or 2) in "Port" window.



Manually Launch the TFTP Server

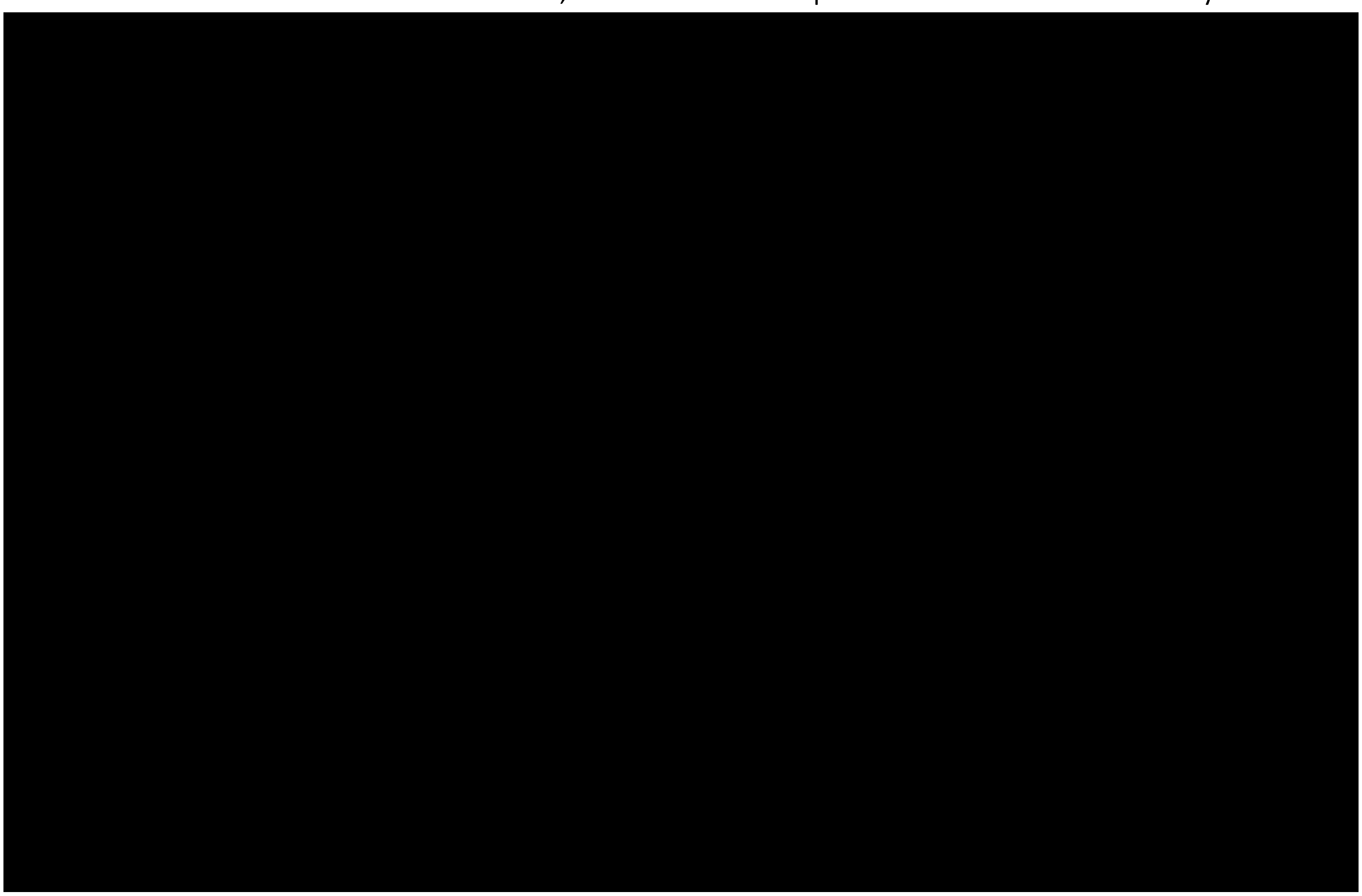
Next, Click on the TFTP icon to start the TFTP Server.



Click on the TFTP icon to start the TFTP Server. Make sure the correct IP and directories are set. It may be helpful to have two scaled windows open, the first with the TFTP server, and the second with MTTY. Then make sure the correct IP and directories are set.

Start MTTY Communication

Select “File->Connect” to start MTTY broadcasting the controller responses. The controller will immediately look for the “config.txt” file to execute. If the “config.txt” is not present, or if the TFTP32 is unavailable, the controller will report the “timeout” error and retry.



When both the TFTP32 and MTTY windows open, the controller will perform its normal loop as presented by a period "." being written to the MTTY window. The "config.txt" can be edited in *"Notepad"* and then saved to cause a new command to be executed. For example, to direct the controller to collect 15 scans, edit the "config.txt" file to include the command "SET_NSCAN: 15". Every time the "Config.txt file is edited, it will require a new "ID:" In the below example, the ID was set to 200. Also, each time the "Config.txt" is edited, it needs to be saved to register the change.

Appendix A - Comparison of RAM2000 and RAM2000 G2 system features

	Original	(G2)
Chassis (Beam Path) Configurations Active Open Path - RETRO Passive Open Path - no IR Source Bi-static Open Path - external IR Source Internal 15cm QA/QC gas cell (optional) Extractive Multi-Pass gas cell (optional) Easy Access Chassis Door	XX	X X X X XX
Optics ZnSe Beam splitters (Detector & Interferometer) Protected Gold mirrors Removable Telescope Assembly Field-Adjustable Primary Mirror Field-Adjustable Focus Assembly Michelson Interferometer at 0.5 cm-1 resolution VCSEL Laser Frequency Thermally stabilized Bench	XX XX	X X X X X X XX
Electronics External Linear Power Supplies Elapsed Time meter Scan Indicator Lamp Low-Noise Pre-Amplifier Software-Controlled Hardware Gain Current Limiting IR Source Circuit	X X XX	X X X X XX
Detector LN2-cooled MCT detector Cryocooled MCT detector	X	XX
Communication to PC 16-Bit ADC with ISA slot DAQ Board 18-Bit ADC with ethernet-embedded Controller	X	X

Software RMMSoft - support through version 3.8 RMMSoft Version 6 - ongoing support Integrated Weather, Positioner, LN Servers Patented Processing Algorithms	X XX	X X X