QUALITY ASSURANCE PROJECT PLAN
SUNCOR ENERGY (USA) – COMMERCE CITY REFINERY AMBIENT AIR MONITORING PROGRAM
COMMERCE CITY, COLORADO

Prepared For:

Suncor Energy (U.S.A.) Inc.
5801 Brighton Blvd
Commerce City, CO 80022

Prepared By:

Montrose Air Quality Services, LLC
990 W 43rd Ave
Denver, CO 80204

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MONTROSE AIR QUALITY SERVICES

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1.0 OBJECTIVES AND SUMMARY OF TEST PROGRAM

1.1 BACKGROUND

Suncor Energy (U.S.A.) Inc. (Suncor) has planned to install an air quality (AQ) monitoring network around their operation facilities and in local communities to provide real-time AQ data. Montrose Air Quality Services, LLC has been selected to deploy, maintain and operate the AQ monitoring network on behalf of Suncor. The ambient air monitoring network will utilize cutting-edge air pollution sensor technology, redeveloped with solar power capabilities, battery storage and data connectivity. The network will also include monitoring stations that are considered 'Near-Federal Equivalent Method' (near-FEM) instruments; these instruments will be used to improve the accuracy of the sensors. The network will include 10 separate monitoring locations with measurement data transmitted to a platform dashboard. The dashboard will display near real-time data and recent alerts.

1.2 GENERAL

The procedures outlined in this document cover the quality assurance procedures to be utilized in the deployment, operations and maintenance of the sensors. The sensors and samplers to be employed during the project are the Lunar Outpost Canary-S, AQMesh Pod, Aeroqual AQM65, and VOC automated canister collection. Meteorological monitoring will also be conducted at all of the locations. A specification sheet on the sensors can be found in Appendix A. As part of this program, an AQ data platform, developed by the third-party company SensibleIOT, manages, quality controls, and reports the sensor data. The following table details the equipment that will be deployed and their respective pollutant and parameters measured:

TABLE 1-1
SUMMARY OF EQUIPMENT

Equipment Model	Pollutant/Parameter
Canary-S	Total VOC (TVOC), PM2.5, Ambient Temperature, Relative Humidity, Wind Speed and Direction
AQMesh Pod	SO2, CO, NO, NO2, H2S
AQM65	TVOC, SO2, CO, NO, NO2, H2S, PM2.5, Ambient Temperature and Relative Humidity.
Summa Canisters	Speciated VOC

A list of locations targeted for initial deployment are outlined in Table 1-2 below. Deployment will be completed by August 3, 2021.

TABLE 1-2
SUMMARY OF INITIAL DEPLOYMENT

Location	Facility	Address	Latitude/Longitude	Equipment
Community Monitoring Site 1	Rose Hill Elementary	6900 E 58th Ave, Commerce City, CO 80022	39.80164, -104.90882	Canary-S and AQMesh
Community Monitoring Site 2	Suncor – Refinery Business Center	5801 Brighton Blvd, Commerce City, CO 80022	39.79599, -104.95603	AQM65, Canary-S, and AQMesh
Community Monitoring Site 3	Adams City High School	7200 Quebec Pkwy, Commerce City, CO 80022	39.82736, -104.90193	Canary-S and AQMesh
Community Monitoring Site 4	Adams City Middle School	4451 E 72nd Ave, Commerce City, CO 80022	39.82893, -104.93499	Canary-S and AQMesh
Community Monitoring Site 5	Central Elementary School	6450 Holly St, Commerce City, CO 80022	39.81457, -104.91928	Canary-S and AQMesh
Community Monitoring Site 6	Focus Point Family Resource Center	2501 E. 48th Ave. Denver, CO, 80216	39.78436, -104.95663	AQM65, Canary-S, and AQMesh
Community Monitoring Site 7	Kearney Middle School	6160 Kearney St, Commerce City, CO 80022	39.80888, -104.91545	AQM65, Canary-S, and AQMesh
Community Monitoring Site 8	Suncor-Monroe St Property	6599-6401 Monroe St, Commerce City, CO 80022	39.8156, -104.94503	Canary-S and AQMesh
Community Monitoring Site 9	48th and Race	East 48th Ave. & Race St., Denver	39.78455, -104.96264	Canary-S and AQMesh
Community Monitoring Site 10	TBD	TBD	TBD	Canary-S and AQMesh

1.3 PROJECT CONTACTS

1.3.2 Personnel

A list of project participants is included below in Table 1-3:

TABLE 1-3
PROJECT PERSONNEL

Montrose Air Quality Services, LLC

Project Contact:	Austin Heitmann	Patrick Clark, PE, QSTI
Title:	Project Manager	VP Ambient and Emerging Tech.
Address:	990 W. 43rd Ave. Denver, CO 80211	990 W. 43rd Ave. Denver, CO 80211
Telephone:	303-670-0530	303-670-0530
Email:	aheitmann@montrose-env.com	pclark@montrose-env.com

Suncor Energy (U.S.A.) Inc.

Suncor Project Technical Lead Contact:	Rob Mennillo
Title:	Senior Environmental Advisor
Address:	5801 Brighton Blvd Commerce City, CO 80022
Email:	rmennillo@suncor.com

Laboratory

Laboratory:	Enthalpy Analytical
City, State:	Durham, North Carolina

Data Platform

Company:	Sensible IOT
Contact:	Matt Beach
Telephone:	805-233-2298
Email:	matt@sensibleiot.com

1.3.2 Responsibilities

Table 1-4 below details the roles and responsibilities of the project team.

TABLE 1-4
PERSONNEL RESPONSIBILITIES

Person/Company	Primary Assignment
Montrose	Project Operator, Sensor Deployment, sensor operations, sensor maintenance and QA/QC
Rob Mennillo	Suncor Project Technical Lead
Lunar Outpost	Sensor manufacturer
AQMesh	Sensor manufacturer
Aeroqual	Near-FEM manufacturer
Enthalpy	Offsite Laboratory
SensibleIOT	Data platform development and ongoing platform operations

2.0 EQUIPMENT DESCRIPTION

2.1 LUNAR OUTPOST CANARY-S

The Canary-S is a solar powered air quality monitoring system manufactured by Lunar Outpost, a Colorado company. It is equipped with a variety of sensors, cellular communication, and powered via a solar panel and battery. A multitude of units can be deployed to create a network of real-time, localized data focusing on air quality and meteorological measurements. The sensors contained in the units are capable of measuring TVOC and $PM_{2.5}$. The units will also measure ambient temperature, barometric pressure, relative humidity, wind speed and direction. The Canary-S principle of operation is outlined in the Table 2-1 and provides a sampling frequency of one (1) minute. A complete datasheet summarizing the specifications of the Canary-S can be found in the Appendix A of this Quality Assurance Project Plan (QAPP).

TABLE 2-1
Canary-S Specifications

Air Pollutant/Parameter Category	Principle of Operation	Lower Detection Limit[1]	Upper Detection Limit[2]
Total VOC	Photoionization Detector	10 ppb	40 ppm or 3 ppm
$PM_{2.5}$	Laser Scattering	1 ug/m^3	1000 ug/m^3
Wind Direction	Sonic Anemometer	N/A	N/A
Wind Speed	Sonic Anemometer	N/A	N/A
Relative Humidity	Solid State	N/A	N/A
Barometric Pressure	Solid State	N/A	N/A
Temperature	Solid State	N/A	N/A

2.2 VOC CANISTER SAMPLING

EPA Method TO-15 will be utilized to collect and analyze all summa canister samples. Sampling canisters will be provided pre-cleaned and batch certified by Enthalpy Analytical (Enthalpy), a NELAC accredited laboratory. Canister sampling will be conducted using an Entech Instruments Silonite™ CS1200E Passive Canister Sampler or equivalent.

The Canary-S system is capable of integrating a passivated stainless-steel canister triggering system that will automatically open the valve of the canister to collect a pre-determined time integrated (1-hour) canister sample based on preset TVOC thresholds. A properly sized critical orifice will be placed at the inlet of the canister to ensure the sample is collected for a predetermined time period. An electronic vacuum gauge is integrated into the canister valve to ensure the integrity of the sample. The vacuum gauge pressure for each system will be included in the sensor payload to the data platform and can be continuously monitored to ensure that the sample media is still valid. If the sample media is compromised an automated alert will be sent out to designated Montrose and Suncor personnel to have the canister replaced. Typically, the canister can maintain a vacuum that does not compromise the sample integrity for 3 months, though this can vary from unit to unit.

[1] This information was provided by the manufacturer spec sheet

2.3 AQMESH POD

The AQMesh Pod is a solar powered air quality monitoring system manufactured by AQMesh, a United Kingdom company. It is equipped with a variety of sensors, cellular communication, and powered via a solar panel and battery. A multitude of units can be deployed to create a network of real-time, localized data focusing on air quality and meteorological measurements. The sensors contained in the units are capable of measuring SO2, CO, NO, NO2, and H2S. The AQMesh Pod principle of operation is outlined in the Table 2-2 and provides a sampling frequency of five (5) minute. A complete datasheet summarizing the specifications of the AQMesh Pod can be found in the Appendix B of this Quality Assurance Project Plan (QAPP).

TABLE 2-2
AQMesh Pod Specifications

Air Pollutant/Parameter Category	Principle of Operation	Lower Detection Limit[2]	Upper Detection Limit[2]
SO_2	Electrochemical Sensor	5 ppb	100 ppm
CO	Electrochemical Sensor	50 ppb	1000 ppm
NO	Electrochemical Sensor	1 ppb	20 ppm
NO_2	Electrochemical Sensor	1 ppb	20 ppm
H_2S	Electrochemical Sensor	1 ppb	100 ppm

2.4 AEROQUAL AQM 65

The “AQM 65” is a ground powered or solar/battery powered air quality monitor manufactured by Aeroqual, a New Zealand company. The AQM 65 is a fully integrated air monitoring station offering near reference levels of performance. The units will be configured to measure the following parameters:

TABLE 2-3
AQM 65 Specifications

Air Pollutant/Parameter Category	Principle of Operation	Lower Detection Limit[3]	Upper Detection Limit[3]
Total VOC	Photoionization Detector	50 ppb	30 ppm
SO_2	Electrochemical Sensor	9 ppb	10 ppm
CO	Electrochemical Sensor	50 ppb	25 ppm

[2] This information was provided by the manufacturer spec sheet
[3] This information was provided by the manufacturer spec sheet

Air Pollutant/Parameter Category	Principle of Operation	Lower Detection Limit[3]	Upper Detection Limit[3]
NO	Semiconductor Sensor	3 ppb	500 ppb
NO_2	Electrochemical Sensor	3 ppb	500 ppb
H_2S	Electrochemical Sensor	12 ppb	10 ppm
$PM_{2.5}$	Laser Scattering	1 ug/m^3	1000 ug/m^3
Temperature	Various	N/A	N/A
Relative Humidity	Various	N/A	N/A

The AQM 65 offers measuring criteria pollutants to concentrations similar to a traditional monitoring station. The AQM 65 comes with a fully integrated calibration system which enables automatic scheduling of validation checks using two gas cylinders. Automatic validations are a key piece to the improved data quality over lower costs instruments. The system automatically zeros itself with the built-in zero air scrubber nightly for $PM_{2.5}$ and every minute for gaseous compounds to mitigate drift issues these sensors typically experience.

The AQM 65 contains different sensor modules that were designed specifically based on the strengths and weaknesses of the sensor selected. A sensor module can incorporate flow control orifices, solenoids, scrubbers, humidity equalizer, and additional electronics to account for sensor drift, noise, humidity, and cross interference. The system is temperature controlled and maintained at 30°C +/- 0.2°C to remove any temperature sensitivity that typical sensors exhibit. Active sampling starts with the stainless steel inlet on top of the enclosure. The inlet is lined with an inert material that ensures no target pollutant is lost. From there sample air is passed through a PTFE filter that removes particulate, protecting the sensors and extending their life. A sampling manifold delivers air to each module independently. Air is drawn continuously by a brushless DC pump. This pump works together with the flow control orifice in each module to deliver a precise flow of air to the sensor. Knowing the exact flow rate allows a higher degree of confidence in the measurement. Exhaust gas is released well away from the inlet to ensure no impact on the inlet sample. The AQM 65 is designed to then be calibrated in the field to minimize system downtime and adjust for any sensor degradation. The analyzer brochure can be found in Appendix B.

2.5 DATA PLATFORM

The AirSense data management platform, developed by SensibleIOT, handles traditional air monitoring data and air sensor data. The AirSense system is a cloud-based system that ingests data, performs quality control, and calibrates air sensor data. AirSense handles 1-second data (fixed or mobile), any pollutant or parameter, and offers intuitive navigation to view and display data for public and technical applications.

For the program staff at Suncor and Montrose, Air Sense's dashboard provides a summary of the operational status of the network. This backend data platform provides features not available on the community site. This backend site gives Montrose access to additional features that Suncor personnel and the public will not, such as instrument and sensor settings, calibration and data

correction features, and data invalidation. Figure 2.2 and 2.3 provide a screenshot of the backend and community dashboard, respectively. For each location, AirSense provides a display showing near real-time readings and a map of the monitor location.

FIGURE 2.1
SCREEN SHOT OF THE AIRSENSE DASHBOARD

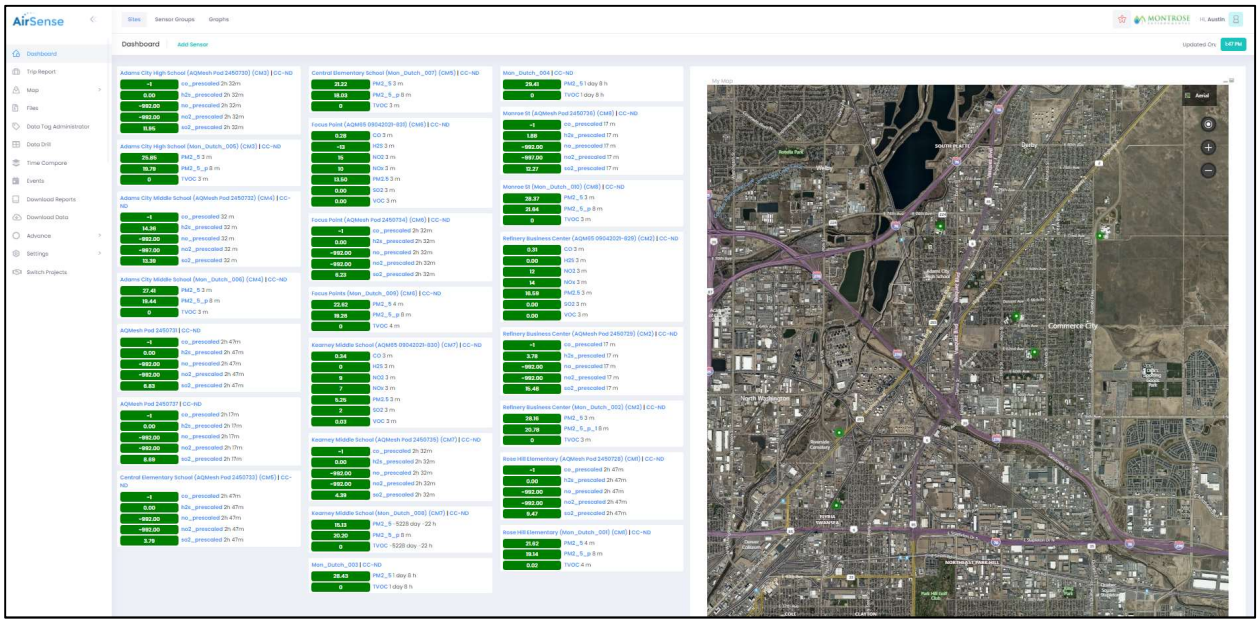
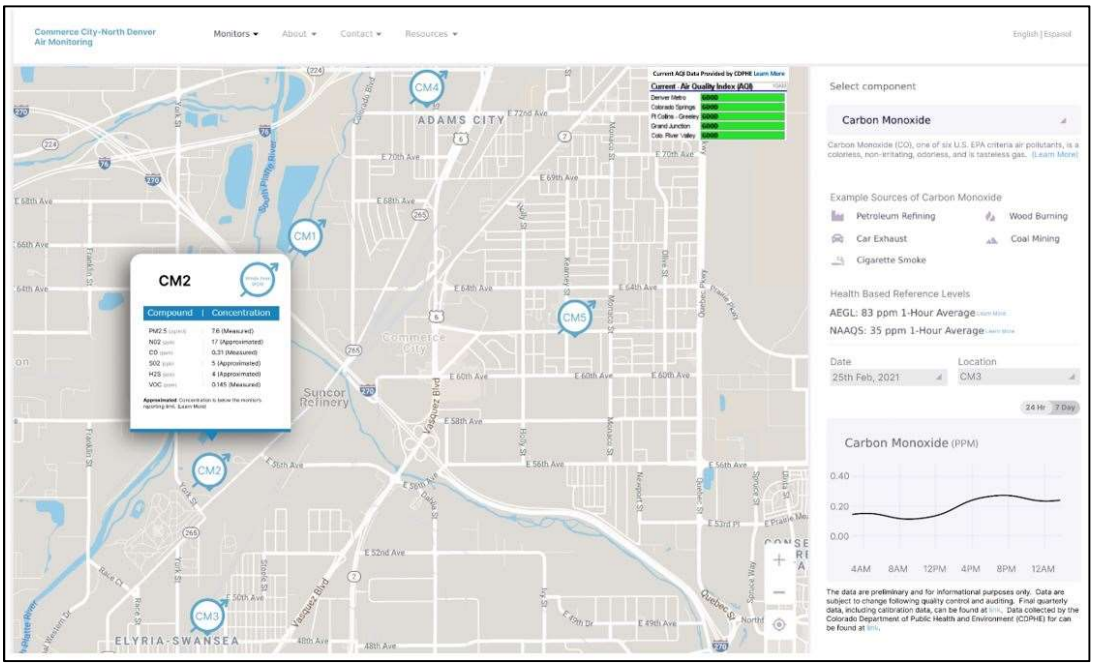


FIGURE 2.2
SCREEN SHOT OF THE PUBLIC DASHBOARD



3.0 QUALITY ASSURANCE QUALITY CONTROL

3.1 KNOWN-LIMITATIONS AND INTERFERENCES

Montrose plans to integrate three (3) of the AQM 65 Sampling Stations into the network. These stations would be collocated with one (1) of the Canary-S and AQMesh Ambient Sampling Stations. This collocation will allow for a multivariable regression between the AQM 65 and Canary-S units. This regression can then be applied to all of the monitors in the network and in doing so will provide higher data quality across the monitoring network. This collocation will also allow for a scaling correction factor to be applied between the AQM65 and the AQMesh Pod. This scaling correction will also be applied to all of the monitors in the network to provide more accurate data if deemed necessary.

Temperature and relative humidity are known to affect the electrochemical sensors being used and could influence data quality. The AQMesh monitors collect sensor temperature and ambient relative humidity data and correct for these interferences via algorithms that were developed during extensive global comparisons with reference data.

Additionally, some of the sensors being used for specific compounds that are being monitored for in this program have known cross sensitivity to other compounds. Some significant cross sensitivities include ozone causing a response on the NO_2 sensor, this program mitigates this issue by using an ozone filter on the face of the NO_2 sensor. Similarly, the SO_2 sensor can have a response caused by the presence of H_2S. Again, the SO_2 sensor has a built-in filter to mitigate the H_2S interference. The SO_2 sensor has additional interference from NO_2. The AQMesh data processing algorithms incorporate any data correction for these interferences.

Sensors like the Canary-S and AQMesh Pod, are also known to produce data that is noisier than traditional reference method quality ambient air monitoring equipment. To mitigate this issue the AirSense data management system will average the data over 1-hour to improve the signal-to-noise of the instrument readings.

The AQM 65 units mitigate many of these issues by additional sensor module design. The typical temperature and humidity issues are mitigated by maintaining the temperature of the sensor modules at 30°C +/- 0.2°C and humidity equalizers or dryers. Each individual sensor module is designed specifically for weaknesses of the sensor itself. For example, the SO_2 module includes the sensor plus: a flow control orifice, solenoid, component scrubbers, humidity equalizer, and electronics. These additional components compensate for sensor drift, noise, humidity and cross interference, and greatly reduce the minimum detection limit in real world conditions. The scrubber works by analyzing the gas sample for SO_2, which will provide a response dictated by SO_2 and any present interferences. Then the sample is run through a selective scrubber that only removes SO_2 from the sample gas, the difference between the SO_2 reading before and after the scrubber is then reported as the true SO_2 concentration.

3.2 DEPLOYMENT PROCEDURES

The following procedures will be followed prior to deploying the sensors to monitoring locations. Any sensors not meeting all the requirements outlined below will be brought back to Montrose's facility and a technician will attempt to resolve the issue at the guidance of the manufacturer. If the issue cannot be resolved by Montrose the instrument will be returned to the manufacturer.

3.2.1 Sensor Deployment/Maintenance Log

Upon completion of the sensor pre-delivery checks, the sensors will be received by Montrose and a sensor deployment/maintenance log initiated. The log will be stored on Montrose's server which is only accessible by Montrose personnel and will contain the following minimum information:

- Sensor serial number
- Sensor model number
- Sensor batch ID
- AirSense key
- Results of the initial sensor calibration check out procedures
- Deployment location, date and time
- Sensor replacement schedule
- History of notes, issues and maintenance procedures organized by date

3.2.2 Canary-S PID Gas Calibration

A calibration will be performed on all Canary-S TVOC sensor during the initial deployment effort using zero air, 1 ppm, and 2 ppm isobutylene certified cylinders. These gas values were chosen based on expected ambient concentrations. A gas hood is installed over the top of the PID sensor and gas is flowed at approximately 0.5 L/min across the sensing portion of the PID face.

TABLE 3-1
MINIMUM PID GAS QUALITY CONTROL CRITERIA

PID Gas Concentration Input	Minimum Criteria[4]
3 ppm Precision	|3*Standard Deviation|<=50 ppb
Zero Air	±10% of span bottle value
1 ppm	±25% of bottle value
2 ppm	±25% of bottle value

Based on the response of the analyzer to each concentration of gas a linear fit will be applied to the data to produce a slope and intercept that is applied to the raw pollutant parameter. PID detectors historically have a logarithmic response and only a small region of the sensors full range is considered linear. In the case of the PID that Lunar Outpost uses, this linear range is from 0 to 3 ppm. Once the units are deployed to the field some minor adjustments are made to the unit's baseline reading, this adjustment is considered when evaluating if the calibration met the minimum criteria outlined above.

3.2.3 AQMesh Pod Criteria Pollutant and H_2S Gas Calibration

A calibration will be performed on the CO, NO, NO_2, SO_2, and H_2S sensors during the initial deployment effort using certified gas cylinders. A gas hood is installed over the top of the sensor and gas is flowed at approximately 0.5 L/min across the sensing portion of the sensor's

[4] Based on 1-minute readings

face. The tables below provide the approximate gas concentrations that will be used for initial calibrations. These gas values were chosen based on expected ambient concentrations.

TABLE 3-2
MINIMUM CO GAS QUALITY CONTROL CRITERIA

CO Gas Concentration Input	Minimum Criteria[4]
1 ppm Precision	|3*Standard Deviation|<=60 ppb
0 ppm	±10% of Mid-Gas
1 ppm	±50% of Input
10 ppm	±50% of Input

TABLE 3-3
MINIMUM NO GAS QUALITY CONTROL CRITERIA

NO Gas Concentration Input	Minimum Criteria[4]
0.5 ppm Precision	|3*Standard Deviation|<=60 ppb
0 ppm	±25% of Mid-Gas
0.5 ppm	±50% of Input
2 ppm	±50% of Input

TABLE 3-4
MINIMUM NO_2 GAS QUALITY CONTROL CRITERIA

NO_2 Gas Concentration Input	Minimum Criteria[4]
0.5 ppm Precision	|3*Standard Deviation|<=60 ppb
0 ppm	±25% of Mid-Gas
0.5 ppm	±50% of Input
2 ppm	±50% of Input

TABLE 3-5
MINIMUM H_2S GAS QUALITY CONTROL CRITERIA

H_2S Gas Concentration Input	Minimum Criteria[4]
0.5 ppm Precision	|3*Standard Deviation|<=40 ppb
0 ppm	±25% of Mid-Gas
0.5 ppm	±50% of Input
2 ppm	±50% of Input

TABLE 3-6
MINIMUM SO_2 GAS QUALITY CONTROL CRITERIA

SO_2 Gas Concentration Input	Minimum Criteria[4]
0.5 ppm Precision	|3*Standard Deviation|<=40 ppb
0 ppm	±25% of Mid-Gas
0.5 ppm	±50% of Input
2 ppm	±50% of Input

Based on the response of the analyzer to each concentration of gas a linear fit will be calculated to the data to produce a slope and intercept that will be applied to the pollutant parameter that is receiving the scaling correction if 50% of the minimum criteria is exceeded. Once the units are deployed to the field some minor adjustments are made to the unit's baseline reading, this adjustment is considered when evaluating if the calibration met the minimum criteria outlined above.

3.2.4 AQM 65 Gas Validation

The AQM 65 is supplied with an internal calibration system, the AirCal 8000, that includes a NIST traceable mass flow meter and controller allowing for dynamic dilution of calibration gas standards. The AirCal 8000 only provides space for two (2) calibration gases and a multipoint calibration will be performed on all sensors during the initial deployment effort. The onboard zero air scrubber will allow for nightly automated zeroing of the instrument. Due to the AirCal 8000 only having the ability to integrate two (2) gas cylinders and certain gases are not stable when mixed in a compressed gas cylinder, weekly quality control checks of the CO, SO_2, NO, and H_2S will occur. CO, SO_2, and NO will be mixed in one bottle, and H2S will be in the second bottle. Monthly quality control checks of the TVOC and NO_2 will be conducted during the gas validation of the collocated Canary-S and AQMesh monitors. No gain or offset correction is made during these validation checks. Quarterly calibrations of the instrument will occur in accordance with the procedures linked to section 3.2.4.

FIGURE 3.1
AQM 65 INTERNAL CALIBRATION SYSTEM

TABLE 3-7
MINIMUM AQM 65 GAS VALIDATION CRITERIA

Gas Concentration Input	Minimum Criteria
SO_2, NO, NO_2, and H_2S Zero	±0.015
CO Zero	±0.200
TVOC Zero	±0.100
CO, SO_2, NO, NO_2, TVOC, and H_2S Span	±10% of Span

3.2.5 Wind Direction Siting

The sonic anemometers on each Canary-S monitor have a North orientation marker that will be aligned to magnetic north using a compass. The field personnel sites the monitor during the initial deployment and then confirms this reading during each subsequent monthly calibration checks. An acceptable check will verify that the North siting is within 10 degrees. If the verification check fails, the monitor will be adjusted and the data since the last verification check will be flagged on the data platform.

3.2.6 Co-Location Study

The near-FEM AQM 65 units used in this program will be collocated with each other prior to deployment in the field to determine system-to-system variability. During this time the data will be collected by the AirSense data platform. The minimum criteria that must be met before these monitors will be deployed in the field are listed in Table 3-8 below.

TABLE 3-8
MINIMUM NEAR-FEM CO-LOCATION CRITERIA

Parameter	Minimum Criteria*
Data Completeness	>95%
AQM 65 System-to-System Agreement $PM_{2.5}$ (Absolute Error from Average)	+/- 3 µg/m3
AQM 65 System-to-System Agreement H_2S, SO_2, NO, and NO_2 (Absolute Error from Average)	+/- 0.02 ppm
AQM 65 System-to-System Agreement CO (Absolute Error from Average)	+/- 0.1 ppm

* Based on 60 min averaged data

Canary-S and AQMesh monitors will be received by Montrose in batches and collocated with a near-FEM AQM 65 unit. The co-location study will be conducted for a period of one week. During that time data will be collected by the AirSense data platform. The collected data will be summarized in the deployment/maintenance log. The purpose of this collocation is to demonstrate that the Canary-S and AQMesh units provide data within a reasonable error to the AQM 65 units and show the unit-to-unit agreement. This unit-to-unit agreement provides confidence in the data from the Canary-S and AQMesh units that will not be collocated with AQM 65 units during community monitoring. Before being deployed at a location, the sensors must meet the minimum criteria found in Table 3-9. One of the parameters that will be used for evaluating the co-location is root mean square error (RMSE). RMSE is the standard deviation of the residuals. Residuals are a measure of how far from the regression line data points are. In other words, it tells you how concentrated the data is around the line of best fit.

TABLE 3-9
MINIMUM SENSOR-NEAR-FEM CO-LOCATION CRITERIA

Parameter	Minimum Criteria*
Data Recovery	>95%
Error to near-FEM $PM_{2.5}$ (RMSE)	<10 µg/m3
Canary-S Sensor-to-Sensor Agreement $PM_{2.5}$ (Absolute Error from Average)	+/- 3 µg/m3
Error to near-FEM H_2S, SO_2, NO, and NO_2 (RMSE)	<0.10 ppm
AQMesh Sensor-to-Sensor Agreement H_2S, SO_2, NO, and NO_2 (Absolute Error from Average)	+/- 0.08 ppm
Error to near-FEM CO (RMSE)	<0.20 ppm

Parameter	Minimum Criteria*
AQMesh Sensor-to-Sensor Agreement CO (Absolute Error from Average)	+/- 0.15 ppm

* Based on 60 minute averaged data

3.2.7 FEM Co-Location Study

The near-FEM AQM 65 units used in this program were collocated with the Welby (AQS ID: 080013001) regulatory Colorado Department of Public Health and Environment (CDPHE) air monitoring station prior to deployment in the field to better understand the error between the AQM 65 and FEM monitors. During this time the AQM 65 data was collected by the AirSense data platform, and the FEM data was provided by CDPHE.

Due to the number of studies done collocating the AQM 65 with referenece monitors for CO, NO_2, and $PM_{2.5}$ and the fact that no CDPHE sites monitor for H_2S, SO_2 was the main driver for selecting a collocation site. Three CDPHE sites in Denver monitor for SO_2: Welby, La Casa, and CAMP. For accessibility reasons Welby was chosen. The study began on June 2, 2021 and completed on June 9, 2021. Compounds that the Welby station and the AQM 65 both monitor for are CO, NO, NO_2, and SO_2. The RMSE value from this study are report in table 3-10 below. Though no criteria was set prior to this study the results suggest the “Near-Reference” claim of the AQM 65 units is fair.

TABLE 3-10
WELBY VS AQM 65 COLLOCATION RESULTS

Compound	RMSE (ppm)
CO	0.096
NO	0.011
NO_2	0.002
SO_2	0.000

3.3 ON GOING QUALITY ASSURANCE QUALITY CONTROL

The following procedures will be followed on an on-going basis to assure the quality of collected data.

Due to the nature of electrochemical sensors used in this program, adverse atmospheric conditions such as extreme humidity, extreme temperature, and other conditions can affect a monitor’s ability to provide reliable data. Since these conditions are uncontrollable, it is not possible to mitigate their effects. Data invalidated due to adverse atmospheric conditions are excluded from data completeness calculations.

3.3.1 Data Platform Alerts

The AirSense data platform will alert Montrose and Suncor according to the table below. These alerts will trigger investigation and corrective actions by Montrose. Alerts will be in the form of an immediate e-mail notification.

TABLE 3-11
PLATFORM ALERT CRITERIA

Parameter	Minimum Criteria
Range Check	-2 to 100 ppm or µg/m^3
Flatline Check	Constant value for more than 60 1-minute data points
Communication Failure Alerts	When no data is received for more than 60 minutes emails alerts will be issued at a frequency of once per 6 hours

3.3.2 Daily Quality Assurance Checks

Montrose will review the morning reports generated as outlined in section 4.2.1 to verify that the deployment criteria in Table 3-4 is met.

TABLE 3-12
MINIMUM DEPLOYMENT CRITERIA

Parameter	Minimum Criteria
Data Recovery	>95%
Daily Maximum Value	As Necessary

If any of the criteria laid out in Table 3-4 fail the following procedures will be followed depending on the parameter in question and a back-up sensor will be ready to replace a failed sensor at all times.

Data Recovery: If the sensor fails to meet the data recovery minimum of 95% over 24 hours a technician will inspect the unit. Each day is defined as the 24-hour period spanning from midnight to midnight. Morning reports are received at approximately 9 am MT each day for review. The inspection will consist of checking for any loose connections within the unit that may be causing a power failure and that 12 volts of power is being generated by the solar panel and can be traced back to the barrel jack plugged in the device. If the technician cannot determine the cause of the data recovery, the unit will be returned to the manufacturer for a more in-depth review.

Maximum Value Criteria: If any of the hourly averages for the parameters being monitored for exceed the levels identified in Table 3-5 below Montrose personnel will review the lower temporal resolution data collected during that period to determine if any instrument issues may have occurred.

TABLE 3-13
MONTROSE REVIEW CRITERIA

Parameter	Montrose Data Review Level
NO, NO_2	0.100 ppm
SO_2, H_2S	0.075 ppm
CO	3 ppm
TVOC	1 ppm
$PM_{2.5}$	35 ug/m^3

3.3.3 Monthly Canary-S and AQMesh Quality Assurance Checks

Montrose will visit each monitoring location monthly and run through validation checks on each of the Canary-S and AQMesh units. Similar to the initial calibration, a gas hood is installed over the top of the sensor and gas is flowed at approximately 0.5 L/min across the sensing portion of the sensor's face. Each of the initial calibration concentration levels will be reintroduced to the sensors. Tables in section 3.1.3 provide the minimum criteria that must be met for the data collected since the previous calibration or validation check was conducted.

If any of the individual monitors fail their quality assurance check the data collected since the previous calibration will be post-processed using an average calibration results of the validation results before and after the sampling period and the data will be flagged and a description of the failed QA will be noted. The instrument will then be inspected for any maintenance issues and the manufacturer will be contacted. If a reason for the failed calibration cannot be found or the issue is irreparable then the sensor will be replaced.

If all of the units in the network fail the validation check then the raw data collected from the monitors (this is the data that was not run through the multivariable regression) will be post-processed with the using an average calibration results of the validation results before and after the sampling period and the data will be flagged and a description of the failed QA will be noted. The AQM65 units will then have a validation check done on the units to determine if the near-FEM data being supplied to the regression is valid. Additional data review will be conducted to determine if the regression is properly correcting the data or if adjustments to the regression need to be made.

During these monthly visits the instruments will be blown out with canned air to remove any accumulated dust from inside the units. The unit will also be visually inspected for any damage or signs of tampering with the unit.

The AQMesh system has an automated built-in quality assurance check that will flag data as described in Table 3-13. Some of these codes will invalidate data and the data will be unrecoverable.

TABLE 3-14
AQMESH AUTOMATED QUALITY ASSURANCE CODES

Reading Value	Sensor State	Description	Long Term Effects
Estimated reading	Reading	No Issue detected	
Estimated reading	Rebased	Indicates the rebasing period after it has completed and values recalculated.	After rebasing completed "Rebasing" is replaced with "Rebased" and pointers reset to ensure data is overwritten with calculated values.
-1000	Not Fitted	Sensor or component not fitted.	Coded flag in data feeds as there is no data to view.
-999	Stabilizing	Either when the POD has just been moved to a new location or manually instigated via server.	Values are redacted as they cannot be relied upon during this 2-day period and will remain non-viewable.
-998	Rebasing	Typically, this is a 2-day period where local variables are calculated for use in the AQMesh algorithm are found.	During the rebasing period the coded flag will remain, however upon completion of this process, valid data will be reinstated – Data will need to be re-retrieved for this period, so API pointers are reset.
-997	Optimizing	When a pod is power-cycled for more than a hour i.e. Maintenance or power failure.	Values are redacted as they cannot be relied upon during this 1-hour period and ill remain as non-viewable.
-996	Failed	The system has detected that the sensor has failed.	Data classified as having a sensor fail is redacted & will remain as non-viewable.
-995	Cross Gas Error	If a sensor fails which is relied upon for the removal of interferences on another sensor, data from the reliant sensor becomes invalid.	Data will be redacted & remain non-viewable until compensating sensor is replaced and producing good results.
-994	No Data	Data points where the instrument has not recorded a reading.	Coded flag in data feeds as there is no data to view.
-993	Destabilized	The system has detected that the sensors output\stability may be compromised due to odd fluctuations in temperature and pressure.	Readings for the prescribed period are redacted and are non-viewable until the condition have normalized.
-992	Extreme Environment	Following intensive testing of all electrochemical sensors we have determined the combination of extreme in climate in which the electrochemical sensor do not provide consistent outputs. As	Data classified as within the extreme ranges of the environment will be redacted and will remain non-viewable.

Reading Value	Sensor State	Description	Long Term Effects
		such precise and accurate measurements is not possible.	

The most common error that is expected to be observed in the program is the "Extreme Environment" code which may occur when the units approach their environmental operating limits, which are -4 to 104 Fahrenheit (F) and 5 to 95% relative humidity. The internal temperature of the unit, where the sensors are housed, can reach temperature higher then ambient temperature. In the event that a unit goes into Extreme Environment mode, typically the unit has to drop in temperature to about 85 F before the unit will begin providing valid data again. To mitigate this issue the units will be installed underneath of the solar panel and/or with the unit facing north to block direct sunlight.

3.3.4 AQM Quality Assurance Checks and Calibration

Aeroqual recommends the maintenance schedule in Table 3-13. A detailed description of the procedures that will take place to complete these maintenance tasks can be found at: https://support.aeroqual.com/Wiki/Maintenance_Schedule

TABLE 3-15
AEROQUAL AQM65 MAINTENANCE SCHEDULE

Service activity	Service frequency
Change filter on gas inlet	Initially 4 weeks, then every 4-12 weeks. Later this can be modified to suit local conditions and data quality objectives.
Check flow of gas inlet	Initially 4 weeks, then every 4-12 weeks. Later this can be modified to suit local conditions and data quality objectives.
Adjust flow of gas inlet	As required following gas inlet flow check
Replace gas pump	Every 12 to 18 months, or when flow rate can't be set correctly
Check flow of gas modules	As required following gas inlet flow check
Check gas module for leaks	As required following gas module flow check
Remove gas module	As required and described below
Replace gas module	As required and described below
Field calibrate (zero and span) gas module	At least every 3 months (four times per year) but no more than once per week.
Change filter for particle monitor	Initially 4 weeks, then every 4-12 weeks. Later this can be modified to suit local conditions and data quality objectives.
Check flow of particle monitor	Initially 4 weeks, then every 4-12 weeks. Later this can be modified to suit local conditions and data quality objectives.
Adjust flow of particle monitor	Adjust as required following inlet flow check
Check particle monitor for leaks	Every 3 months
Check zero of particle monitor using external filter	Every 3 months

Service activity	Service frequency
Check zero of particle monitor using auto cycle (AQM)	Every 3 months
Check laser and detector	Every month
Clean sharp cut cyclone	Every 3 months
Replace pumps in particle monitor	Every 12 to 18 months, or when flow rate can't be set correctly
Clean compressor cassette	As required
Refill compressor with gas	As required or when directed by Aeroqual technical support.
Factory calibrate particle monitor	Every 24 months (2 years)

3.3.5 Sensor Replacement Schedule

The electrochemical sensors and PID in the AQM 65, AQMesh, and Canary-S degrade over time. The lifespan of the sensors vary and is dependent on preventative maintenance and level of pollutant exposure. Degradation can be indicative of failed monthly (Canary-S/AQMesh) or weekly (AQM 65) data validation. The manufacturers specify the sensor lifespan for these systems is greater than 24 months. Each sensor will be removed from the location and replaced when degradation characteristics are observed or at a minimum after 24-months of operation. After replacement, the sensors will be transferred to Montrose and the Co-Location study will be repeated. All QA/QC checks as outlined for initial deployment will be repeated and documented in the deployment/maintenance log.

4.0 REPORTING

A morning system report will be issued by the AirSense data platform and e-mailed to the principle parties at Suncor and Montrose. The system report will have at a minimum, the following 24-hour data summary of each parameters listed below. An example system report can be found in the Appendix.

- Sensor ID
- Minimum value
- Maximum value
- Average value
- Percent data capture

APPENDIX A
Lunar Outpost Canary-S Specification Sheet

Canary – S

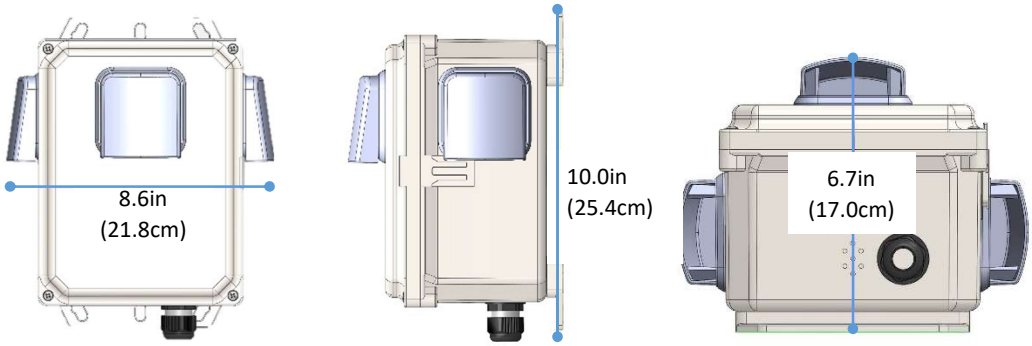
Air Quality Monitoring System

Gen 4 Revised: 12/17/19

I. Introduction

The Canary-S is a continuous solar powered air quality and meteorological monitoring system designed to be class leading in size, reliability, and flexibility. With cellular communication these systems can be placed nearly anywhere to provide measurements on particulate matter, targeted gases, and meteorological data. Multiple units can be deployed to create a network of real-time data integrated into existing customer databases or into Lunar Outpost's platform.

II. Mechanical



A. Physical Properties

See Table 1.

Table 1: Physical Properties of air quality monitor

Dimension	Value
Width	8.6 in
Height	10.0 in
Depth	6.7 in
Weight	~4.3 lbs

B. Mounting Options

The Canary enclosure allows mounting to either tripods, large diameter poles, or DIN rails.

C. Certifications and Environmental

The Canary enclosure meets the following certifications: UL508A, UL 50, CSA-C22.2 No. 14, NEMA 1,2,3,3R,4,4X,5,6,6P,12,13, UL94V-0 Flame rating, and UL746C-F1 UV and submersion testing. The original enclosure before modification had an IP68 rating. The rating after modification is reduced due to the designed addition of vents for airflow, but the unit maintains protections against inclement weather when mounted correctly. The enclosure is UV-Stabilized Polycarbonate and the units have undergone extensive testing in a variety of outdoor environments to ensure robust functionality. Canary units have an operational temperature range of -20F to 140F (-28.89C to 60C).

III. Power

Table 2: Power characteristics of air quality monitor

Battery		Charging	
Chemistry	Lithium-Ion	Solar Panel	12V DC (20W)
Capacity	8000 mAh	Solar Charge Controller	12V DC
Run-time without power input	120 hours* *under proper conditions	Wall Charger	120V AC (US std) input to 12V DC output (24W)

IV. Communication and Data

Canary-S units communicate over commercial cellular bands and data is transmitted to a secure cloud. From the cloud, the data can be routed to the customer's database or Lunar Outpost's custom database. The connection to the cloud is database agnostic, allowing integration with a variety of commercial or custom databases. Table 3 and 4 outline the cellular data connection specifications of two of the cellular modems used in the Canary units.

A. Cellular Communication

Table 3: 2G/3G Cellular Data Connection Specifications

Network	2G/3G HSPA/GSM	**Cellular Modem**	Ublox SARA-U260
HSPA Bands	850/1900 MHz	**GSM Bands**	850/1900 MHz

Table 4: 4G Cellular Data Connection Specifications

Network	4G LTE Cat M1	**Cellular Modem**	Ublox SARA-R410M
LTE Bands	3, 4, 5, 8, 12, 13, 20, 28	**2G/3G Bands**	None

B. Data

The Canary-S allows for data integration into the platform of choice and puts data ownership and control in the customer's hands. JSON formatting is used for the data unless otherwise requested by the customer. Micro-SD capability allows for data-backups and redundancy storing up to 7 years of data locally.

- **Integrate to client database:** Canary-S data can be routed to a customer's existing database or routed to multiple databases simultaneously.
- **Lunar Outpost's custom database:** Lunar Outpost's custom database is an effective, user friendly platform that allows customers to view, interact with, analyze, and download data.

V. Sensors

Table 5: Base Unit Sensor Specs

Property	Range	Resolution
PM2.5	0~1000 µg/m³	1 µg/m³
PM10	0~1000 µg/m³	1 µg/m³
Internal Temperature	-40 to 85 °C (-40 to 185°F)	+/-1.5 °C (2.7 °F)
Internal Humidity	0-100% RH	+/-3%
Atmospheric Pressure	300-1250 hPa (mbar)	+/-1.7 hPa (mbar)

Table 6: Optional Sensor Specs

Property	Range	Max Resolution Limit
Total VOC (tVOC)	0 to 50 ppm	1 ppb
Ozone (O_3)	0 to 20 ppm	15 ppb
NO_2	0 to 20 ppm	15 ppb
CO	0 to 1000 ppm	4 ppb
CO_2	0 to 5% volume	1 ppm
H_2S	0 to 100 ppm	5 ppb
SO_2	0 to 100 ppm	5 ppb
CH_4	0 to 50000 ppm	100 ppm
External Temperature	-40 to 80°C (-40 to 176°F)	+/-0.3 °C (0.54 °F)
External Humidity	0-100% RH	+/-2%
Wind Speed	0-75 m/s (0-168mph)	0.01 m/s
Wind Direction	0-360 deg	+/- 2 deg

For more information: info@lunaroutpost.com

wind

YOUNG

Model 91000

ResponseONE™ Ultrasonic Anemometer

YOUNG Model 91000 *ResponseONE*™ Ultrasonic Anemometer

The YOUNG ***ResponseONE***™ Ultrasonic Anemometer is designed to reliably measure wind speed and direction. The ***ResponseONE***™ is wind tunnel calibrated and will accurately measure wind speeds up to 70 m/s (156 mph). The high sampling rate of the Model 91000 provides for fast response to changing wind conditions and wind data may be updated as fast as 10 times per second. An easy-to-use Windows setup program is provided with each sensor. The program allows the user to customize device settings such as sampling rates and communication parameters.

The compact IP-66 rated design features durable, corrosion-resistant construction. A variety of useful standard serial output formats are provided including SDI-12, NMEA, and ASCII text. The sensor installs on readily available 1 inch (IPS) pipe and wiring connections are made in a convenient weather-proof junction box. Special connectors and cables are not required. The Model 91000 is available in black or white.

Specifications

Wind Speed	Range:	0 – 70 m/s (156 mph)
	Resolution:	0.01 m/s
	Starting Threshold:	<0.01 m/s
	Accuracy:	±2% or 0.3 m/s (0 – 30 m/s)
		±3% (30 – 70 m/s)
	Response Time:	<0.25 seconds
Wind Direction	Azimuth Range:	0 - 360 degrees
	Resolution:	0.1 degree
	Starting Threshold:	<0.01 m/s
	Accuracy:	±2 degrees
	Response Time:	<0.25 seconds
Electronic Compass	Range:	0 – 360 degrees
	Resolution:	1 degree
	Accuracy:	± 2.0 degrees
Serial Output (selectable)	Interface:	RS-232, RS-485/422, SDI-12
	Formats:	NMEA, SDI-12, ASCII (polled or continuous)
	Baud Rates:	1200, 4800, 9600, 19200 and 38400
	Wind Units:	m/s, knots, mph, kmph
	Output Update Rate:	0.1 to 10 HZ
Power	Voltage:	10 – 30 VDC
	Current:	7 mA @ 12 VDC typical, 80 mA max
General	Protection Class:	IP66
	EMC Compliance:	FCC Class A digital device, IEC Standard 61326-1
	Dimensions:	22.0 cm high x 13.5 cm wide
	Weight:	0.5 kg (1.1 lb)
	Shipping Weight:	1.4 kg (3.1 lb)
	Operating Temperature:	-40 to +60 °C
	Removable Bird Spikes:	Included

The ***ResponseONE***™ is compatible with a broad range of data loggers and displays, including the YOUNG Model 06206 Marine Wind Tracker.

Ordering Information

	MODEL
ResponseONE™ Ultrasonic Anemometer – White	**91000**
ResponseONE™ Ultrasonic Anemometer – Black	**91000B**

CE Complies with applicable CE directives.

R.M. YOUNG COMPANY
2801 Aero Park Drive
Traverse City, Michigan 49686 USA
TEL: (231) 946-3980 FAX: (231) 946-4772
E-mail: met.sales@youngusa.com
Web Site: www.youngusa.com

APPENDIX B
AQMesh Pod Specification Sheet

AQMesh

Technical specification

AQMesh | Technical specification

Gas algorithm V5.3, PM algorithm V3.0h*

GASES

Sensor	Type	Units	Range[#1]	LOD	LOC[#2]	Precision[#3]	Accuracy[#4]
NO	Electrochemical	ppb or µg/m^3	0-20,000 ppb	<1 ppb	<5 ppb	>0.9	1 ppb
NO2	Electrochemical	ppb or µg/m^3	0-20,000 ppb	<1 ppb	<5 ppb	>0.85	4 ppb
NOx	Electrochemical	ppb or µg/m^3	0-40,000 ppb	<2 ppb	<10 ppb	>0.9	4 ppb
O3	Electrochemical	ppb or µg/m^3	0-20,000 ppb	<1 ppb	<5 ppb	>0.9	5 ppb
CO	Electrochemical	ppb or µg/m^3	0-1,000,000 ppb	<50 ppb	<50 ppb	>0.8	20 ppb
SO2	Electrochemical	ppb or µg/m^3	0-100,000 ppb	<5 ppb	<10 ppb	>0.7	20 ppb
H2S	Electrochemical	ppb or µg/m^3	0-100,000 ppb	<1 ppb	<5 ppb	>0.7	1 ppb
TVOC[#11]	Electrochemical	ppm	0-2.5 ppm	<0.1 ppm	<0.25 ppm	>0.95	0.05 ppm
CO2	NDIR	ppm or mg/m^3	0-5,000 ppm	<1 ppm	<1 ppm	>0.9	30 ppm

PARTICLES

Sensor	Type	Units	Range[#1]	LOD	Precision[#3]	Accuracy[#4]
PM1[#5]	Optical particle counter	µg/m^3	0-100,000 µg/m³	0 µg/m³	>0.9	5 µg/m³
PM2.5[#5]	Optical particle counter	µg/m^3	0-150,000 µg/m³	0 µg/m³	>0.9	5 µg/m³
PM4[#5]	Optical particle counter	µg/m^3	0-225,000 µg/m³	0 µg/m³	>0.9	5 µg/m³
PM10[#5]	Optical particle counter	µg/m^3	0-250,000 µg/m³	0 µg/m³	>0.85	5 µg/m³
PM_Total[#5]	Optical particle counter	µg/m^3	0-350,000 µg/m³	0 µg/m³	>0.85	5 µg/m³

ADDITIONAL SENSORS

Sensor	Type	Units	Range[#1]	LOD	Precision[#3]	Accuracy[#4]
Pod temperature	Solid state	°C or °F	-20°C to 100°C	0.1°C	>0.9	2°C
Pressure	Solid state	mb	500 to 1500 mb	1 mb	>0.9	5 mb
Humidity	Solid state	%	0 to 100%	1% RH	>0.9	5% RH
Noise[#6]	Omnidirectional mic	dB	35 to 100 dB SPL	20 Hz – 20 kHz	>0.8	1 dB

WIND SPEED & DIRECTION SENSOR

Sensor	Type	Units	Range	Resolution	Accuracy[#7]
Wind speed	Solid state	ms^{-2}	0 to 30 ms^{-2}	0.01 ms^{-2}	2%
Wind direction	Solid state	° degrees	0 to 359 °	1 °	2 °

SENSOR LIFE

Sensor Type	Expected lifespan	Notes
Electrochemical	2 years[#8]	See AQMesh standard operating procedure
NDIR	5 years	See AQMesh standard operating procedure
Solid state	5 years	See AQMesh standard operating procedure
Omnidirectional microphone	5 years	See AQMesh standard operating procedure
Optical particle counter	2 years[#8]	Maintenance dependent on application & settings[#9]

POWER

Option	Expected lifespan	Notes
External DC	>5 years	9 – 24V DC
Lithium metal battery pack[#10]	>24 months	Dependent on measurement strategy & pod spec
External high capacity battery pack[#10]	>60 months	Dependent on measurement strategy & pod spec
NiMH rechargeable battery pack	>4 months	Dependent on measurement strategy & pod spec
Solar power pack	>5 years	Change internal lead-acid battery every 24 months

AQMesh | Technical specification

Gas algorithm V5.3, PM algorithm V3.0h*

PHYSICAL

Enclosure	ABS, protection IP65
Environmental	Temperature range:-20°C to +40°C Humidity range: 15 to 95% RH
Mounting	Pod supplied with mounting bracket for walls / posts
Approx. size & weight	Length: 170 mm Width: 220 mm Height (excl antenna): 250mm Height (incl antenna): 430mm Weight: 2 – 2.7kg

DATA ACCESS & COMMUNICATIONS

Communication	Raw data sent to server by cellular network. Worldwide coverage 4G/5G LTE Cat M1/NB1 with 2G fallback
Measurement period	Variable, from 1 minute to 1 hour
Transmission frequency	Variable, from 5 minutes to 12 hour intervals
Server software	Web browser based Processing of sensor output to give reading Database storage on secure server
Data access	Tables, graphs Data download Multi-user access Password controlled Optional API data access

Product designs and specifications are subject to change without prior notice.

The user is responsible for determining the suitability of the product.

*h denotes when used with optional heated inlet for PM monitoring

#1 From sensor manufacturer's specification. This data was derived from independent lab tests. Standard test conditions are 20°C and 80% RH and in the absence of interfering gases. Tested range is-30°C to +30°C.

#2 Readings provided below this level, however due to interferences the level of uncertainty is greater than at higher levels of the target pollutant.

#3 Correlation co-efficient derived from extensive global co-location comparison testing against certified reference.

#4 Best "out of the box" accuracy without any local scaling/calibration against reference.

#5 Mass estimation based on standardisation of particle shape and density. Range is based on optical range of 0.3-30µm particle size.

#6 Noise measures average noise and peak noise. Peak noise is the highest recorded value over the gas reporting interval while average noise is calculated using all noise samples over the same period.

#7 Wind speed and direction stated accuracy is at 12ms-2

#8 Electrochemical sensors and particle sensors carry a 12-month warranty.

#9 Detail of maintenance required is listed in the standard operating procedure.

#10 Subject to carrier restrictions on dangerous goods.

#11 Values are based on testing for Ethylene Oxide (EO) and correction factors will affect these results

APPENDIX C
Aeroqual AQM65 Specification Sheet

aeroqual

AQM65

Near reference real-time monitor for multiple gases plus particulate fractions

The AQM 65 is a fully integrated, temperature controlled air quality monitoring station that delivers 'near reference' levels of performance in real-time for multiple gases, particulates and environmental parameters.

Continuously measure air pollutants including ozone O_3, NO_2, NOx, CO, SO_2, VOC, H_2S, CO_2, TSP, PM_{10}, $PM_{2.5}$, PM_1, noise and meteorological parameters.

AQM 65 shown with Optional integrated Calibration system

What is it?

- Proven long term performance in extreme climates with purpose-built enclosure and advanced temperature and humidity control
- Reduce site visits using two-way communications – remotely troubleshoot, upgrade software, change settings, and calibrate
- Plug in all your devices – noise, weather, reference monitors – to the AQM 65 and view data in one software dashboard
- Enables automatic scheduling of calibrations with optional integrated calibration system
- Respond in real-time via configurable email / SMS alerts

What can it measure?

- Multiple gases, dust fractions, wind, weather and noise

Who is it for?

- Industrial operators who need a cost-effective and robust solution to manage and control dust and gas emissions from site activities within regulatory or permitted limits:
  - Industrial perimeter monitoring
  - Oil and gas facilities
  - Quarry and mine operators
  - Port and bulk handling authorities
  - Waste management sites
- Regulatory authorities who need to fill the gaps in the regulatory monitoring networks
- Environmental consultants and Researchers who want defensible data without the usual time and hassle of air monitoring projects
  - Research and consultancy projects
  - Environmental impact assessments
  - Short term hot spot monitoring
  - Roadside air monitoring

Specifications | AQM 65

Gas module	Range	Resolution	Noise Zero; Span % of reading	Lower Detection Limit (2σ)	Precision	Linearity (% of FS)	Drift 24 hour Zero; Span % of FS
Ozone O_3	0-500 ppb	0.1 ppb	1 ppb; 1 %	1 ppb	2 % of reading or 2 ppb	1.5 %	1 ppb; 0.2 %
Nitrogen dioxide NO_2	0-500 ppb	0.1 ppb	1 1 %	1 ppb	2 % of reading or 2 ppb	1 %	2 ppb; 1 %
Carbon Monoxide CO	0-25 ppm	0.001 ppm	0.02 ppm; 1 %	0.04 ppm	3 % of reading or 0.050 ppm	1 %	0.02 ppm; 0.2 %
Sulfur Dioxide SO_2	0-10000 ppb	1 ppb	4 ppb; 2 %	9 ppb	3 % of reading or 9 ppb	1 %	1 ppb; 0.2 %
Nitrogen Oxides NO_X	0-500 ppb	0.1 ppb	1 ppb; 1 %	1 ppb	3 % of reading or 3 ppb	1 %	1 ppb; 0.2 %
Hydrogen Sulfide H_2S	0-10000 ppb	0.1 ppb	6 ppb; 2 %	12 ppb	3 % of reading or 12 ppb	1 %	1 ppb; 0.6 %
Carbon Dioxide CO_2	0-2000	1 ppm	5 ppm; 1 %	10 ppm	3 % of reading or 10 ppm	2 %	1 ppm; 0.6 %
VOC (Low range)	0-500 ppb	0.1 ppb	1 ppb 1 %	1 ppb	2 % of reading or 2 ppb	1 %	1 ppb; 1 %
VOC (High range)	0-30 ppm	0.01 ppm	0.1 ppm; 1 %	0.05 ppm	2 % of reading or 0.05 ppm	2 %	0.1 ppm; 1 %

Particle module	Sizes	Range	Accuracy	Resolution	Lower Detectable Limit (2σ)
Nephelometer	PM_1, $PM_{2.5}$, PM_{10} OR TSP	0 to 60,000 µg/m³	±(2 µg/m³ + 5% of reading)	0.1 µg/m³	1 µg/m³
Profiler (Optical Particle Counter)	PM_1, $PM_{2.5}$, PM_{10} AND TSP	PM_1 200 µg/m³ $PM_{2.5}$ 2000 µg/m³ PM_{10} 5000 µg/m³ TSP 5000 µg/m³	±(5 µg/m³ + 15% of reading)	0.1 µg/m³	1 µg/m³
	Optional Particulate Counts: 0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10 microns (counts range: 0-100,000 counts/L)				

System specifications	
Control system	Embedded fanless PC (Intel Celeron® N3350, 1.1GHz, dual core, 4GB RAM, 32GB SSD hard drive), Debian Linux Operating System
Communications[1]	Standard: WIFI, Ethernet (LAN) Optional modem: Cellular IP 3G HSPA or 4G LTE
Software	**Aeroqual Cloud** – Choose a plan that is right for you **Optimize:** Reduce site visits and improve data quality by managing your monitors and optimizing network performance remotely. **Plus**: Stay one step ahead with enhanced features for viewing and sharing data, real-time alerts, and analysis. Talk to our sales team to learn more about Aeroqual Cloud plans.
Data logging	32 GB Hard Drive (> 5 years data storage)
Averaging period	1 min, 5 min, 10 min, 15 min, 20 min, 30 min, 1 hr, 2 hr, 4 hr, 8 hr, 12 hr, 24 hr
Power requirements[2]	90 - 264 Vac, 47 - 63 Hz Typical draw: 100 W (depends on configuration and ambient temperature)
Enclosure	Outer: IP65 rated aluminum skin with solar reflective coating Inner: 40 - 50 mm (1.6 - 2 “) layer of cross-linked PE foam insulation
Gas sampling system	Inlet: Teflon, glass-coated stainless-steel Pump: 12 V brushless DC diaphragm
PM sampling system	Inlet: Omni-directional 36 cm (14.1 inches) heated inlet; Optional sharp cut cyclones for PM_{10}, $PM_{2.5}$ or PM_1 size selection Pump: 12 V brushless DC diaphragm Optics: 670 nm laser, near-forward scattering nephelometer with sheath air protection
Dimensions[3]	Standard: 1310 H x 510 W x 280 D mm (51.6 H x 20 W x 11 D “) With AirCal 8000: Width = 655 mm (25.8 “)
Weight[4]	< 30 Kg
Operating range	-35 °C to +50 °C (-31 °F to 122 °F)
Mounting	Pole, tripod and wall mounting brackets included
47mm sample filter[5]	47 mm filter for particle loading analysis
Factory integrated sensors[5]	Gill WindSonic (ultrasonic wind sensor), Vaisala WXT536 (weather transmitter), Met One MSO (weather transmitter), Cirrus MK427 Class 1 (noise sensor), Novalynx Pyranometer (solar radiation)
Compatible tested sensors	BSWA 308 (sound level meter), Met-One BC-1060 (black carbon monitor), Met-One E-BAM PLUS (Beta-Attenuation Mass Monitor)

[1] 4G LTE not available in all markets.
[2,4] Configuration used for power and weight calculations: base unit, nephelometer, PM_{10} sharp cut, modem, heater on.
[3] Dimensions are for enclosure. PM sampling inlet with cyclone adds 360 mm (14.17") to total height.
[5] Optional

Sira MC130235/01

APPENDIX D
Example Morning System Report

AirSense

Suncor: 24 Hour (8/5/2021 12:00:00 AM - 8/6/2021 12:00:00 AM Mountain Standard Time)

Site	Instrument	Sensor	Last Updated	% Complete	01 AM	02 AM	03 AM	04 AM	05 AM	06 AM	07 AM	08 AM	09 AM	10 AM	11 AM	12 PM	01 PM	02 PM	03 PM	04 PM	05 PM	06 PM	07 PM	08 PM	09 PM	10 PM	11 PM	12 AM	Max Reading	Min	Ave
	Adams City High School (Mon_Dutch_005) (CM3)	PM2_5	08/06/21 07:59	1500	42.3	42.6	41.5	41.4	41.8	41.6	41.8	42.2	41.8	41.8	40.7	40.2	41.4	42.3	42.2	41.9	39.9	41.0	42.1	40.7	41.2	44.6	42.7	42.5	55.6	35.7	41.8
		TVOC			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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For questions, please use Table 1-3 to contact the individual that would be most prepared to answer your question.