Antrum Guide Specification: Optimized Laboratory Ventilation

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			2. SUMMARY
				1. This document contains the specifications for AntrumXTM, an Air Quality Monitoring System (AQMS), which utilizes centralized sensing to monitor the Indoor Air Quality (IAQ) of a facility and communicate the data to the Building Management System (BMS) or Laboratory Airflow Control System (LACS), and the cloud. The system architecture shall utilize centralized sensors located in a Sensor Pack inside the monitoring panel. The air sampling network shall consist of duct probes / faceplates, tubing, and an air accelerator that creates a vacuum to draw air samples from the monitored environments to the Sensor Pack.
				2. The AQMS provides continuous monitoring of environmental conditions and ventilation performance as described in the Sensor Pack section. The AQMS shall provide end-to-end encryption to ensure secure access to information via a cloud-based website. With access to AntrumEYETM, the user will have visibility to data driving the demand for ventilation, including air quality data specific to each monitored zone, charts, trends, etc. The AQMS shall interface with the BMS as described.
				3. The AQMS specified herein shall be Antrum. No other manufacturers are allowed.

IF FLAT SPEC IS FORBIDDEN:

Alternate manufacturers may bid based upon meeting all requirements of the specification and receiving approval from the engineer, at minimum, 30 days prior to bid.

* + - 1. DEFINITIONS
				1. BMS/BAS: Building Management/Automation System.
				2. Ethernet: Local area network based on IEEE 802.3.1 standards.
				3. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
				4. I/O: Input/output.
				5. RS-485: A TIA standard for multipoint communications using two twisted pairs.
				6. AA: Air Accelerator.
				7. MUX: Multiplexer, which is a manifold of air solenoid valves.
				8. AQMSC: Air Quality Monitoring System Contractor responsible for this section of the specification.
				9. OTA: Over-the-Air updates, pertaining to the wireless delivery of new software, firmware, or other data.
				10. CO: Carbon Monoxide.
				11. CO2: Carbon Dioxide.
				12. CH2O: Formaldehyde.
				13. NH3: Ammonia.
				14. PC2.5: Number of Particulates detected from 0.3 to 2.5 microns in size.
				15. TVOC: Total Volatile Organic Compounds.
1. PRODUCTS
	* + 1. CONTRACTOR RESPONSIBILITIES
				1. The installing contractor shall provide all necessary hardware, software, mechanical, electrical, tubing, and computing equipment necessary to provide a complete and functional system necessary to perform as defined in this specification.
				2. Installation of all AQMS components, and all associated mechanical and electrical work required as an integral part of this installation as specified in Part 3 Execution, including but not limited to: air accelerators, duct probes / faceplates, duct couplers, tubing, monitoring panel, Sensor Pack, Gateway, etc.. [INSERT DIVISION OR SECTION NUMBER OR NAME, CONTRACTOR NAME, TRADE GROUP, ETC., WHO WILL PERFORM THE AQMS INSTALLATION.]
				3. The price of the AQMS will include access to the AntrumEYE software platform.
			2. SYSTEM REQUIREMENTS
				1. All equipment and components shall be standard, regularly manufactured, and available from the manufacturer, not custom designed for this project.
				2. The system shall have the ability to monitor multiple environments from a single location, the monitoring panel.
				3. The system shall have the ability to simultaneously sense multiple parameters using a single sensing device, i.e., Sensor Pack.
				4. The system shall provide the user the ability to select which parameters will be sensed in the monitored environment.
				5. The system shall have the ability to sense a multitude of environments: OA, GEX, SA, Indoor Space, utilizing the same sensing device and associated hardware.
				6. The system shall be modular, permitting expansion of hardware and software.

System shall allow for OTA updates

* + - * 1. The system shall provide priority-based reporting regarding the severity of the sensed environment.
				2. The system shall have the ability to communicate directly with the BMS or LACS.

This includes sending sensed contaminant levels of monitored environments to the BMS/LACS.

Data is regularly written and read over the network as specified in Appendix A in this specification.

* + - * 1. The system shall securely send data to the cloud to allow for user access to detailed reports.
			1. EQUIPMENT
				1. Hardware

The AQMSC shall provide all Duct Probes / Faceplates, Air Accelerators, Tubing, and Monitoring Panels (including Sensor Packs and Gateways) as necessary to provide a complete and functional system to perform as defined in this specification.

* + - * 1. Software

All necessary software for the AQMS shall come installed on the necessary components in the Monitoring Panel from the manufacturer.

The AQMSC shall provide a BACnet compatible system and software to interface with the BMS. Protocol shall be BACnet over IP or BACnet MS/TP.

[DELETE 2. ABOVE IF THE PROJECT DOES NOT REQUIRE BACnet INTEGRATION]

* + - * 1. Building Connections

The owner shall provide CAT-5e or CAT-6 network drops between the AQMS and

The building’s Ethernet Network to serve as a path to the offsite storage, analysis, and reporting database of the AQMS.

The owner’s BACnet communications network (if BACnet over IP is required) to serve as a path to the BMS

The owner shall provide an RS-485 network drop between the AQMS and the owner’s BACnet communications network (if BACnet MS/TP is required) to serve as a path to the BMS.

The AQMS shall provide RS-485 wiring between monitoring panels, as required.

* + - * 1. The AQMSC shall coordinate environment naming conventions and network map requirements with the owner’s BAS department. The naming convention shall be part of the submittal package.
			1. SYSTEM OVERVIEW
				1. PURPOSE

The purpose of the AQMS is to validate the cleanliness of the indoor zones or lab and optimize ventilation for energy savings when conditions allow. The analysis of the indoor zone or laboratory for indoor airborne contaminants will be application specific and include sensing for any combination of the following: CO, CO2, CH2O, Dew Point, NH3, and PC2.5, TVOC (EC), TVOC (PID).

Data captured will be communicated to the BMS (if applicable) to allow for optimal ACH, allowing the owner to take advantage of energy savings when allowed.

The data will also be available on Antrum’s cloud-based platform: website and mobile application. The data will be analyzed and displayed in a variety of reports, tables, and graphs and unique identifiers for varying levels of severity.

MONITORING PANEL

The Monitoring Panel is a complete, self-contained control panel housing all electronics, Multiplexer, Gateway, Sensor Pack, Transformers for power, firmware, and software. The Monitoring Panel shall be furnished with all internal devices and wiring, assembled and tested at the factory.

Each Monitoring Panel will have its own communication Gateway.

SENSOR PACK

The Sensor Pack is a device that allows multiple parameters to be sensed and measured simultaneously. The Sensor Pack is comprised of unique sensors with specific performance characteristics designed to facilitate demand-based control. Any combination of the following sensors shall be utilized to meet the required specifications: CO, CO2, CH2O, Dew Point, NH3, TVOC (EC), TVOC (PID), and PC2.5.

The Sensor Pack communicates to the Gateway over an isolated RS-485 network.

The Sensor Pack shall be capable of proper operation in an ambient temperature environment of -4 degrees to 120 degrees F (-20-50C), 0-90% RH (non-condensing).

On-board diagnostics shall continuously perform system checks, including but not limited to a leak-down test.

The Sensor Pack continuously monitors atmospheric pressure and compensates sensor outputs accordingly.

There is a single electrical connection on each Sensor Pack that comes wired to the Sensor Pack from the factory.

Sensor Packs need to be calibrated as specified in the submittal, to ensure the accuracy of the system.

Calibration shall be tool-less and can be performed by any qualified technician working in the building.

GATEWAY

The core of the AntrumX technology platform is the BTL Listed Gateway, a controller located in the Monitoring Panel that integrates the Sensor Pack, BMS, and the cloud.

The Gateway shall receive data from the Sensor Pack and simultaneously communicate to the BMS and the cloud.

AIR ACCELERATOR (AA)

The AA uses the airflow of the existing HVAC system to create a continuous vacuum between the duct probe / faceplate in each monitored environment and the Monitoring Panel.

The AA shall not be installed more than 50’ from the supply and exhaust ducts, and no more than 100’ from the Monitoring Panel. See Antrum installation guide for more information.

The AA shall continuously draw air samples from all monitored environments to the MUX (located in the Monitoring Panel) simultaneously.

Each set of AAs shall serve a single Sensor Pack.

In a critical environment the AA must be connected to both the supply and exhaust ducts, whereas non-critical environments only need a supply connection.

If the AA is connected to both the supply and exhaust, all air samples will be exhausted out of the building.

The AA shall have no moving parts.

DUCT PROBE OR FACEPLATE

The Duct Probe or Faceplate shall collect air samples from each monitored environment for them to be delivered to the Multiplexer located in the Monitoring Panel, via the Tubing, at which point the Sensor Pack determines which environment to sense.

TUBING

Any application sampling TVOCs or PM shall utilize ¼” conductive fluoropolymer tubing specifically designed for transporting air samples to be analyzed against a multitude of parameters, namely, gases and particles.

Other applications shall utilize ¼” poly tubing.

The Tubing shall not require any specialized tools for installation.

The length of Tubing between each monitored environment and the Monitoring Panel shall not exceed 300’.

* + - 1. SYSTEM SOFTWARE OVERVIEW
				1. The AQMS shall come from the manufacturer loaded with the necessary software for configuration, operation, and commissioning of the system specified herein. The AQMS shall be provided with the following as a minimum:

Environment mapping database.

Access to the AntrumEYE application.

* + - * 1. SYSTEM CONFIGURATION

During start-up and commissioning, flow through the vacuum line will need to be verified as well as validating zones are connected to the appropriate channels on the monitoring panel. See startup checklist for more information.

During start-up and commissioning, each Gateway will need to be discovered by the BMS so that all BACnet points can be communicated to the BMS. See BACnet cutsheet for more information.

* + - * 1. CLOUD-BASED USER INTERFACE

All monitored data shall be securely delivered to the cloud for a web-based user experience when the panel is connected to the internet.

antrumEYE, the application, shall be password protected and equipped with a company and user management module.

See antrumEYE cutsheet for more information.

* + - 1. SEQUENCE OF OPERATIONS
				1. *Critical Environment:* The AQMS will either send raw data or send a signal to be used to execute DCV to the BMS or LACS in response to the differential reading between a clean supply air reference and the greatest reading of sensed indoor contaminants selected above.

The LACS will control the airflow control valves in response to the greatest of three demands:

Temperature control

Fume hood demand

DCV command from the AQMS

The temperature controls and fume hood controls will operate independent of the AQMS and shall override the DCV signal when required to maintain comfort, space pressurization, and well-being. The AQMS shall provide a signal to be used for DCV that corresponds to the greatest contaminant concentration sensed through the duct probes and/or faceplates.

The sensed contaminants, as selected above, shall be measured against a clean supply air reference point that shares the same sensor pack and is representative of the air being supplied to the lab space. This methodology cancels sensor drift and provides a differential measurement that is ultimately converted into a DCV signal.

The signal to be used for DCV shall correspond to an Air Change per Hour (ACH) ventilation rate that is defined by the Laboratory Ventilation Management Plan (LVMP). The concentration trigger limit of each contaminant shall be determined by the LVMP. Although establishing the LVMP is not part of Antrum’s scope, Antrum, or the Antrum supplier, will participate in meetings or calls with the necessary parties as needed.

When GEX contaminant concentrations sensed by the AQMS are all below their low thresholds as defined in the LVMP, the DCV signal shall be 0.

When GEX contaminant concentrations sensed by the AQMS are all at or above their high thresholds as defined in the LVMP, the DCV signal shall be 100.

When GEX contaminant concentrations sensed by the AQMS are all between their low and high thresholds as defined in the LVMP, the signal shall be between 0 and 100, and shall represent the percentage of contamination, as defined by the thresholds, of the contaminant with the greatest percentage of contamination.

For example, using Table 1 below if the CO reading was 75ppm above the clean air reference then the percent contamination according to CO see equation 1:

75 – 25 / 200 – 25 = 0.285 = 29% Contaminated (Equation 1)

Additionally, if the TVOC (PID) reading was 0.4ppm above the clean air reference then the percent contamination according to TVOC (PID) see equation 2:

0.4 – 0.1 / 1 – 0.1 = 0.333 = 33% Contaminated (Equation 2)

Then the DCV signal would be 33 because the percentage of TVOC (PID) contamination was the greatest. The actual lab ACH shall be dynamic and equal to the higher of the temperature control demand, the fume hood exhaust demand and the DCV signal from the AQMS. Table 2 is to be completed by the customer.

Table 1: Suggested Contaminant Thresholds Table 2: Contaminant Thresholds

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 100 | % |  |  | 0 | 100 | % |
| CO | 25 | 200 | ppm |  | CO |  |  | ppm |
| CO2 | 400 | 3,000 | ppm |  | CO2 |  |  | ppm |
| CH2O | 0.5 | 2.0 | ppm |  | CH2O |  |  | ppm |
| NH3 | 25 | 50 | ppm |  | NH3 |  |  | ppm |
| PC2.5 | 5 | 15 | µg/m3 |  | PC2.5 |  |  | µg/m3 |
| TVOC1 | 0.3 | 3 | ppm |  | TVOC |  |  | ppm |
| TVOC (PID)1 | 0.1 | 1 | ppm |  | TVOC (PID) |  |  | ppm |

1calibrated to isobutylene

* + - * 1. Non-Critical Environment: The AQMS will send a signal to be used to execute DCV to the BMS in response to the differential reading between a clean supply air reference and the greatest reading of sensed indoor contaminants selected above.

The BMS will control the airflow control valves in response to the greatest of the below demands:

Temperature control

DCV command from the AQMS

The temperature controls will operate independent of the AQMS and shall override the DCV signal when required to maintain comfort, space pressurization, and well-being. The AQMS shall provide a signal to be used for DCV that corresponds to the greatest contaminant concentration sensed through the duct probes and/or faceplates.

The sensed contaminants, as selected above, shall be measured against a clean supply air reference point that shares the same sensor pack and is representative of the air being supplied to the space. This methodology cancels sensor drift and provides a differential measurement that is ultimately converted into a DCV signal.

The signal to be used for DCV shall correspond to a ventilation rate that is defined by the BMS. The concentration trigger limit of each contaminant shall be determined by the BMS. Although establishing the limit is not part of Antrum’s scope, Antrum, or the Antrum supplier, will participate in meetings or calls with the necessary parties as needed.

When zone contaminant concentrations sensed by the AQMS are all below their low thresholds as defined by the BMS, the DCV signal shall be 0.

When zone contaminant concentrations sensed by the AQMS are all at or above their high thresholds as defined by the BMS, the DCV signal shall be 100.

When zone contaminant concentrations sensed by the AQMS are all between their low and high thresholds as defined by the BMS, the signal shall be between 0 and 100, and shall represent the percentage of contamination, as defined by the thresholds, of the contaminant with the greatest percentage of contamination.

The actual zone ventilation rate shall be dynamic and equal to the higher of the temperature control demand, and the DCV signal from the AQMS. Table 3 below identifies typical high and low concentration thresholds. Although defined by the BMS, Table 4 is to be completed by the customer.

Table 3: Suggested Contaminant Thresholds Table 4: Contaminant Thresholds

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0 | 100 | % |  |  | 0 | 100 | % |
| CO | 25 | 200 | ppm |  | CO |  |  | ppm |
| CO2 | 400 | 3,000 | ppm |  | CO2 |  |  | ppm |
| CH2O | 0.5 | 2.0 | ppm |  | CH2O |  |  | ppm |
| NH3 | 25 | 50 | ppm |  | NH3 |  |  | ppm |
| PC2.5 | 5 | 15 | µg/m3 |  | PC2.5 |  |  | µg/m3 |
| TVOC1 | 0.3 | 3 | ppm |  | TVOC |  |  | ppm |
| TVOC (PID)1 | 0.1 | 1 | ppm |  | TVOC (PID) |  |  | ppm |

1calibrated to isobutylene

* + - 1. SUBMITTALS
				1. Submittals are prepared and distributed digitally to expedite the approval process.
				2. Operation and Maintenance (O&M) Manuals

O&M Manuals shall include detailed installation instructions for the specific installation containing at a minimum:

System overview

Hardware cut sheets and descriptions

Wiring diagrams

Networking architecture

* + - 1. WARRANTY
				1. Repair or replace any defective product, material, or workmanship for a period of 60-months following date of shipment, except the Sensor Pack.

Sensor Packs require calibration per the submittal.

Each Sensor Pack, both on initial install and calibration/replacement, comes with a warranty equal to the calibration frequency.

* + - 1. ANTRUMEYE
				1. Included in AntrumEYE.

Ventilation dashboard

Smart analytics

Export sensor data

Room-level IAQ visibility

EXECUTION

* + - 1. EXAMINATION
				1. Examine for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
				2. Examine roughing-in for equipment to verify actual locations of connections before installation.
				3. Examine roughing-in for equipment installed in duct systems to verify actual locations of connections before installation.
				4. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
				5. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. INSTALLATION, GENERAL
				1. Install products level, plumb, parallel, and perpendicular with building construction.
				2. Support instruments, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <Insert value> force.
				3. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
				4. Install all equipment in accordance with the manufacturers' most current version of the installation guide. Should there be conflicting information between this document and the installation guide, the most stringent requirement shall apply.
				5. AQMS Monitoring Panel shall be mounted directly to the wall and provided with a minimum of 3’ of clearance with the ability for the Monitoring Panel door to open at least 90$°$ from its closed position. If wall-mounting is not possible, the Monitoring Panel shall be mounted on a steel Unistrut frame securely fastened to the floor, or approved equal.
				6. The Monitoring Panel shall be installed at a maximum height, floor to top of panel, of 6’6”.
				7. Verify mechanical and control systems are complete and able to safely operate prior to starting-up AQMS.

A continuity test on the AQMS shall be performed verifying that each tube is labelled and terminated correctly.

An airflow test shall be performed verifying that there is enough flow through all vacuum lines and ¼” tubes.

* + - 1. ELECTRIC POWER
				1. Furnish and install electrical power to products requiring electrical connections.
				2. Furnish and install power wiring. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
				3. Furnish and install raceways. Comply with requirements in Section 26 0533 "Raceways and Boxes for Electrical Systems."
			2. MAINTENANCE SERVICE
				1. <INSERT LANGUAGE IF SELLING A MAINTENANCE CONTRACT>.
			3. DEMONSTRATION
				1. [Engage a factory-authorized service representative to train]
				2. Coordinate with factory authorized representative for videos, operation and maintenance manuals and instruction for use by Owner in operating, maintaining, and troubleshooting.
			4. ACCEPTANCE
				1. Upon completion of the installation, the AQMSC shall initiate the start- up process for the Antrum system and perform all necessary calibration, testing, and debugging operations including, but not limited to, the leak-down test. An acceptance test by the AQMSC in the presence of the design engineer, job site project manager, and owner’s representative shall be scheduled with at least 10 working days advance notice.
				2. After electrical circuitry has been energized, start units to confirm proper unit operation.
				3. Demonstrate compliance with specifications, including functionality of could-based website, mobile application, and BMS integration.
				4. The acceptance test shall include, but not be limited to:

The AQMSC shall verify each Gateway is online and communicating to the BMS (if applicable) and the Antrum cloud.

The AQMSC shall verify that the specified sampled data is displayed on the cloud-based website and mobile application.

When the field test procedures have been successfully demonstrated to the design engineer, job site project manager, or owner’s representative, and the system performance is determined to meet specifications, the system is deemed accepted.

END OF SECTION 23 0944

**APPENDIX A**

BACNET INTEGRATION

AQMS NETWORK INTEGRATION

The building will be equipped with an AQMS as detailed in these specifications. The purpose of the system is to analyze specific parameters of the laboratory environment and to provide data to the BMS. As a result of this analysis, the AQMS will provide the BMS with the necessary data to facilitate changes in operational parameters, most significantly ventilation rates. The AQMS is a continuous monitoring solution and therefore also provides feedback of how the indoor environment responds as a result of the data provided to the BMS.

The BAS contractor shall be responsible for integrating the AQMS with the BMS via BACnet MSTP/IP.

The BAS contractor shall be responsible for:

Executing Antrum’s most recent BACnet integration procedure

Providing a unique BACnet Device Object Instance Number and static IP address (if applicable) by registering the AQMS with the BAS so it is a recognized component in the BMS.

Creating the necessary BACnet Objects in the BAS’ database which allow for the mapping of the AQMS signals for the purposes of control or so the data may be displayed on the front end.

Exposing the necessary BACnet Objects’ present value and reliability properties over the network to allow the AQMS to read the necessary values using the BACnet Client Service.

If applicable, writing the present value for all requested points by the AQMSC to the BACnet Objects created in the AQMS and exposed over the BACnet network. After creating the project file, the AQMSC shall furnish an exported ‘points list’ to the BAS.

Implementing the necessary control sequences based on the values from the AQMS. The BAS shall also be responsible for prioritizing signals from the AQMS.

Providing qualified on-site staff during start-up of the AQMS to ensure that communication is functional, data values are received from, and transmitted to the AQMS, and BAS control sequences are implemented properly and effectively.

Reading the values of the AQMS as inputs to the BAS to determine values such as minimum outside air levels, overall ventilation rates, humidity levels, and others as indicated in the specification or on the drawings.