t 847.516.0992
f 312.440.2303
www.baileyedward.com

104 Northwest Hwy
Fox River Grove, IL
60021-1017

June 2, 2021

Chris Kornsey
Illinois Math and Science Academy
1500 Sullivan Road
Aurora, IL 60506

Re: Indoor Air Quality Report

Chris,
Bailey Edward was tasked to engage a qualified testing company to evaluate the air quality in the main building and in the residence halls and review the results of their findings.

We hired Aero Building Solutions to provide this testing based on previous experience with them and their current experience and certifications with testing for other companies and school districts in the same situation. Their reports are attached.

Aero took test readings at 44 locations (in coordination with BE and IMSA), comprising of 4 locations in each residence hall and 16 locations in the main building of different occupancies and functions. At each test location, Aero tested the Temperature/Humidity, Carbon Dioxide level (CO2), Carbon Monoxide level (CO), Particles/Particulate Matter; Ozone (O3) and Volatile Organic Compounds (VOC).

The test readings at all locations meet or exceed standards/levels established by LEED (Leadership in Energy and Environmental Design) and ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers).

Aero took air flow readings at 13 locations (in coordination with BE and IMSA), comprising of 4 locations in each residence hall and 9 locations in the main building of different occupancies and functions. At each test location, Aero tested the air quantity delivered to the individual spaces from the central air distribution system.
The following are the air changes per hour (ACH) for the rooms measured.
A119 – 6.9 ACH; A136 – 14.1 ACH; AC Pit – 3.8 ACH; B105A – 9.7 ACH; B115 – 5.7 ACH; C137 – 10.8 ACH; Gym – 8.6 ACH; Café – 10.5 ACH.
The average ACH for the residence halls was 3.4 ACH given the fact that all the corridors and common areas are open to each other.

The test readings at all locations meet or exceed standards/load requirements established by ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) except for one. There are four VAV boxes providing air to this area. The AC Pit ACH is low due to a VAV box not working and delivering no air. Once this box is fixed, in the current CDB HVAC project, the additional air flow will drive the ACH over the standards/design requirements.

All the rooftop unit air handling units serving the facility (44 total) have economizers and MERV 13 filtration. These are the two levels of protection relating to indoor air quality – proper outside air and filtration. The economizers use the outside air to cool the spaces when the outside air conditions are at the correct temperature to provide “free cooling”. When the outside air temperatures are too warm, the economizer provides the required minimum outside air per ASHRAE standards. The air filters have the

t 847.516.0992
f 312.440.2303
www.baileyedward.com

104 Northwest Hwy
Fox River Grove, IL
60021-1017

appropriate levels of filtration and additional filtration is not needed nor required. The CDC follows these standards established by ASHRAE – Make sure units are operating correctly, maximize the outside air to the spaces and provide adequate filtration.

At this time, no additional work is needed to be compliant with quality standards other than the repair of the VAV box.

The current project under construction includes testing of all HVAC units and duct systems to verify the air flow rates and air handling unit conditions. Once the test results are received, appropriate actions could be made to resolve any deficiencies.
The testing included in this report is just a sample of the current conditions.

If you have any questions regarding the above or attached report, please do not hesitate to call.

Sincerely,
Bailey Edward

Kent Locke
Associate Principal

Air Survey Report

IMSA

Illinois Mathematics and Science Academy

Prepared By:

Brian Benson

Aero Building Solutions

Illinois Mathematics and Science Academy

1500 Sullivan Road

Aurora, IL 60506

5/21/2021

Contents

Executive Summary

Aero Building Solutions was contracted by IMSA to perform an air survey to determine the airflow for various spaces throughout the facility. During our time on site, we surveyed 19 separate areas of various use cases and found all but one had proper airflow and ventilation per system design and good practice. VAV-A63 serving the AC PIT area was found to have no airflow at the time of the survey. This use should be investigated and repairs made.

Air Test Reports

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: A119-Supply/VAV-A32

Air Test Data	
Primary Max Actual CFM	1609 CFM

A119-Supply/VAV-A32 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	A119		Hood	NA	NA	Hood	277
Outlet-02	A119		Hood	NA	NA	Hood	83
Outlet-03	A119		Hood	NA	NA	Hood	268
Outlet-04	A119		Hood	NA	NA	Hood	320
Outlet-05	A119		Hood	NA	NA	Hood	367
Outlet-06	A119		Hood	NA	NA	Hood	294
Totals:	-	-	-	-	**0**	-	**1609**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: A136-Supply/VAV-A65

Air Test Data	
Primary Max Actual CFM	665 CFM

A136-Supply/VAV-A65 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	A136		Hood	NA	NA	Hood	177
Outlet-02	A136		Hood	NA	NA	Hood	89
Outlet-03	A136A		Hood	NA	NA	Hood	147
Outlet-04	A136B		Hood	NA	NA	Hood	124
Outlet-05	A136C		Hood	NA	NA	Hood	128
Totals:	-	-	-	-	**0**	-	**665**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: AC Pit-Supply/VAV-A58

Air Test Data	
Primary Max Actual CFM	193 CFM

AC Pit-Supply/VAV-A58 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	AC PIT		Hood	NA	NA	Hood	0
Outlet-02	AC PIT		Hood	NA	NA	Hood	193
Totals:	-	-	-	-	**0**	-	**193**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: AC Pit-Supply/VAV-A59

Air Test Data	
Primary Max Actual CFM	437 CFM

AC Pit-Supply/VAV-A59 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	AC PIT		Hood	NA	NA	Hood	115
Outlet-02	AC PIT		Hood	NA	NA	Hood	90
Outlet-03	AC PIT		Hood	NA	NA	Hood	129
Outlet-04	AC PIT		Hood	NA	NA	Hood	103
Totals:	-	-	-	-	**0**	-	**437**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: AC Pit-Supply/VAV-A62

Air Test Data	
Primary Max Actual CFM	640 CFM

AC Pit-Supply/VAV-A62 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	AC PIT		Hood	NA	NA	Hood	143
Outlet-02	AC PIT		Hood	NA	NA	Hood	143
Outlet-03	AC PIT		Hood	NA	NA	Hood	154
Outlet-04	AC PIT		Hood	NA	NA	Hood	154
Outlet-05	AC PIT		Hood	NA	NA	Hood	46
Totals:	-	-	-	-	**0**	-	**640**

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: AC Pit-Supply/VAV-A63

Air Test Data	
Primary Max Actual CFM	0 CFM

AC Pit-Supply/VAV-A63 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	AC PIT		Hood	NA	NA	Hood	0
Outlet-02	AC PIT		Hood	NA	NA	Hood	0
Totals:	-	-	-	-	**0**	-	**0**

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: B105A-Supply/VAV-B46

Air Test Data	
Primary Max Actual CFM	403 CFM

B105A-Supply/VAV-B46 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	B105A		Hood	NA	NA	Hood	143
Outlet-02	B105A		Hood	NA	NA	Hood	128
Outlet-03	B105A		Hood	NA	NA	Hood	132
Totals:	-	-	-	-	**0**	-	**403**

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: B115-Supply/VAV-B43

Air Test Data	
Primary Max Actual CFM	901 CFM

B115-Supply/VAV-B43 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	B115		Hood	NA	NA	Hood	197
Outlet-02	B115		Hood	NA	NA	Hood	212
Outlet-03	B115		Hood	NA	NA	Hood	217
Outlet-04	B115		Hood	NA	NA	Hood	275
Totals:	-	-	-	-	**0**	-	**901**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: C137-Supply/VAV-C11

Air Test Data	
Primary Max Actual CFM	684 CFM

C137-Supply/VAV-C11 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	C137		Hood	NA	NA	Hood	88
Outlet-02	C137		Hood	NA	NA	Hood	214
Outlet-03	C137		Hood	NA	NA	Hood	198
Outlet-04	C137		Hood	NA	NA	Hood	184
Totals:	-	-	-	-	**0**	-	**684**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: Dorm Bldg 15-01 B Wing

Unit Nameplate Information	
Location	Dorm Bldg 15-01 B Wing

Dorm Bldg 15-01 B Wing GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	1st Floor Corridor		Hood	NA	NA	Hood	92
Outlet-02	Commons		Hood	NA	NA	Hood	185
Outlet-03	Commons		Hood	NA	NA	Hood	521
Outlet-04	Commons		Hood	NA	NA	Hood	539
Outlet-05	Kitchen		Hood	NA	NA	Hood	135
Outlet-06	1st Floor Corridor		Hood	NA	NA	Hood	127
Outlet-07	2nd Floor Corridor		Hood	NA	NA	Hood	206
Outlet-08	2nd Floor Corridor		Hood	NA	NA	Hood	203
Outlet-09	2nd Floor Corridor		Hood	NA	NA	Hood	115
Totals:	-	-	-	-	**0**	-	**2123**

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: 15-01 Dorm Rm B11

Unit Nameplate Information	
Location	15-01 Dorm Rm B11

15-01 Dorm Rm B11 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	Dorm RM B11		Hood	NA	NA	Hood	320
Totals:	-	-	-	-	**0**	-	**320**

15-01 Dorm Rm B11 GRD - Exhaust Inlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Inlet-01	Dorm RM B11 Washroom		Hood	NA	NA	Hood	136
Totals:	-	-	-	-	**0**	-	**136**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: Dorm Bldg 15-06 B Wing

Unit Nameplate Information	
Location	Dorm Bldg 15-06 B Wing

Dorm Bldg 15-06 B Wing GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	1st Floor Corridor		Hood	NA	NA	Hood	116
Outlet-02	Commons		Hood	NA	NA	Hood	555
Outlet-03	Commons		Hood	NA	NA	Hood	133
Outlet-04	Commons		Hood	NA	NA	Hood	553
Outlet-05	Kitchen		Hood	NA	NA	Hood	208
Outlet-06	1st Floor Corridor		Hood	NA	NA	Hood	163
Outlet-07	2nd Floor Corridor		Hood	NA	NA	Hood	170
Outlet-08	2nd Floor Corridor		Hood	NA	NA	Hood	159
Outlet-09	2nd Floor Corridor		Hood	NA	NA	Hood	195
Totals:	-	-	-	-	**0**	-	**2252**

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: 15-06 Dorm Rm B11

Unit Nameplate Information	
Location	15-06 Dorm Rm B11

15-06 Dorm Rm B11 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	Dorm RM B11		Hood	NA	NA	Hood	363
Totals:	-	-	-	-	**0**	-	**363**

15-06 Dorm Rm B11 GRD - Exhaust Inlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Inlet-01	Dorm RM B11 Washroom		Hood	NA	NA	Hood	91
Totals:	-	-	-	-	**0**	-	**91**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: Gym G-2

Unit Nameplate Information	
Location	Gym G-2

Gym G-2 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	Gym	28x14	2.13	NA	NA	810	1725
Outlet-02	Gym	28x14	2.13	NA	NA	875	1864
Outlet-03	Gym	36x14	2.76	NA	NA	859	2371
Outlet-04	Gym	36x14	2.76	NA	NA	941	2597
Outlet-05	Gym	36x14	2.76	NA	NA	1020	2815
Outlet-06	Gym	36x14	2.76	NA	NA	998	2754
Outlet-07	Gym	36x14	2.76	NA	NA	997	2752
Outlet-08	Gym	36x14	2.76	NA	NA	432	1192
Totals:	-	-	-	-	**0**	-	**18070**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

SYSTEM/UNIT: Gym F-2

Unit Nameplate Information	
Location	Gym F-2

Gym F-2 GRD - Supply Outlet Summary

System/Unit	Area Served	Size	AK Factor	Design Velocity	Design CFM	Final Velocity	Final CFM
Outlet-01	Gym	28x14	2.13	NA	NA	960	2045
Outlet-02	Gym	28x14	2.13	NA	NA	694	1478
Outlet-03	Gym	36x14	2.76	NA	NA	847	2338
Outlet-04	Gym	36x14	2.76	NA	NA	924	2550
Outlet-05	Gym	36x14	2.76	NA	NA	527	1455
Outlet-06	Gym	36x14	2.76	NA	NA	1127	3111
Outlet-07	Gym	36x14	2.76	NA	NA	1156	3191
Outlet-08	Gym	36x14	2.76	NA	NA	583	1609
Totals:	-	-	-	-	**0**	-	**17777**

Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

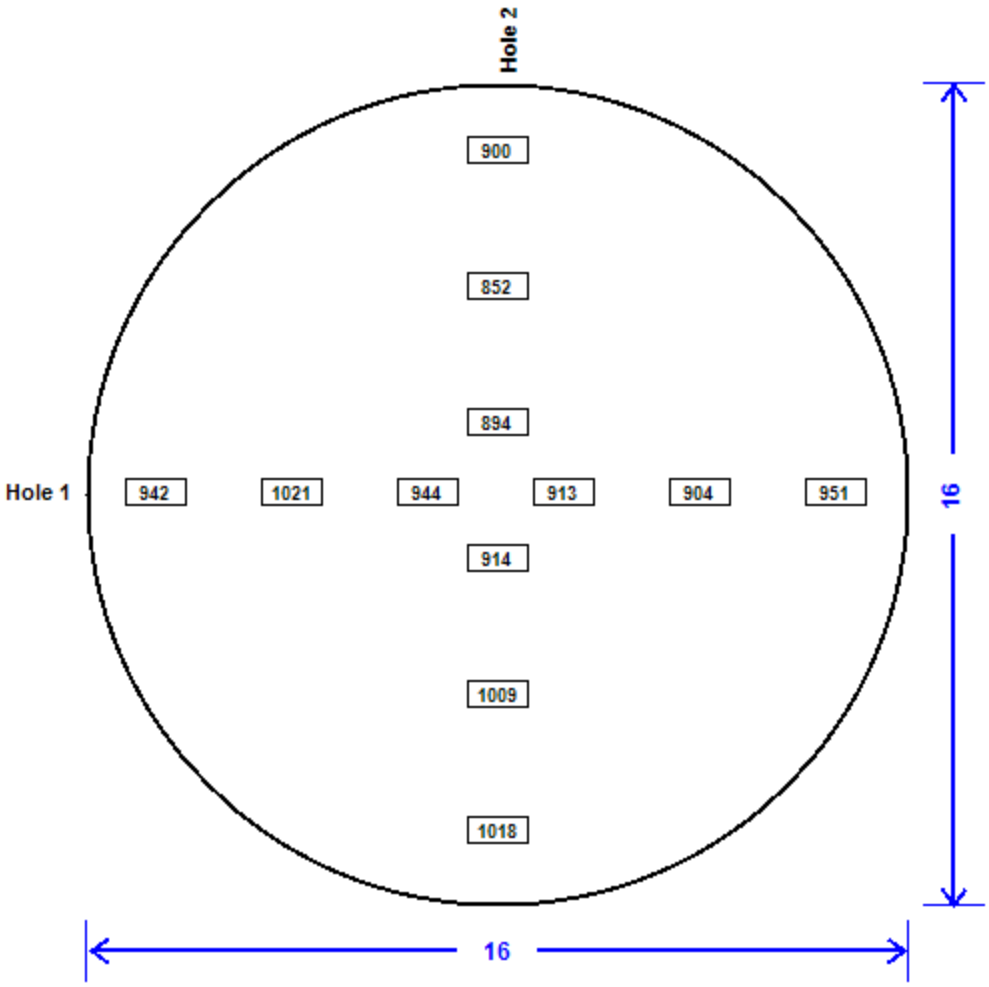
SYSTEM/UNIT: Dorm Bldg 15-06 Main Commons/15-06 Main Commons-01

Unit Nameplate Information	
System	N/A
Area Served	Bldg 15-06 Main Commons
Condition of Test	100% Return Air/Minimum OA
Location of Test	Main Commons
Point of Traverse	Discharge of Fan
Type of Instrument	Shortridge/Pitot

Final Test Data	
Average Reading	938.50 FPM
Operating Hz	60 Hz
Center Line Static Pressure	.03 in.
Actual Total Flow	1314 CFM

Traverse Summary	
Type of Traverse	Round
Outer Width	0 in.
Outer Height	0 in.
Diameter	16 in.
Insulation Width	0 in.
Free Area	1.40 sq. ft.
Number Of Rows	2
Readings Per Row	6
Total Readings	12
Sum of Readings	11262

Traverse Data Points



Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

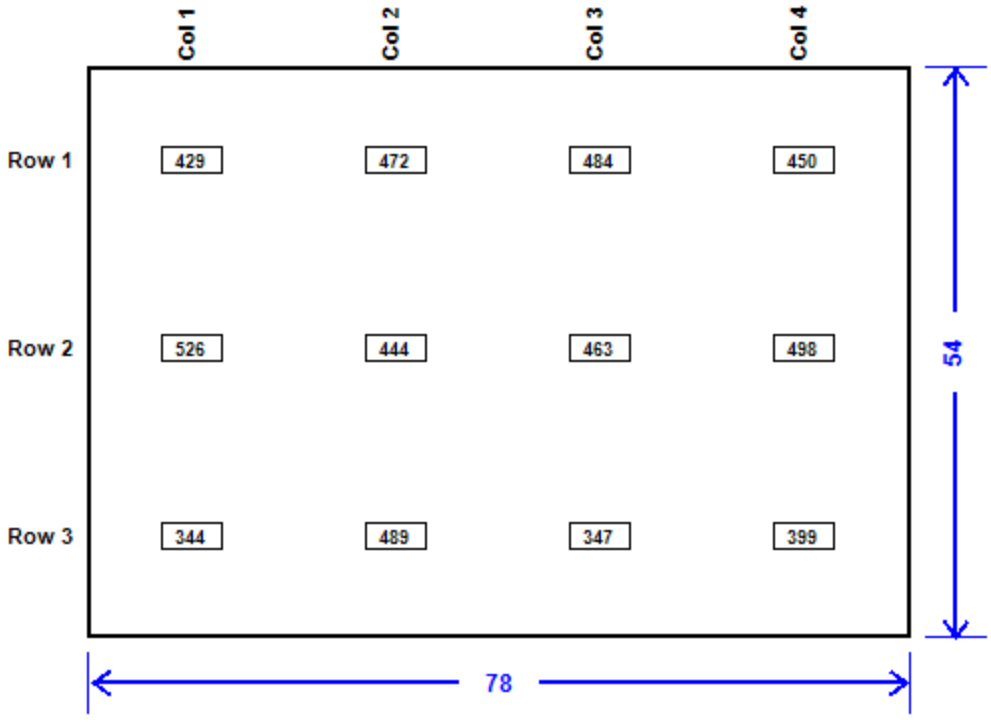
SYSTEM/UNIT: Auditorium D-3/Coil Section D-3

Unit Nameplate Information	
System	D-3
Area Served	Auditorium
Condition of Test	100% Outside Air
Location of Test	Roof
Point of Traverse	Suction of Fan
Type of Instrument	Shortridge/Velgrid

Final Test Data	
Average Reading	445.42 FPM
Operating Hz	N/A Hz
Center Line Static Pressure	N/A in.
Design Total Flow	N/A CFM
Actual Total Flow	13028 CFM
Final Deviation	N/A %
AFMS Reading	N/A CFM
AFMS Calibration Factor	N/A

Traverse Summary	
Type of Traverse	Rectangular
Outer Width	78 in.
Outer Height	54 in.
Diameter	0 in.
Insulation Width	0 in.
Free Area	29.25 sq. ft.
Number Of Rows	3
Readings Per Row	4
Total Readings	12
Sum of Readings	5345

Traverse Data Points



Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

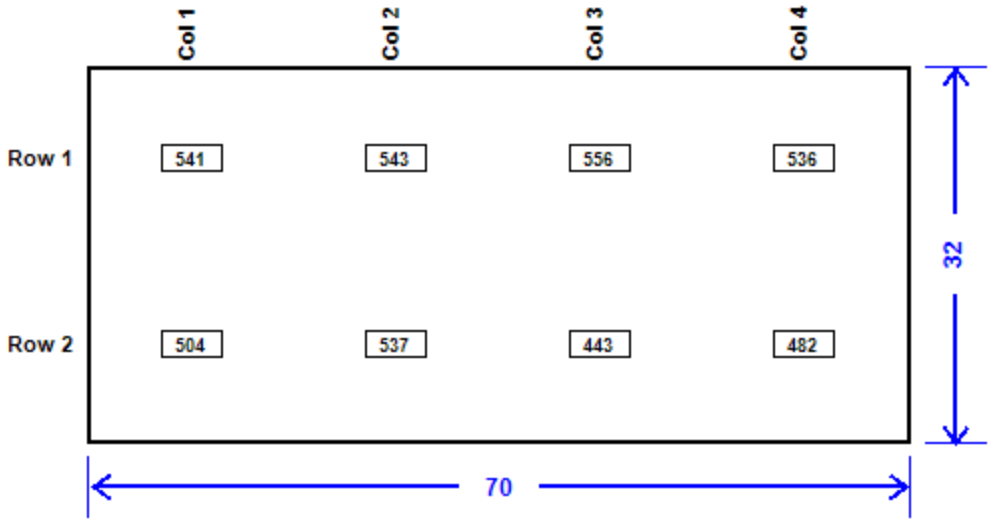
SYSTEM/UNIT: Cafe B-1/Coil Section B-1

Unit Nameplate Information	
System	B-9
Area Served	Cafeteria
Condition of Test	100% Outside Air
Location of Test	Roof
Point of Traverse	Suction of Fan
Type of Instrument	Shortridge/Velgrid

Final Test Data	
Average Reading	517.75 FPM
Operating Hz	N/A Hz
Center Line Static Pressure	N/A in.
Design Total Flow	N/A CFM
Actual Total Flow	8056 CFM
Final Deviation	N/A %
AFMS Reading	N/A CFM
AFMS Calibration Factor	N/A

Traverse Summary	
Type of Traverse	Rectangular
Outer Width	70 in.
Outer Height	32 in.
Diameter	0 in.
Insulation Width	0 in.
Free Area	15.56 sq. ft.
Number Of Rows	2
Readings Per Row	4
Total Readings	8
Sum of Readings	4142

Traverse Data Points



Air Handling Unit

PROJECT: IMSA
LOCATION: Auroroa, IL
PROJECT #: 11615

DATE: 5/24/2021
CONTACT: Mike Skraba

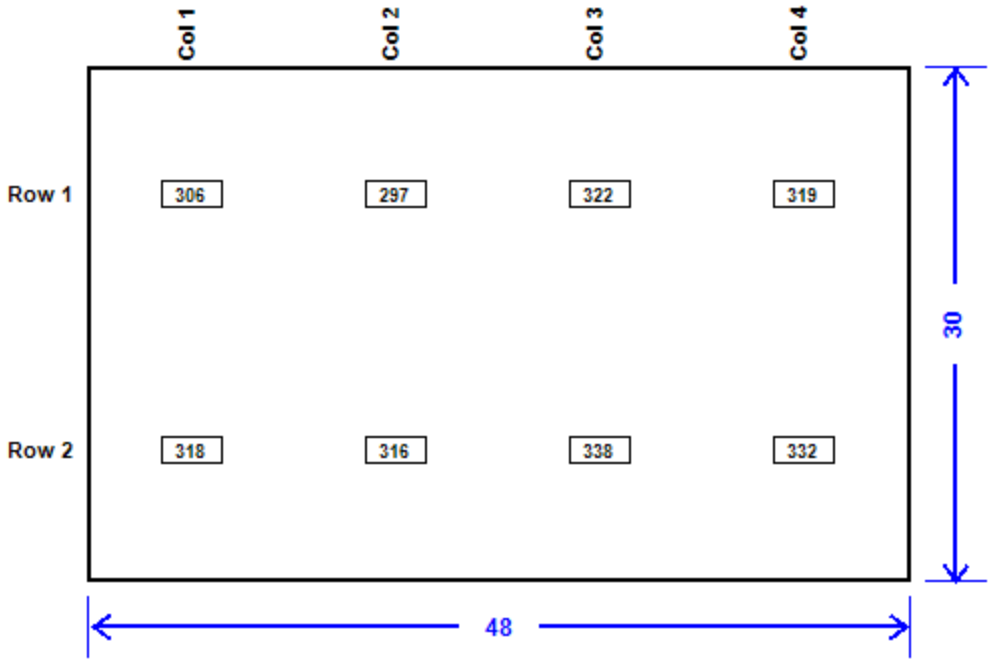
SYSTEM/UNIT: Cafe B-9/Coil Section B-9

Unit Nameplate Information	
System	B-9
Area Served	Cafeteria
Condition of Test	100% Outside Air
Location of Test	Roof
Point of Traverse	Suction of Fan
Type of Instrument	Shortridge/Velgrid

Final Test Data	
Average Reading	318.50 FPM
Operating Hz	N/A Hz
Center Line Static Pressure	N/A in.
Design Total Flow	N/A CFM
Actual Total Flow	3185 CFM
Final Deviation	N/A %
AFMS Reading	N/A CFM
AFMS Calibration Factor	N/A

Traverse Summary	
Type of Traverse	Rectangular
Outer Width	48 in.
Outer Height	30 in.
Diameter	0 in.
Insulation Width	0 in.
Free Area	10.00 sq. ft.
Number Of Rows	2
Readings Per Row	4
Total Readings	8
Sum of Readings	2548

Traverse Data Points



Indoor Air Quality Report

Illinois Mathematics and Science Academy

Prepared By:

Kevin Keating

Aero Building Solutions

Kevin.Keating@aerobuild.com

Illinois Mathematics and Science Academy

1500 Sullivan Road

Aurora, IL 60506

6/3/2021

Contents

Executive Summary

Aero Building Solutions was contracted by IMSA to perform Indoor Air Quality tests for total volatile organic compounds, particles, carbon monoxide, ozone, ion levels, and interior carbon dioxide levels at 44 locations, comprising of 4 locations in each residence hall and 16 locations in the main building of different occupancies and functions. Only two points were found to be above the thresholds set by ASHRAE 62.1 & 62.2 / LEED. All other points that were tested were found to be below the thresholds set by ASHRAE 62.1 & 62.2 / LEED. Even though two spaces were above the limits set by LEED/ASHRAE 62.1 & 62.2 there is no concern in any of the spaces as they are still below thresholds which could prove harmful for occupants. The following provides a brief summary of the IAQ metrics evaluated and a description of methods, testing locations and results.

Both locations that had high values were retested on 6/2/21 after corrective measures were taken within the spaces. The measures taken in A157 removed all shower curtains from the offices and the measure in the residence hall involved cleaning the coil on the unit serving the space. The new round of testing showed the spaces are all now compliant with LEED/ASHRAE 62.1 & 62.2.

Aero is both a TABB and NEBB certified company.

“TABB is your assurance that HVAC systems operate at the highest standards of energy efficiency, ventilation effectiveness, indoor air quality and comfort in a healthy and green indoor environment.” - TABBcertified.org.

“There are more than 700 NEBB Certified Firms worldwide and over 1,000 NEBB Certified Professionals and Certified Technicians. These firms and their personnel are recognized as highly skilled specialists who are able to measure the efficiency of building systems and provide customized solutions for business owners. NEBB certification is tangible proof of their qualification to perform their work in accordance with NEBB Procedural Standards.” - NEBB.org

General Information

Temperature (°F) and Relative Humidity (%)
Thermal comfort in any building is dependent on several factors including: clothing insulation, air temperature, radiant temperature, air speed, humidity, and even individual metabolic rates. One of the major purposes of HVAC systems is to supply air to the occupied areas of a building at what is generally accepted as the most comfortable range of temperature and relative humidity. Given the number of personal factors involved in individual comfort, this is at least part of the reason why thermal comfort is one of the top complaints in IAQ and why ASHRAE defines thermal comfort as satisfaction for at least 80% of building users.

In Standard 55-2004 “Thermal Environmental Conditions for Human Occupancy,” ASHRAE recommends seasonal comfort temperature ranges of approximately 68 to 75°F for winter and 73 to 79°F for summer. Acceptable relative humidity is considered less than 65% for indoor air. Currently, no minimum humidity threshold is offered.

Humidity conditions play an important factor in thermal comfort. ASHRAE maintains a maximum humidity condition at 65% as conditions above this point reduce occupant satisfaction. In addition, at this level the moisture in the air is so great that the probability of condensation increases as cooler indoor surfaces reach below the dew point of the air. Condensation can lead to mold and the proliferation of dust mites.

Carbon Dioxide (CO_2)
Carbon dioxide is a natural component of air. When indoor concentrations are elevated (in reference to outside air), it is typically due to building occupants. People exhale carbon dioxide, and without adequate ventilation to dilute and remove carbon dioxide, it can accumulate to levels which may adversely impact occupants’ wellness and comfort.

As modern buildings have become more “tight” in an attempt to minimize energy use, reliance on the building’s mechanical ventilation delivery systems to effectively ventilate the building with outdoor air has become vital. At the same time, building owners and property managers seek to maximize their occupancy levels. The result is the increasing potential for contaminants to accumulate in the building, raising health concerns. When properly used, carbon dioxide is one tool that can be used to measure the impact of these pollutant sources, and find the balance between energy-efficient outdoor air delivery and pollutant control.

Using basic assumptions about occupancy and activity levels, carbon dioxide concentrations maintained at less than 700 ppm above outdoor levels are expected to meet the satisfaction criteria. It is this guideline that Healthy Buildings uses to judge the threshold of comfort. With typical outdoor carbon dioxide levels ranging from 360 – 460 ppm, indoor carbon dioxide concentrations exceeding approximately 1,100 ppm signify possible ventilation deficiencies or overcrowding issues, with an increasing potential for odor complaints and/or IAQ-related concerns.

Carbon Monoxide (CO)
Carbon monoxide (CO) is a colorless, odorless gas that is produced by the incomplete combustion of carbon-containing fuels. Oil, gasoline, diesel fuels, wood, coke and coal are the main sources with small amounts produced by burning cigarettes. Spaces that typically have higher amounts of carbon monoxide are indoor garages, boiler rooms, and other similar mechanical spaces.

The symptoms of carbon monoxide exposure include headaches, drowsiness, nausea, upper respiratory complaints, chest pain, impaired judgment, and death from asphyxiation. As a result, Healthy Buildings adopts the most conservative guidelines of 9 ppm for indoor environments. In the case of motor vehicle garages, because there are inevitably more sources of carbon monoxide from the exhausts, we suggest the adoption of 25 ppm as an acceptable guideline. This value is the one specified by the International Code Council (ICC) International Building Code 2003, as the action level for automatic fan controllers triggered by carbon monoxide detectors.

Particles (PM2.5 and PM10)
Particulate matter (also referred to as PM or particle pollution) is a complex mixture of solid and/or liquid particles suspended in air. These particles can vary in size, shape and composition, these sizes are typically written as PM2.5, and PM10 which translates to dust particles that are 2.5 micrometers and 10 micrometers respectively. EPA is especially concerned about particles that are 10 micrometers in diameter or smaller because these particles are inhalable. Once inhaled, particles can affect the heart and lungs and in some cases cause serious health effects.

The levels of airborne particle contamination inside a building depend on several factors. The outdoor air that is brought into the building contains variable amounts of fine dusts due to weather changes, prevailing winds, activities from adjacent buildings, construction sites, smoke stacks or chimneys, traffic density, season of year, etc. The types of filtration used in the building, humidification, the condition of the supply ducts and quantity of recirculated air. Finally, the number of people, housekeeping practices, and the wide range of human activities that can affect airborne dust levels.

Ozone (O_3)
Ozone is a gas composed of three atoms of oxygen (O_3). Ozone occurs both in the Earth's upper atmosphere and at ground level. Ozone can be good or bad, depending on where it is found.

Ozone in the air we breathe can harm our health. People most at risk from breathing air containing ozone include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk from ozone exposure.

Breathing elevated concentrations of ozone can trigger a variety of responses, such as chest pain, coughing, throat irritation, and airway inflammation. It also can reduce lung function and harm lung tissue. Ozone can worsen bronchitis, emphysema, and asthma, leading to increased medical care.

Volatile Organic Compounds (VOC)

Volatile organic compounds are chemical compounds that may be found in all-natural or synthetic materials, and can exist in liquids, solids and vapors. Consideration of VOC levels is important when analyzing elements of building operations and material selection that could impact occupancy wellness. The extent and nature of the health effects from VOCs depends on many factors, including type of VOC, levels of exposure and length of time exposed.

In commercial buildings, it is not uncommon to find VOC levels two to ten times higher than outdoor levels as there are multiple sources of these compounds in buildings, especially following major renovations. VOCs originate from hundreds of different sources and literally thousands of different chemicals are involved.

Healthy Buildings has adopted a value of 500 µg/m3 (equivalent to approximately 0.3 ppm) for TVOC concentrations as our recommended guideline (upper limit) for a healthy commercial building. Evidence suggests that concentrations below this value can be considered “background levels” and at such low concentrations, they are extremely unlikely to cause any occupant discomfort. This is considered to be the “comfort” range.

Locations

Locations were decided by the building at locations they felt were highly occupied where air quality was most important. A total of 43 locations of different room types were tested, the list of rooms and the current state of each space are as follows:

- Auditorium
  - Space typically will have a large amount of occupants during normal occupied hours. During the time of air quality testing the space remained unoccupied and the space was not in use by anyone for the entirety of the day.
- Innovation Center
  - Space typically will have a large amount of occupants during normal occupied hours. During the time of air quality testing the space remained unoccupied and the space was not in use by anyone for the entirety of the day.
- A119
  - Space typically will have a large amount of occupants during normal occupied hours. During the time of air quality testing the space remained unoccupied and the space was not in use by anyone for the entirety of the day.
- A157
  - Space typically will have a large amount of occupants during normal occupied hours. During the time of air quality testing the space remained unoccupied and the space was not in use by anyone for the entirety of the day.
- A136
  - Space is typically occupied by one to two people consistently with various amounts of visitors throughout most days. During the time of air quality testing the space remained unoccupied with HVAC equipment running normally as if the space was occupied.
- A136 (Post HEPA Filter)
  - Space A136 was tested a second time after a HEPA filter was used in the space for a period of 24 hours.
- Academic Pit
  - Space typically will have a large amount of occupants during normal occupied hours. During the time of air quality testing the space remained unoccupied and the space was not in use by anyone for the entirety of the day.
- B105A
  - Space is typically occupied by one to two people consistently with various amounts of visitors throughout most days. During the time of air quality testing the space remained unoccupied with HVAC equipment running normally as if the space was occupied.
- Outside C137
  - Space has a varying occupancy from very few to a large amount of occupants depending on time of day due to being a hallway. During the time of air quality testing the space remained unoccupied with HVAC equipment running normally as if the space was occupied.
- Math Study
  - Space has a varying occupancy from very few to a large amount of occupants depending on events. During the time of air quality testing the space remained unoccupied with HVAC equipment running normally as if the space was occupied

- Outside A113
    - Space has a varying occupancy from very few to a large amount of occupants depending on time of day due to being a hallway. During the time of air quality testing the space remained unoccupied with HVAC equipment running normally as if the space was occupied.
- Nurse's Office
    - Space is typically occupied by one to two people consistently with various amounts of visitors throughout most days. During the time of air quality testing the space remained unoccupied with HVAC equipment running normally as if the space was occupied.
- B154
    - Space has a varying occupancy from very few to a large amount of occupants depending on events. During the time of air quality testing the space remained unoccupied with HVAC equipment running normally as if the space was occupied.
- Science Atrium
    - Space typically will have a large amount of occupants during normal occupied hours. During the time of air quality testing the space remained unoccupied and the space was not in use by anyone for the entirety of the day.
- Cafeteria
    - Space typically will have a large amount of occupants during normal occupied hours. During the time of air quality testing the space remained unoccupied and the space was not in use by anyone for the entirety of the day.
- Residence Halls
    - Space typically will have a large amount of occupants during normal occupied hours. Residence Halls are split into (4) separate wings and testing was performed in each wing on either the upper or lower floor. During the time of air quality testing the space remained mostly unoccupied and the space was not in use by anyone for the entirety of the day.

Results Summary

Below are the results of the indoor air quality measurements performed on 5/13/21 through 5/20/21. There are no concerns for any of the spaces. Only two spaces that were tested had values that were higher than what is recommended while all other spaces had all aspects of the test were well below the limits and recommendations set by ASHRAE 62.1 & 62.2 and LEED. The spaces that tested high were retested on 6/2/21 and their results can also be found below.

Room A157 in the main building had high TVOCs and this may be caused due to a large amount of vinyl shower curtains that are in the room to separate spaces. This type of material may contain a sizeable amount of VOCs that are potentially dangerous if exposed to for extended periods of time. The amount of TVOCs that were found within the space though are not dangerous levels, even though they are above the levels set by LEED/ASHRAE. The building is currently bringing in a large amount of outside air which adequately ventilates the space, it is recommended to remove the shower curtains to lower the TVOC count within the space.

The C Wing in Residence Hall 1505 had high PM10 particle counts but it was unclear what may have been causing these levels. PTAC units were being replaced in the residence hall around the time of testing so that may be the cause for the higher dust levels due to a large amount of foot traffic. The building is currently bringing in a large amount of outside air which adequately ventilates the space and utilizing MERV 13 filters to condition the space. All other sections of the residence hall were well below the limits set by LEED/ASHRAE 62.1 & 62.2 and retesting this hall is recommended as proper actions to clean the space are already being done.

Both spaces that had high values were retested on 6/2/21 after corrective measures were taken within the spaces. The measures taken in A157 removed all shower curtains from the offices and the measure in the residence hall involved cleaning the coil on the unit serving the space. The new round of testing showed the spaces are all now compliant with LEED/ASHRAE 62.1 & 62.2.

Carbon dioxide does not have an actual limit set by ASHRAE 62.1 & 62.2 / LEED and only has recommended amounts. Due to not having an actual requirement a table has been provided to show typical comfort levels and levels once discomfort can start occurring.

Carbon Dioxide (CO_2) levels:

Average CO_2 Results	**CO_2 Reference levels** Reference: ASHRAE Standard 62.1-2007	
414 ppm	250-350 ppm	Normal background concentration in outdoor ambient air
	350-1,000ppm	Concentrations typical of occupied indoor spaces with good air exchange
	1,000-2,000ppm	Complaints of drowsiness and poor air
	2,000-5,000 ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present.
	5,000	Workplace exposure limit (as 8-hour TWA) in most jurisdictions.
	>40,000 ppm	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death.

The TVOC table below is provided due to TVOCs being a total count of compounds as opposed of individual compounds. Another table can be found in appendix A that shows some of the compounds that are part of the TVOC test. ASHRAE has shown that by setting a limit of 500 µg/m3 that spaces are satisfied, clean, and present no threats to the occupants within the space.

Volatile Organic Compound (VOC) levels:

Highest of Average TVOC Results	**VOC Reference levels** Reference: ASHRAE Standard 62.1-2007
232 (µg/m3)	Limit is 500 µg/m3. See Reference table under *Appendix A*

Detailed Results

IMSA Main Building

INDOOR AIR QUALITY TESTING FOR IMSA Main Building					
TEST	LIMITS AND NOTES	Auditorium	Innovation	A119	A157
Space Temperature (°F)	Recommended 68-78	5/14/2021	5/14/2021	5/14/2021	5/14/2021
	Average	72.6	75.3	73.2	73.2
Relative Humidity (%)	Recommended 20-60				
	Average	16.7	15.9	16.9	19
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	372	393	390	392
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0	0.3	0.2	0.4
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	0.7	0.69	0.58	0.67
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	2.75	1.16	2.3	1.2
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.1	0.1	0.09	0.08
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	164	182	188	890*

*TVOC levels were above acceptable limits.

INDOOR AIR QUALITY TESTING FOR					
IMSA Main Building					
TEST	LIMITS AND NOTES	A136	A136 (Post HEPA Filter)	Academic Pit	B105a
Space Temperature (°F)	Recommended 68-78	5/14/2021	5/19/2021	5/14/2021	5/14/2021
	Average	72	74	70.4	68.4
Relative Humidity (%)	Recommended 20-60				
	Average	20.1	56.2	23.2	26.2
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	388	463 *	388	381
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.5	0.3	0.8	1.3
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	0.99	1.57 *	1.23	1.97
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	1.28	3.22 *	1.71	4.78
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.08	0.08	0.08	0.09
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	228	238	245	301

* Increases were seen in CO2 emission, PM 2.5 particles and PM 10 particles within the space after a HEPA filter was used for a period of 24 hours prior to testing.

INDOOR AIR QUALITY TESTING FOR					
IMSA Main Building					
TEST	LIMITS AND NOTES	Hall near C137	Math Study	Hall near A113	Nurse's Office
Space Temperature (°F)	Recommended 68-78	5/13/2021	5/13/2021	5/13/2021	5/13/2021
	Average	74.2	75.1	74	72.6
Relative Humidity (%)	Recommended 20-60				
	Average	16.6	16.1	17.6	18.2
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	410	413	414	404
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.2	0.4	0.5	0.5
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	0.49	0.64	0.52	0.76
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	1.85	3.87	3.7	2.6
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.07	0.06	0.06	0.07
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	184	241	188	183

INDOOR AIR QUALITY TESTING FOR					
IMSA Main Building					
TEST	LIMITS AND NOTES	B154	Science Atrium	Cafeteria	Library
Space Temperature (°F)	Recommended 68-78	5/13/2021	5/13/2021	5/13/2021	5/13/2021
	Average	72.7	72.2	70.3	66
Relative Humidity (%)	Recommended 20-60				
	Average	18.8	19	20.3	26.8
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	405	408	403	400
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.7	1	1.4	2.1
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	0.68	0.69	1.23	1.12
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	2.39	1.59	3.29	5.43
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.06	0.06	0.07	0.07
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	184	200	208	280

Residence Hall 1501

INDOOR AIR QUALITY TESTING FOR					
IMSA Residence Hall 1501					
TEST	LIMITS AND NOTES	A Upper	B Lower	C Upper	D Lower
Space Temperature (°F)	Recommended 68-78	5/19/2021	5/19/2021	5/19/2021	5/19/2021
	Average	78.4	74.5	76.6	73.9
Relative Humidity (%)	Recommended 20-60				
	Average	48.8	55	51.1	57.3
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	445	417	438	423
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.5	0.7	0.6	1
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	1.7.	1.75	2.08	2.11
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	5.8	3.72	6.16	4.85
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.08	0.09	0.08	0.1
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	192	257	225	315

Residence Hall 1502

INDOOR AIR QUALITY TESTING FOR IMSA Residence Hall 1502					
TEST	LIMITS AND NOTES	A Upper	B Lower	C Upper	D Lower
Space Temperature (°F)	Recommended 68-78	5/20/2021	5/20/2021	5/20/2021	5/20/2021
	Average	76	70.8	75.8	75.3
Relative Humidity (%)	Recommended 20-60				
	Average	52.3	53.4	50.4	56.9
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	434	423	437	435
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.5	0.8	0.4	0.7
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	2.93	3.69	2.74	3.68
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	7.68	5.57	5.77	7.01
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.08	0.07	0.08	0.09
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	296	411	269	366

Residence Hall 1503

INDOOR AIR QUALITY TESTING FOR IMSA Residence Hall 1503					
TEST	LIMITS AND NOTES	A Lower	B Upper	C Lower	D Upper
Space Temperature (°F)	Recommended 68-78	5/17/2021	5/19/2021	5/19/2021	5/19/2021
	Average	73.1	78.3	78.1	80.5
Relative Humidity (%)	Recommended 20-60				
	Average	40.7	54.1	53.7	45.8
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	416	427	440	456
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	1.3	0.4	0.6	0.5
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	2.08	2.79	2.62	1.63
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	6.48	6.11	6.85	4.04
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.11	0.09	0.08	0.07
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	261	217	243	202

Residence Hall 1504

INDOOR AIR QUALITY TESTING FOR					
IMSA Residence Hall 1504					
TEST	LIMITS AND NOTES	A Lower	B Upper	C Lower	D Upper
Space Temperature (°F)	Recommended 68-78	5/17/2021	5/17/2021	5/17/2021	5/17/2021
	Average	74.6	75.5	76.2	76.6
Relative Humidity (%)	Recommended 20-60				
	Average	40.5	40	40.8	38.9
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	410	395	396	415
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.9	0.5	0.6	0.8
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	1.92	1.37	1.26	1.14
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	6.3	2.8	2.43	4.31
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.11	0.11	0.12	0.11
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	203	164	157	184

Residence Hall 1505

INDOOR AIR QUALITY TESTING FOR IMSA Residence Hall 1505					
TEST	LIMITS AND NOTES	A Lower	B Upper	C Lower	D Upper
Space Temperature (°F)	Recommended 68-78	5/17/2021	5/17/2021	5/17/2021	5/17/2021
	Average	78.6	79.3	79.9	79.4
Relative Humidity (%)	Recommended 20-60				
	Average	37.4	37	36.8	37
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	411	424	424	403
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.5	0.3	0.4	0.3
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	1.14	1.19	4.74	0.99
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	4.39	11.93	78.93*	6.11
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.1	0.1	0.1	0.1
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	159	132	166	165

*Large particle count was above acceptable limits

Residence Hall 1506

INDOOR AIR QUALITY TESTING FOR					
IMSA Residence Hall 1506					
TEST	LIMITS AND NOTES	A Upper	B Lower	C Upper	D Lower
Space Temperature (°F)	Recommended 68-78	5/18/2021	5/18/2021	5/18/2021	5/18/2021
	Average	78.9	76.5	78.5	75.7
Relative Humidity (%)	Recommended 20-60				
	Average	43	44.8	43.1	47.9
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	426	434	432	395
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.5	0.7	0.6	1.3
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	1.28	1.65	2.03	1.57
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	3.23	11.92	8.8	3.12
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.09	0.09	0.09	0.1
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	163	201	182	220

Residence Hall 1507

INDOOR AIR QUALITY TESTING FOR IMSA Residence Hall 1507					
TEST	LIMITS AND NOTES	A Upper	B Lower	C Upper	D Lower
Space Temperature (°F)	Recommended 68-78	5/18/2021	5/18/2021	5/18/2021	5/18/2021
	Average	80.9	76.9	79.1	76
Relative Humidity (%)	Recommended 20-60				
	Average	42.8	47.4	45.9	47.9
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	430	377	418	393
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	0.4	0.4	0.4	0.2
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	2.36	1.42	2.14	1.59
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	6.94	4.49	6.49	5.46
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.09	0.1	0.1	0.1
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	167	187	180	205

6/2/2021 Retesting.

INDOOR AIR QUALITY TESTING FOR IMSA			
TEST	LIMITS AND NOTES	Residence Hall 1505 – C Wing	Main Building – A157
Space Temperature (°F)	Recommended 68-78	6/2/21	6/2/21
	Average	72.2	69.2
Relative Humidity (%)	Recommended 20-60		
	Average	36.4	47.8
Carbon Dioxide (PPM)	Typical Comfort < 1,100 Recommended < 1,100 No Limit	474	439
Carbon Monoxide (PPM)	Typical Comfort < 3 Recommended < 30 Limit = 9, or 2 above OA	1.5	2.0
Small Particles (PM 2.5) (µg/m³)	Typical Comfort < 20 Recommended < 20 Limit = 15	1.43	1.74
Large Particles (PM 10) (µg/m³)	Typical Comfort < 40 Recommended < 40 Limit = 50	3.99	2.30
Ozone (PPM)	Typical Comfort < 0.1 Recommended < 0.3 No Limit	0.04	0.07
Total Volatile Organic Compounds (TVOC) (µg/m³)	Limit = 500	164	213

Appendix A

BSR/ASHRAE Addendum q to ANSI/ASHRAE Standard 62.1-2007, Table B-3

Guide for Using TABLE B-3

Table B-3 provides information that may be beneficial for designers who choose to comply with the Indoor Air Quality Procedure of this Standard. The VOCs included in the table were reported in published, peer-reviewed surveys conducted in office buildings and in new and existing residences in North America during the period 1990–2000.[B-42,B-43,B-45] Only those VOCs for which exposure guidelines for the general population have been developed by cognizant authorities are listed in Table B-3.

Reference Exposure Levels (RELs) are guidelines for acute, 8-hour and chronic inhalation exposures developed by California Office of Health Hazard Assessment (OEHHA). Minimal Risk Levels (MRLs) for hazardous substances are guidelines for acute, intermediate and chronic inhalation exposures developed by the Agency for Toxic Substances and Disease Registry (ATSDR). Factors for $\mu g/m^3$ to ppb concentration conversions are shown.

The table does not purport to represent (a) all possible chemicals found in nonindustrial indoor environments and (b) all concentration guidelines, standards, and regulatory limits. Published, peer-reviewed surveys conducted in office buildings and in new and existing residences in North America since 2000 may identify several more compounds, for some of which guidelines may be available from the cognizant authorities described above.

TABLE B-3 Concentrations of Interest for Selected Volatile Organic Compounds

Compound	CAS Number	Chemical Class[a]	Conversion Factor: µg/m³ to ppb[b]	CA OEHHA REL[B-36]			ATSDR MRL[B-46]		
				Acute[c] (µg/m³)	8-hr[d] (µg/m³)	Chronic[e] (µg/m³)	Acute[f] (ppb)	Intermediate[g] (ppb)	Chronic[h] (ppb)
Acetaldehyde	75-07-0	Ald	0.554	470	300	140			
Acrolein	107-02-8	Ald	0.436	2.5	0.7	0.35	3	0.4	
Acrylonitrile	107-13-1	Misc	0.460			5	100		
Benzene	71-43-2	Arom	0.313	1300		60	9	6	3
Bromomethane (Methyl bromide)	74-83-9	Halo	0.258				50	50	5
1,3-Butadiene	106-99-0	Alke	0.452			20			
2-Butanone	78-93-3	Ket	0.339	13,000					
2-Butoxyethanol	111-76-2	Gly	0.207				6000	3000	200
t-Butyl methyl ether (Methyl-t-butyl ether)	1634-04-4	Ethr	0.277			8000	2000	700	700
Carbon disulfide	75-15-0	Misc	0.321	6200		800			300
Carbon tetrachloride	56-23-5	Halo	0.159	1900		40		30	30
Chlorobenzene	108-90-7	ClAro	0.217			1000			
Chloroform	67-66-3	Halo	0.205	150		300	100	50	20
1,4-Dichlorobenzene	106-46-7	ClAro	0.166			800	2000	200	10
1,2-Dichloroethane (Ethylene dichloride)	107-06-2	Halo	0.247						600
Dichloromethane (Methylene chloride)	75-09-2	Halo	0.288	14,000		400	600	300	300
1,4-Dioxane	123-91-1	Ethr	0.278	3000		3000	2000	1000	1000
Ethylbenzene	100-41-4	Arom	0.230			2000	10,000	700	300
Ethylene glycol	107-21-1	Gly	0.394			400	788		
Formaldehyde[i]	50-00-0	Ald	0.815	55	9	9	40	30	8
n-Hexane	110-54-3	Alka	0.284			7000	600		
Naphthalene	91-20-3	Arom	0.191			9			0.7
Phenol	108-95-2	Alc	0.260	5800		200			
2-Propanol (Isopropanol)	67-63-0	Alc	0.407	3200		7000			

TABLE B-3 Concentrations of Interest for Selected Volatile Organic Compounds *(continued)*

Compound	CAS Number	Chemical Class[a]	Conversion Factor: µg/m³ to ppb[b]	CA OEHHA REL[B-36]			ATSDR MRL[B-46]		
				Acute[c] (µg/m³)	8-hr[d] (µg/m³)	Chronic[e] (µg/m³)	Acute[f] (ppb)	Intermediate[g] (ppb)	Chronic[h] (ppb)
2-Propanone (Acetone)	67-64-1	Ket	0.421				26,000	13,000	13,000
Styrene	100-42-5	Arom	0.235	21,000		900	2000		200
Tetrachloroethene (Tetrachloroethylene, Perchloroethylene)	127-18-4	Halo	0.147	20,000		35	200		40
Toluene	108-88-3	Arom	0.265	37,000		300	1000		80
1,1,1-Trichloroethane (Methyl chloroform)	71-55-6	Halo	0.183	68,000		1000	2000	700	
Trichloroethene (Trichloroethylene)	79-01-6	Halo	0.186			600	2000	100	
Vinyl chloride	75-01-4	Halo	0.391	180,000			500	30	
Xylene isomers	1330-20-7	Arom	0.230	22,000		700	2000	600	50

[a] Alc – alcohol; Ethr – ether; Gly – glycol ether; Ket – ketone; Ald – aldehyde; Estr – acetates and other esters; Acid – carboxylic acid; Alka – alkane HC; Alke – alkene HC; Cycl – cyclic HC; Terp – terpene HC; Arom – aromatic HC; ClAro – chlorinated aromatic HC; Halo – halogenated aliphatic HC; Misc – miscellaneous category.
[b] Conversion factors from µg/m³ to ppb.
[c] Exposure averaging time is 1 hour.
[d] Exposure averaging time is 8 hours and which may be repeated.
[e] Designed to address continuous exposures for up to a lifetime; the exposure metric used is the annual average exposure.
[f] Exposure to a chemical for a duration of 14 days or less, as specified in the toxicological profiles.
[g] Exposure to a chemical for a duration of 15–364 days, as specified in the toxicological profiles.
[h] Exposure to a chemical for 365 days or more, as specified in the toxicological profiles.
[i] See also Tables B-1 and B-2 for additional guidance on formaldehyde.

Appendix B

AdvanceSense Pro Specifications

FEBRUARY 2016

ADVANCEDSENSE® PRO

Environmental Test Meter Plus

SPECIFICATIONS:
(for additional sensor/probe specifications refer to GrayWolf's DirectSense®, pitot tube and thermocouple brochures)

General:

Dimensions:	96.0mm (3.8in.) w. x 177mm (7.0in.) h. x 47.0mm (1.8in) d.
Construction:	Rugged polycarbonate plastic with rubberized side grips. IP64
Weight:	700gr (1lb 8.5oz.) Add 50gr (1.5oz.) for auto-zeroing ΔP option
Screen Size:	3.5" HVGA 320 x 480 color touch screen with backlight
Memory:	32GB for data-logging (millions of readings) and notes (photo/video/audio), help videos, documents and WolfSafe™ auto-data backup
Camera/LED:	Integral 2MP photo/video camera and 17cd LED illuminating/inspection light
Wireless Network:	WiFi 802.11 a/b/g with integrated antenna and Bluetooth 4.0 standard (may optionally be ordered with wireless hardware removed)
Audio:	Integral electret microphone (on front, for audio recording) and 8 ohm speaker (on back, for audio queues, help videos and audio note replay)
Mounting:	¼" - 20 thread (on back) for belt clip, etc. (& for included mini tripod/stand)
Operating Range:	-10°C to 50°C (15°F to 122°F), 0 to 100 %RH non-condensing

Connectors:

2 x Lemo 8F pin for GrayWolf DirectSense probes (the AdvancedSense Pro will support up to 4 x DirectSense probes with Y-adapters)
1 x Lemo 7F pin for particulate meters or RH-AS2 direct-connect TRH probe
2 x sub-mini type K thermocouple temperature sockets. Range -80 to 1100°C (-110 to 2010°F)
1 x Lemo 7M pin for formaldehyde meter, borescope, external photo/thermal imaging camera or optional USB key download adapter cable
1 x USB mini B socket. 1m mini USB B to USB A download cable supplied as standard
1 x 12V, 2.1mm DC power socket
Optional: 2 x 4mm posts for differential pressure tubing

Power:

Battery:	4250 mAh Lithium Ion rechargeable
Battery Life:	18+ hours typical for new battery with backlight off (and probes self-powering) The AdvancedSense Pro can power DirectSense probes. Battery life will vary when powering probes, pressure sensors or wireless.
Recharge time:	4 hours typical. Red/green front LED displays charging/fully charged status
Power supply:	100/240VAC, 50-60Hz external charger. Specify local plug

All specifications are subject to change without further notice

Optional Built-in Sensors:

	Differential Pressure (**DP-702LH**)	Barometric Pressure (**BP-101**)*
Range	±10,000Pa, ±40 inH$_2$O, ±1000 mmH$_2$O, ±100 mbar, ±70 mmHg	600 to 825 mmHg, 800 to 1100mBar, 23.50 to 32.50 inHg, 0.80 to 1.10atm
Resolution	0.1 Pa, 0.001 inH$_2$O, 0.01 mmH$_2$O, 0.001 mbar, 0.001 mmHg	0.1mmHg, 0.1mBar, 0.01 inHg, 0.01atm
Accuracy (over setting ranges)	±1% of rdg ±0.1Pa up to 250Pa, ±1%rdg ±4Pa >250Pa (±1% of rdg ±0.001 inH$_2$O to 1.000 inH$_2$O, ±1%rdg ±0.015 inH$_2$O>1.000 inH$_2$O)	±0.1% rdg

Differential Pressure is auto-zeroing (every 2 minutes by default but zeroing frequency is user adjustable to 5 min. or OFF)

*The barometric pressure sensor, when installed, will compensate mass concentration readings (µg/m³) for pressure changes.

WolfSense® PC data transfer and analysis software supplied as standard

MEASURE SMART

Front View

REPORT EFFICIENTLY

Top View

Bottom View

Right Side View

Back View

2m dual tubing is supplied with optional differential pressure sensor. GrayWolf offers a selection of pitot tubes for air velocity and K thermocouples for temperature measurement.

PCC-AS01 pouch with neck-strap for hands free surveys. Also eyelets for camera/inspection light and hand-strap/belt-loop.

PCC-10A Hardshell Security case holds AdvancedSense Pro, probes & accessories. Smaller/larger cases also available.

Cloud-based Access Software, Advanced Reporting Software, Calibration kits and other accessories are available from GrayWolf. View them online at accessories.graywolfsensing.com

GRAYWOLF SENSING SOLUTIONS
6 Research Drive (Worldwide Headquarters)
Shelton, CT 06484 USA
Ph. (1)203-402-0477
800-218-7997

Email: salesteam@GrayWolfSensing.com
www.GrayWolfSensing.com

GRAYWOLF SENSING SOLUTIONS
Annacotty Industrial Park, Unit 1C
Annacotty, County Limerick
Ireland
Ph. (353) 61358044

LEED Performance Score IAQ Testing

NOVEMBER 2020

GRAYWOLF SENSING SOLUTIONS

ADVANCEDSENSE® DIRECTSENSE® IAQ

Indoor Air Quality Meters

✔Measure Smart ✔Report Efficiently

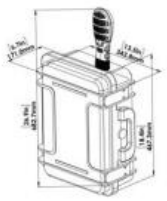
SPECIFICATIONS: IQ-410, IQ-610, DSII-3/5/7*, DSII-8*

*DSII SENSORS CAN BE MIXED AND MATCHED TO BEST SUIT YOUR APPLICATION; TRH + up to 6 SENSORS (8 total) for DSII-8, TRH + 5 (excepting CO2) for DSII-7, TRH +3 for DSII-5, TRH + 1 for DSII-3

Carbon Monoxide: (electrochemical)	Range: 0 to 500ppm
	Accuracy: ±2ppm <50ppm, ±3%rdg >50ppm
Carbon Dioxide: (NDIR)	Range: 0 to 10,000ppm
	DSII Accuracy: ± 35ppm over the IAQ range (350ppm-2000ppm) ± 35ppm ±3%rdg >2000ppm
	DSI Accuracy: ± 50ppm ±3%rdg over the full range
VOCs: (PID) not for IQ-410	Range: 5 to 20,000ppb
	(user selectable units: ppb, ppm, µg/m3, mg/m3)
	Resolution: 1ppb, L.O.D. <5ppb
	10.6 eV PIDs do not respond to VOCs with ionization potentials >10.6, such as ethane, methane or formaldehyde. However, they do respond to the vast majority of VOCs. Standard calibration is to Isobutylene. Users may calibrate to alternative VOCs.
Relative Humidity: (capacitive)	Range: 0 to 100 %RH
	Accuracy: ±2%RH <80%RH (±3%RH>80%RH)
Temperature: (Pt100)	Range: -10° to 160°F (-25° to +70°C)
	Accuracy: ±0.3°C
Response Time:	All sensors exhibit 90% response <1 minute
DSI Probe Dimensions**:	2in. (5cm) dia. x 12.5in. (30cm) lgth.
Weight (probe):	w/batteries 1lb. 10oz. (0.7kg)
Power (IQ-410) :	2 x D cells; probe battery life 100+ hrs.
(IQ-610) :	typical probe battery life 50+ hrs.
	**Refer to DirectSense II brochure for DSII dimensions and battery life.
Operating Range	
PID (VOC) sensors:	0 to 90%RH, -15 to 60°C
Probe & other sensors:	0 to 98%RH (non-condensing), -15 to 60°C
PC Software Requirements:	Windows 7/8/10

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT FURTHER NOTICE

- **AdvancedSense IAQ** kits include an AdvancedSense meter. **DirectSense IAQ TAB** kits include a WIN10 tablet PC. These complete kits also come with probe, WolfSense PC desktop data transfer software, hardshell security case, and more. Contact GrayWolf for details.
- Alternative carry cases, pouches, belt clips, extension cables and other accessories are also available from GrayWolf. View them on our website at: GrayWolfSensing.com/Accessories.



PCC-20 DSII Security Case ▲ (shown above w/optional **ACC-BRK1** brackets for external HCHO or other meters)

ACC-TPDL-KIT includes tripod and mounts for various meters/ probes, plus nylon carrying pouch ▼

PCC-AS01 AdvancedSense pouch and **PCC-05IQ** probe pouch (shown w/ **FM-801** formaldehyde meter)

PCC-15 Dual DSI Probe Security Case (shown with optional **FM-801** formaldehyde meter and **PC-3016** particulate meter)

CA-HD2 Gas Calibration Hood for DSI Probes, may also be used for fan/ pump air sampling

▲ **CA-HD4-A1** Gas Calibration Cap for DSII Probes

◀ **CA-GS25L** TVOC Calibration Kit for DSI (specify CA-GS25L-DSII for DSII). NIST traceable reference gases are also available for CO2, CO and other gases.

GRAYWOLF® SENSING SOLUTIONS
6 Research Drive (Worldwide Headquarters)
Shelton, CT 06484 USA
Ph. (1) 203-402-0477
800-218-7997

Email: Salesteam@GrayWolfSensing.com
www.GrayWolfSensing.com

GRAYWOLF SENSING SOLUTIONS
Annacotty Industrial Park, Unit 1C
Annacotty, County Limerick
Ireland V94 PR2Y
Ph. (353) 61358044

LEED Performance Score IAQ Testing

SEPTEMBER 2018

PC-3016A

6-channel Particle Counter

✔Measure Smart ✔Report Efficiently

Specifications: PC-3016A

Size Range: 0.3 - 25.0 µm+ (145 µm max into inlet)
Channel Sizes: 0.3, 0.5, 1.0, 2.5, 5.0, 10.0 µm
Optional: inquire about other size cuts (Particle Count only)
Flow Rate: 0.1 CFM (2.83 LPM)
Counting Efficiency: 50% @ 0.3 µm; 100% for Particles >0.45 µm (per ISO 21501-4)
Laser Source: Extreme Life Laser Diode with >20 Years MTTF
Zero Count Level: <1 Count / 5 minutes (per ISO 21501-4)
Concentration Limits: 8,000,000 Particles / ft^3 @ 10% Coincidence Loss
Calibration: Meets ISO 21501-4 Calibration using NIST Traceable PSL Spheres, DMA and Condensation Particle Counter
Count Modes: Automatic, Manual, Beep, Concentration, Cumulative/Differential, Mass Concentration
Data Storage (on-board): 3,000 Sample Records, Rotating Buffer (includes particle and environmental data, plus alphanumeric location and time)
Communication Modes: RS232 converted to USB (via included RJ-45 to USB cable) for PCs or Printers. RS232 to AdvancedSense, WolfPack or tablet/PC w/GWSS cable/software.
Touch Screen Display: 3.5" (8.89cm, Color TFT)
Alarms: Internal Alarm Buzzer. Alarms on Counts, Low Battery, Sensor Failure
Sample Inlet: Isokinetic Sampling Probe
Sample Output: Internally Filtered to HEPA Standards (>99.97% @ 0.3µm)
Vacuum Source: Internal Pump, Automatic Flow Control
Enclosure: High Impact Injection Molded Plastic (with handle)
Power: External 100-240V, 50-60Hz Power Supply (12VDC, 1.25A)
Battery: Li-Ion, Removable & Rechargeable
Dimensions: 8.75" x 5.0" x 2.5" (22.23 x 12.7 x 6.35 cm)
Weight: 2.2lb (1kg)
Languages: English (U.S.), Deutsch, Espanol, Italiano, Français, Russian, Japanese, Korean and Chinese.
Warranty: 2 years on instrument, 1 year on accessories

Environmental Conditions:

Operating: 50°F to 104°F (10°C to 40°C) / 20% RH to 95% RH non-condensing
Storage: 14°F to 122°F (-10°C to 50°C) / Up to 98% RH non-condensing

Accessories Included:

Operating manual on thumb drive, Removable battery, Isokinetic Sample Probe (direct mount), Purge (zeroing) Filter, 100/240V AC charger/adapter, Belt Clip, GrayWolf's WolfSense PC Data Download and Reporting Software.

Options:

PC-GW6AAS-KIT also includes PCC-GW6 hardshell carrying case, interface cable for interface to AdvancedSense (specify **PC-GW6AWP-KIT** for WolfPack).
PC-GW6ADSL-KIT also includes PCC-GW6 hardshell carrying case, mobile PC interface cable, and WolfSense LAP Software for interface to Tablet/Laptop/Desktop PCs
PC-GW6-RHCF Temperature/Relative Humidity Probe
32-122ºF (0-50ºC), +/- 1ºF (0.5ºC), 15-90% +/- 5% RH
WolfSense ARG Advanced, Automated Reporting Software
PCC-GW6 Hardshell case. Dimensions: 38.1cm x 33.0cm x 17.8cm (15" x 13" x 7")
PCC-36P Hard-shell Security case with foam cutouts for AdvancedSense meter, sensor exposure for DSII probe plus space & inlet exposure for internal PC-3016
AD-L71M-PC3016 Cable for interfacing PC-3016A to AdvancedSense Meter
AD-L6P-PC3016 Cable for for interfacing PC-3016A to WolfPack (includes power socket for powering PC-3016A from the WolfPack)
WS-LAP WolfSense application for WIN 7/8/10 PC interface

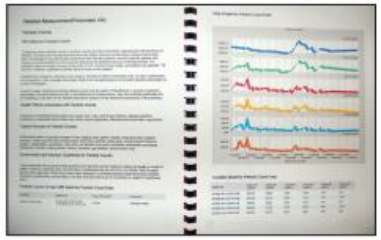
GrayWolf Sensing Solutions reserves the right to change specifications without notice.

◀ Optional PC-GW6-RHCF %RH, °F/°C probe (removable)

Example ▲ AdvancedSense Screen (interface enables GrayWolf's powerful in-situ features for particulate data, optional remote WiFi access and more)

◀ PCC-GW6 Hard-Shell Case

◀ Example WolfSense PC Screen data transfer & analysis software (supplied as standard)



▶ Example WolfSense ARG report (optional automated report generation software)

GRAYWOLF SENSING SOLUTIONS
6 Research Drive (Worldwide Headquarters)
Shelton, CT 06484 USA
Ph. (1)203-402-0477
800-218-7997

CE
Email: Salesteam@GrayWolfSensing.com
www.GrayWolfSensing.com

GRAYWOLF SENSING SOLUTIONS
Annacotty Industrial Park, Unit 1C
Annacotty, County Limerick
V94 PR2Y Ireland
Ph. (353) 61358044