Healthy Indoor Air with Energy Savings Using Bi-Polar Ionization

www.AtmosAir.com

Partners & Allies

Design Community Allies

Architects and Mechanical Engineering Consultants Specifying Bi-Polar Ionization:

Pristine health and wellness in the workplace is being demanded by millennials and major corporations.

These companies have All incorporated BPI For improved Health and Wellness

Key Markets for BPI:

- Commercial Offices
- Healthcare
- Schools
- Hospitality
- Sports
- Airports
- Marine
- Convention Centers
- Grocery Stores
- Government
- Performing Arts

The Urgent Need

HEALTH AND WELLNESS MARKET IS WORTH $3.4 TRILLION

- The indoor air quality (IAQ) market in the U.S. totaled $7.8 billion in 2015. The market should total $8.3 billion in 2016 and $10.8 billion by 2021, increasing at a compound annual growth rate (CAGR) of 5.3% from 2016 to 2021. (BCC Research)

- The IAQ equipment market totaled $4.0 billion in 2015, and should total nearly $4.3 billion in 2016 and exceed $5.9 billion in 2021, at a CAGR of 6.9% from 2016 to 2021. (BCC Research)

RESEARCHANDMARKETS

United States $10+ Billion Indoor Air Quality Market, 2021

GLOBAL WELLNESS INSTITUTE™

EMPOWERING WELLNESS WORLDWIDE

HOME ABOUT RESEARCH INITIATIVES NEWS ARCHIVE ROUNDTABLES WELLNESS EVIDENCE GWI BRIEF DONATE

Media Contact: Beth McGroarty
beth.mcgroarty@globalwellnessinstitute.org - +1.213.300.0107

GLOBAL WELLNESS INSTITUTE STUDY: $3.4 TRILLION GLOBAL WELLNESS MARKET IS NOW THREE TIMES LARGER THAN WORLDWIDE PHARMACEUTICAL INDUSTRY

Following annual summit, industry leaders unveil milestone study, new clearinghouse for evidence-based research on wellness therapies, and 2015 launch of wellness industry think tank

New York, NY – September 30, 2014 – With consumer demand for wellness services and products higher than ever, a landmark study released today by The Global Wellness Institute reveals that the global wellness market is now worth $3.4 trillion, making it nearly three times larger than the $1 trillion* worldwide pharmaceutical industry.

Indoor Environmental Quality Matters

90% of OUR lives are spent Indoors

"Indoor air quality is one of the top five most urgent environmental risks to public health."

People care about what they put in their bodies.
People don't drink tap water they drink bottled water.
People don't eat GMO food or milk with hormones or meat with antibiotics, they eat organic.
People don't want to breathe just ok air, they want healthy air.

"50% of all illness is caused by indoor air pollution."

Health and Productivity Benefits Proven

- **Proven beyond reasonable doubt that inadequate indoor air quality in buildings can decrease productivity in addition to causing visitors to express dissatisfaction.**

- **The size of the effect on most aspects of office work performance appears to be as high as 6-9%, the higher value being obtained in field validation studies.**

Productivity Quantified:

- Example Building with 673 people with an average salary and benefits of $55,000 = $37,015,000 Total Cost of Occupancy (or $322/SF).
- 1% improvement in productivity is equal to $370,150

SCIENCE

Poor Indoor Air Quality Linked To Workers' Low Cognitive Function

A new Harvard study shows that reducing pollutants and carbon dioxide can have a "profound impact" on decision-making.

10/26/2015 07:43 pm ET | Updated Oct 27, 2015

Less sickness. Less asthma. Less Allergies. More productivity.

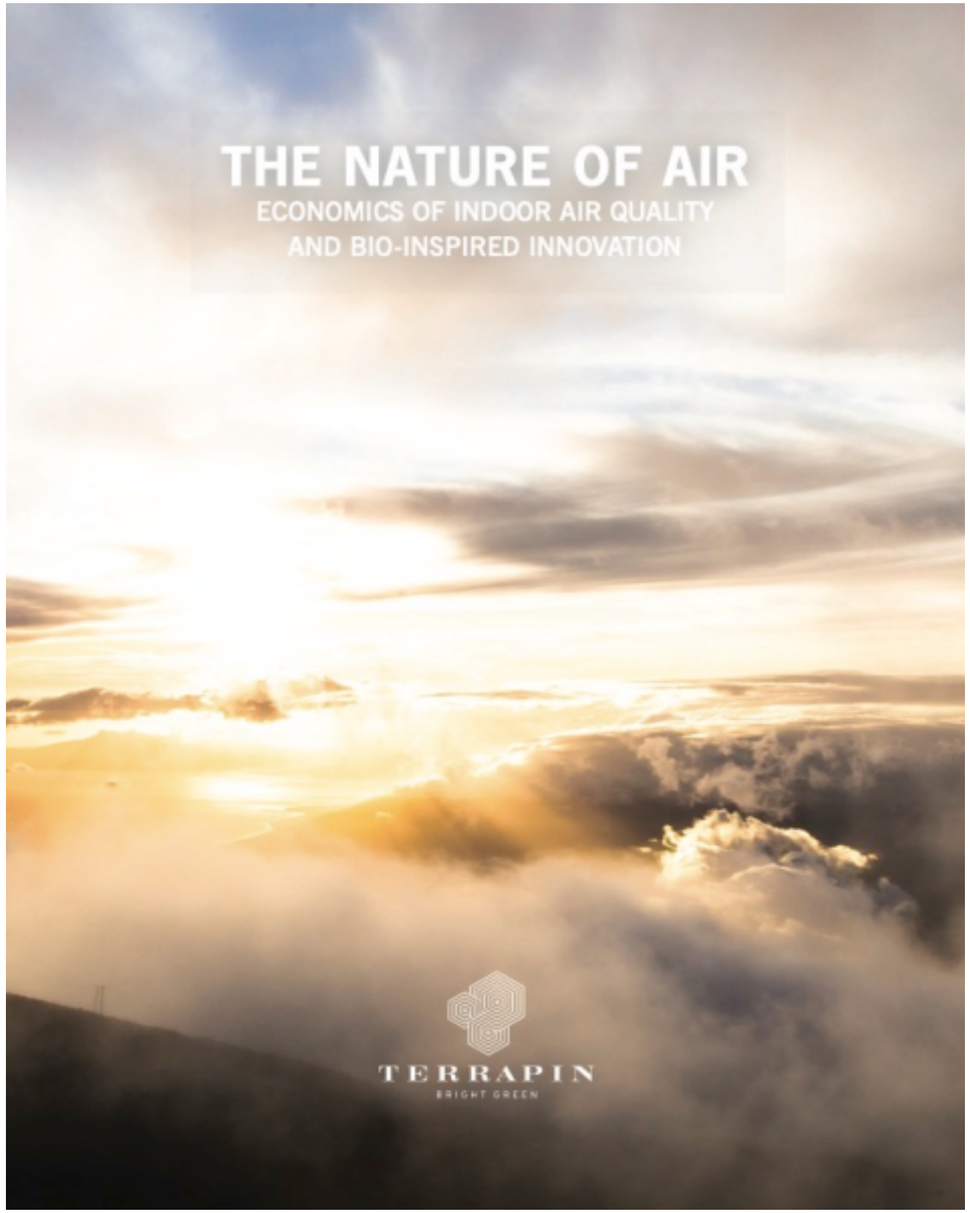
The impact of air quality

[JLL 3-30-300 Rule]

1% improvement in productivity is equal to $3,265 per employee.[1]

1. The average total compensation (salary and benefits) for an employee in the Professional and Business Services sector is $85,925 (Bureau of Labor Statistics, 2017). Given an office with 100 employees, we determined annual employee costs to equal $8,592,500. Wargocki, Wyon, and Fanger (2000) saw an average 1.9% positive relationship for every two-fold increase in air quality. Given two offices with a discrepancy of four-fold in air quality, employees would perform 3.8% better in the improved IAQ office. This difference translates into approximately $326,496 squandered as unproductive time due to poor IAQ.

Terrapin Bright Green White Paper



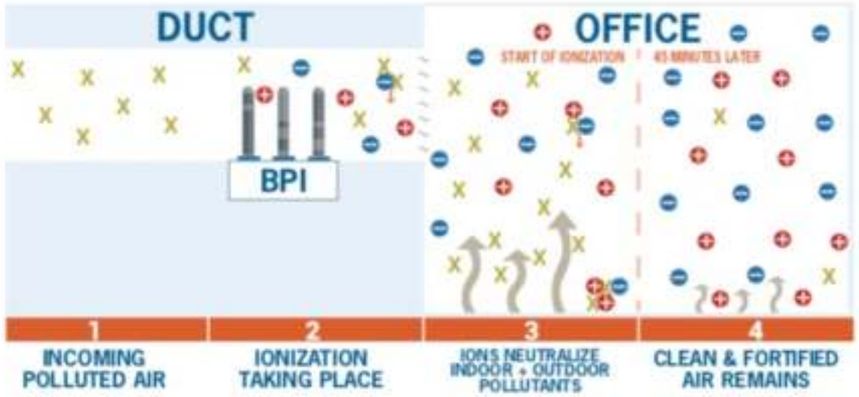
A key challenge to addressing human design challenges with bio-inspired innovation is in recognizing the differences between natural and man-made environments. For instance, IAQ management is limited by centralized sources of conditioned air and of the energy required to create air cleaning molecules. One emerging technology, known as photocatalytic oxidation (PCO), introduces oxidizing aerosols—most often the hydroxyl radical (see sidebar)—into indoor air to remove VOCs and microorganisms. While such a mechanism is highly effective in Earth's atmosphere, where free radicals can be created homogeneously throughout the stratosphere, a centralized source of hydroxyl radicals indoors cannot travel very far with a lifespan of less than one second. As a result, PCO works much like UV light sterilization, cleaning air when it passes through the duct.

Bi-polar ionization (BPI), another technology mirroring the mechanisms for atmospheric self-cleaning, moves one step beyond PCO by enabling air cleaning to occur through a space. BPI introduces positive and negatively charged ions into the air to neutralize VOCs, PM, bacteria, viruses, mold and odors. Because of the longer lifespan of air ions—typically 5 to 60 seconds—they can travel farther and remain active for longer. These air ions essentially fortify office air against air pollutants that emanate from indoor and outdoor sources alike, as opposed to only those that pass through a duct.

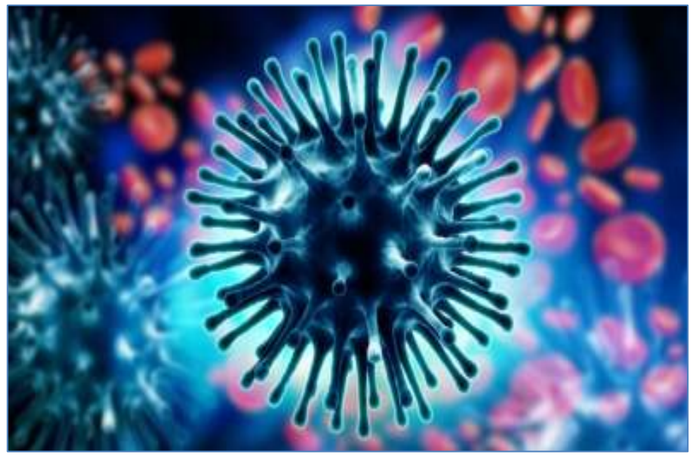
HOW BI-POLAR IONIZATION WORKS

The diagram below shows air traveling through a duct into an office space. Bi-polar ionization emits positive and negative ions within the duct that move into office space to neutralize air pollutants emanating from outdoor and indoor sources.

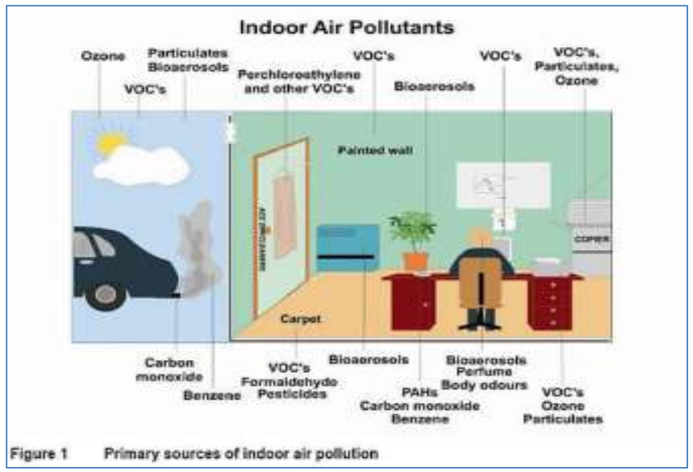
Image Credit: Terrapin Bright Green



Bipolar Ionization Improves Indoor Air Quality

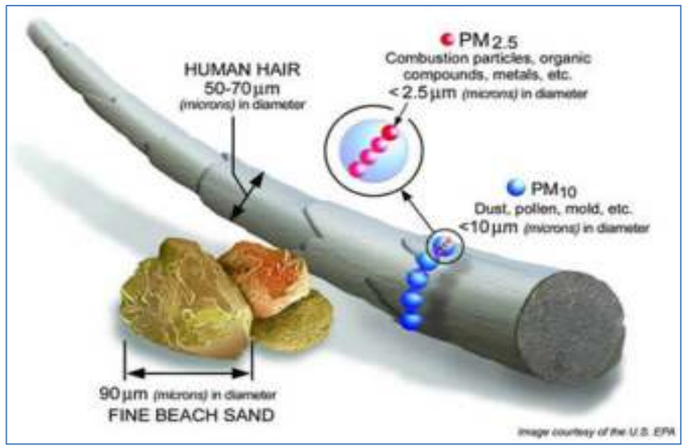


Microorganisms (Bacterium, Virus, or Fungus)



Volatile Organic Compounds (VOCs)

Mold



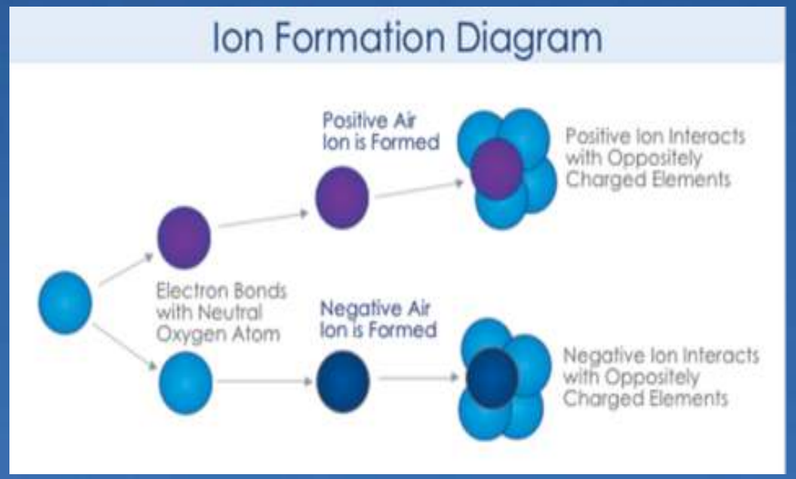
Particulate Matter (PM)

Smoke

Bioeffluents

The Bi-Polar Ionization Solution

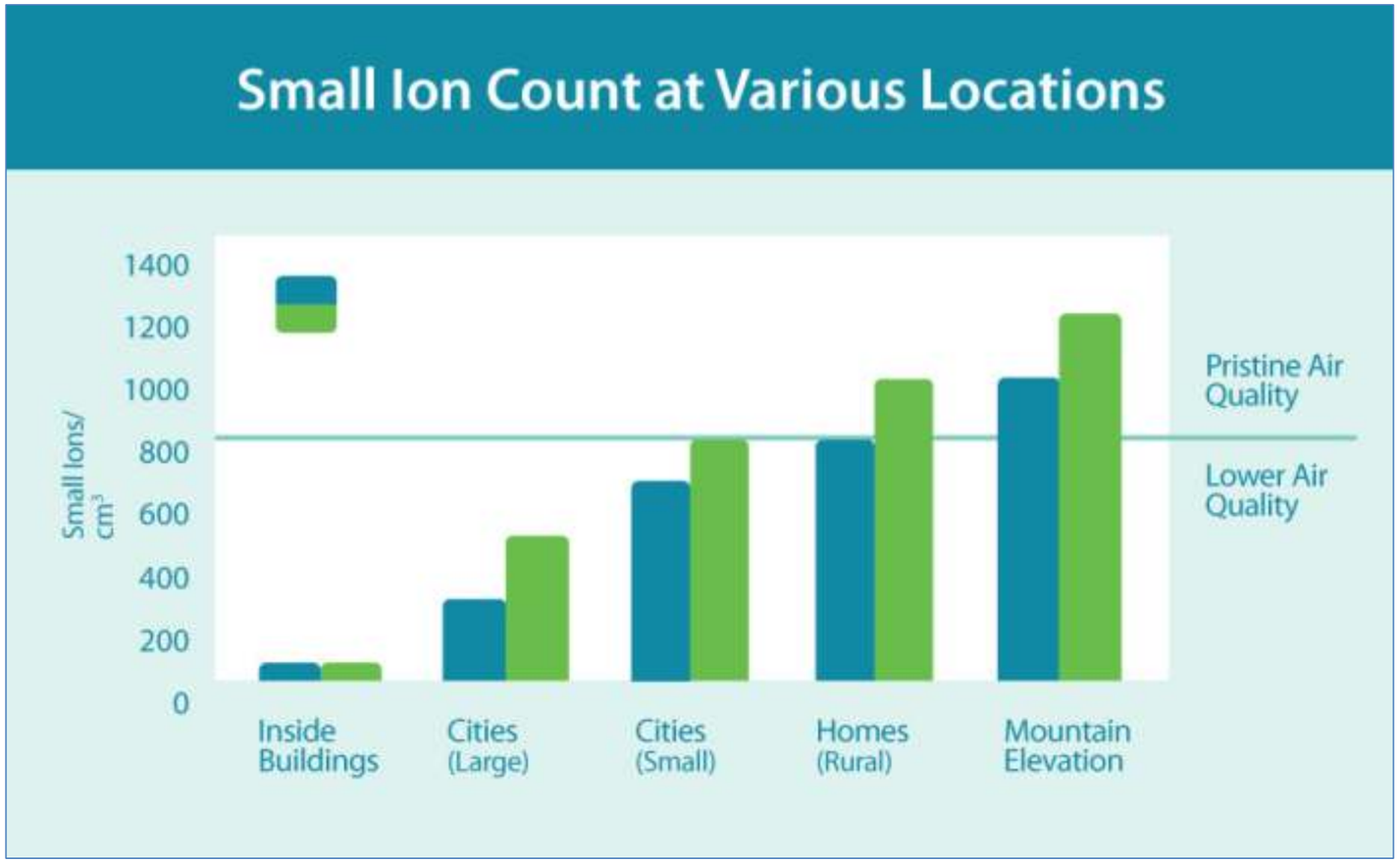
BiPolar Ions Have Always Existed In Nature



Ionization is nature's air cleaning process. The positively and negatively charged ions generated by the Bi-Polar Ionization system mimic the process that occurs in nature and actively attract, bind, and neutralize all types of pollutants from the air in indoor environments.

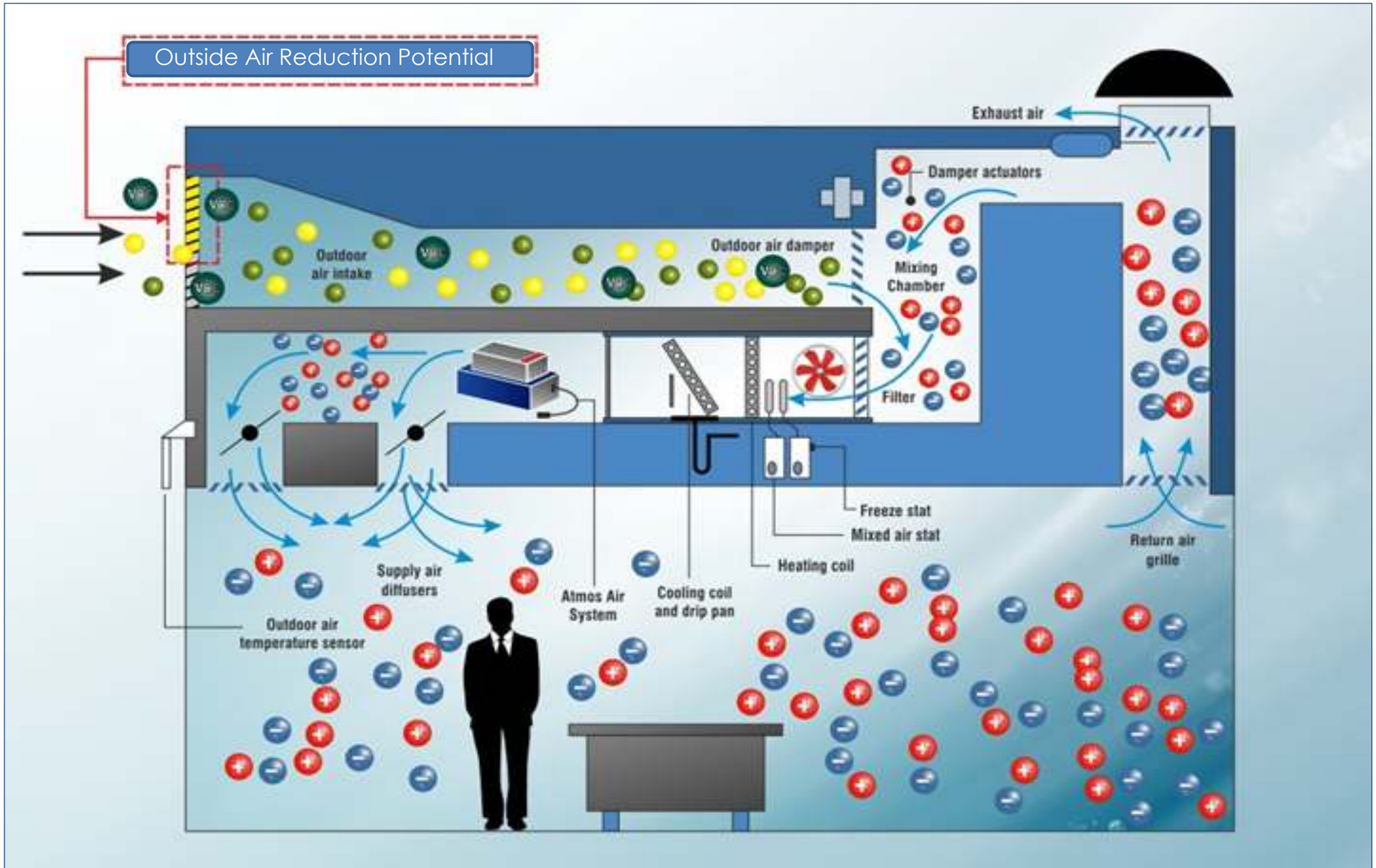
The Bi-polar Ionization Advantage

- In the most pristine environments there are naturally higher ion levels. These levels fall as we enter into more populated and polluted environments.
- Ion – An atom or molecule with a net electric charge due to the loss or gain of one or more electrons.
- Bi-Polar Ion (BPI) systems are designed to increase air ions as would be found in a natural state where no pollution exists.
- Ions help improve many various elements of indoor and outdoor air quality (PM, VOCs, virus).



FAQ: Does AtmosAir™ have a device that measures ion levels?
Yes. There is a specially designed ion meter that reports ion levels.

Bipolar Ionization in an HVAC System (DBD System)



Third Party Validation:
Measurement & Verification

3rd Party Validation: Positive Published Research on BPI

Penn State University
University of Michigan
University of Cincinnati
Columbia University
New York University
University of Washington
University of London
ASHRAE Journal
India Institute of Technology
US Govt – Nature (Journal)
Yonsei University
Peking University
University of Greifswald
University of Bradford
PLOS Medicine
Helsinki University Central Hospital
Scientific Report Journal
Global Energy Partners
Imperial College (London)
BMC Psychiatry
Griffith University
Infectious Diseases Research Centre Kuala Lumpur
Allergy Journal
The Science of the Total Environment
Toyohashi University of Technology
The Chemical Engineering Journal
Concordia University
University of Texas
IEEE Transactions on Plasma Science
National Taiwan University
Beijing University of Technology
Plasma Sources Sci. Tech

3rd Party Validation: A Safe Technology, researched since 1972

- **Hambraeus A.**: Studies on the Transmission of Staphylococcus aureus in an Isolation Ward for Burned Patients. J Hyg 71:171-175, 1973
- **CIBA-Geigy Geissen University**: BPI Evaluation On Humans-Animals April-1972
- **Dr. Paavo Makela P, et al. Studies**: Effects of Ionization on Bacterial Aerosols in a Burns and Plastic Surgery Unit. J Hyg (London), 1978
- **Pubmed**: Effects of Air Ions on Bacteria, Dec-1989
- **Dr. Paavo Makela**: Studies on the effects of ionization on bacteria, Helsinki University Central Hospital, Helsinki, 1978
- **Dr. Stacy Daniels**: Applications of Air Ionization for Control of VOCs and PM, University of Michigan, 1998
- **Dr. Stacy Daniels**: Report to FAA on BPI Benefits for Airports, 2002
- **Dr Philip Tierno**: Cleaning Indoor Air Using Bi-Polar Ionization Technology, NYU School Medicine, 2017
- **Dr. Philip Tierno**: BPI, The Safe Solution, NYU-School Medicine, 2019

Whitepaper

Dr. Phil Tierno (NYU Langone Medical Center)

Conclusion = BPI is Extremely Effective at:

- Mold and Pathogen Reduction
- Particulate Matter Decay
- VOC and Odor Reduction
- Mold Spore Reduction
- Energy Conservation

Cleaning Indoor Air using AtmosAir Bi-Polar Ionization Technology

Dr. Philip M. Tierno Jr., Professor of Microbiology and Pathology, New York University School of Medicine

April 2017

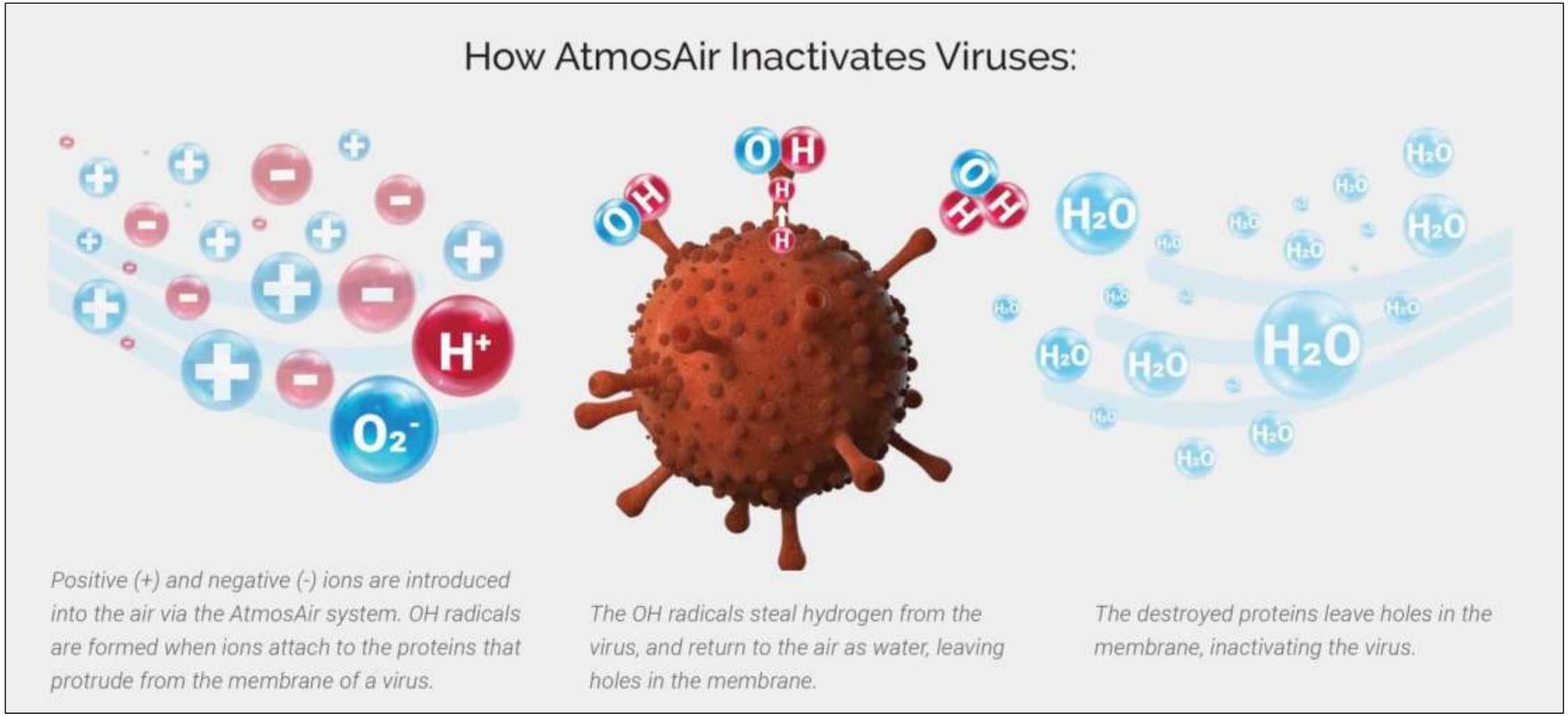
Clean air, both outdoors and indoors, is an essential determinant of a healthy life and a person's well being.

Outdoor Air Quality (OAQ): The federal government has made great progress towards cleaning outdoor air since 1970 via the Clean Air Act (CAA) and its additional amendments signed into law in 1990. This Act resulted in a significant 70% reduction of aggregate emissions of six representative indicators of common pollutants between the years of 1970 to 2014! Thusly, the CAA laws define the EPA's responsibilities for protecting and improving the nation's outdoor air quality utilizing the advances in science and technology to accomplish this task (1). These outdoor air quality improvements have enabled many areas of the country to meet national air quality standards set to protect public health and the environment. To simply summarize: for more than 40 years the CAA has significantly cut outside air pollution even as the U.S. economy has grown. Because of the act, Americans breathe less outdoor air pollution and face lower premature death and other adverse health effects (1).

Indoor Air Quality (IAQ): Despite public health awareness and progress on outdoor air pollution, progress on indoor air pollution has significantly lagged behind. The quality of air inside homes, offices, schools, day care centers, hospitals and other health care facilities (where multi-drug resistant bacteria reside), as well as other private and public buildings where people spend a large part of their life, is also an essential determinant of health and well being. Interestingly, indoor air quality is profoundly important for two main reasons. First, most Americans spend about 90% of their time indoors! Second, the EPA has reported that indoor air pollution is 25 to 100 times worse than the outdoor air. However there are some standards for indoor air. For example, if you work with certain chemicals, sprayed substances, powders or known carcinogens or allergens, the Occupational Health and Safety Administration (OSHA), the EPA of the workplace, requires employers to reduce risk for workers (2). The EPA has also developed some additional IAQ tools for schools (3). Certainly also the WHO (World Health Organization) has a long tradition in synthesizing the evidence on the health aspects of air quality and in providing air quality guidelines defining conditions for healthy air (4). IAQ is a term, which refers to air quality within as well as around buildings and structures, especially as it relates to the health and comfort of the occupants (5). IAQ is affected by gases (such as carbon monoxide and carbon dioxide), volatile organic compounds (VOCs), particulates, microbes (including bacteria, viruses and mold fungi), allergens, odors of a variety of types, and anything else that might affect the quality of the air.

How We Make Each Other Sick: There are available techniques for cleaning indoor air, but in order to better understand these options it is imperative to first discuss the dynamics of how we make each other sick. The great majority of human infections, about 80%, are transmitted by direct and indirect contact and the remaining 20% of infections are transmitted by 3 other modalities, namely, common source (contaminated food or drink), arthropod vectors (such as

AtmosAir "Continuous Disinfection"



AtmosAir is the only SUPPLY SIDE indoor air treatment solution that continuously measures, monitors and *smartly* disinfects viruses and air in the occupied space.

TOP LAB STUDY

AtmosAir™

*Proven to Neutralize Coronavirus by More than **99.9%***

NEW RESULTS ANNOUNCED JUNE 2020

From bogus vaccines to fake testing sites, there's no shortage of products flooding the market erroneously promising to defend against COVID-19. But AtmosAir Solutions is proud to share that our bi-polar ionization technology is now verified by one of the preeminent laboratories for testing EPA and FDA registered sanitizing products.

RESEARCH

The purpose of the study was to determine the effectiveness of the AtmosAir Matterhorn Series device against Human Coronavirus Strain 229E at contact times of 30 minutes, 60 minutes, and 120 minutes. The researchers observed the viruses activity on a controlled surface and on a surface treated with the AtmosAir Matterhorn Series at varying temperatures.

IN A STUDY LAST WEEK, MICROCHEM LABORATORY, FOUND THAT:

*The presence of coronavirus was reduced by **99.92% within 30 minutes** of exposure to AtmosAir's bi-polar ionization technology*

OF THE FINDINGS

President and CEO of AtmosAir Solutions, Steve Levine, said "We are delivering a cost-effective, environmentally and socially sustainable public health product that can deliver results so that we can start coming together again safely."

"This result further validates how beneficial the active continuous disinfection with AtmosAir bi-polar ionization can be to neutralize Coronavirus," said Tony Abate, Vice President and Chief Technical Officer at AtmosAir Solutions.

ATMOSAIR IS THE LEADER IN BI-POLAR IONIZATION TECHNOLOGY AND...

- AtmosAir is over 99.9 percent effective in reducing the coronavirus on surfaces.
- AtmosAir's technology proactively emits bi-polar ions that attack and neutralize coronavirus in a continuous way.
- Unlike many unverified products, AtmosAir Solutions is backed by science.
- AtmosAir has been installed in 7,500 other commercial and residential buildings, sports facilities, airports, hotels, hospitals and casinos.

Table 2: Test Results at 30 minutes

		Test Results Replicate 1 30 minutes	Test Results Replicate 2 30 minutes	Test Results Replicate 3 30 minutes
Cell Control		0 0 0 0	0 0 0 0	0 0 0 0
Dilution	10^{-1}	0 0 0 +	0 0 0 +	0 0 0 0
	10^{-2}	0 0 0 0	0 0 0 0	0 0 0 0
	10^{-3}	0 0 0 0	0 0 0 0	0 0 0 0
	10^{-4}	0 0 0 0	0 0 0 0	0 0 0 0
	10^{-5}	0 0 0 0	0 0 0 0	0 0 0 0
$TCID_{50}$ per 0.1 ml		0.75 Log_{10}	0.75 Log_{10}	≤0.50 Log_{10}
$TCID_{50}$ per Carrier		1.05 Log_{10}	1.05 Log_{10}	≤0.80 Log_{10}
Average Log_{10} Reduction			2.78 Log_{10}	
Average Percent Reduction			99.92%	

Key: + = Virus recovered; 0 = Virus not recovered and/or no cytotoxicity observed; T = Cytotoxicity observed; *†Taking cytotoxicity and neutralization controls into account.*

Active BPI vs. Bacteria, Virus, Germs

"The negative and positive ions that are generated by AtmosAir BPI are designed to treat and allow energy imparted by the ions to transform ordinary oxygen into Hydroxyls. Ions cluster around harmful substances such as airborne molds, viruses, bacteria and allergens. Ions create a chemical reaction occurs on the cell membrane surface and rob the harmful substance of a hydrogen atom (H). The result is that they are inactivated by severing the protein on cell membrane, thusly destroying the entity.

It is most important to note that bipolar ionization kills microbes without damaging DNA in the interior of cells, unlike other physical and chemical agents, such as UV. My colleagues and I at NYU Medical Center have personally tested BPI, use it at the medical center, and recommend the technology regularly. It is 100% safe."

-Dr. Phil Tierno, NYU Langone Medical Center, Cleaning Indoor Air with Bipolar Ionization

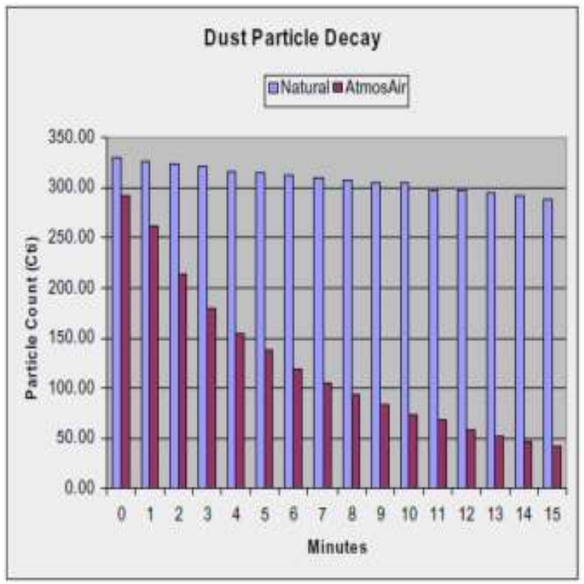
Removing From The Air Anything We Shouldn't Be Breathing

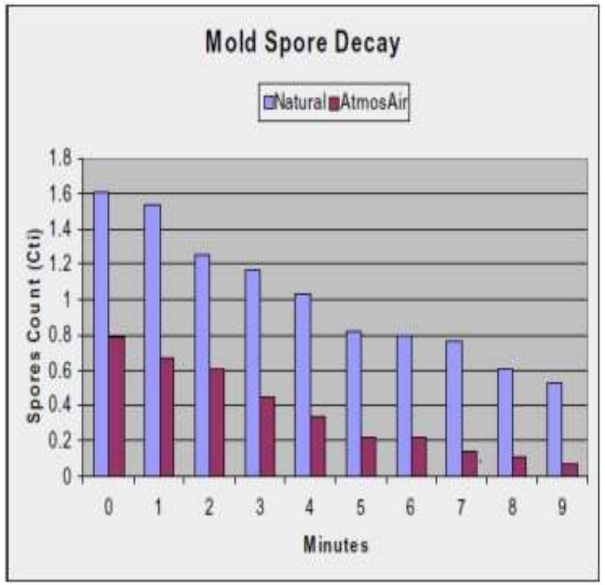
Effective on viruses, germs, dust particulates, molds, spores, VOCs

Volatile organic compounds (VOCs), particulate, allergens and asthmagens are potential pollutants that come from humans, building materials, carpets, finishes, cleaning products, office equipment, building densification, and outside air.

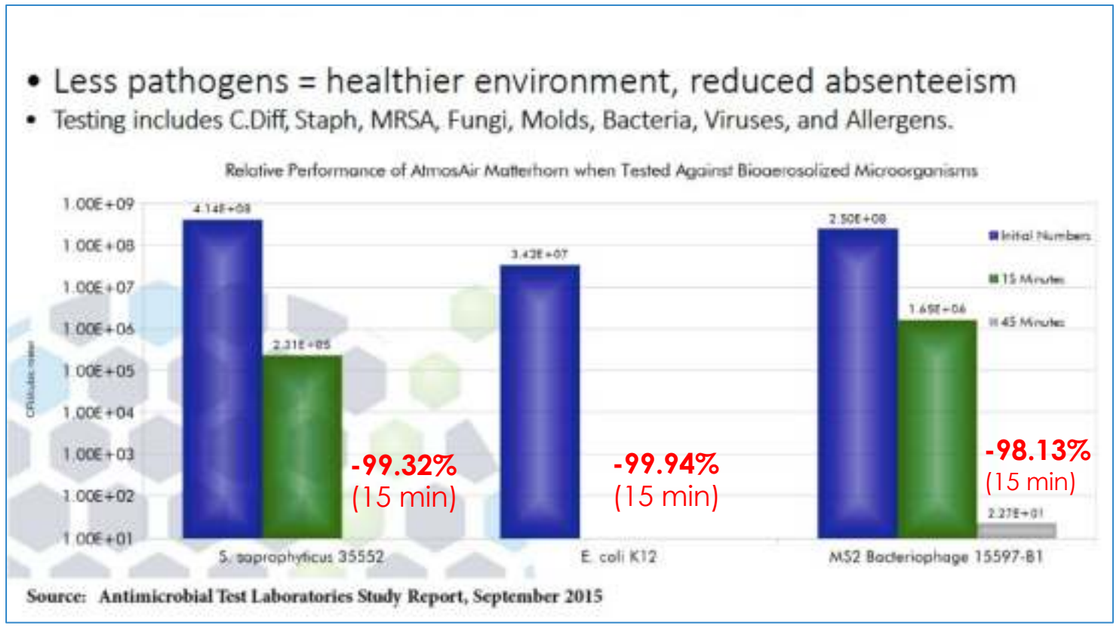
Ultrafine Particulate & Mold Spore Reduction Testing

by ETL Intertek Semco





Tested Results Against Virus and Microorganisms



Effect on VOCs

SYRACUSE UNIVERSITY
BUILDING ENERGY AND ENVIRONMENTAL SYSTEMS LABORATORY (BEESL)
263 Link Hall, Syracuse University, Syracuse, NY 13244-1240; http://BEESL.Syr.Edu

Table 5 Test2 Reduction rate after turning on the air cleaner

Time from turn on AC (hr)	hexane	2-butanone	iso-butanol	toluene	tetrachloroethylene	hexanal	ethylbenzene	decane
0.000	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.225	87.4%	84.3%	68.6%	87.1%	88.7%	79.6%	89.4%	93.7%
1.008	63.9%	63.8%	32.1%	57.4%	61.1%	36.9%	58.9%	65.6%
2.008	43.6%	36.6%	20.9%	31.9%	40.0%	12.9%	34.0%	36.3%
4.075	21.1%	25.7%	9.4%	11.2%	18.8%	5.1%	11.0%	12.4%

Conclusions

Test results showed good regression and repeatability between the two duplicate tests. Test indicated that the air cleaners reduced the concentrations in the chamber air (57.12 m^3 in volume) for Hexane by 94.6%, 2-Butanone by 91.1%, Iso-butanol by 97.1%, Toluene by 98%, Tetrachloroethylene by 94.5%, Hexanal by 97.5%, Ethylbenze by 96.3% and Decane by 96.4% over the 6 hours pull-down test period. These corresponded to the equivalent clean air delivery rate (CADR) for the two units tested to range from 12 cfm to 22.5 cfm, depending of the VOCs.

3rd Party Validation: Whitepaper by NYU Medical Center

Human Health Benefits Listed

- Decreased respiratory rate
- Decreased basal metabolic rate (reduces energy loss)
- Decreased blood pressure
- Produced a feeling of well being
- Increased vital capacity (airflow from the lungs)
- Decreased skin temperature
- Decreased blood sedimentation rate (a measure of inflammation)
- Increased ciliary activity (human airway defense system)
- Increased frequency of mitosis (production of new or replacement cells)
- Increased resistance to infection
- Suggested as therapy:
  - Migraine — Insomnia
  - Asthma — Hay Fever
  - Bronchitis — Conjunctivitis
  - Sinusitis — Chronic Rhinitis
  - Tuberculosis — Emphysema
  - Chlorine gas — Wound and Burn healing

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Dr. Philip M. Tierno Jr., Professor of Microbiology and Pathology, New York University School of Medicine

April 2017

Clean air, both outdoors and indoors, is an essential determinant of a healthy life and a person's

NYU Langone MEDICAL CENTER

Dr. Philip M. Tierno Jr.
Professor of Microbiology & Pathology
New York University School of Medicine

Steve Levine
AtmosAir Solutions/Clean Air Group, Inc.
418 Meadow Street, Suite 204
Fairfield, CT 06824

Dear Steve,

Thank you for your support of our school, and all your help with providing us with the best possible indoor environments, not an easy thing in New York City.

Feel free to use me as a reference regarding the efficacy of AtmosAir's air purification technology.

You can mention that I have evaluated AtmosAir and also personally use AtmosAir in my own home.

Myself, and my colleague Professor John Oxford, Chairman of the Hygiene Council and Professor of Virology at St Bartholomew's and the Royal London Hospital, Queen Mary's School of Medicine and Dentistry, have investigated and highly recommend AtmosAir bipolar ionization technology for air purification for indoor application, especially in medical facilities where the most antibiotic multi-drug resistant germs reside.

Please keep in mind that I generally do not endorse products but I make a qualified exception here because of AtmosAir's efficacy and the importance of air quality.

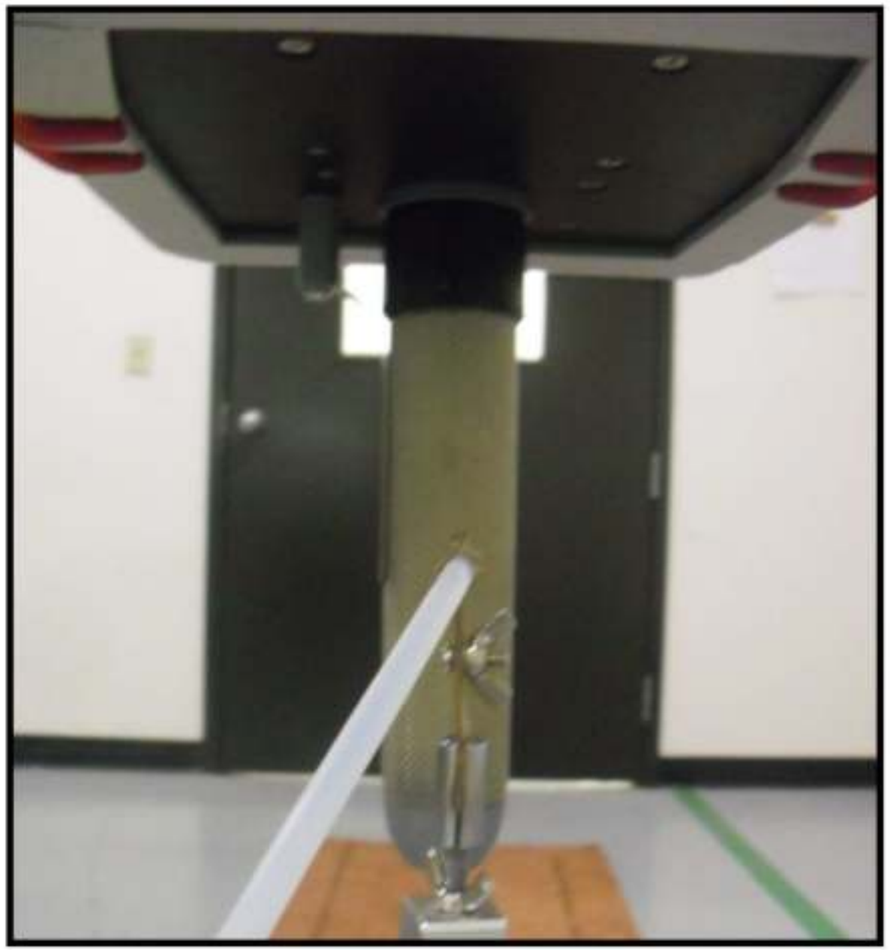
Also I'll be glad to answer any questions that anyone may have.

Regards,

Phil

Dr. Philip M. Tierno, Jr.
Professor of Microbiology & Pathology
NYU School of Medicine
NYU Langone Medical Center
US Member of the Global Hygiene Council

3rd Party Validation: Latest UL-867 & UL-2998 Ozone Testing



All AtmosAir products have passed latest UL-867 & UL-2998 Zero Ozone tests (measurable ozone compliance for electronic air cleaners)

Energy Efficiency with Bi-Polar Ionization

BPI Energy Opportunity

Airside efficiency is typically the largest untapped opportunity for building owners.

Bi-Polar Ionization:

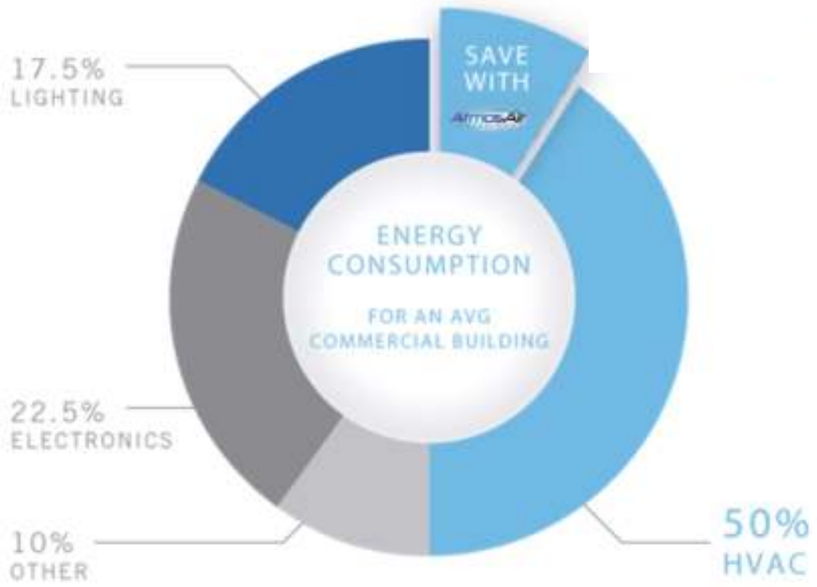
- Can Reduce OA Requirements up to 50% within ASHRAE 62.1/IMC code
- Takes up little space within duct a duct or air handler.
- Has little to no pressure drop.
- Requires negligible power to operate.

Capex Benefits:

- 15% Reduction in Equipment.
- Collateral Cost Savings in Installation, Piping, Electrical, Ductwork
- Potential 20-30% Reduction in HVAC Tonnage/Plant Sizes
- Less of an opportunity to bring in pollution from outside.

Opex Benefits:

- 20-40% Reduction in HVAC Energy Expenditures
- 4-8% Reduction on ENTIRE utility bill.
- Extend life of HVAC filters
- Extend life of HVAC equipment (sustainability)



ASHRAE 62.1 IAQ Procedure

ASHRAE established Standard 62.1 - Ventilation for Acceptable Air Quality

This standard governs ventilation rates needed in various environments, offices, schools, casinos, etc.

ASHRAE researches and develops standards with ANSI (American National Standards Institute). IMC (International Mechanical Code). IMC is the code compliance a project must conform to.

The IMC section which covers needed ventilation rates is Chapter 4 Section 403.

ASHRAE Offers Two Compliance Paths to Meet Ventilation Requirements:

1. **The Ventilation Rate Procedure (aka: VRP method) and**
2. **The Indoor Air Quality Procedure (aka: IAQ Procedure)**

62.1 Compliance Paths No 1: Ventilation Rate Procedure

The VRP method is the Prescriptive method where the needed outside air rate is predetermined within the 62.1 standard tables, as shown below:

TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values			Air Class
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s·person	cfm/ft^2	L/s·m^2		#/1000 ft^2 or #/100 m^2	cfm/person	L/s·person	
Correctional Facilities									
Cell	5	2.5	0.12	0.6		25	10	4.9	2
Dayroom	5	2.5	0.06	0.3		30	7	3.5	1
Guard stations	5	2.5	0.06	0.3		15	9	4.5	1
Booking/waiting	7.5	3.8	0.06	0.3		50	9	4.4	2
Educational Facilities									
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6	2
Daycare sickroom	10	5	0.18	0.9		25	17	8.6	3
Classrooms (ages 5–8)	10	5	0.12	0.6		25	15	7.4	1
Classrooms (age 9 plus)	10	5	0.12	0.6		35	13	6.7	1
Lecture classroom	7.5	3.8	0.06	0.3		65	8	4.3	1
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3		150	8	4.0	1
Art classroom	10	5	0.18	0.9		20	19	9.5	2
Science laboratories	10	5	0.18	0.9		25	17	8.6	2
University/college laboratories	10	5	0.18	0.9		25	17	8.6	2

62.1 Compliance Paths No 2: IAQ Procedure

The IAQ Procedure is an engineered alternative that requires the following steps be performed by the design engineer of record. (Simplified)

- **Perform VRP calculations for the space(s) chosen**
- **Identify the Contaminants of Concern typical to the type of space and their generation rates (ASHRAE Applications Handbook)**
- **Select a design approach to control these contaminants (Bi-Polar Ionization)**
- **Perform a mass balance analysis for each contaminant or mixture of contaminants to determine the minimum outdoor flow rates.**
- **Look at contaminant concentration levels in the space(s) using the design approach and mass balance analysis and compare those levels to standards and guidelines as published by recognized authorities. (OSHA, EPA, NIOSH, WHO, MAK, ACGIH, NAAQS)**

IMC - International Mechanical Code

The IMC also allows for an engineered alternative compliance path to the prescriptive rate, this is found in **IMC Section 403.2 Exception**

403.2 Outdoor air required:

The minimum outdoor airflow rate shall be determined in accordance with Section 403.3.

Ventilation supply systems shall be designed to deliver the required rate of outdoor airflow to the breathing zone within each occupiable space.

Exception:

Where the registered design professional demonstrates that an engineered ventilation system design will prevent the maximum concentration of contaminants from exceeding that obtainable by the rate of outdoor air ventilation determined in accordance with Section 403.3, the minimum required rate of outdoor air shall be reduced in accordance with such engineered system design.

Mass Balance Analysis – Yikes!

Below are the required Mass Balance Analysis Equations as found in ASHRAE 62.1

TABLE D-1 Required Zone Outdoor Airflow or Space Breathing Zone Contaminant Concentration with Recirculation and Filtration for Single-Zone Systems

Required Recirculation Rate			Required Zone Outdoor Airflow (V_{oz} in Section 6)	Space Breathing Zone Contaminant Concentration
Filter Location	Flow	Outdoor Airflow		
None	VAV	100%	$V_{oz} = \frac{N}{E_z F_r (C_{bz} - C_o)}$	$C_{bz} = C_o + \frac{N}{E_z F_r V_{oz}}$
A	Constant	Constant	$V_{oz} = \frac{N - E_z R V_r E_f C_{bz}}{E_z (C_{bz} - C_o)}$	$C_{bz} = \frac{N + E_z V_{oz} C_o}{E_z (V_{oz} + R V_r E_f)}$
A	VAV	Constant	$V_{oz} = \frac{N - E_z F_r R V_r E_f C_{bz}}{E_z (C_{bz} - C_o)}$	$C_{bz} = \frac{N + E_z V_{oz} C_o}{E_z (V_{oz} + F_r R V_r E_f)}$
B	Constant	Constant	$V_{oz} = \frac{N - E_z R V_r E_f C_{bz}}{E_z [C_{bz} - (1 - E_f)(C_o)]}$	$C_{bz} = \frac{N + E_z V_{oz} (1 - E_f) C_o}{E_z (V_{oz} + R V_r E_f)}$
B	VAV	100%	$V_{oz} = \frac{N}{E_z F_r [C_{bz} - (1 - E_f)(C_o)]}$	$C_{bz} = \frac{N + E_z F_r V_{oz} (1 - E_f) C_o}{E_z F_r V_{oz}}$
B	VAV	Constant	$V_{oz} = \frac{N - E_z F_r R V_r E_f C_{bz}}{E_z [C_{bz} - (1 - E_f)(C_o)]}$	$C_{bz} = \frac{N + E_z V_{oz} (1 - E_f) C_o}{E_z (V_{oz} + F_r R V_r E_f)}$

IAQP Design Software: **AtmosIQ**

Why the IAQ Procedure isn't more widely implemented:

- **It is difficult to apply & calculations are complicated & time consuming**
- **Design engineers are uncomfortable with identifying contaminants of concern, etc.**

The IAQP software performs the calculations for the design engineer and he or she can include these right into their ventilation design.

Credible manufacturers provide all required code documentation to meet:

ASHRAE 62.1 IAQP, ASHRAE 90.1, IEC and IMC 2012.

		Total OA Per VRP	Max Total Supply CFM					Pressurization Confirmation	Min Total Supply CFM	Pressurization Confirmation	Total OA with IAQ Procedure	Total Return Air CFM	
		6672	43399	Healthcare Requirements				Max Supply CFM	43399	Min Supply CFM	3336	40131	
	Table 6.2 Ventillation Effectivness Ez	Outdoor Air to Zone (CFM) with Ez correction (Vbz/Ebz)	Maximum Supply Air (CFM)	OA ACH	Meets Min OA ACH (Yes or No)	Total ACH	Meets Min Total ACH (Yes or No)	Maximum Supply Air > or = to Exhaust Air (Yes or No)	Minimum Supply Air (CFM) (VAV systems only)	Minimum Supply Air > or = to Exhaust Air (Yes or No)	Target OA CFM (IAQ Procedure) (50% of VRP)	Return Air	R
	0.8	692	6642	N/A	N/A	N/A	N/A	Yes	6642	Yes	346	6296	
	0.8	3546	17499	N/A	N/A	N/A	N/A	Yes	17499	Yes	1773	15726	
	0.8	812	7345	N/A	N/A	N/A	N/A	Yes	7345	Yes	406	6939	
	0.8	956	8607	N/A	N/A	N/A	N/A	Yes	8607	Yes	478	8129	
	0.8	75	0	N/A	N/A	N/A	N/A	Yes	0	Yes	38	0	
	0.8	60	0	N/A	N/A	N/A	N/A	Yes	0	Yes	30	0	
	0.8	316	1929	N/A	N/A	N/A	N/A	Yes	1929	Yes	158	1771	
	0.8	215	1377	N/A	N/A	N/A	N/A	Yes	1377	Yes	108	1270	

IAQP Design Software: **AtmosIQ**

Proprietary IAQP contaminant modeling software

Summary:

Example - Texas School Project						
Total Zone Square Footage	Total Number of Occupants	Total OA Per ASHRAE 62.1 VRP	Max Total Supply CFM	Min Total Supply CFM	Total OA with AtmosIQ and IAQP	Total Return Air CFM
39370	1043	13723	57910	30990	6861	51049

Input Data:

Zone Tag	Area Served	Space Occupancy	Zone Type	Zone Room Area (square feet) Az	Zone Max Occupancy (# of people) Pz	Table 6.1 Outside Air per Occupant Rp	Table 6.1 cfm/ft^2 Ra	Pz*Rp	Az*Ra	Air Distribution Configuration
RTU-3	Student Dining	Educational Facilities	Cafeteria/fast food dining	1850	125	7.5	0.18	937.5	333	Ceiling Supply of cool air
RTU-4	Student Dining	Educational Facilities	Cafeteria/fast food dining	1850	125	7.5	0.18	937.5	333	Ceiling Supply of cool air
RTU-25	Life Skills Classroom	Educational Facilities	Classrooms (ages 9 plus)	1000	25	10	0.12	250	120	Ceiling Supply of cool air
RTU-26	Classroom 109	Educational Facilities	Classrooms (ages 9 plus)	666	25	10	0.12	250	79.92	Ceiling Supply of cool air

Getting Started – Required Information

AtmosAir Project:		Building Information Required					
Rep:					Date:		
MEP Engineer:							
Zone TAG	Space Occupancy Type	Zone Type	Zone Room Area [square feet] Az	Zone Max Occupancy [No of People] Pz	Maximum Supply Air (CFM)	Minimum Supply Air (CFM) (VAV systems only)	Zone Height (Ft)

IAQP FAQ

Can the IAQP be used with a DOAS (Dedicated Outside Air System)?

A) Yes. In a new design the IAQP can allow for possible downsizing of the DOAS unit due to lower OA requirements.

In a retro-fit this may be difficult as the DOAS airflow was typically designed to maintain a pressurization balance.

Also unless a VFD or some other control is integrated these systems airflow is not adjustable.

Can the IAQP be used with 100% OA systems?

A) YES. See above.

LEED Performance Credit 124

USGBC now allows the IAQp to be used in a LEED Project

INDOOR ENVIRONMENTAL QUALITY		POSSIBLE: 16
Prereq	Minimum IAQ performance	REQUIRED
Prereq	Environmental tobacco smoke control	REQUIRED
Credit	Enhanced IAQ strategies	2
Credit	Low-emitting materials	3
Credit	Construction IAQ management plan	1
Credit	IAQ assessment	2
Credit	Thermal comfort	1
Credit	Interior lighting	2
Credit	Daylight	3
Credit	Quality views	1
Credit	Acoustic performance	1

INNOVATION		POSSIBLE: 6
Credit	Innovation	5
Credit	LEED Accredited Professional	1

Table 1. Maximum concentration levels, by contaminant and testing method

Contaminant			Maximum concentration	ASTM and U.S. EPA methods	ISO method
Particulates	PM10 (for all buildings)		50 µg/m³ Healthcare only: 20 µg/m³	EPA Compendium Method IP-10	ISO 7708
	PM2.5 (for buildings in EPA nonattainment areas for PM2.5, or local equivalent)		15 µg/m³		
Ozone (for buildings in EPA nonattainment areas for Ozone, or local equivalent)			0.075 ppm	ASTM D5149 - 02	ISO 13964
Carbon monoxide (CO)			9 ppm; no more than 2 ppm above outdoor levels	EPA Compendium Method IP-3	ISO 4224
Total volatile organic compounds (TVOCs)			500 µg/m³ Healthcare only: 200 µg/m³	EPA TO-1, TO-17, or EPA Compendium Method IP-1	ISO 16000-6
Formaldehyde			27 ppb Healthcare only: 16.3 ppb	ASTM D6197, EPA TO-11, or EPA Compendium Method IP-6	ISO 16000-3
Target volatile organic compounds*	1	Acetaldehyde	140 µg/m³		
	2	Benzene	3 µg/m³	ASTM D5197; EPA TO-1, TO-17, or EPA Compendium Method IP-1	ISO 16000-3, ISO 16000-6
	3	Carbon disulfide	800 µg/m³		
	4	Carbon tetrachloride	40 µg/m³		
	5	Chlorobenzene	1000 µg/m³		
	6	Chloroform	300 µg/m³		
	7	Dichlorobenzene (1,4-)	800µg/m³		
	8	Dichloroethylene (1,1)	70 µg/m³		
	9	Dimethylformamide (N,N-)	60 µg/m³		
	10	Dioxane (1,4-)	3000 µg/m³		
	11	Epichlorohydrin	3 µg/m³		
	12	Ethylbenzene	2000 µg/m³		
	13	Ethylene glycol	400 µg/m³		
	14	Ethylene glycol monoethyl ether	70 µg/m³		
	15	Ethylene glycol monoethyl ether acetate	300 µg/m³		
	16	Ethylene glycol monomethyl ether	60 µg/m³		
	17	Ethylene glycol monomethyl ether acetate	90 µg/m³		
	19	Hexane (n-)	7000 µg/m³		
	20	Isophorone	2000 µg/m³		
	21	Isopropanol	7000 µg/m³		
	22	Methyl chloroform	1000 µg/m³		
	23	Methylene chloride	400 µg/m³		
	24	Methyl t-butyl ether	8000 µg/m³		
	25	Naphthalene	9 µg/m³		
	26	Phenol	200 µg/m³		
	27	Propylene glycol monomethyl ether	7000 µg/m³		
	28	Styrene	900 µg/m³		
	29	Tetrachloroethylene (Perchloroethylene)	35 µg/m³		
	30	Toluene	300 µg/m³		
	31	Trichloroethylene	600 µg/m³		
	32	Vinyl acetate	200 µg/m³		
	33-36	Xylenes, technical mixture (m-, o-, p-xylene combined)	700 µg/m³		

Products & Installation

Different Air Purification Technologies on the Market

- **Ultra Violet Light (UV-C)**
  - Limited to prevent bacteria & viruses on the coil only (**not** in the space)
  - Needs 6-10 Sec @ 6” from Light source to kill viruses & Bacteria
  - 75 ft of duct needed at 800 ft/min velocity
- **PCO/PhotoCatalytic Oxidation**
  - Generates Hydroxyls that work best on bacteria, **not** VOCs & particulates
  - Hydroxyls have a half life of only 1-2 sec…..will only travel 25 ft.

- **Enhanced Filtration**
  - MERV 13 to MERV 16 & HEPA: can only clean the air going through the filter, high static pressure
- **Electronic Air Cleaners**
  - Single Polarity Ionization: works only on particulates, captured on media or collector plates
  - Does **not** work on pathogens, VOCs, odors
- **Bi-Polar Ionization (BPI):** Only technology that works in the space
  - Only Use Products that have passed UL-867 or UL-2998 Ozone tests: Key: No Ozone in Occupied Spaces
  - **Dielectric Barrier Discharge (DBD) Tubes (since 1950s in Europe):** Highest “Ion Volt Potential” (*Ev over 12.60*)
    - Only BPI system to produce “Superoxide Anion” that destroys pathogens. 1000s of sustainable reactions.
    - Works on longer duct runs. Newer patented composite core tubes, no glass tubes, more ion power, longer life, larger commercial projects.
  - **NeedlePoint BPI (since 2005):** Lower “Ion Volt Potential” *(Ev under 12.00)*
    - No Superoxide Anion, rapid ion decay, fewer reactions, limited duct runs, best for smaller spaces

Large Induct Systems

508FC

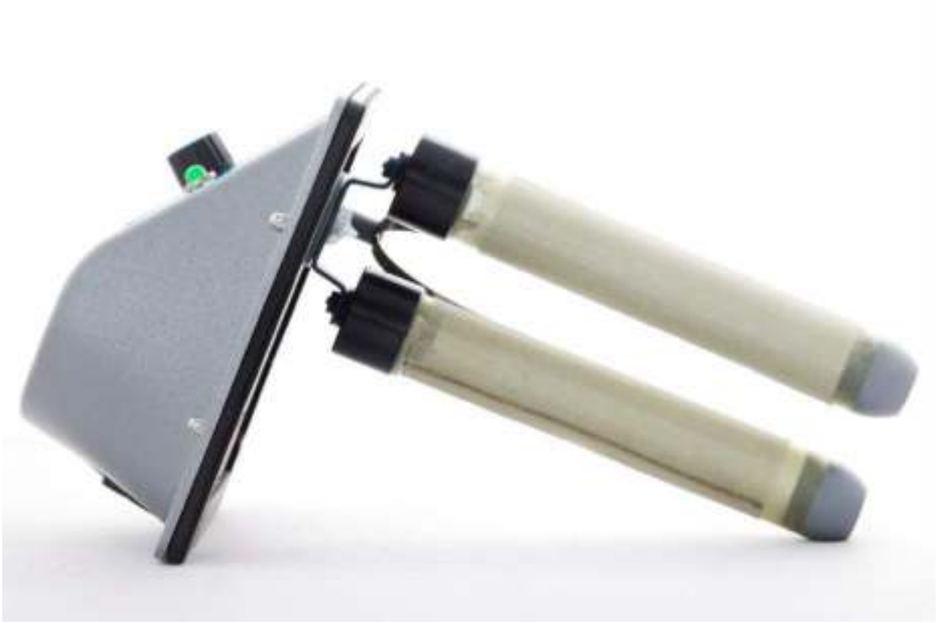
500FC & 500FC

Large Induct Systems			
	508FC	500FC	500EC
Number of Tubes	8	5	5
CFM	15,000	10,000	8,000

Products have been tested to UL 867 Ozone Standard (induct products): No measurable ozone

Small Induct Systems

Matterhorn M880 & 1000 Series



FC400 Series

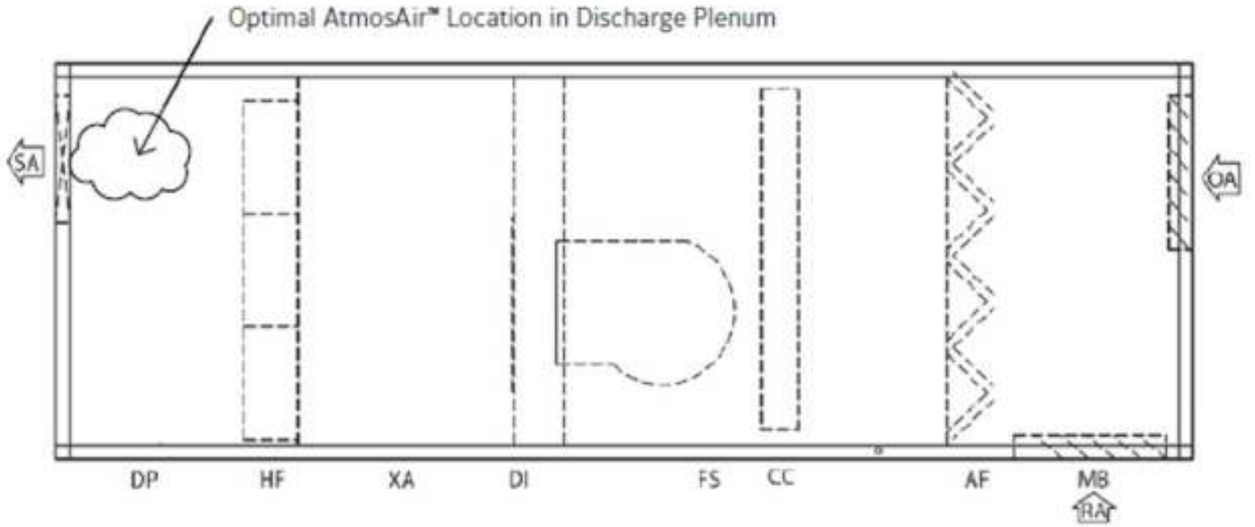
Small Induct Systems			
	M1000	M1002	FC400
Number of Tubes	1	2	1
CFM	2,500	5,000	1,400

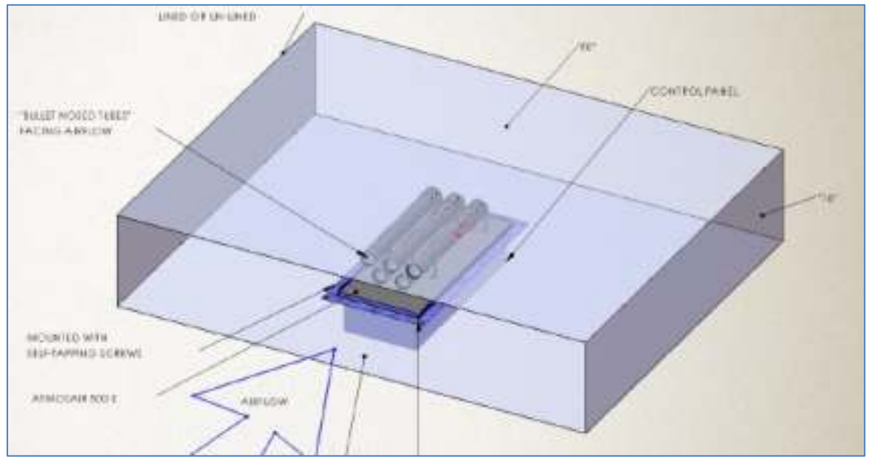
Products have been tested to UL 867 Ozone Standard (induct products): No measurable ozone

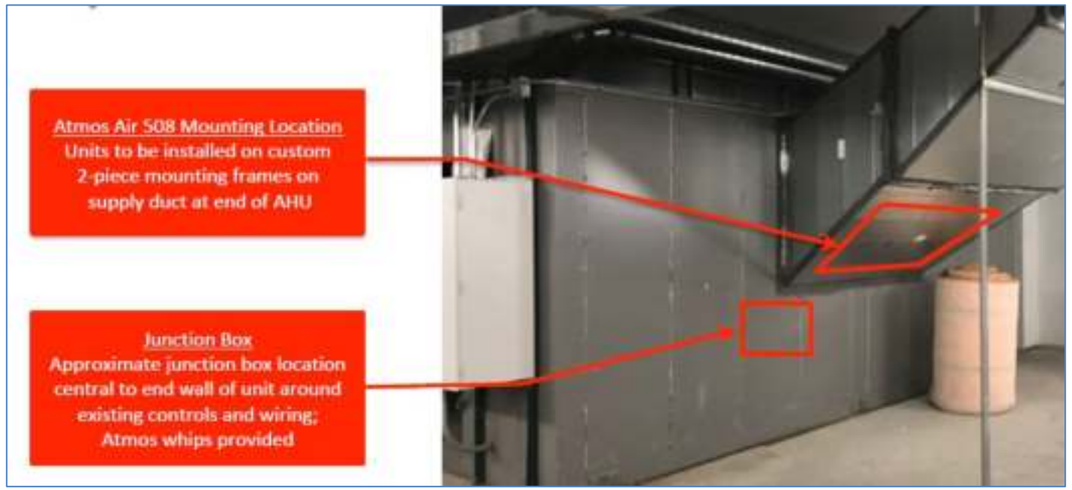
AtmosAir Placement - In AHU or Duct

Application and Placement

The AtmosAir™ bipolar ionization system is intended to be mounted in the discharge plenum of an air handler, operating only when airflow is present. Thus, power to the ionization unit should be interlocked with fan operation or controlled via an air pressure switch. The size and number of recommended systems is dependent upon the airflow, the size of the space and the severity of pollution and odors. The level of ionization is adjustable.







AtmosAir Installation Locations

- Supply Duct Mount
- Rack or Wall Mounted in Discharge of AHU/RTU

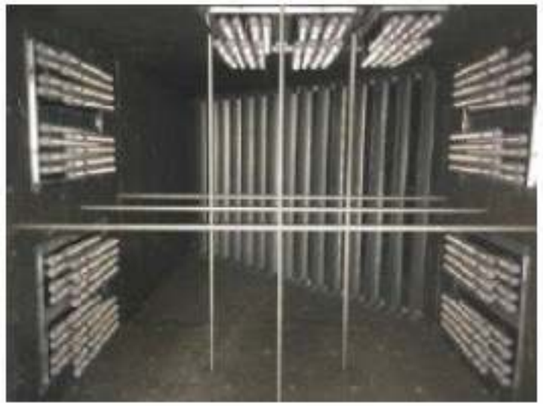
AtmosAir Installation Locations

- Supply Duct Mounted
- Rack Mounted in AHU Supply (Discharge) Plenum
- Duct Mounted in AHU Main Supply
- Supply Duct Mounted with Exterior Insulation
- Exterior Duct Mounted with Custom Weatherproof Enclosures (RTU installation)
- Wall Mounted on Custom Frame in AHU Supply Chamber
- Duct Mounted in Custom Frame

Exterior Duct Mounted with Custom Enclosure

Rack Mounted AHU Supply Plenum

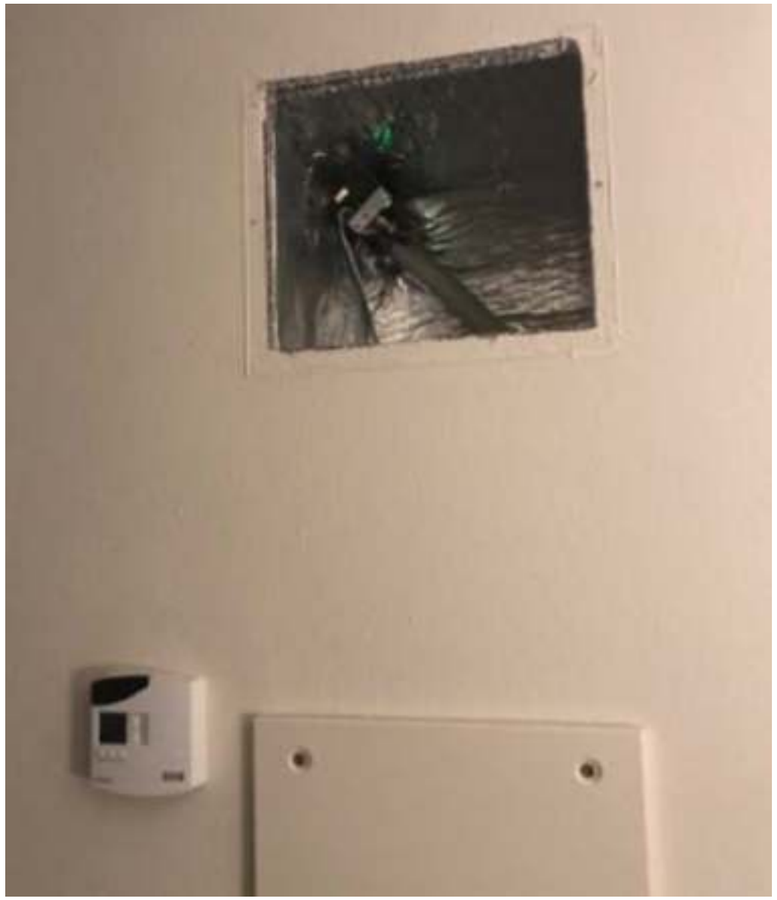
Duct Mounted in AHU Main Supply



Duct Mounted in AHU Main Supply

AtmosAir Installation Locations

AtmosAir FC400 in FCU



AtmosAir FC100 in FCU

AtmosAir FC400 in Cassette/VRF

- Mounted in Supply or Return of FCU/PTAC/Cassette

Measurement, Verification, and Control

AtmosAware (Sensedge) Air Quality Monitoring

AtmosAware Real-time Measurement and Verification

Air quality monitor made for healthy buildings
Know what is in the air, instantly and accurately:
Sensedge offers 24/7, real-time IAQ monitoring

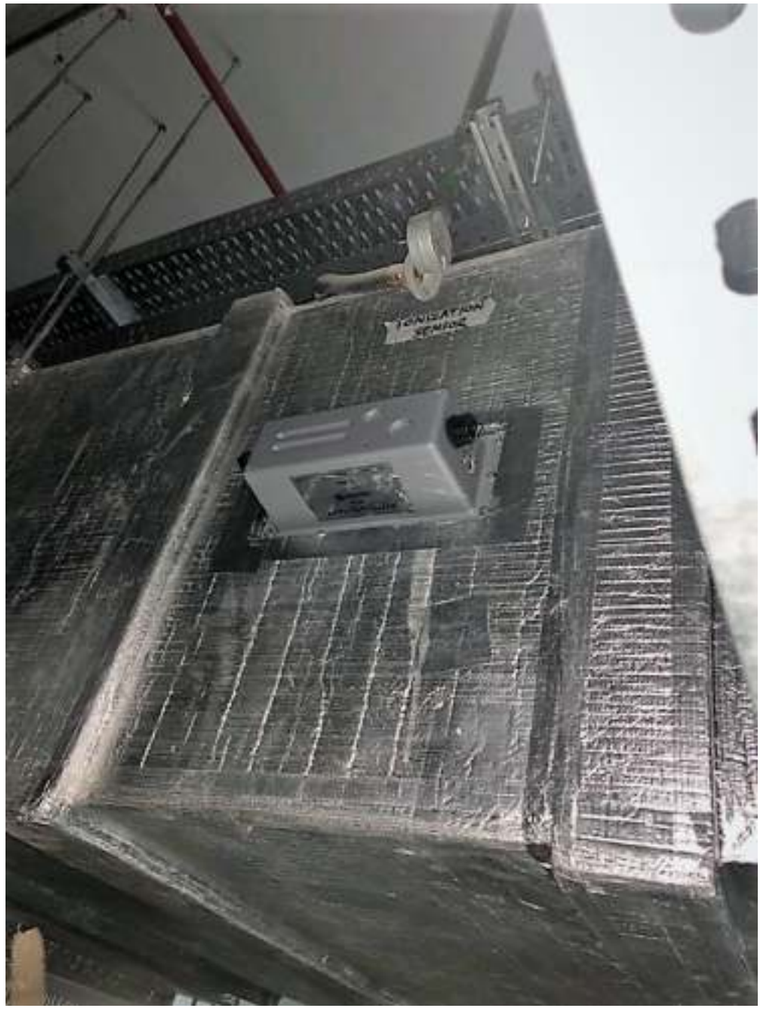
PM2.5 AQI TVOC CO2
TEMPERATURE HUMIDITY

Display Local Outdoor Air Quality and Indoor Air Quality on SmartPhone, App, or Monitor

Dynamic Control BPI Purification: **AtmosSmart**

- **Smart sensor arrays designed to be installed in the RETURN duct of a Typical HVAC AHU system.**
- **This array captures and senses air quality brought back from the treated space through the air return and measures a number of different parameters to control the purification levels of the air purification system it is connected to.**
- **Measures and control based on Particulate Matter (PM2.5), Relative Humidity, Temperature, Carbon Dioxide (CO2), Total Volatile Organic Compounds (TVOC), Formaldehyde, and Ozone(O3).**

Dynamic BPI Control and Air Purification



Case Studies

Case Study | US Army – Fort Belvoir

US Army – Fort Belvoir
Virginia

SITUATION

- BPI was looked at as part of energy efficiency/IAQ strategy
- NEVESD has over 50 buildings on Fort Belvoir Campus

IMPLEMENTATION

- BPI installed into AHUs
- Air Sampling taken by Fort Belvoir team
- AHUs were metered and energy readings were taken
- ASHRAE 62. Indoor Air Quality Procedure Applied

Case Study | US Army – Fort Belvoir

Fort Belvoir Power and IAQ Testing	Before	After	Percentage Difference
Power			
Outside Air	40%	5% (5 CFM Per Person)	-35%
Energy Consumption Costs	$363,232	$306,235	$56,996
Avg amps/kWh rooftop readings	29.6	23.06	28%
Avg kWh rooftop readings	3.44	2.65	23%
IAQ			
PM2.5	19	5	-74%
PM10	24	7	-71%

RESULTS

Systems were paid back in less than three years with HVAC cost savings. IAQ was dramatically improved.

BPI is now installed in > 45 US Army Buildings.

U.S.ARMY

Case Study | GENSLER

Pilot

AtmosAir was first installed throughout Gensler's LA offices, 'The Gensler Jewel Box.
Advanced air testing showed measurable reductions in IAQ contaminants:

- **40% reduction in VOCs**
- **34% reduction in PM10 particles**
- **30% reduction in PM2.5 particles**

Results

- AtmosAir has worked with Gensler on over 30 projects.
- AtmosAir/AtmosAware is now installed in 5 Gensler offices. (LA, NYC, CHI, Shanghai, SF)
- Gensler San Fransisco is monitoring their air quality with AtmosAware indoor air monitors.
- Gensler produced a short video on AtmosAir technology in 2017.

Gensler

"AtmosAir BPI has been a technology that we have been promoting since our installation in Los Angeles. We are constantly promoting advanced air purification and air monitoring to our clients and we feel very secure with this product recommendation based around the extensive testing they have performed for us."

— Joseph Brancato, Principal, Gensler, New York

Gensler LA Jewel Box

Case Study | Jaros Baum & Bolles NY (MEP)

"To bring fresh, outdoor air into a building consumes space, raises capital costs and requires energy to heat and cool this air. But it can be done in a feasible way. With BPI, you can nearly eliminate mold spores, VOCs, and other unwanted particles — and save on your energy bills at the same time."

— Scott Frank, Partner, JB&B – Crain's New York Business July 2016

Results

AtmosAir was installed throughout JB&B's New York Offices. .

90% reduction in VOCs

75% reduction in PM2.5 particles

JBB
JAROS BAUM & BOLLES

AtmosSmart at JB&B Offices

Case Study | Staples Center

Staples Center
Los Angeles, CA

SITUATION

AEG Facilities has set aggressive missions regarding energy efficiency and sustainability. AtmosAir and independent laboratory EMSL tested the air qualities in Staples Center's Lexus Club, a private dining room located inside the Staples Center. AEG/Staples Center engineering wanted a baseline measurement of contaminant levels with the air handling and filter systems operating as installed, and later with bipolar ionization systems working in the same air space, using reduced outside air. After a successful test in the Lexus Club, the Staples Center engineering team wanted to determine if AtmosAir systems generated an electrical energy savings when installed in a large arena.

IMPLEMENTATION

The AEG Facilities engineering team tested HVAC power demanded in a "before and after" AtmosAir test. Weather conditions were identical. The "before" test was 48-hour test with BPI purification systems installed and operating, and the dampers set in a position for reduced outside air. The "after" test was a 48-hour test beginning immediately after the BPI purification "before" test. The outside air dampers were returned to normal, automatic operation.

Case Study | Staples Center

"We have proven that the BPI system does in fact provide cleaner air, and a savings in electrical energy. This system helps us in our efforts towards becoming more sustainable."

– Bill Potoroff, VP, AEG

RESULTS

Air quality, especially gaseous elements, VOCs and TVoc, improved significantly from baseline measurements to measurements taken with BPI systems installed and outside air reduced.

- **Energy Savings: 21%**
- **PM10 Reduction: 25%**
- **TVOC Reduction: 90%**

BPI is currently installed throughout the entire arena. Third party air testing was performed by EMSL laboratories.

Case Study | Los Angeles International Airport

Los Angeles World Airports

Los Angeles International Airport
Los Angeles, CA

SITUATION

- Unpleasant jet fuel (VOC/hydrocarbon) odors
- Unpleasant odors from retail spaces
- Food and restaurant odors
- General IAQ concerns/complaints

IMPLEMENTATION – Terminals that installed AtmosAir

- Midfield (750k Square Feet, 2018)
- Tom Bradley International Terminal
- Terminal 1, 3, 4, 5 and 7

Case Study | Los Angeles International Airport

"AtmosAir's Bi Polar Ionization technology, from what we have found and tested, works well to combat jet fume odors to improve air quality here at LAX. We have all the terminals with AtmosAir systems in place and they require very little maintenance and have worked for us as intended – to purify the air and also clean and purify the HVAC system. We have been very satisfied with this technology."

– Rich Yakel, Manager, Los Angeles World Airports, HVAC and Maintenance

RESULTS

- Reduced VOCs by 90%.
- Installed in 200+ different AHUs
- Over 400 AtmosAir Systems installed
- Service contract to maintain and repair
- No IAQ complaints in over three years
- AtmosAir has been specified in transportation projects at O'Hare Airport, Charlotte Airport, LaGuardia Airport, and more.

Case Study | University of Southern California

University of Southern California John McKay Center

SITUATION

BPI systems were installed at the University of Southern California's John McKay Center. USC's new $70 Million,100,000-square foot athletic and academic facility is a powerful symbol of the rich USC history. Third party indoor air quality testing was completed to test the effects of the BPI technology.

IMPLEMENTATION

USC chose 5 areas within the training facility for testing. They included the football training center, the weight room, the locker room, and two open spaces on the first and second floors.

Case Study | University of Southern California

University of Southern California John McKay Center

RESULTS

BPI improved indoor air quality significantly, and the reduction of particulate matter and TVOC was substantial.

PM10 particles are small enough to be breathed in and enter the lungs. These particles can cause illness and discomfort. TVOCs are gaseous elements that can cause odors and irritations.

- **VOC Reductions: 90%**
- **PM2.5 Reduction: 50%**
- **PM10 Reduction: 95%**

BPI is currently installed in multiple USC Athletic Facility buildings, including the entire John McKay Center and Heritage Hall.

"At USC we believe performance both on and off the filed is tied to IAQ and keeping our student-athletes healthy. BPI has helped our facilities in many ways." – Russ Romano, Assistant Athletic Director, USC

Questions ?