

Should Ionization be Part of an Effective IAQ Strategy

August 17, 2021



Negative Ionization News

- Global Plasma Solutions is sued in a class action lawsuit claiming GPS made false advertising statements and claims for financial gains.
- Trane tests ionization. Mixed results on ionization benefits.
- Boeing tests ionization and determines it does not clean surfaces.
- 3 Colleges (Portland State University, Illinois Tech and Colorado State University) test ionization and question if ionization works.
- Several media outlets run stories about ionization manufacturers taking advantage of consumers especially schools spending federal grants on ionization.
- Ionization competitors putting out articles/reports attacking ionization claims.
- Articles questioning ion testing procedures and their results.



Negative Ionization News

- Some commentators say that ionization has not been around long enough to have been peer reviewed.
- When researching ionization online, some articles show how well ionization works and some articles talk about how ionization doesn't work.
- Boeing conducted testing on ionization. Their conclusion was they could not duplicate other 3rd party testing.
- Several major HVAC companies are not utilizing ionization:
 - Trane
 - JCI
 - Siemens
 - Watsco
- Much of this information is very technical. It is hard to know what studies and data are accurate even if you are a technically savvy.





iAIRE's Opinion on Ionization

- Ionization has been around for more than over 100 years.
- Claims made by other ionization manufacturers have hurt the ionization industry as a whole and many of these claims are not true.
- Ionization is not the "magic bullet" that will solve all indoor air quality issues.
- Ionization is a very good air cleaner and purifies the space.
- Ionization does help remove SARS-CoV-2 from the air when used properly.
- Ionization has proven to remove 436 VOCs of a total of 477 from the air when used properly.
- Ionization should be used properly with the rest of the HVAC system to deliver predictable results.
- Ionization helps agglomerate particulates in the air which leads to better filter efficiencies. –
 Proven to increase MERV Ratings by 4 5 MERV (MERV 8 to 13 and MERV 12 to over 16)
- Ionization has the lowest total installed cost to help improve indoor air quality. Low to no maintenance costs or replacement parts and components.
- Ionization is easy to install.
- Most of the cleaning done by the ions are done near the device producing the ions.
- Ionization does very little surface cleaning.
- Monitoring ionization in a space does not guarantee that the air is clean.
- iAIRE does not recommend downsizing the HVAC system with the use of the ASHRAE 62 IAQ procedure.



Ionization has been around forever

- Ionization occurs naturally like rain, waterfalls, high mountain regions so ionization has existed on Earth since water first formed on the planet.
- Ionization has been known for many years having been recognized by the Father of Modern Chemistry, JJ Thompson, in 1899.
- It has been tested by numerous universities and manufacturers.
- Ionization has been shown to be a very effective air cleaner when properly used.
- The production of ions has changed in the last 15 years as it was determined that ionization could produce ozone that was harmful to humans if produced improperly.
 - Reduced ion output to eliminate ozone.
 - Meet UL867 standard.



Ionization has been around forever



ASHRAE journal

September 1966



DUANE D. PEARSALL

There is much evidence of the effects of static electricity, ranging from the expenses of sparkignited fires to static discharges caused by walking across carpets. Many industries have been plagued with economic losses from statics generated in moving processes, and have developed products for its control. Most of these applications involve static charges which are large enough to create sparks or strong enough to force relatively large particles to move through air to a surface on which there is a static potential. The clean room static hazard is more subtle, and therefore requires a greater understanding of the methods by which static is generated, since static can seriously interfere with the cleanliness of the ultimate product.

Distribution of ions by air for effective control of electrostatic charges

Static electricity is produced by the action of contact and separation of dissimilar materials. The technical explanation that has long been accepted describes the interaction of electrons between two surfaces as they come into contact. Upon separation, the electron will attempt to return to its source material, and the speed of separation of the two surfaces results in the electron remaining predominantly with the more resistive material. The more resistive material then has a surplus of electrons and is called negatively charged. The other material, being less resistive, now has a deficiency of electrons or is positively charged. Rubbing two materials together is simply a multiple contact and separation process creating higher levels of static potential. A metal part on a metal table or a stack of plastics bags behaves in the same manner.

From the description of the methods of static generation and the many materials involved, a generaliza-tion can be made. A clean room, because of the many non-conductive surfaces, is inherently an area susceptible to high static generation. It should be noted that the generation of static electricity cannot be prevented. We must, therefore, find ways of neutralizing or con-

Dume D. Pearsall is President, Statistal Corp., Denver, Cola. This Groundling paper was presented at the ASHRAE Region IX Conference in Denver, April 14-16, 1966.

The most common method of controlling statics is to maintain a high relative humidity in the space. A high absolute moisture content in the air itself, in grains of moisture per lb of dry air, has little or no effect on static generation or dissipation. The effect of a high relative humidity creates, on the surfaces of materials in the space, a film of moisture which acts as a surface conductor draining off static charges. The higher the relative humidity in the space, the faster the rate of static removal.

The subject of moisture control involves many considerations. Adding humidity is relatively inexpensive, although its accurate control is difficult and its side effects may be undesirable.

The growing requirements in the aerospace industry, in particular, demand extremely low moisture levels, often necessitating dew points far below the freezing level to prevent damage to sensitive components which might corrode in storage or where moisture might condense on these parts as a part of a space vehicle operating at cryogenic temperatures.

Effective grounding and bonding of personnel and sur-

ASHRAE JOURNAL September 1966

SUMMARY

The average clean room facility is not equipped with static measuring devices. The clean room operator usually does not recognize that static precipitates dirt like a magnet, and that static is virtually impossible to pre-Without instrumentation, static will not be recognized unless the potential exceeds 3000 to 5000 v; other words, a sufficient amount to create a spark that can be felt. A 400-v potential is enough to cause a

Heavy dust particles will precipitate to static potentials as low as 1500 v. The infinitely small particles that today's clean room operator must avoid may precipitate to his product at potentials under 500 v.

The purpose of this article is to demonstrate that static potentials can be controlled or eliminated in any area of a clean room by creating an atmosphere essentially saturated with ions of each polarity. The control of statics is fundamental to an efficient clean room operation. These tests have demonstrated one method of creating electrical charges for effective static control. It is suggested, therefore, that the electrical characteristics of the clean room atmosphere be considered as a controllable variable in the same margier as we recognize humidity, temperature and air cleanliness as con-trollable variables.

APPENDIX A. IONIZATION DISTRI-BUTION BY AIR-HANDLING SYSTEMS

The term air conditioning, in its broadest sense, implies control of any or all of the physical and chemical qualities of the air. As defined in Chapter 67, Comfort Air Conditioning, it is the process of treating air to control simultaneously its temperature, humidity, cleanliness and distribution to meet the comfort requirements of the occupants of the conditioned space.

There are no less than 300 technical papers relating to the physiological characteristics of ionization.

Most of the papers suggest some value in the generation or control of ionization. We have found no information to suggest that ionization is unhealthy to the human environment. This Appendix considers the possible use of bi-

polar ions distributed by air-conditioning ducts to reduce electrostatic charges in the conditioned space. If static charges on surfaces can be eliminated, then one of the forces causing dirt deposition on walk, ceilings or other surfaces is removed. However, before any practical use of ions can be made, it must first be established that these ions can be generated in quantity and then distributed in an economical manner.

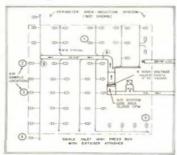
The following brief test was conducted Tuesday. April 12, in a typical air-conditioned office space. Fig. A-1 shows the floor area of the entire sixth floor of the Denver Club Building. The core area of approximately unit of approximately 12,000 cfm.

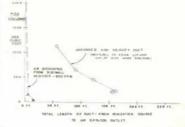
The four ionizer discharge points are located at the fan outlet in an air velocity of 2600 fpm. Air velocity at point A is 5109 fpm and at point B it is 3220 fpm. At the terminus of each branch duct is a high-velocity sound attenuator box. The diffuser assembly is mounted directly to the box. For these tests, the core of the diffuser was removed for ease of air sampling. Since each of the boxes is manually regulated by a high-pressure valve, the system air distribution pattern was not

Fig. A-2 is a summary graph of the averages of the cordings made at five different locations. Location I (Fig. A-1) is the eksest sampling to the ionization source In each test the air-sampling moter was placed on a Sft step ladder, 26 in, below the diffuser outet. In each location a minimum 5-min recording was taken with the onizer on, and a separate recording was taken with the ionizer off to establish a base trace at each location. The figure reflects the net difference in ion concentration

Fig. A-1 Flour area of the sixth floor of the Dencer Club Building

Fig. A-2 Ion density decay rate per lineal foot





ASHRAE JOURNAL September 1966



False Claims by other manufactures

- Ionization will solve all your indoor air quality issues.
 - It is a "magic bullet" solution
- Ionization is a good surface cleaner.
- Monitoring ionization in the space guarantees that the air is clean.
 - There are appropriate levels of ionization in the space that ensures clean, healthy air
- There is only one manufacturer of ionization that is UL867 certified.
- Ionization output on submittals is accurate.
- Other ionization manufacturer's ionization product is inferior.

ı





False Claims by other manufacturers

- 1. Ionization will solve all indoor air quality issues. It is a "magic bullet" solution.
 - Ionization is **not** an end all solution for indoor air quality. It is a very good air cleaner when used appropriately.
- 2. Ionization is a good surface cleaner.
 - Testing done by iAIRE as well as many other sources has shown there is a small amount of surface cleaning provided by ionization, but ionization should **not** be relied upon to clean surfaces.
 - Some other technology should be used to clean surfaces.
- 3. Monitoring ionization in a space guarantees that the air is clean.
 - All ionization monitoring reports is the presence of ions in the space. It does not indicate if the monitored air is clean or dirty
 - In systems that are installed and working properly, small amounts of ions will be present in the space. These ions do help to clean pathogens from the air, but the bulk of the cleaning is done very near the ionization device, normally after the fan.
 - Monitoring VOCs indicates if the air is clean or unhealthy. iAIRE recommends the use of VOC sensors **with** ionization generators for proper feedback of the condition of the air space.
- 4. There are precise levels of ionization in a space that ensures clean air.
 - As stated above with ionization monitoring, a specific level of ionization in a space does not guarantee the air in the space is clean and healthy.
- 5. There is only one manufacturer of ionization that is UL867 certified for **NO** ozone Production.
 - Almost every major US manufacturer of ionization has UL867 certification



False Claims by other manufacturers

- 6. Ionization output on submittals is accurate.
 - The published data of manufacturers of ionization is very different than what iAIRE has tested under controlled conditions. How do these manufacturers really know what is required to clean the air. How can a device with a lower ion count clean more CFM?

| | Max tested Ion count (Millions) | | | Published Ion C | Counts (Millions) | Difference | Published | Actual |
|----------------------|---------------------------------|-----|--------------|-----------------|-------------------|------------|---------------|---------|
| <u>Unit</u> | <u>+</u> | Ξ | <u>Total</u> | Ξ | <u>Total</u> | (Millions) | Airflow (CFM) | lon/cfm |
| iaire ion-oaaoo | 156 | 133 | 289 | 155 | 310 | 0 | 2500 | 115600 |
| GPS-FC24 | 48 | 111 | 159 | 150 | 300 | -141 | 2400 | 66250 |
| GPS-FC48 | 129 | 169 | 298 | 200 | 400 | -102 | 4800 | 62083 |
| GPS-DM48 | 138 | 156 | 294 | 200 | 400 | -106 | 4800 | 61250 |
| Phenomenal Aire R6.0 | 57 | 56 | 904 | 1500 | 3000 | -2096 | 6000 | 150667 |

All units tested AC voltage



False Claims by other manufacturers

- 7. Other ionization manufacturer's ionization product is inferior technology.
 - Since it is understood that the way ionization cleans air is by the production of the most ionization without producing ozone, then the best technology in the market would be the company producing the most ions without producing ozone. As seen from the ionization output chart from the previous page, iAIRE produces the most ions without producing ozone for the lowest price in the market. That would mean that iAIRE has the best technology in the market.



Ionization is a very good air cleaner

- Ions are present naturally in the air and are found in the highest concentrations near ocean shores, waterfalls and high elevation in the mountains and after rainstorms.
- The ionization process will artificially create the ions found in these desirable locations and supply them into the building, enhancing the indoor air quality. The process has been around since the late 1800's

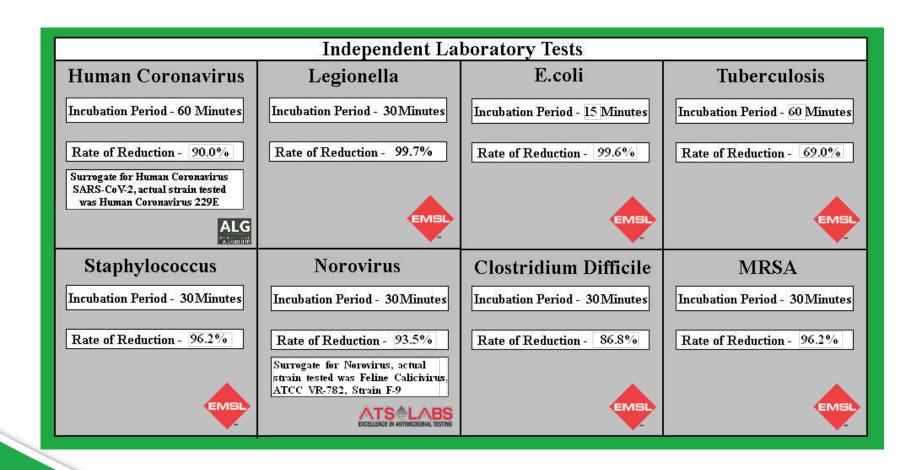


What does Ionization impact?

- Virus
- Bacteria
- Mold & Mildew
- Smoke
- Radon
- Pathogens
 - Staphylococcus (Staph)
 - E. Coli
 - MRSA
 - Legionella
- VOCs



Independent Test Results





Ionization does help remove SARS-CoV-2

- Independent test results (see previous slide) show that ionization can aid in the reduction of the amount of SARS-CoV-2 in the air.
- Testing by Trane reported in "A Taxonomy of Air-Cleaning Technologies Featuring Bipolar Ionization" (used by Trane to explain why Trane was not utilizing ionization) shows that ionization reduces SARS-CoV-2 in the air.



Ionization does help remove VOCs

- There have been various studies by numerous universities and manufacturers that have tested ionization's impact on the removal of VOCs from the air.
- The results from these studies are contradictory.
- When reviewing how ionization was applied to the space being tested, almost all these tests and how ionization was applied in the space used different methodologies.
- iAIRE believes that if ionization is installed properly (see next section), ionization will reduce many VOCs from the air.
- The ionization energy level when ions are produced electrically is high enough to help remove many VOCs (even new devices with lower power that meet UL 2998 ozone production).
 - The maximum power limit to not produce ozone would be 12.07 eV



Proper installation

- Install the ionization device after the filters prior to the supply fan.
- Size appropriately to clean the CFM moving in the air. The only time iAIRE reduces the CFM load of the ionization is in smoking or kitchen equipment environments.
- HVAC distribution and filtration system sized appropriately.
- Constantly circulate the air during occupied hours. This is required to bring the appropriate outside air into the space and helps the ionization work better.
- Almost all the air cleaning is done near the ionization device.
 - Need mixing of air
 - Installation after the blower because the most turbulent air mixes the ions and allows the ions to be spread over a larger area for cleaning
 - Ions normally are gone in about 60 seconds
 - The most ionization and potential to clean the air flow is near the ion device

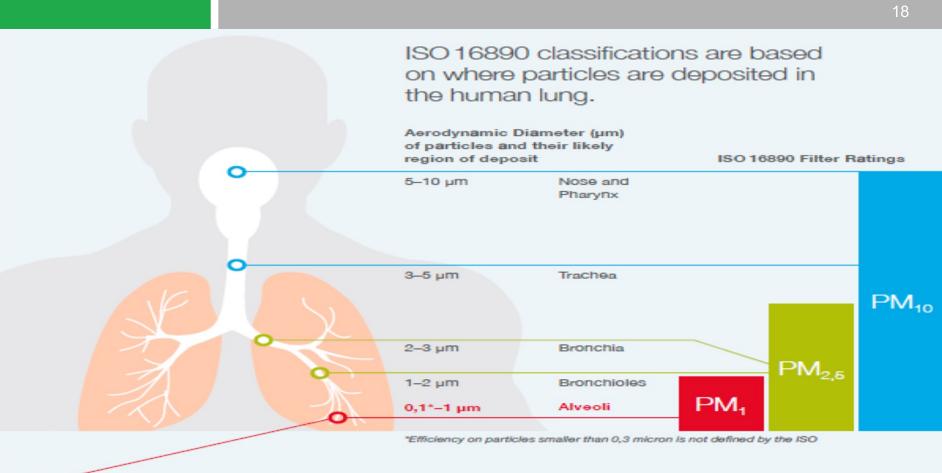


Ionization and filtration

- Because of way that ionization works, there is an agglomeration process that happens with some airborne particles that make them larger. This makes it easier for these particles to be caught in filters or potentially fall to surfaces easier, removing them from the air.
- The larger particles are prevented from getting into human lungs.
- Ionization helps improve filtration rates on filters.
 A MERV 8 filter used with ionization increases the effectiveness of the filter to a MERV 12 rating.



Particle Sizes



PM, - The Smaller the More Dangerous!

A variety of studies are focusing on the health effects of PM1 particles:



Independent Test Results

% of SARS VIRUS CONTROLLED BASED ON TECHNOLOGY¹

| MERV Rating | Filter Only | Filter+UVC*** | Filter + Ionization*, ** |
|-------------|-------------|---------------|--------------------------|
| | | | |
| 6 | 6.2% | 10% | 34% |
| 7 | 7% | 12% | 61% |
| 8 | 11% | 19% | 84% |
| 10 | 12% | 35% | 89% |
| 13 | 46% | 84% | 98.8% |
| 15 | 71% | 97% | 99.0% |
| 16 | 76% | 98.80% | 99.90% |
| 17 (HEPA) | 99.90% | 99.99% | 99.999% |
| | | | |

^{*}Ionization increases the filter efficiency 4-5 MERV levels - this column added later

^{**}Does not take into account ionization treats the occupied space

^{***}UVC does not effectively kill airborne pathogens in high RH conditions2

ASHRAE Technical Paper on Airborne Infectious Diseases

 ²⁰⁰⁹ EPA Tech Paper





Ionization Increases Filter Merv Rating 4-5 Points

If MERV 13 Filters cannot be installed, consider the following:

- Increase the filtration in the Unit to the maximum available
- Provide a recirculation fan filtration unit and duct into the return of units
- Provide a HEP filtration unit which recirculates the air within the space
- Consider Air Ionization system or static charge on filters
- Consider UV treatment BUT review location to avoid impacts of liners and other internal components
- Refer to ASHRAE filtration and Disinfection System section for additional information
- MERV 8 + NPBI => MERV 13 (Blue Heaven labs)
- MERV 12 + NPBI => MERV 16 (NRC Canada)
- Saves cost of higher MERV filter + fan energy





Ionization and filtration

- In an existing building (and HVAC system) iAIRE believes ionization with MERV 13 filters provides the best approach to provide clean air to building occupants and visitors.
 - Most standard units have 1-2" MERV 7 or 8 filters
 - The cleaning potential of a filter **only** is around 11%
 - The cleaning potential of a filter plus ionization is around 80%
 - Going to 4" MERV 13 filters has the same static pressure drop as a 2" MERV 7 or 8 filter.
 - No changes to the fan or electric system
 - The cleaning potential of a filter **only** is around 46%
 - The cleaning potential of a filter plus ionization is around 98%



Cost of ionization

- Changing existing HVAC systems to add HEPA filters and/or UV lights to help clean the air is very difficult.
 - HEPA filters would add significant static to the system. This would require a new fan/motor combination to overcome the increased static. This larger fan/motor might not fit in the existing unit. It would also require additional electrical capacity to run the larger fan/motor.
 - Normal UV light installation is designed to keep the coils clean on the unit, but only cleans what it sees. Shadowing only allows the top 1/3rd of the fins to be cleaned. The dwell time of the air in the vicinity of the UV light is not long enough to kill most airborne particles. To kill the particles, there would need to be more UV lights added into the ductwork, so that the UV light is in contact with the air long enough to kill airborne pathogens. Installing UV lights and electrical in ductwork not designed for this application is almost impossible.
 - UV lights lose efficacy by more than 50% in less than 6 months. Install costs and the need to protect all insulation, wiring and belts is timely and mundane, but necessary.
- Ionization can be installed in an existing HVAC system to help clean the air without a major overhaul of the HVAC system.



Comparing Air Cleaning Technologies

| | NPBI | Corona Discharge | HFPA Filters | Carbon B | Ultraviolet (UV) | UV-PCO | Scent Generators |
|---|--------------|------------------|--------------|----------|------------------|--------|------------------|
| Destroys VOC's | Yes | Yes | No | Captures | No | Yes | No |
| Reduces Airborne particulates | Yes | Yes | Yes | No | No | No | No |
| Kills Pathogens, bacteria, virus & germs | Yes | Yes | No | Captures | Yes | Yes | No |
| Treats in-room air | Yes | Yes | No | No | No | No | Yes |
| Produces harmful byproducts | No | Yes | No | No | Yes | No | Yes |
| | When brushes | | | | | | |
| Maintenance | go bad | 2 years | Quarterly | Monthly | Yearly | Yearly | Monthly |
| Easy to install | Yes | No | No | No | No | No | Yes |
| Low total cost | Yes | No | No | No | Yes | Yes | No |
| Reduces Energy Cost | Yes | Yes | No | No | No | No | No |
| Re-engineering of HVAC needed | No | No | Yes | Yes | No | No | No |
| Produces Ozone | No | No | No | No | Yes | Yes | No |
| | | | | | | | |
| NPBI = Needle point bi-polar ionization - This is the form that iAIRE sells | | | | | | | |



Does ion count in the space matter

- Systems that were described previously with properly installed ionization will eventually cause ions to migrate to a space downstream from the ionization source.
- Low quantities of ions that are measured in the space by themselves are not enough to clean the air.
 - Several manufacturers claim that 1,200 ions/CC or 5,000 ions/CC are enough ion concentration in a space to clean the air
 - This is why some of the testing that has been done by 3rd parties have shown that ionization does not clean VOCs (and other contaminants from the air).
- This means that even if the BAS is reading ion concentrations in a space, there is no guarantee that the air is clean.
- Therefore, iAIRE has **always** recommended measuring VOCs in the space. Measurement of the VOC level in a space is the best way to know if there is clean, healthy air in the space.



ASHRAE 62 IAQ procedure

- ASHRAE 62 is the standard that describes how much outside air is required to be brought into a building to maintain a healthy environment for occupants.
- There are two recommended procedures on how to calculate this standard:
 - Ventilation rate procedure (VRP). VRP is used for most buildings.
 - IAQ procedure (allows an engineer to determine a lesser amount of outside air to be used in the building).
- Less outside air means less load on the system.
 - Potentially lower capital costs because of smaller units
 - Lower utility operating cost because of less air to heat/cool/dehumidify in the space
- 2 Ways to apply IAQ procedure
 - Design system up front to bring in less outside air
 - HVAC system is downsized to permanently bring in less outside air
 - Gets both a capital and utility savings
 - Utilize iAIRE's patented process
 - Use a system sized for VRP
 - Use VOC and CO₂ sensors to monitor the air and bring in less outside air when sensors determine less outside air is required based on the iAIRE algorithm
 - Only utility savings but can be as much as 30% savings



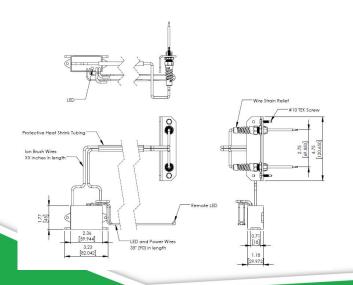
ASHRAE 62 IAQ procedure

- One of ASHRAE's main goals is that all HVAC designs do not cause any harm to the
 occupants of the building.
- ASHRAE has always relied on diluting the air to make a building safe for occupants.
- Designing a system with the IAQ procedure that permanently reduces the outside air could mean
 - If something happened where a contaminant existed in a space that ionization or the reduced amount of outside air could **not** remove/dilute, the possibility exists that high concentrations of contaminants or pathogens that are harmful to the occupants could then build up in the space.
- iAIRE believes that ionization **does reduce** many of the harmful contaminants or pathogens in the air, but it does not reduce **all** of them. Because of this, iAIRE recommends **not** utilizing the IAQ procedure to reduce the size of the equipment. iAIRE **only** recommends:
 - Utilize a system designed to bring in the VRP outside air
 - Utilize the iAIRE patented system with a VOC and CO₂ sensor to reduce the outside air when the space can handle the outside air reduction
 - NO capital equipment saving
 - Significant utility savings
 - The reduced outside air intake should not cause an issue with occupants as the system will deliver the VRP outside air to the space, if the system is properly installed and maintained according to the ASHRAE 62 procedure.



Made in America

- iAIRE has two ion devices that comply with the Made in America ACT.
 - Stand alone device 61% Made in America
 - Duct device 78% Made in America







Why utilize iAIRE's ionization

- iAIRE has the best understanding of how to apply ionization in systems.
- iAIRE is not making claims that can possibly lead to legal issues.
- iAIRE has been advising for years to monitor clean air with VOC sensors when using ionization as the only way to tell if ionization is cleaning the air in a space.
- iAIRE's patented process.
 - If this is specified, there will be NO competition due to the patented process
 - The patented process can be installed on any OEM platform