

Global Plasma Solutions®
Engineering Air for a Cleaner World™

Charlie Waddell – Founder & CTO

How Needlepoint Bipolar Ionization

Reduces

Particles, Odors, Pathogens & Energy

Member ASHRAE SSPC 62.1, TC 2.3, ICC, USGBC

Formerly Secretary of TC 8.12



Installation Base

- Over 1,000 K-12 Schools with OA reduced to 5 CFM Per Student or LESS
- Many Healthcare Applications including hospitals, outpatient centers and offices
- Over 300,000 installations Worldwide



- NY Presbyterian, NYC
- Mayo Clinic, Rochester, MN
- Children's Hospital, Boston
- Cleveland Clinic, Westin, FL
- University of Miami Medical Center
- Tulane Medical, New Orleans
- Methodist Hospital, Houston, TX
- Anderson Medical Center, Houston, TX
- Baylor College of Medicine, Houston, TX
- Winn Army Hospital, Ft. Stewart, GA
- Duke Medical, Raleigh, NC
- Banner Healthcare, Phoenix, AZ
- AI Dupont Hospital, Wilmington, DE
- Abbott NW Heart Hospital, Minn, MN

Hospitals



The Whitehouse



Higher Education



SMU.



HARVARD
UNIVERSITY



Yale University

Virginia Tech
The logo for Virginia Tech includes the word "Virginia" above "Tech" and the year "1872" in a maroon block below it.



Aviation- Gulfstream, Boeing, Agusta

GPS is the only company to pass DO-160 for mounting products on airplanes, in this technology category. DO-160 tests for shock, vibration, EMF, line noise, extreme cold and high pressure



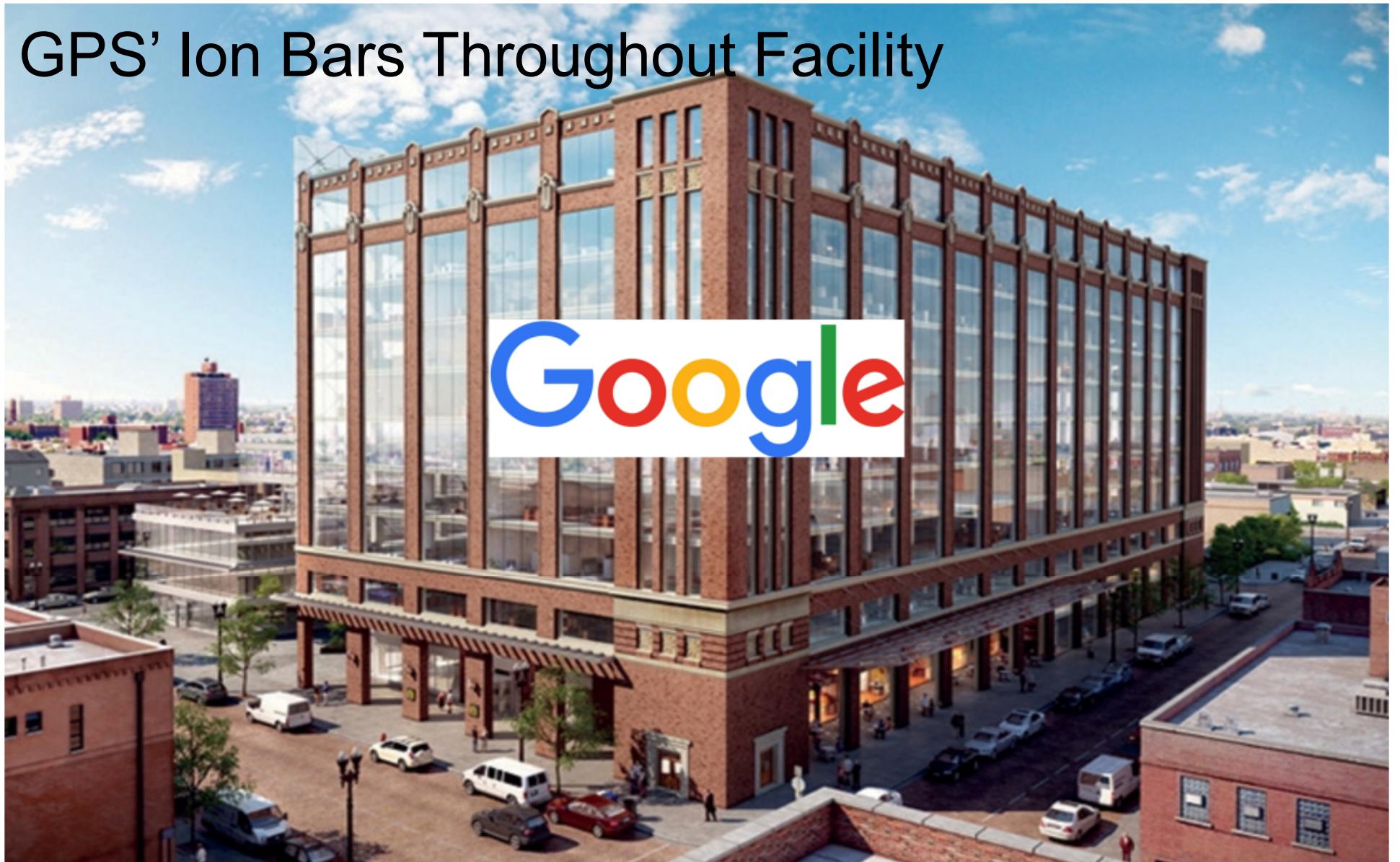
Many Large Office Buildings

NORTHROP GRUMMAN



Google – Chicago & San Jose

GPS' Ion Bars Throughout Facility



Large Airports



Phoenix Skyharbor



Charlotte-Douglas
INTERNATIONAL AIRPORT

ASHRAE 62

- VRP – Dilution method, most often used
- IAQP – included since 1981, engineered app

5.7 Ozone Generating Devices. The use of ozone generating devices shall comply with the following sections.

Exception to 5.7: Electronic devices used exclusively for the operation of HVAC equipment and controls.

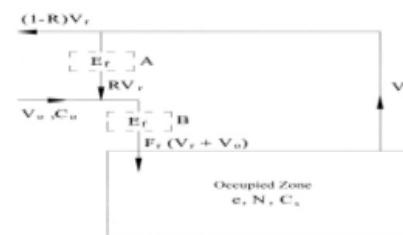
Informative Note: Ozone generation is expected from ozone generators, corona discharge technology, some ultraviolet lights, electronic devices that create chemical reactions within the system, and some devices using a high voltage (>480 V). Motors and relays are examples of electronic devices that would be exempt.

5.7.1 Air-Cleaning Devices. Air-cleaning devices shall be listed and labeled in accordance with UL 2998.

Informative Note: The use of devices not intended for air cleaning with the potential to generate ozone should be avoided.

Zone Tag	Facility Type	Zone Use	Zone Floor Area (square ft)	Zone Max Occupancy Pz	Table 6.1 OA per Occupant Rp	Table 6.1 cfm/ft ² Ra	Pz * Rp	Az * Ra	Table 6.2 Ventilation Effectiveness Ez	Outdoor Air to Zone (CFM) with Ez correction (Vbz/Ez)
Classrooms	Educational Facilities	Classrooms (AGE 9 +)	800.0	28.0	10.0	0.12	280	96	0.8	470

Zone Height (feet)	9
Desired Outside Air (Vo) IAQP	140
Supply Air (Vs)	1,000
Return Air (Vr)	860
Recirc. Flow Factor (R)	0.86
Ventilation Effectiveness (Ez)	0.8
Level of Physical Activity	Standing (desk work)
Filter Location	B
HVAC Flow Type	Constant
Outdoor Air Flow Type	Constant



Air Changes Per Hour	8.3	VRP OA CFM per person	16.8
Outside Air Per VRP	470 CFM	IAQ OA CFM per person	5.0
Outside Air Per IAQ	140 CFM		
Outside Air Savings	330 CFM	Winter Heating Savings	
OA Summer Drybulb	94.0	OA Winter Design DB (F)	0
OA Summer Wetbulb	74.0	Supply Air DB Setpoint (F)	85
Coil Leaving Air Drybulb (F)	55.0	MBH Saved Winter	30.4
Coil Leaving Air Wetbulb (F)	54.0	KW Saved Winter	8.9
OA MBH Saved Summer*	27.1		
OA Tons Saved Summer*	2.3		

*OA = Outside Air

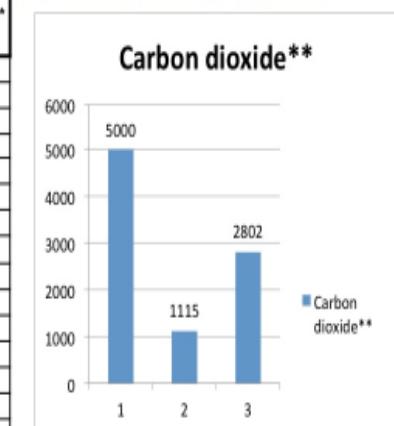
***OSHA, NIOSH & WHO most conservative values used
<http://www.cdc.gov/niosh/npg/npgsyn-a.html>

Indoor Contaminants Generated By People	Maximum Threshold Value (PPM)	Steady State Using the VRP* (Prescribed OA) Plasma Off	Steady State Using the IAQ Method (Reduced OA) Plasma On	Is Steady State Level Acceptable at Reduced OA Levels?	Contaminant Generation Rate (PPM)	Filtration Effectiveness	Cognizant Authority**
Acetaldehyde	100.0	0.01112	0.00139	Yes	0.00048	50%	OSHA
Acetone	250.0	0.00175	0.00102	Yes	0.00654	25%	NIOSH
Ammonia	25.00	0.01771	0.01339	Yes	0.21460	50%	NIOSH
Benzene	1.0000	0.00252	0.00092	Yes	0.00022	20%	OSHA
2- Butanone (MEK)	200.0	0.00020	0.00019	Yes	0.00133	20%	NIOSH
Carbon dioxide**	5000	1115	2802	Yes	441	0%	NIOSH
Chloroform	2.0000	0.00011	0.00001	Yes	0.00004	80%	NIOSH
Dioxane	100.0	0.00000	0.00000	Yes	0.00000	10%	OSHA
Hydrogen Sulfide	10.0	0.00000	0.00000	Yes	0.00000	25%	NIOSH
Methane	NA	1.68094	1.68094	Yes	0.00000	0%	NA
Methanol	200.0	0.00000	0.00000	Yes	0.00000	0%	NIOSH
Methylene Chloride	25.0	0.00078	0.00057	Yes	0.00121	10%	OSHA
Propane	1000.0	0.00998	0.00998	Yes	0.00000	0%	NIOSH
Tetrachloroethane	5.0000	0.00000	0.00000	Yes	0.00000	15%	OSHA
Tetrachloroethylene	100.0000	0.00037	0.00016	Yes	0.00001	15%	OSHA
Toluene	100.0000	0.00533	0.00134	Yes	0.00032	30%	NIOSH
1,1,1 - Trichloroethane	350.0000	0.00070	0.00013	Yes	0.00050	50%	NIOSH
Xylene	100.0000	0.00230	0.00057	Yes	0.00000	30%	OSHA

Building materials and furnishings assumed to have no VOCs and off-gassing is complete

All yellow shaded boxes require user input or review

Is IAQ acceptable at reduced outside air levels?	Yes
--	-----



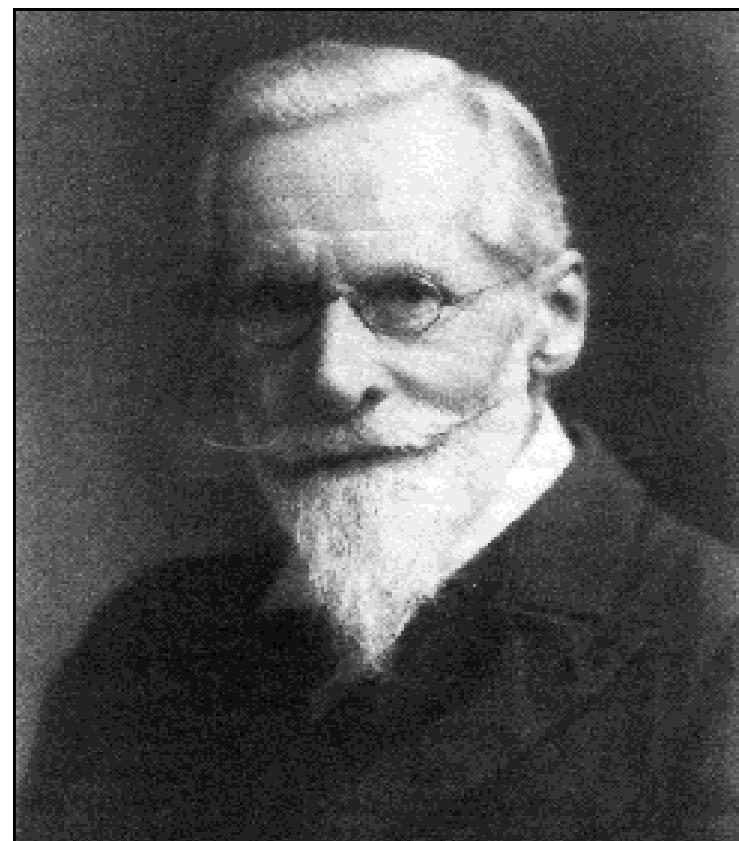
1 = ASHRAE & NIOSH C02 Limit
 2 = C02 Level at Ventilation Rate OA Flow Rate
 3 = C02 Level at IAQ Procedure OA Flow Rate
 **Carbon dioxide has been provided for reference only for gathering demand control ventilation (DCV) setpoints. The National Research Council was commissioned by the US Navy to prove C02 is not a contaminant of concern when using air purification to control the other contaminants of concern, as found on submarines.

Date	1/12/16
Job Name	-
Representative	-
Engineer	-

IMC 2006 & later allows for ASRHAE 62 IAQP through the engineered exception found in Section 403.2
 Exhaust flow rates may differ from Table 6.5 based on ASHRAE 62 IAQP via Section 6.5.2

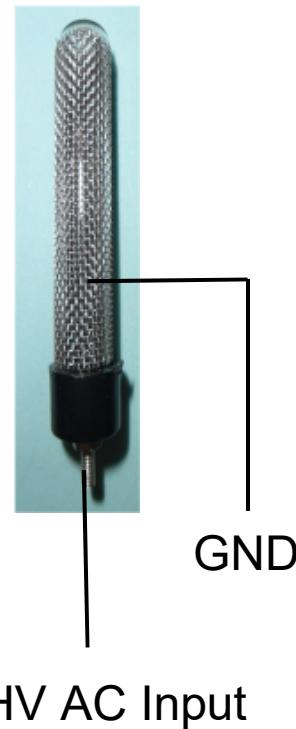
History of Air Ionization

Plasma was first identified in a Crooks tube, and so described by Sir William Crookes in **1879** (he called it "radiant matter"). The nature of the Crookes tube "cathode ray" matter was subsequently identified by British physicist Sir J.J. Thomson in **1897**. The term "plasma" was coined by Irving Langmuir in **1928**, perhaps because the glowing discharge molds itself to the shape of the Crooks tube. Other terms associated with this technology are Dielectric Barrier Discharge, DBD and Corona Discharge.



Sir William Crookes, OM, FRS was a British chemist and physicist who attended the Royal College of Chemistry, London, and worked on spectroscopy.

Glass is the dielectric (insulator) barrier to voltage completing the path to ground. Voltage and current (power) must be higher than needlepoint systems to make the glass conduct electricity to complete the electrical circuit. That overall power level exceeds 12.07 eV, oxygen is ionized and ozone produced.



Needlepoint systems can operate with precise power output, which prevents ionizing oxygen and ensures no ozone is produced



Ions leave tip based on polarity of voltage applied



HV Input
No Dielectric Barrier

CLEAN THE AIR NATURALLY

Ions are present naturally in the air and are found in the highest concentrations where the ocean meets the shore and high elevation in the mountains.

The plasma process will artificially create the ions found in these desirable locations and supply them into the building, enhancing the indoor air quality. Process has been around since the late 1800's

Units of Measure = ions/cc
(cubic centimeter)

Waterfalls/High Elevation – 5,000
i/cc

City – 200 ions/cc

Inside Buildings - <100 ions/cc



“POPE” – NPBI BENEFITS

Item 1

Particle Reduction – Technology makes particles clump together and a lower efficiency filter can capture them from the air

Item 2

Odor Control – Odors, volatile organic compounds and the like are oxidized to gases already prevalent in the air such as oxygen, nitrogen, water vapor or carbon dioxide, eliminating the odors

Item 3

Pathogen Control – Independent testing by CDC Affiliate Labs confirms kill rates as high as 99.9% of various pathogens and mold spores

Item 4

Keeps new cooling coils clean and cleans up old coils

Item 5

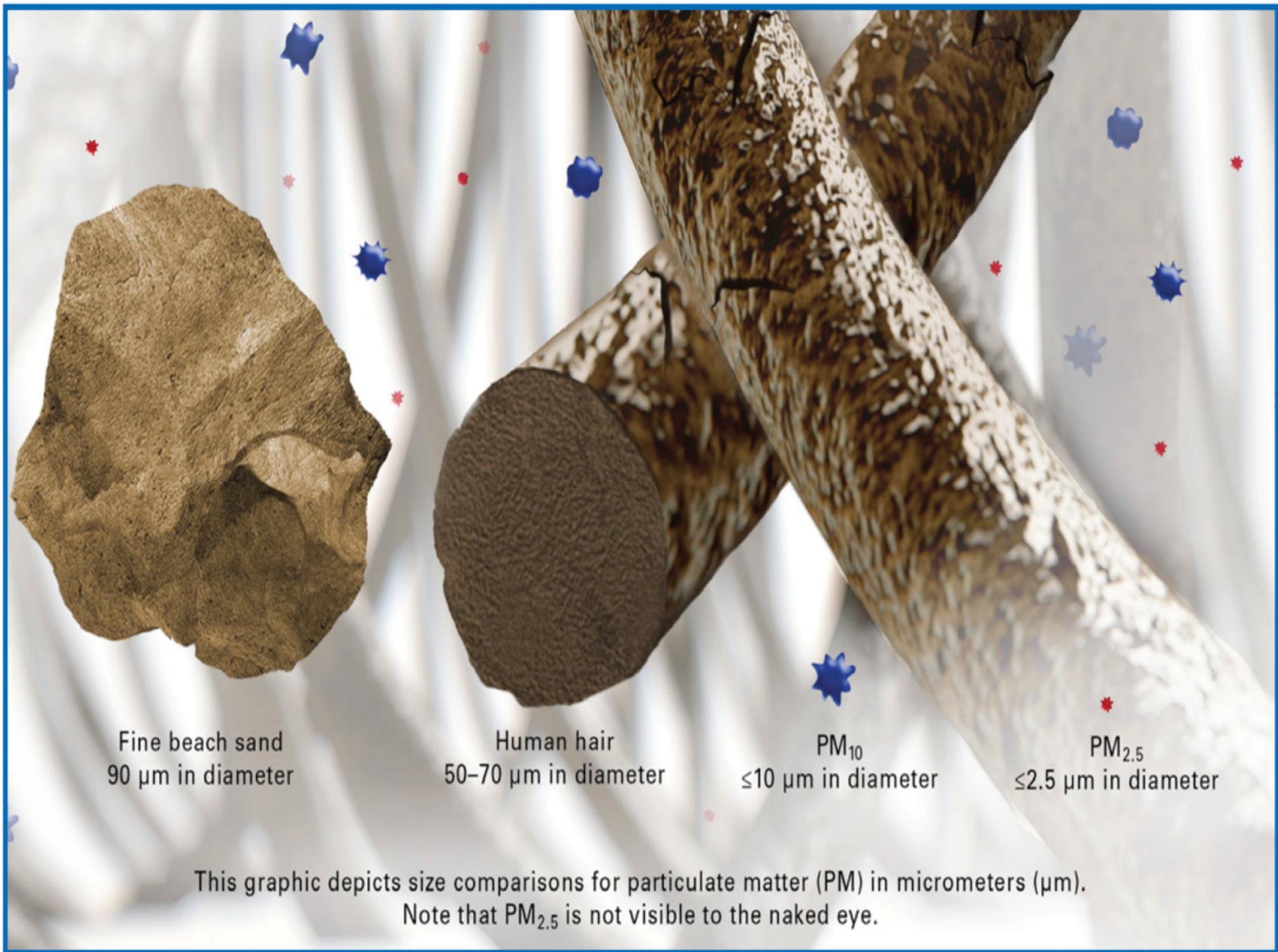
Energy Savings by Outside Air Reduction – By cleaning indoor air and recirculating it – Less Outside Air is required. Less OA = Less Load on Cooling/Heating System – ASHRAE 62 & IMC Compliant

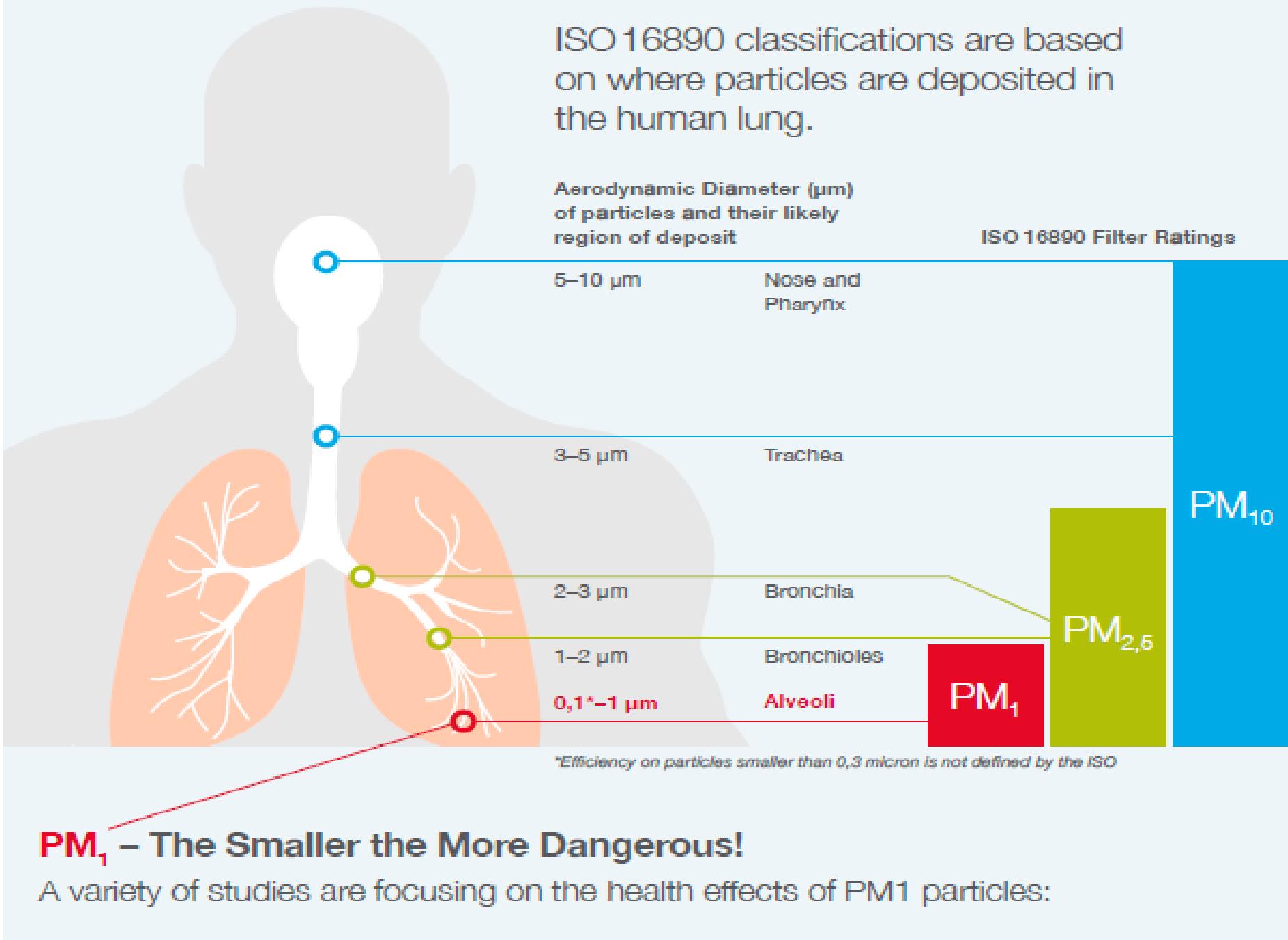
HOW PARTICLES ARE CREATED

- A person sitting or stopped generates about 100,000 particles per cubic ft.
- Sitting down or standing up generates about 2,500,000 particles cubic ft.
- Walking generates about 10,000,000 particles per cubic ft.
- Horseplay generates about 30,000,000 particles per cubic ft.
- Grinding, sweeping, welding adds billions of particles per cubic ft.
- Two surfaces rubbing generate billions of particles per cubic ft.



There are over 18 Million particles
in 1 cubic ft of air





GPS' technology can reduce particles, control odors & kill pathogens.

The Problem - A large Midwest medical device manufacturer contacted GPS due to a new chemical being introduced into the manufacturing process that was creating odor issues for the employees working in those rooms and adjoining spaces that shared the same air handling system. Upon reviewing the molecular structure of the chemical, it was determined that GPS' cold plasma technology could control the odor effectively.

The Solution - A GPS-iBar system was installed on the air entering side of the cooling coil in the air handler conditioning the clean rooms.

The Results – After installation of the GPS-iBar system, the odors were eliminated in less than 24 hours. The GPS-iBar system also provided a pleasant surprise to the owner when the annual clean room certification occurred. The clean room certification company found the total particle counts to be 89.7% less than any other time prior to the GPS-iBar installation, which includes over 10 years of prior testing with similar, consistent results.

Pharmaceutical Manufacturing Facility

Total Particle Counts

Date	Before	After
6/17/2013	2015	
6/25/2014		208*

Total Particle Count Reduction 89.7%

*GPS-iBar installed & activated 6 months prior to "After" testing



MERV 8 + GPS = > MERV 13



**Blue Heaven
Technologies**

2820 S. English Station Rd.
Louisville, Ky 40299
Tel: (502) 357-0132
Fax: (502) 267-8379

Date:	23-Oct-17
Report No.	17-618
MODIFIED CADR CHAMBER TEST	
TEST REPORT SUMMARY	
Chamber Smoke Concentration Decay Test	
MERV 13 vs. MERV 8 w/GPS Device	

Test Results

- 1 It was determined that the 1" MERV 13 Panel filter reduced particle count from 2,730,958 to 808 particles in a timeframe of 34 minutes.
- 2 It was determined that the 1" MERV 8 Panel filter with GPS Technology reduced particle count from 3,645,943 to 745 particles in a timeframe of 16 hours.
- 3 It was determined that the 1" MERV 8 Panel filter with GPS Technology reduced particle count from 2,753,181 to 745 particles in a timeframe of 15 hours - 40 minutes in comparison to the MERV 13 at 34 minutes.

Quantitative Results

MERV 13 Filter

Elapsed Time, Min.	Microns								# total Particles	#/cm3 Concentration
	0.30	0.40	0.55	0.70	1.00	1.30	1.60	2.20		
4	1805492	738537	144867	40941	865	153	96	3	2730958	2730
34	636	101	25	23	8	5	2	5	808	0.81

MERV 8 Filter with GPS Technology

Elapsed Time, Min.	Microns								# total Particles	#/cm3 Concentration
	0.30	0.40	0.55	0.70	1.00	1.30	1.60	2.20		
5	1958081	1222632	332433	129698	2610	341	136	6	3645943	3645
19	1876059	736434	117644	22892	116	11	20	5	2753181	2753
16 hours	619	90	12	17	?	1	?	?	745	0.74

National Research Council of Canada

The combination of the NPBI with MERV 12 has the same efficiency as a MERV 16 filter for size bin E2 (PM2.5), i.e. a filter eff. $\geq 95\%$

Testing based on GPS-iMOD in a western CA hospital

Needlepoint Bipolar Ionization for TVOC CONTROL

What Are VOCs?

Volatile: Vapor at Room Temperature

Organic: Contains Hydrogen & Carbon

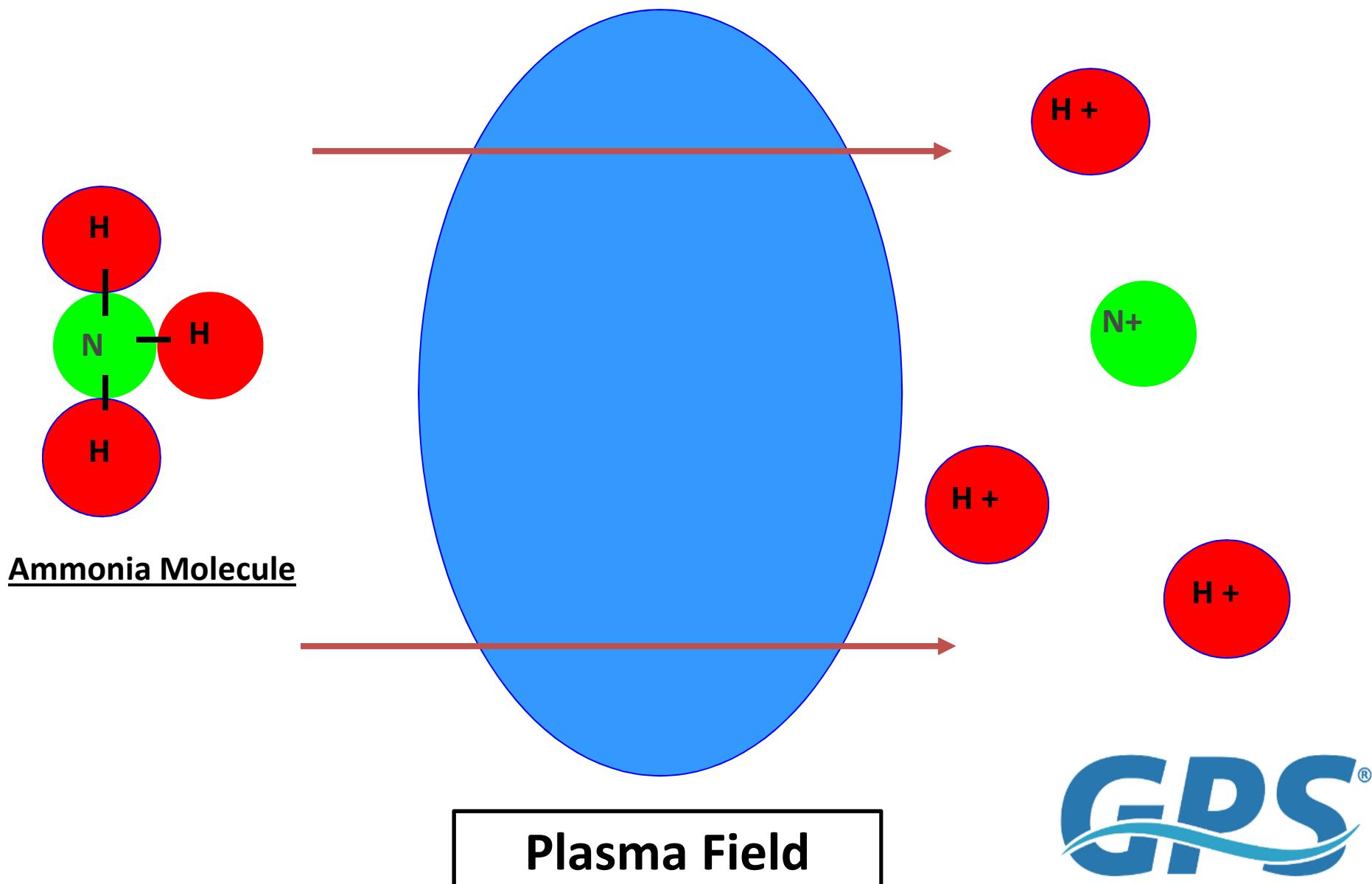
Compounds: More than one gas

- Natural & Man-Made
- We Come in Contact w/100's Each Day
- Human & Non-Human Sources

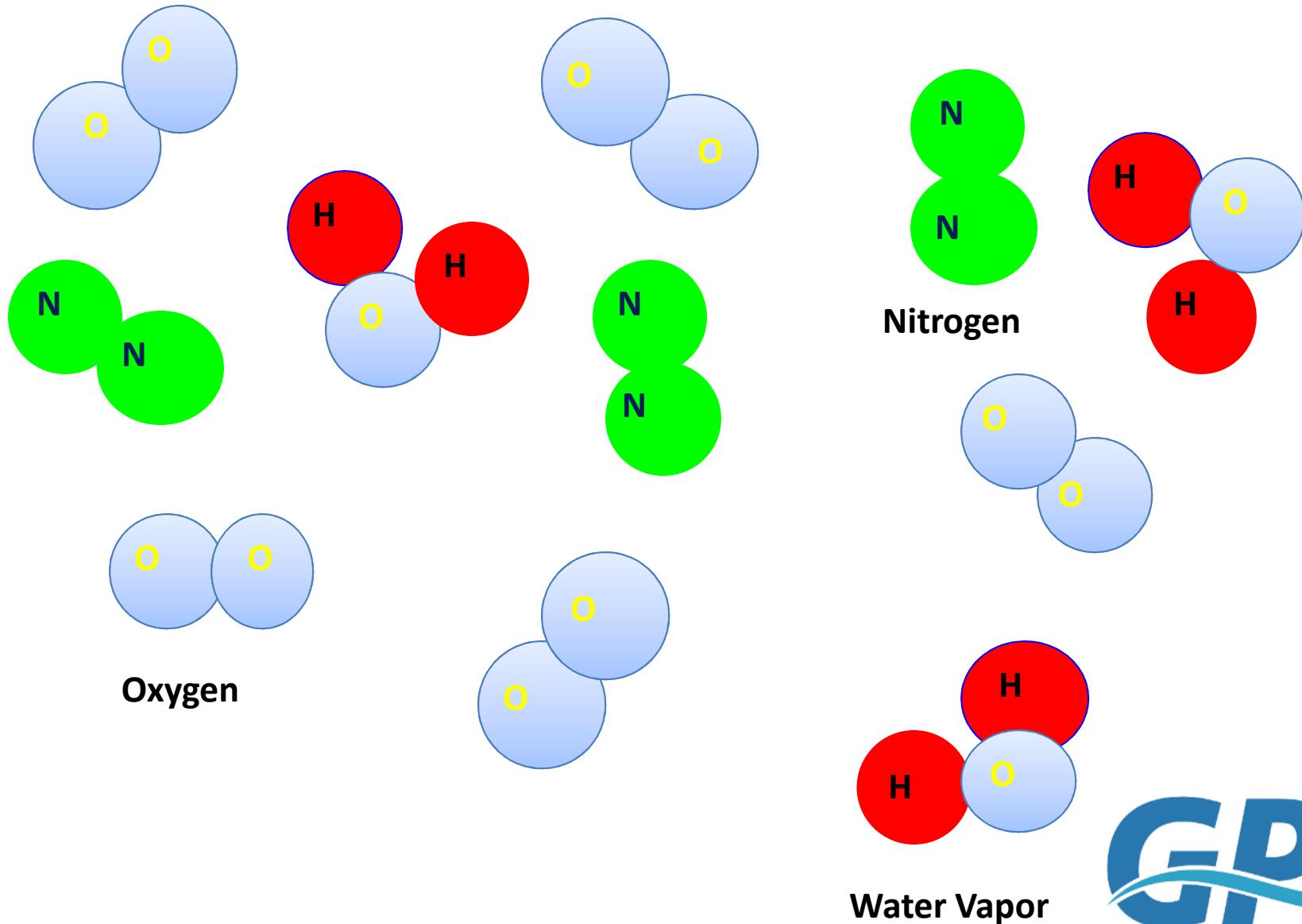


©2005

Plasma Breaks Down Gases To Less Objectionable Forms



The Objectionable Gases Regroup To Form Safe & Desirable Gases Already Prevalent in Our Atmosphere!



Chemical Compounds Ionization Can Easily Control

CHEMICAL	FORMULA	Electron Volt
Xylene*	C ₈ H ₁₀	7.89
Styrene*	C ₈ H ₈	8.46
Methyl Ethyl Ketone*	C ₃ H ₈ O	9.52
Ammonia*	NH ₃	10.07
Acetaldehyde*	CH ₃ CHO	10.23
Ethyl Alcohol*	C ₂ H ₅ OH	10.48
Formaldehyde*	CH ₂ O	10.88
Oxygen	O ₂	12.07
Glass tubes require >12.07 to break down the dielectric		



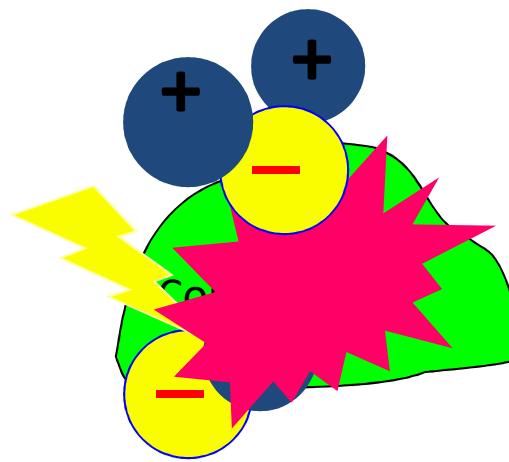
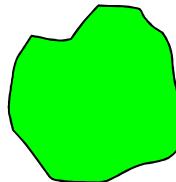
- * Typical contaminants of concern as contained within ASHRAE 62.1
- Electron Volt Energy greater than 12Ev, creates ozone (O₃)

CORONA DISCHARGE TUBE

Plasma Source

Mold, Virus & Bacteria Control

The Positive and Negative Ions Attack DNA/RNA Cell Structure of Single Cell Organisms & Removes Hydrogen



Like Purell for the air and surfaces

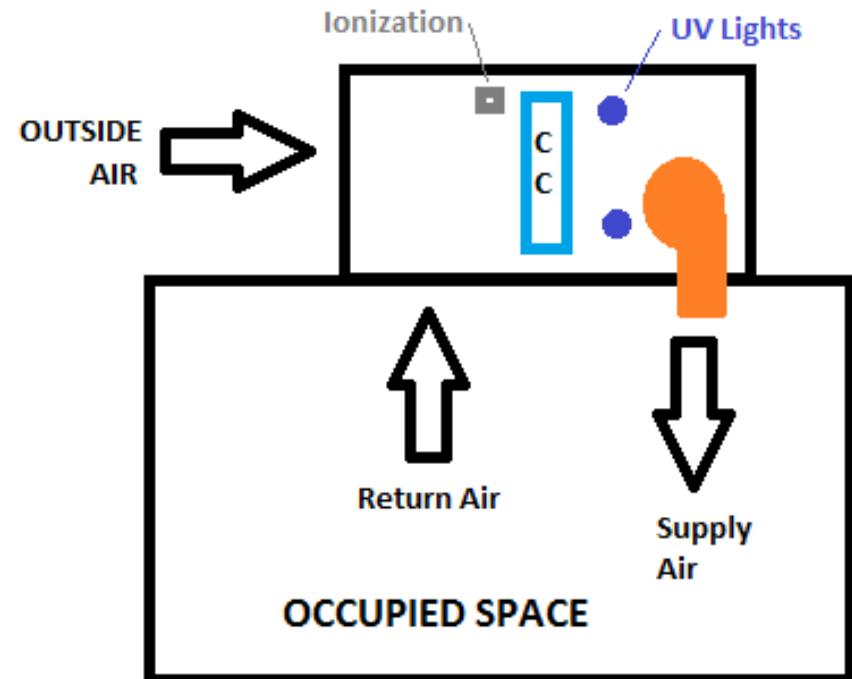
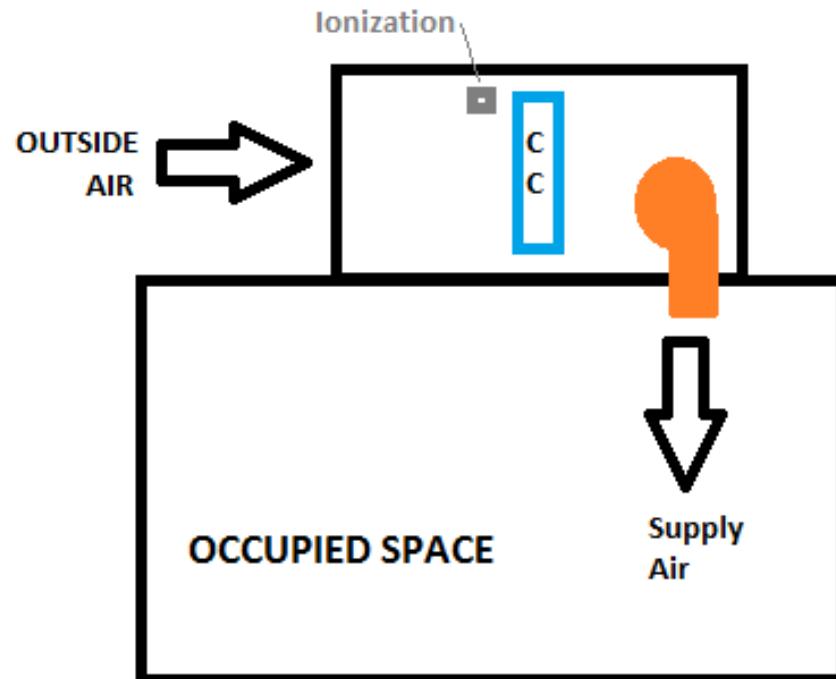
Independent Testing by World Renowned EMSL & ATS Labs

THE ONLY PRODUCT PROVEN TO KILL PATHOGENS IN THE SPACE

Pathogen	Time Exposed	Kill Rate
E.coli	15 minutes	99.68%
MRSA	30 minutes	96.24%
TB	60 minutes	69.01%
Noro Virus*	30 minutes	93.50%
C.diff	30 minutes	86.50%



*Norovirus is not an enveloped virus and is harder to kill than COVID-19, an enveloped virus



Viruses can be generally categorized in three groups by virus structure

Structure affects the effectiveness of disinfectants in killing the viruses

- Enveloped viruses are easiest to kill. (An example is Influenza A Virus)
- Large, non-enveloped viruses are more difficult to kill. (An example is Rotavirus)
- Small, non-enveloped viruses are hardest to kill. (An Example is Norovirus)

Coronaviruses are enveloped viruses, meaning they are one of the easiest types of viruses to kill with the appropriate product



% of 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%	97%
15	71%	97%	99%
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 by GPS

**Does not take into account ionization kills in the space and on surfaces

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

UVC CHARACTERISTICS

1. OUTPUT REDUCES AS TEMPERATURE DROPS
2. EFFECTIVENESS REDUCES AS HUMIDITY GOES UP*
3. LAMP OUTPUT DECREASES WITH TIME
4. LAMPS MUST BE REPLACED
5. LAMPS CONTAIN MERCURY – HOW DO YOU DISPOSE?
6. HARMFUL VISIBLE LIGHT PRODUCED
7. ORGANICS EXPOSED TO LIGHT WILL BREAK DOWN

*ASHRAE AIRBORNE INFECTIOUS DISEASE WHITEPAPER

HOW CAN WE REDUCE GERM TRANSMISSION IN THE ENVIRONMENT?

CONTROL WHAT WE CAN CONTROL and
LET PPE DO THE REST!

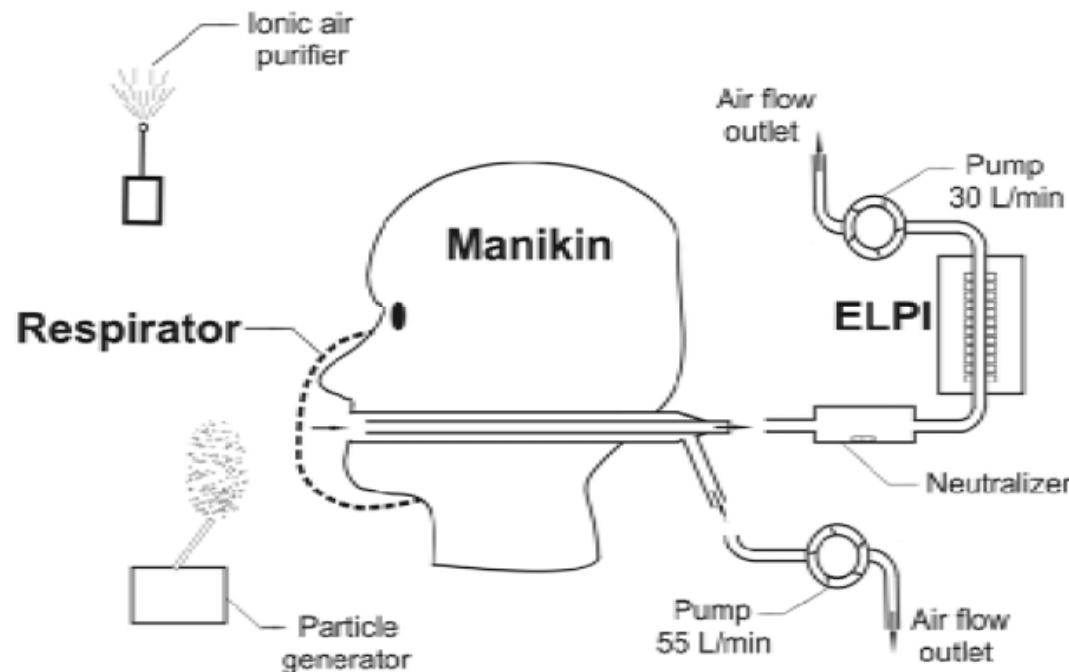
- CONTROL HUMIDITY – 40% to 60%
- REDUCE STATIC ELECTRICITY
- REDUCE PARTICLES
- USE "ACTIVE" TECHNOLOGY

Filtering Efficiency of N95- and R95-Type Facepiece Respirators, Dust-Mist Facepiece Respirators, and Surgical Masks Operating in Unipolarly Ionized Indoor Air Environments

Table 1. Enhancement factors due to the ion emission for four facepiece filtering masks.

Half-mask respirator	N95	R95	Dust-mist respirator	Surgical mask
Enhancement factor	48.4	22.3	3250	194

Note: Ion emitter = VI-2500; inhalation flow rate = 30 L/min; emission time = 12 min.



Data Provided by:

Center for Health-Related
Aerosol Studies

Dept. of Environ. Health
University of Cincinnati

New LED TV



Old Tube TV



New Plasma Ion
Generators



Corona Discharge
Ion Generators



GPS-iRIB-36 or -18

Flexible Ionization Strip



Typical Location Install on Ductless Wall System:

Figure 6



Affix iFlex to the top of coil on plastic strip (or top of fins) to treat coil, blower and living space.

GRS®
GLOBAL PLASMA SOLUTIONS

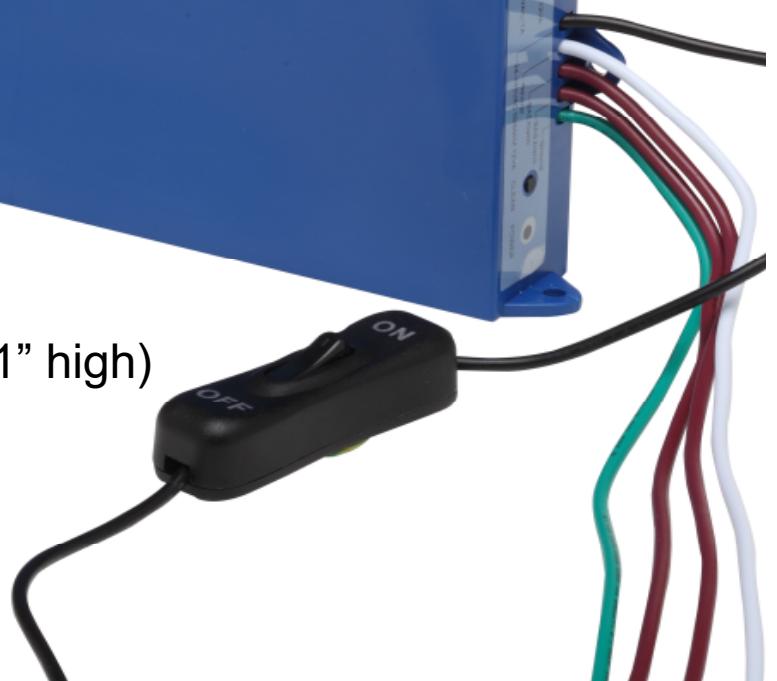
Affix iFlex power pack to back of cabinet.

Self-Cleaning Ion Generator

GPS-FC24-AC



Designed for VRF/VRV Ceiling Cassette Units (only 1" high)
0-2,400 CFM
24VAC-240VAC Input, includes BAS contacts

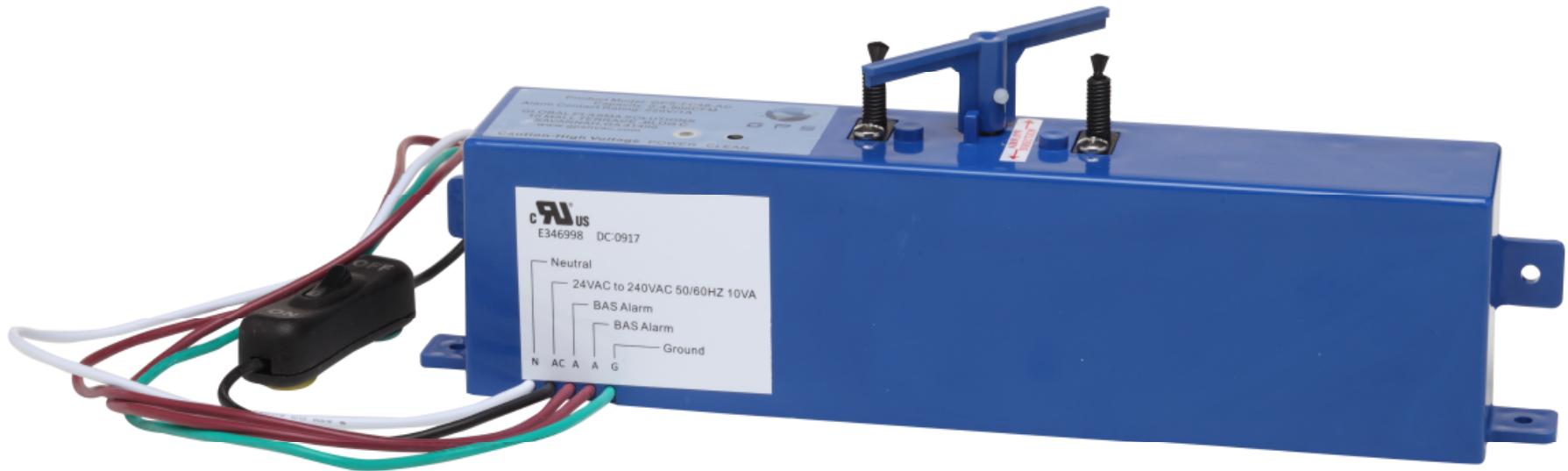


GPS-FC24-AC Installation



SELF CLEANING ION GENERATOR

GPS-FC48-AC



Capacity: 0-4,800 CFM

Self-Cleaning – No Maintenance

Universal Voltage: 18VAC-240VAC, with BAS contacts

GPS-FC48-AC Installed



GPS - DM48-AC

THE WORLD'S FIRST SELF CLEANING NEEDLEPOINT BIPOLAR ION GENERATOR



2016 HVAC IAQ PRODUCT OF THE YEAR!
0-4,800 CFM, Mounts Indoors or Out
24-240VAC Universal Voltage Input w/BAS Contacts
Provided with Display for Operation Status

GPS-DM48-AC Installation



Valencia College

Independent
Testing Results:

0 Bacteria
0 Fungi

Throughout
Entire Depth
Of Cooling Coil

Indoor VOCs < OA VOCs!

No E/A Fans

No DCV

No Relief Fans



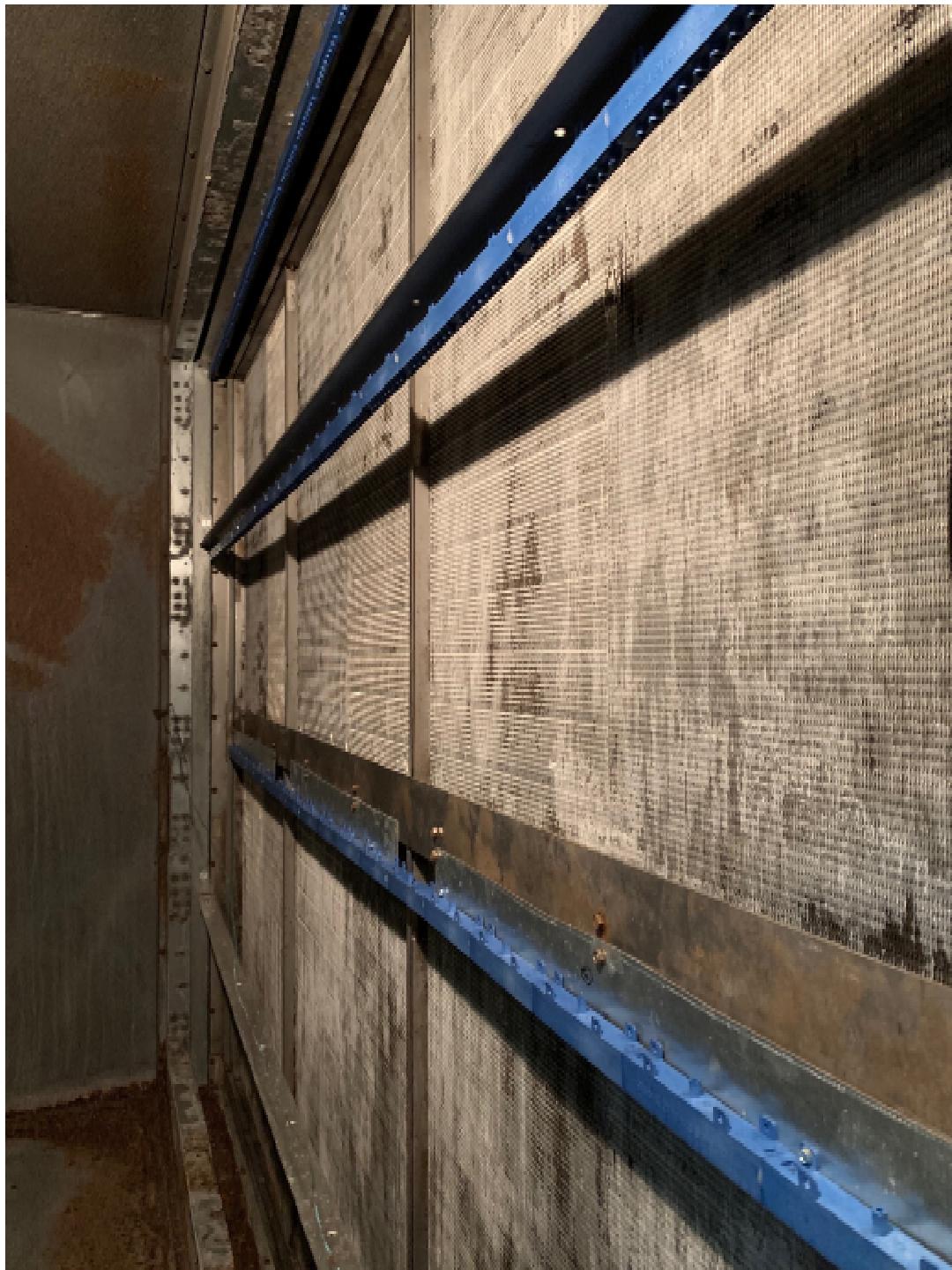
GPS-iMOD

Modular Ionization Product – Fits Any Size HVAC System



- 24VAC, 110VAC or 208-240VAC INPUT
- ONLY 15 WATTS REQUIRED FOR ANY LENGTH BAR
- UP TO 6 BARS PER POWER SUPPLY
- OSHPD CERTIFIED

GPS-iMOD Installation



GPS-iMOD Sizing

- Coil Cleaning – 1 bar for every 5' of coil height
- Odor Control – 2 bars per coil, one at top and one midway down, both pointing towards floor
- Space Pathogen Control – Mount after final filters and provide 1" of bar length per 400 CFM

PRODUCT PLACEMENT IS IMPORTANT WHAT'S YOUR GOAL?

- COOLING COIL CLEANING – MOUNT TO AIR INLET SIDE OF COIL
- SPACE TREATMENT – MOUNT AFTER FINAL FILTERS
ANY FILTER WILL STOP THE IONS

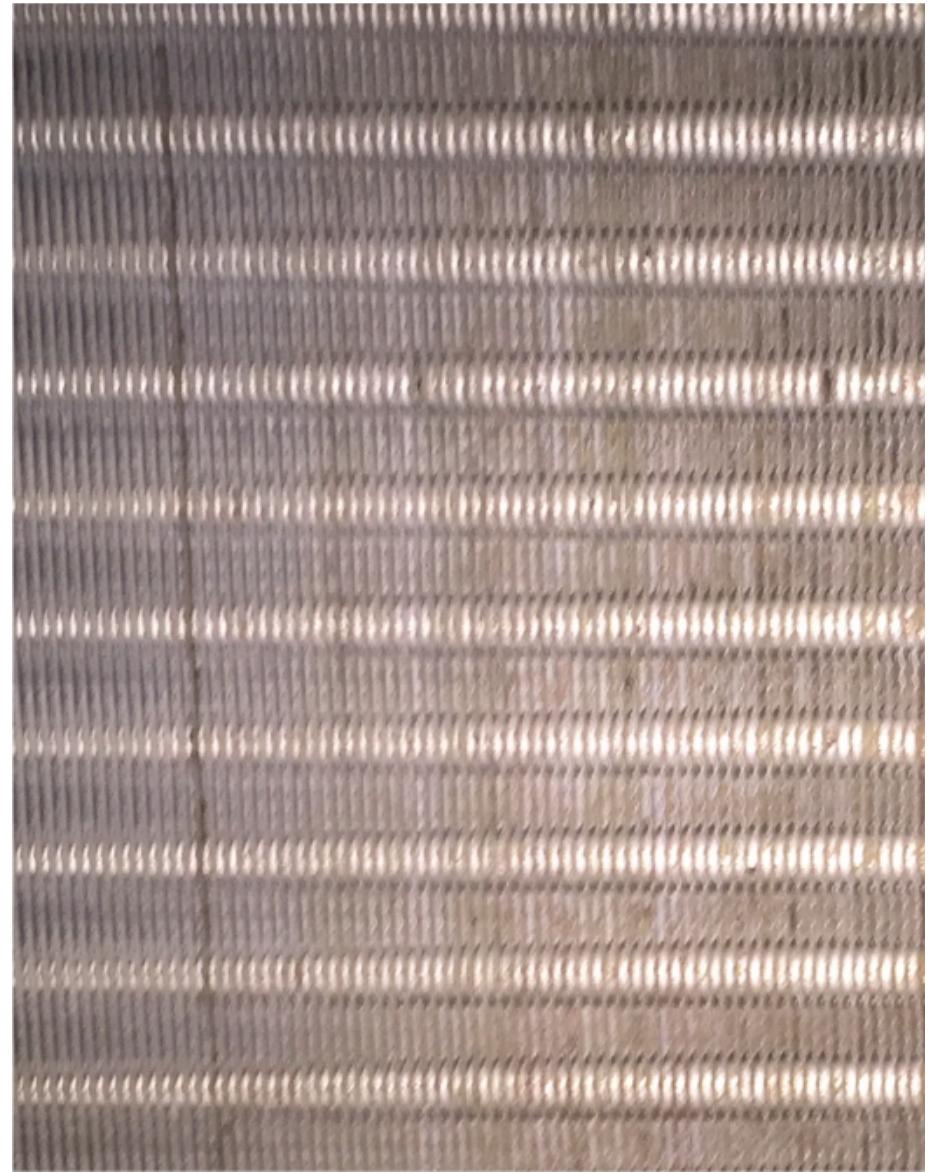
Many healthcare clients are installing two sets of ionization bars to get total system and space protection





BEFORE GPS

GREENSBORO HOSPITAL



THREE WEEKS AFTER GPS

Ion Sensing Solutions

GPS-iMEASURE™

The GPS-iMEASURE is the first commercially available ion detector that can be permanently mounted in the space to measure ion levels in real time and report back to a BAS.



MONITOR IONIZATION LEVELS REMOTELY

- Auto Calibration/Auto Zero
- 0 – 1,000,000 Ions/cc

GPS-iMEASURE-D™

The GPS-iMEASURE-D ion detector is permanently mounted in the duct downstream of any GPS ionization device. It measures ion levels in real time and reports back to a BAS. It includes three sensitivity levels: 20,000/200,000/2,000,000 ions/cc/sec that can be set based on the application and in-duct location.

MONITOR IN-DUCT IONIZATION LEVELS

- 20,000 to 2M Ions/cc
- Input Voltage 12 to 24V AC or DC
- LED Operation Status



GPS-iDETECT-P™

The GPS-iDETECT-P is a plenum-mounted ionization detector that confirms the output from the GPS-iMOD. The GPS-iDETECT-P provides the ability to monitor ionization status in a plenum to confirm that the ionization equipment is working properly.



GPS-AIC Handheld



Features

- Universal Voltage Input
- 1,000 – 200,000,000 Ions/cc (+ or -)
- 0-100% Humidity

TVOC Sensing Solutions

Metal Oxide Semiconductor



Rib Relay
Analog Input to BacNet
RIBMNW24B-BCAI (0-10V)



RIBTW24B-BCAO
4-20mA Device

Self-Calibrates
0-10VDC Output
Correlated Value for DCV Apps
Not "Absolute" Technology
Cannot be used for "Inlet/Outlet"
Approximately \$500

Photoionization Detector



Annual Manual Recalibration
4-20mA Output
"Absolute" Technology
Used for "Inlet vs Outlet" Efficiency Calc
Approximately \$3,500

Register
your instrument
online to receive
your extended
warranty.

Inlet v/s Outlet Efficiency Calculation



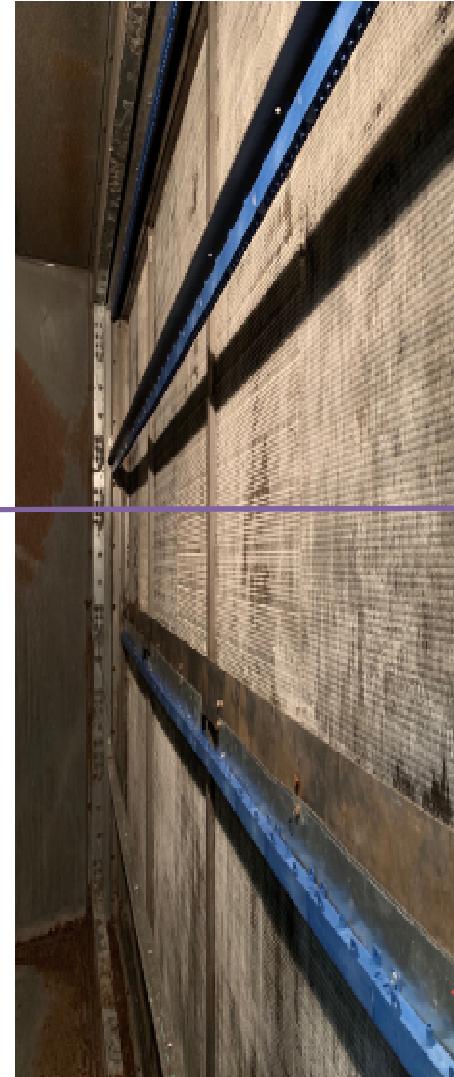
Use PID



Use PID



Don't Use Metal Oxide



Don't Use Metal Oxide

Non-Healthcare Benefits of NBPI

- Saves on First & Renovation Construction Costs
 - Rule of Thumb – 5 CFM per person of Outside Air
- Saves Energy
- Reduces Maintenance
- Reduces Mold
- Provides Particle, Odor, Pathogen and Energy Reduction (POPE)



NBPI Healthcare Benefits

- Kills Mold, Bacteria and Virus
- Reduces Particulates
- Controls Odors
- Keeps Coils Clean
- Treats the Space
- Reduces Static Electricity



Global Plasma Solutions®

Engineering Air for a Cleaner World™



Questions?

GPS
GLOBAL PLASMA SOLUTIONS