GPS®

GLOBAL PLASMA SOLUTIONS

Engineering Air for a Cleaner World™

VALIDATED

• ZERO OZONE EMISSIONS - MEASURED OZONE EMISSIONS FROM GPS IMOD DURING USE PHASE DOES NOT EXCEED 0.005 PPM AS TESTED BY UL 2998

UL.COM/ECV

With over 30 patents and more than 150,000 installations worldwide using our NEEDLEPOINT BIPOLAR IONIZATION technology, also known as NPBI, GPS is truly the Indoor Air Quality (IAQ) revolutIONIZER.

Our proven technology delivers clean indoor air that is safe and healthy – producing neither ozone nor other harmful by-products. All our NPBI products are UL and CE approved. Through NPBI, our products purify the air by eliminating airborne Particulates, Odors and Pathogens. All this while saving you 30% on Energy consumption and lowering your carbon footprint by reducing outdoor air intake by up to 75%.

Engineering Air for a Cleaner World™

GPS FACT: GPS can be installed in any system in any building...

- Agriculture
- Airports
- Animal Care
- Arenas & Stadiums
- Banks
- Casinos
- Child Care
- Convention Centers
- Fitness
- Food Service
- Healthcare
- Hospitality
- Hospitals
- Institutional
- Manufacturing
- Office Building
- Retail
- Schools & Universities
- Senior Care
- Transportation
- Theater
- Worship

Truly a revolutIONIZER

A pioneer with many innovations:

1st

... with universal power supply
... with auto-cleaning
... duct-mounted design
... to use carbon fiber brush needlepoint emitters
... with ionization bar
... with flexible ionization strip
... modular ionization bar
... to achieve UL 867 Ozone Standard
... AND ONLY to pass the RCTA DO-160 standard for aircraft
... to be installed on a commercial jet
... to be certified by FAA
... to be installed in commercial hand driers
... AND ONLY to receive UL 2998 Ozone Free Certification
... to receive OSPHD seismic (OSP) certification

WHY GPS?

GPS DELIVERS P.O.P.E.

PARTICLES REDUCED

Particle Reduction

The GPS NPBI technology reduces airborne particles (i.e., dust, pet dander, pollen) through agglomeration. The ions attach to the airborne particles. The particles are subsequently attracted to one another, effectively increasing their mass and size. The air filtration system easily captures the larger particles, increasing the capture efficiency of your HVAC system.

PATHOGENS KILLED

Pathogen Reduction

During the GPS cleaning process the NPBI technology attacks and kills viruses, mold spores and bacteria. The ions steal away hydrogen from the pathogens, leaving them to die, and leaving you with clean and healthy indoor air.

ODORS NEUTRALIZED

Odor Reduction

During the GPS cleaning process chemical, pet, cooking, and other odors are broken down into basic harmless compounds, leaving the indoor air fresh smelling and free of odor causing VOCs.

ENERGY SAVED

Energy Saving

GPS' environmentally friendly cleaning process allows commercial buildings to significantly reduce the amount of outdoor air required to operate. This equates to a safer, more comfortable environment that requires up to 30% less energy to condition.

THE GPS ADVANTAGE

	GPS NPBI	OTHER BPI	CORONA DISCHARGE	HEPA FILTERS	CARBON FILTERS	ULTRAVIOLET (UV)	UV-PCO
Produces Harmful Byproducts	None	Yes	Yes	No	No	Yes	Yes
Reduces Airborne Particles	✔	Yes	Yes	Yes	No	No	No
Destroys VOCs	✔	Yes	Yes	No	Captures	No	Yes
Kills Pathogens	✔	Yes	Yes	No	Captures	Yes	Yes
Reduces Energy Cost	30%	Yes	Yes	No	No	No	No
UL 2998 No-Ozone Certified	✔	No	No	N/A	N/A	N/A	N/A
Treats In-Room Air	✔	Yes	Yes	No	No	No	No
No Replacement Parts	✔	No	No	No	No	No	No
Auto Self-Cleaning	✔	No	No	No	No	No	No
Simple to Install	✔	No	No	No	No	No	No
Low Total Cost	✔	Yes	No	No	No	No	No

AUTO-CLEANING NPBI

GPS-FC48-AC™

An automatic self-cleaning, lightweight NPBI system that handles up to **4,800 CFM or 12 tons**. Designed for multiple mounting options including fan inlet, interior duct walls or floors. The composite construction allows for mounting in corrosive environments.

Features

- > 400 Million + and – Ions Per cc/sec
- Universal Voltage Input (24 – 240 VAC)
- Programmable Auto-Cleaning Cycle
- Carbon Fiber Brush Emitters
- Alarm Contacts

UNIVERSAL VOLTAGE

MAINTENANCE FREE

GPS-FC24-AC™

An automatic self-cleaning, lightweight NPBI system that handles up to **2,400 CFM or 6 tons**. Designed for multiple mounting options including fan inlet, interior duct walls or floors. The composite construction allows for mounting in corrosive environments.

Features

- > 300 Million + and – Ions Per cc/sec
- Universal Voltage Input (24 – 240 VAC)
- Programmable Auto-Cleaning Cycle
- Carbon Fiber Brush Emitters
- Alarm Contacts

CARBON FIBER EMITTERS

APPLICATIONS

- Agriculture
- Airports
- Animal Care
- Arenas & Stadiums
- Banks
- Casinos
- Child Care
- Convention Centers
- Fitness
- Food Service
- Healthcare
- Hospitality
- Hospitals
- Institutional
- Manufacturing
- Office Building
- Retail
- Schools & Universities
- Senior Care
- Transportation
- Theaters
- Worship

GPS-DM48-AC™

The world's first automatic self-cleaning, duct mounted, lightweight NPBI electronic air cleaner. The maintenance free unit is designed for indoor or outdoor duct mounting and can handle up to **4,800 CFM or 12 tons**.

Features

- > 400 Million + and – Ions Per cc/sec
- Universal Voltage Input (24 – 240 VAC)
- Programmable Auto-Cleaning Cycle
- Carbon Fiber Brush Emitters
- Alarm Contacts
- 3/4 Quick-Turn Duct Adapter

SELF-CLEANING

2016 IAQ GOLD AWARD WINNER

BARS & STRIPS

GPS-iMOD®

The GPS-iMOD is a modular NPBI system that is field assembled to any length up to 240 inches in 6-inch increments. The fiberglass composite and carbon fiber GPS-iMOD can be mounted in corrosive environments. It can treat **50 – 250 CFM per inch** of bar, depending on the application.

OSHPD

Features

- > 140 Million + and - Ions Per Inch/cc/sec
- Universal Voltage Selector Switch
- Six HV Output Ports
- Alarm Contacts
- Illuminated On/Off Switch
- Plasma on Indication Light
- UL 2998 Ozone Free

UL VALIDATED

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GPS-iRIB® 18/36

The GPS-iRIB is available in 18" and 36" lengths. They are made from a flexible chemical, heat and cold resistant Kapton® material containing a circuit with special carbon fiber ion emitters soldered into the circuit traces. This mechanism is engineered to deliver the highest level of ionization with the least amount of energy in the most compact size. **Designed for 3200 CFM or 8 tons.**

Perfect For

- Traditional Split Systems
- Ductless Mini Splits
- Heat Pump PTACs
- Ducted Modules
- Fan Coils

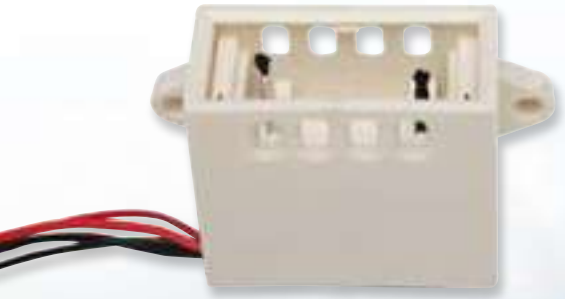
Features

- > 35 Million + and - Ions Per Foot/cc/sec
- Fold-To-Length Circuit
- Local LED Power Indication
- Integral Control Relay for BAS Interface
- Velcro® for Easy Installation
- Voltage Input 110VAC to 240VAC

GPS-NEMA4-OE

The GPS-NEMA4-OE is a NEMA 4X-rated fiberglass enclosure designed to house one GPS-iMOD power supply. The panel adds a superior finished look to any project while providing the required protection against foreign substances, such as water and dust, when power supplies are mounted in non-NEMA 1 rated environment.

COMPACT NPBI



GPS-FC-1™ / GPS-FC-2™

The GPS-FC series is designed to be mounted inside fan coils, heat pumps, PTACs, ductless mini-splits and air handlers up to **1,200 CFM or 3 tons**. Their compact size allows them to be mounted almost anywhere in just a few minutes.

Features

- > 25 Million + and – Ions Per cc/sec
- GPS-FC-1 Powered by 110 - 120 Volts AC
- GPS-FC-2 Powered by 208 – 240 Volts AC
- Carbon Fiber Brushes
- LED Operation Status
- Carbon Fiber Brush Emitters

GPS-FC-3-BAS™

The GPS-FC-3-BAS unit is designed to be mounted inside fan coils, heat pumps, PTACs, ductless mini-splits, and air handlers up to **3,200 CFM or 8 tons**. Its compact size and simple mounting requirements allow it to be quickly mounted almost anywhere.

Features

- > 170 Million + and – Ions Per cc/sec
- Powered by 24 Volts AC
- Carbon Fiber Brush Emitters
- BAS Alarm Contacts
- LED Operation Status

SENSORS & MEASUREMENTS

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.

Features

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

How Ionization Works

GPS' NPBI technology works to safely clean the air inside industrial, commercial and residential buildings. The patented technology uses an electronic charge to create a plasma field filled with a high concentration of + and - ions. As these ions travel with the air stream they attach to particles, pathogens and gas molecules. The ions help to agglomerate fine sub-micron particles, making them filterable. The ions kill pathogens by robbing them of life-sustaining hydrogen. The ions breakdown harmful VOCs with an Electron Volt Potential under twelve (eV<12) into harmless compounds like O_2, CO_2, N_2, and H_2O. The ions produced travel within the air stream into the occupied spaces, cleaning the air everywhere the ions travel, even in spaces unseen.

What is an Ion you may ask?

An ion is a molecule or atom that is positively or negatively charged, meaning that it has electrons to give or needs electrons to become uncharged, thus becoming stable.

Mother Nature's Way of Cleaning

GPS' technology generates the same ions as Mother Nature creates with lightning, waterfalls, and ocean waves. Mother Nature uses energy to break apart molecules. It is nature's way of cleansing the air naturally and creating a healthy environment. The only difference is that GPS' technology does it without forming ozone or other harmful byproducts.

GPS' NPBI technology has been certified by UL 867 and UL 2998 to be ozone free.

UL VALIDATED
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3rd Party Testing Summary

Pathogen	Time in Chamber	Kill Rate	Test Agency
Tuberculosis	60 minutes	69.09%	EMSL
Clostridium Difficile	30 minutes	86.87%	EMSL
Norovirus	30 minutes	93.50%	ATS Labs
MRSA	30 minutes	96.24%	EMSL
Staphylococcus	30 minutes	96.24%	EMSL
Mold Spores	24 hours	99.50%	GCA
E.coli	15 minutes	99.68%	EMSL
Legionella	30 minutes	99.71%	EMSL

Airborne Mold Spores Reduced by 95%

EMSL ATS LABS
EXCELLENCE IN ANTIMICROBIAL TESTING
Owned by Accuratus Lab Services

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GPS PRODUCT CHART

AUTO-CLEANING LINE	VOLTAGE	CFM RATING	IONS/cc/sec
GPS-FC24-AC	24-240 VAC	2,400	> 300 million
GPS-FC48-AC	24-240 VAC	4,800	> 400 million
GPS-DM48-AC	24-240 VAC	4,800	> 400 million
COMPACT LINE	**VOLTAGE**	**CFM RATING**	**IONS/cc/sec**
GPS-FC-1	110-120 VAC	1,200	> 25 million
GPS-FC-2	208-240 VAC	1,200	> 25 million
GPS-FC-3-BAS	24 VAC	3,200	> 170 million
BARS & STRIPS LINE	**VOLTAGE**	**CFM RATING**	**IONS/cc/sec**
GPS-iMOD	24-240 VAC	50-250 CFM/inch	> 140 million/in
GPS-iRIB-18	110-240 VAC	3,200	> 35 million/ft
GPS-iRIB-36	110-240 VAC	3,200	> 35 million/ft

GPS FACT: Aviation Application

GPS' technology is the only active air purification system that has been designed and approved to operate in commercial and private aircraft. Aviation applications require passing the stringent RTCA DO-160 test proving the technology does not generate EMF, line noise or interfere with the avionics in any way. This is important to note because GPS' technology is used in many healthcare applications and will not cause interference with the imaging equipment.

RTCA

DO-160

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980-279-5622

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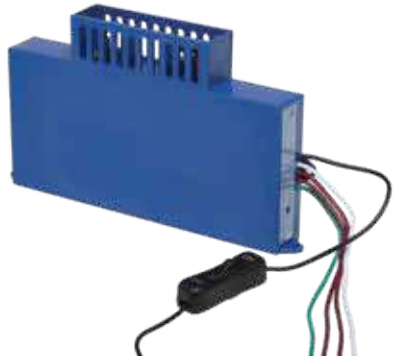
GPS-FC24-AC™



2,400 CFM Auto-Cleaning Needlepoint Bipolar Ionization System

Product Description

The GPS-FC24-AC is an auto-cleaning, needlepoint bipolar ionization system designed to handle up to 2,400 CFM. The unit is designed for multiple mounting options including fan inlet, interior duct wall or interior duct floor. The composite and carbon fiber construction allows the product to be mounted in corrosive environments.

Standard Features

Universal voltage input, in-line On/Off switch, programmable auto-cleaning cycle, plasma on indication light, alarm contacts, magnets for ease of installation and replaceable carbon fiber brush emitters.*

*Life cycle testing shows no mechanical degradation of the carbon fiber brushes due to repeated cleaning cycles

Benefits

- **P**article Reduction and Smoke Control
- **O**dors Neutralized by destroying VOCs
- **P**athogens Killed (Bacteria, Viruses, Mold), Helps to Control Allergens/ Asthma*, Prevents Dirty Sock Syndrome
- **E**nergy Savings of 30% by Reducing Outdoor Air Intake by up to 75%, reduces pressure loss by keeping coils clean without expensive UV system, and requires No Maintenance!

*These statements are based on numerous customer testimonials and have not been evaluated by the FDA

Specifications

Input Voltage	24VAC to 240VAC
Amps	0.17-0.017A operating/0.33-0.03A cleaning cycle
Power	4 Watts operating / 8 Watts cleaning cycle
Frequency	50/60HZ
Total Ion Output	> 300 Million ions/cc/sec
Airflow Capacity	0 to 2,400 CFM or up to 6 tons
Temperature/Humidity	-20°F to 200°F / 0 - 100% RH
Unit Dimensions/Weight	7.9"L x 1.1"W x 5.0"H / 1.25 lbs
Electrical Listings	UL, cUL, CE
Alarm Contact Rating	250VAC / 1A
Compliance & Certifications	UL 867, OSHPD Seismic (OSP), IAQP

Commercial Applications

- Schools and Universities
- Arenas and Stadiums
- Transportation Hubs
- Office Buildings
- Manufacturing
- Food Service
- Animal Care
- Institutional
- Senior Care
- Healthcare
- Hospitality
- Child Care
- Worship

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Global Plasma Solutions, Inc.
www.GlobalPlasmaSolutions.com

GPS-FC48-AC™

4,800 CFM Auto-Cleaning Needlepoint Bipolar Ionization System

Product Description

The GPS-FC48-AC is an auto-cleaning, no maintenance, needlepoint bipolar ionization system designed to handle up to 4,800 CFM. The unit is designed for multiple mounting options including fan inlet, interior duct wall or interior duct floor. The all-composite and carbon fiber construction allows the product to be mounted in corrosive environments.

Standard Features

Universal voltage input, in-line On/Off switch, programmable auto-cleaning cycle, plasma on indication light, alarm contacts, magnets for ease of installation and replaceable carbon fiber brush emitters.*

*Life cycle testing shows no mechanical degradation of the carbon fiber brushes due to repeated cleaning cycles

Benefits

- **P**article Reduction and Smoke Control
- **O**dors Neutralized by destroying VOCs
- **P**athogens Killed (Bacteria, Viruses, Mold), Helps to Control Allergens/ Asthma*, Prevents Dirty Sock Syndrome
- **E**nergy Savings of 30% by Reducing Outdoor Air Intake by up to 75%, reduces pressure loss by keeping coils clean without expensive UV system, and requires No Maintenance!

*These statements are based on numerous customer testimonials and have not been evaluated by the FDA

Specifications

Input Voltage	24VAC to 240VAC
Amps	0.41A to 0.041A
Power	10 Watts
Frequency	50/60HZ
Total Ion Output	> 400 Million ions/cc/sec
Airflow Capacity	0 to 4,800 CFM or up to 12 tons
Temperature/Humidity	-20°F to 200°F / 0-100% RH
Unit Dimensions/Weight	11.1"L x 1.84"W x 3.52"H / 1.32 lbs
Electrical Listings	UL, cUL, CE
Alarm Contact Rating	250VAC/ 1A
Compliance & Certifications	UL 867, OSHPD Seismic (OSP), IAQP

Commercial Applications

- Schools and Universities
- Arenas and Stadiums
- Transportation Hubs
- Office Buildings
- Manufacturing
- Food Service
- Animal Care
- Institutional
- Senior Care
- Healthcare
- Hospitality
- Child Care
- Worship
- Theatre

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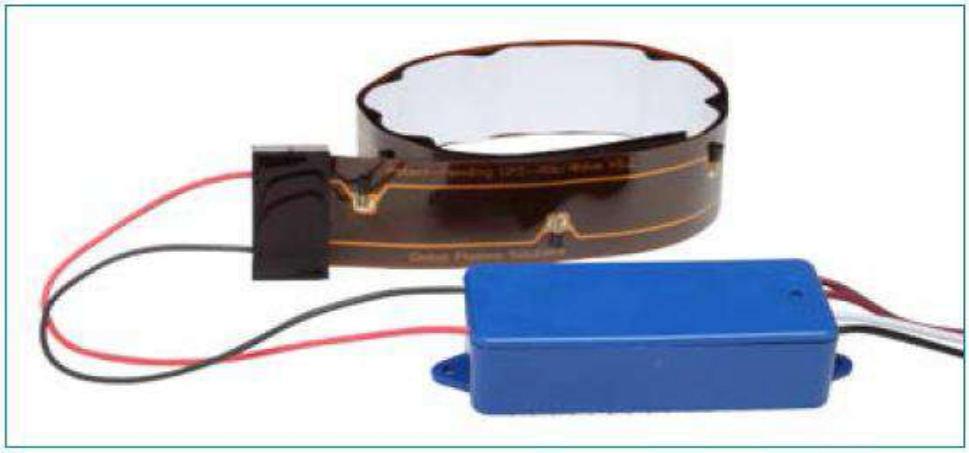
Installation, Operation & Maintenance Manual

GPS-iRIB-18 and GPS-iRIB-36



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Engineering Air for a Cleaner World™

Thank you for purchasing a GPS-iRIB™ from Global Plasma Solutions. The GPS-iRIB is a highly versatile device designed to be installed on the coiling coil of ductless systems or PTACs. The units can be installed on systems where there may not be enough room between the filter and the coil for traditional GPS products. The unit comes with adhesive-backed hook and loop tape for ease of installation.

DUCTLESS MINI-SPLIT AND PTAC MOUNTING AND WIRING INSTRUCTION

1. Turn off the power to the air handling unit (AHU).
2. Remove the filter screens and the cover to expose the coil surface and the power box.
3. Determine where you want to mount the ionization strip on the AHU.
4. Peel off the loop section from the GPS-iRIB and then peel off the paper layer to expose the adhesive.
5. Carefully attached the adhesive backed loop on the AHU at the desired location. Some mini split systems come with a plastic strip along the top of the coil. If so, mount the GPS-iRIB to the plastic strip. Otherwise mount the GPS-iRIB on the finned surface. See FIGURE 1.

CAUTION – keep the emitter tips away from loose wires or any grounded parts.

6. Each AHU brand will have different space constraints for the power supply. Find an appropriate space to mount the power supply using the included hook and loop tape. Press the power supply firmly to the mounting location. See FIGURE 1.
7. Run the wires to the electrical compartment. Connect the black wire to 100-240VAC and the white wire to neutral. For 208-240VAC installations, connect the white wire to the other hot leg, depending on the power supplied.
8. Trim the wires to length and connect to the appropriate power terminals, normally L1 and L2. Secure wires properly with wire ties or other NEC approved methods.

Figure 1

OPERATION

1. Turn on power to the AHU.
2. The ion device will be powered when power is applied to the AHU. Note: the ion device is designed to remain energized 24/7 and does not have to cycle with the fan.
3. Once unit is energized, the integral LED on the power pack will illuminate, indicating the unit is active.

BAS ALARM OPERATION

1. The purple wires connect to the integral alarm relay. When the unit is powered and there are no faults, the alarm contacts will be closed. When there is a fault, the contact will open.

MAINTENANCE

1. Remove power from the AHU and remove the required parts to access the iRIB. Confirm the iRIB power supply LED is not illuminated. It is good practice to ensure all voltage is removed from the iRIB. Take a screwdriver with insulated handle and touch a carbon fiber brush brass connector on one side to another on the opposite side. This will discharge any remaining voltage that could cause a potential shock hazard during maintenance.
2. Use a wet wipe or damp cloth to clean the iRIB. A soft bristle brush, like a toothbrush, can also be used to clean debris from ion emitters. Do not expose the iRIB to corrosive cleaners.

Engineering Air for a Cleaner World™

TOTALINE®

Aire Acondicionado y Refrigeración

Contáctanos:
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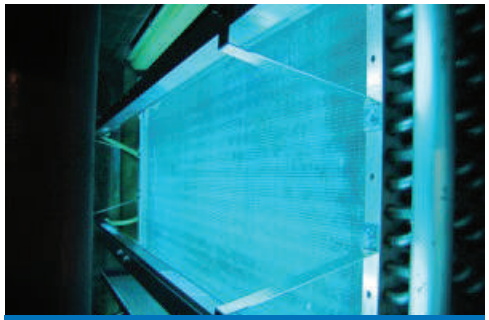
Correo: atencion@tienda.totaline.com.mx

NPBI AS REPLACEMENT TO UVC

Needlepoint Bi-polar Ionization vs. UVC

	Bi-polar Ionization	UVC Light
Replacement Interval?	**NONE**	Annually
Produces Detectable Ozone?	No	No
Kills Mold, Bacteria and Virus?	Yes	Yes
Kills Pathogens in the Space?	**YES**	No
Controls Odors?	**YES**	No
Reduces Particulate?	**YES**	No
Contains Mercury?	**NO**	Yes
Electrodes Fragile?	**NO**	Yes
Shock Resistant?	**YES**	No
Hazardous Disposal Required?	NO	Yes

***NOTE:** Cleans entire coil depth, not just "line of sight"*



WET SIDE

DRY SIDE

GlobalPlasmaSolutions.com

% of VIRUS CONTROLLED BASED ON TECHNOLOGY[1]

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

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

***UVC does not effectively kill airborne pathogens in high RH conditions[2]

2. ASRHAE Technical Paper on Airborne Infectious Diseases

1. 2009 EPA Tech Paper

NADCA White Paper on Ultraviolet Lighting Applications in HVAC Systems

Contributors:

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Introduction

Awareness of indoor air quality has increased substantially in recent years, and the systems that supply air to our living and working spaces are critical to the maintenance of a healthy indoor environment. As the global industry's leading advocate and trusted resource for reliable information, the National Air Duct Cleaners Association (NADCA) is uniquely qualified to provide guidance for consumers and the industry on the best practices for inspecting, cleaning and restoring HVAC systems.

It is generally agreed that source removal of contaminants remains the single best method for cleaning and decontaminating HVAC systems. One of the tools used to improve air quality from HVAC systems is the use of ultraviolet lighting within the system, intended to decrease the level of airborne pathogens and allergens going through the HVAC system and thus into the indoor air environment. Currently a broad range of information exists regarding the use and efficacy of ultraviolet lighting. In working with all parties associated with indoor air quality, NADCA recognizes the need to provide direction in this area.

Although the following information reflects the current state of the art for the use of ultraviolet lighting in HVAC systems, readers should recognize that new developments regularly occur and should familiarize themselves with the most current information when determining the appropriate steps to take.

Disclaimer

NADCA recognizes that differences in opinion will exist as to how to manage the use of ultraviolet lighting in HVAC systems. NADCA also recognizes that industry professionals will decide whether or not the application of ultraviolet lighting is appropriate for a given HVAC system, based on the unique circumstances surrounding that system. Ultimately, the decision of whether or not to apply ultraviolet lighting to an HVAC system rests with the owner of the system.

Ultraviolet lighting does not clean HVAC systems and should not be used as a substitute for HVAC cleaning.

This document was written in the United States of America and is intended primarily for use in that country. This material may also prove useful for industry professionals and others operating outside the USA. All users of this document are encouraged to refer to applicable federal, state/provincial, and local authorities having jurisdiction over the subjects addressed within this document.

Definition of Ultraviolet Lighting

A rainbow is made when light shines through droplets of water and breaks into its various colors. The light just beyond the violet end of the spectrum is not visible to the naked eye and is called ultraviolet ("beyond violet"), known commonly as UV light.

There are three types of UV light: A, B, and C, each representing a different section of the UV light spectrum. Type C, known as UVC, is the form used for germicidal activity. Although 10% of the sun's radiation is composed of UV light, virtually all of the sun's UVC rays are blocked by the Earth's ozone layer, so most UVC exposure is created by artificial means.

Typical Use

When UVC light is used for germicidal purposes, it is referred to as UVGI, ultraviolet germicidal irradiation.

UVGI "deactivates" or kills microorganisms, including viruses, bacteria, molds, and other fungi by disrupting their DNA. "Deactivated" means the organism is not necessarily killed but can no longer reproduce. Some deactivate after microseconds of exposure while others require much longer exposure. However, the effectiveness of UVGI depends on a number of factors, including:

1. Intensity of lamp(s).
2. Length of time of exposure.
3. An organism's ability to withstand UVGI.
4. The presence of particulate that may protect the organism from exposure by providing shadows or a shielding effect.
5. Increased humidity which may protect the organism.
6. Location of the UVC lamp(s).
7. Ambient temperature.
8. Number of lamps.
9. Reflectivity of surrounding surfaces.

Among other things, UVC is used for:

- Upper-room air disinfection (lighting designed for the top of a room)
- Surface disinfection
- HVAC air disinfection
- Cooling coil disinfection
- Water treatments
- Curing plastics and other materials
- Printing
- Chemical processing

Application method in HVAC systems

Bioaerosols are airborne particles that contain living organisms or were released from living organisms. They exist in the air around us and in the air that passes through HVAC systems. Inactivating them reduces the risk of occupant illness, allergic response, and infection from microbes. The use of UVGI to reduce microorganisms on the surfaces and bioaerosols in the airstreams of HVAC systems dates back to about 1900.

UVGI in HVAC systems has been studied and reviewed extensively by many scholars internationally, by professional organizations such ASHRAE – the leaders in the HVAC engineering field, and by government agencies.

UVGI lamps are categorized by the internal pressure of the gas in the lamp. Low-pressure lamps are, by far, the most commonly used in HVAC systems. Medium-pressure lamps are typically used where critical levels of disinfection are required.

On hard surfaces, like evaporator coils and drain pans, where UVGI exposure is constant and within adequate proximity, the kill rate for organisms contacted is up to 99.9%. However, deactivating bioaerosols is a more complex activity.

A common question asked is, “How effective is UVGI at killing (deactivating) bioaerosols in the airstreams of HVAC systems?” The answer is, “The technology can be effective, but many variables can impact its effectiveness.”

For example, a single UVC lamp randomly placed in an HVAC system would not be nearly as effective as multiple lamps of the same intensity installed at strategic locations. To get maximum benefit from UVGI, the installer should be well-trained in proper placement of lamps and the proper intensity and number of lamps needed for optimal deactivation of bioaerosols.

A key report from the Air-Conditioning and Refrigeration Technology Institute (ARTI), the global association of the manufacturers of HVAC and water heating equipment, states, “Be extremely cautious regarding claims about UVGI systems’ high levels of inactivation of pathogenic bioaerosols…. It would be irresponsible to claim a high inactivation rate for a pathogenic bioaerosol without substantial testing. Even with substantial testing, design failures may occur.”[1]

Studies of UVGI in commercial HVAC systems are not common. However, one study of office systems reports a 25-30% reduction in airborne bacteria when UVGI was used on HVAC drip pans and cooling coils. [2] Comparable results would require approximating the conditions of the study, including the number of lamps used, lamp intensity, lamp placement, and the initial condition of the drip pans and cooling coils.

Organisms vary dramatically in how quickly they deactivate from UVGI. Bacteria deactivate faster than fungi spores by an approximate factor of 200:1.[3] Some bacteria and mold spores are resistant to UVGI. The rates (length of exposure and wattage) required for deactivating specific species of microorganisms are available in various reference materials on UVGI.

Low-pressure UVC lamps operate best at 72° - 105° F, less effectively below 72°, and are not operable below 32° F. When placed in the airstream of an HVAC system, the operating temperature of the lamp will be altered through cooling or heating or through heat transfer because of air flow, potentially impacting the effectiveness of the lamp. Additionally, humidity can impact optimum operating temperature. While the impact can be significant, above 32° F UVC lamps still maintain a degree of effectiveness in HVAC systems, depending on ambient air conditions.

Medium-pressure lamps are more effective at lower temperatures than low-pressure lamps. However, they have shorter life spans, consume more energy and are rarely used in HVAC systems except for specialized commercial applications.

UVGI can be amplified by using certain reflective materials in the near vicinity, thus increasing its effectiveness against bioaerosols.

UVC lamps have a limited lifespan and their effectiveness reduces over time. In HVAC systems, they typically need replacement after one to three years, depending on the manufacturer’s specifications.

Any installation of a UVC lamp in an HVAC system should include a method of visually inspecting it periodically. Dirty lamps will result in reduced effectiveness, and the rate at which a lamp will become dirty depends on the cleanliness of the air that passes by the lamp. If the lamp has become dirty, it should be cleaned with a lint-free cloth and commercial glass cleaner or alcohol. Never inspect or

clean a lamp while it is turned on. If it is burned out or failing, it should be replaced.

All access panels or doors near UVC lamps where UV radiation may penetrate or be reflected should have clearly visible warning labels on the outside in appropriate languages.

Since improper placement of UVC lamps can result in poor efficiency and hazards, it is recommended that anyone installing UVC lamps in HVAC systems be fully educated on the matter and related issues. Detailed instructions can be found in the *ASHRAE Handbook – HVAC Systems and Equipment*, Chapter 17: Ultraviolet Lamp Systems.

Hazards

Material Decomposition

Organic material is that which was derived from living organisms, such as rubber, petroleum products and many components of adhesives. UVGI can seriously degrade organic materials over time in an HVAC system, including filters, sealants, gaskets, and wiring insulation, resulting in air leaks, fire hazards, and/or a loss of system performance. This is a major consideration when choosing if and where to install UVC lamps in such a system. Vulnerable materials should be shielded or substituted. If in doubt, consult the manufacturer of the potentially vulnerable material.

Filters, for example, vary greatly in their resistance to UVGI. Some made of inorganic fibers may hold up well, while others using organic fibers, binders or adhesives may disintegrate. Consult your filter dealer and, if needed, the UVC lamp manufacturer for guidance. Ensure the client is informed if specific types of filters are required in the system due to UVC lamp proximity.

The rate of UVGI deterioration for many materials was reviewed by ASHRAE in their research project RP-1509 and may be found in their final report by Kaufman.[4] See also Kowalski (2009) for additional information on UV photodegradation.[5]

ASHRAE recommends, “Although UV-C photodegradation is of concern, with the selection of the proper material or metallic shielding of other components, the problem is significantly reduced and components can be expected to meet product design life. As a simple, practical approach, it is wise to shield all organic material components within about 5 feet of the UV lamp.”[6]

Human Exposure

UVC exposure can be dangerous and should be taken seriously. Workers should not be subject to direct UV exposure. Lamps should be powered off, following lockout/tagout procedures, when being serviced. Per the ASHRAE Handbook, "if exposure is unavoidable, personnel should wear protective clothing (no exposed skin), protective eyewear, and gloves. Most eyewear, including prescription glasses, are sufficient to protect eyes from UV, but not all offer complete coverage; standard-issue protective goggles may be the best alternative."

Most of us are familiar with warnings of sunburn from too much UVA or UVB exposure. Direct UVC exposure – as used in HVAC systems - is hazardous, particularly to the skin and eyes. Ocular damage consists of inflammation of the eye with discomfort, *sometimes severe*, appearing within 6-12 hours after exposure and usually resolving within 24-48 hours. Skin damage from excess exposure is similar to sunburn. The ASHRAE Handbook reports that "acute overexposure to UVC band radiation is incapacitating, but generally regresses after several days, leaving no permanent damage."[7]

Mercury Exposure

UVC lamps are a type of bulb referred to as a compact fluorescent lamp (CFL). CFLs contain a small amount of toxic mercury so if a bulb breaks, care should be taken to reduce exposure.

Procedures for broken lamp cleanup can be found in the *ASHRAE Handbook – HVAC Systems and Equipment*, Chapter 17: Ultraviolet Lamp Systems:

If a lamp breaks, all workers must exit the HVAC equipment. Panels or doors should be left open and any additional lamp chamber access points should also be opened. Do not turn air-handling unit fans back on. After a period of 15 minutes, workers may reenter the HVAC equipment to begin bulb clean-up.

If a lamp breaks in a worker's hand, the worker should not exit the HVAC equipment with the broken bulb. Carefully set the broken bulb down, then exit the equipment. When possible, try not to set the broken lamp in any standing condensate water. Follow standard ventilation and reentry procedures.

Cleanup requires special care because of mercury drop proliferation, and should be performed by trained workers. As a minimum, workers should wear cut-resistant gloves, as well as safety glasses to protect eyes from glass fragments. Large bulb pieces should be carefully picked up and placed in an impervious bag. HEPA vacuum

the remaining particles, or use other means to avoid dust generation.[8]
Additionally, according to scientists from the Lawrence Berkeley National Laboratory of the U.S. Dept. of Energy, following the cleanup steps below results in about as much mercury exposure as a bite of tuna:

1. "Ventilate the area where the lamp is broken with outside air,
2. "Promptly clean up and remove any visible debris to a ventilated (preferably outdoor) area,
3. "Vacuuming forces mercury into the air and should be avoided if possible. (Any vacuuming should be limited to one or two minutes, and the vacuumed space should be vacated, while ventilating, for one to two hours. In addition, the vacuum cleaner should be emptied, then used and stored in ventilated areas until it has been used several more times.)

"If they have already broken the lamp and vacuumed it up and are worried, you can tell them that they have been exposed to about as much mercury as they would get from eating the FDA recommended amount of fish per week. They can reduce any potential risk to a prenatal infant by limiting their fish intake over the next couple of weeks."[9]

Ozone Generation

Ozone can be generated by UV lamps depending on the wavelength of the light generated. Ozone is produced at a wavelength of 185 nanometers. To avoid ozone production, use UVC lamps with a wavelength of 254 nanometers.

Best practices

It is generally agreed that source removal of contaminants remains the single best method for cleaning and decontaminating HVAC systems.

The application of UVGI in HVAC systems can be an effective means to reduce airborne pathogens but *only* if lamps are properly and strategically installed in sufficient number and/or intensity and are properly maintained.

If installed in HVAC systems without proper training, UVC lamps can be largely ineffective and can create hazards or material decomposition that negatively impact the functioning of the system and put occupants and installers at risk.

It is recommended that installers be well educated on the materials from the manufacturer and in the *ASHRAE Handbook – HVAC Systems and Equipment*, Chapter 17: Ultraviolet Lamp Systems.

It is also recommended that proper safety precautions be taken to protect workers and occupants from unnecessary UVGI exposure and the effects of lamp breakage should it occur.

References

[1]VanOsdell, D. and K, Foarde. 2002. Defining the effectiveness of UV lamps installed in circulating air ductwork. *Final Report*, Air-Conditioning and Refrigeration Technology Institute 21-CR Project 610-40030.
From http://www.osti.gov/energycitations/servlets/purl/810964-SRS2Dd/native/810964.pdf
[2]Menzies, D., J. Popa, J.A. Hanley, T. Rand, and D.K. Milton. 2003. Effect of ultraviolet germicidal lights installed in office ventilation systems on workers' health and wellbeing: double-blind multiple crossover trial. *The Lancet* 362:1785-1791.
[3] Kowalski, W.J. 2004. Predicted Air Disinfection Performance of Air Wave: Analysis of Performance Characteristics and Effectiveness in a Model Room. Pennsylvania State University October 14, 2004, Proprietary Report Prepared for UVC LLC
From: http://www.uvcm.com/Support/Penn_State.pdf.
[4]Kauffman, R. 2011. Study the degradation of typical HVAC materials, filters and components irradiated by UVC energy. ASHRAE Research Project. RP- 1509, Final Report.
[5]Kowalski, W. 2009. *Ultraviolet Germicidal Irradiation Handbook*, Springer, NY.
[6]ASHRAE, 2012. *2012 ASHRAE Handbook—HVAC Systems and Equipment*. Chapter 17: Ultraviolet Lamp, Systems, 17.6.
[7] Ibid, 17.6-17.7.
[8]©ASHRAE, www.ashrae.org. (2012) *ASHRAE Handbook—HVAC Systems and Equipment*
[9] R. Clear, F. Rubenstein, J. Howells. 2009. Dangerous mercury in CFLs? One big fish story. *Lighting Design and Application* 39(9):53-56.