
EvergreenUV
Environmental Disinfection
LUMALIER®
Industry leadership since 1963
SAFEAIR SOLUTIONS
Professional Turnkey UV Installation

EvergreenUV

- **Originally** Lumalier UV Products (est. 1963)
  - EvergreenUV/SafeAir Solutions – Largest Lumalier Contractor
- **December 2013** – Evergreen/SafeAir purchases Lumalier UV Corp.
- **January 2014** – Evergreen-Lumalier becomes 1st in UV industry to offer both Manufacturing & Turn-Key installation support
  - Company focused shifted from NC to Retrofit & ESPC work
- **Owner/President**:
  - David Skelton – ASHRAE TC2.9 Secretary
- **Full Turn-Key support throughout the country**

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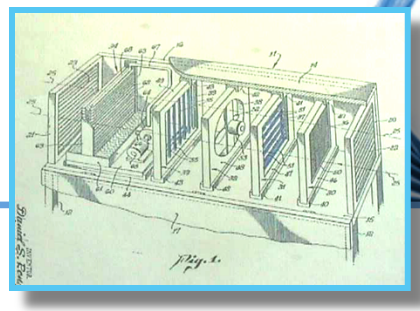
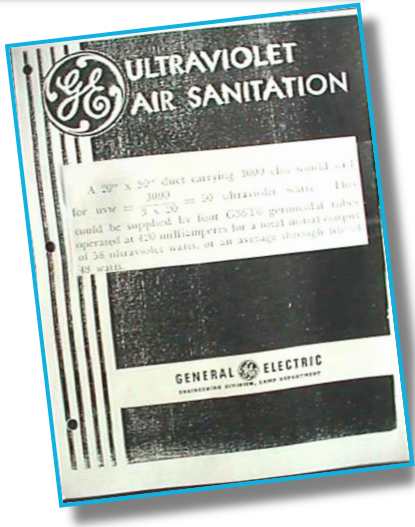
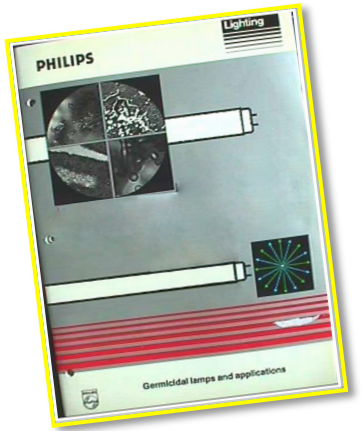
UV-C 100+ Year History - Old & New:



- **1903: UV-C wins Nobel Prize for Medicine & Physiology**
- 1937: 1st Univ. Study – Hospital Infection 10% - .24%
- 1941: 1st UV-C into HVAC patent
- 1963: Lumalier Manufacturing opens its doors
- 1973: GE – Air/Surface Disinfection Info
- 1985: Philips – UV-C for disinfection
- **1998-2003 – UV first used in HVAC to provide IAQ & clean coils**
- **2005: EvergreenUV – SafeAir offers turn-key UV-C installs**
- **2008: ASHRAE – Chapter 16 UV-C**
- 2016: EvergreenUV – Manufacturing Solutions
  - IAQ
  - Coil Optimization





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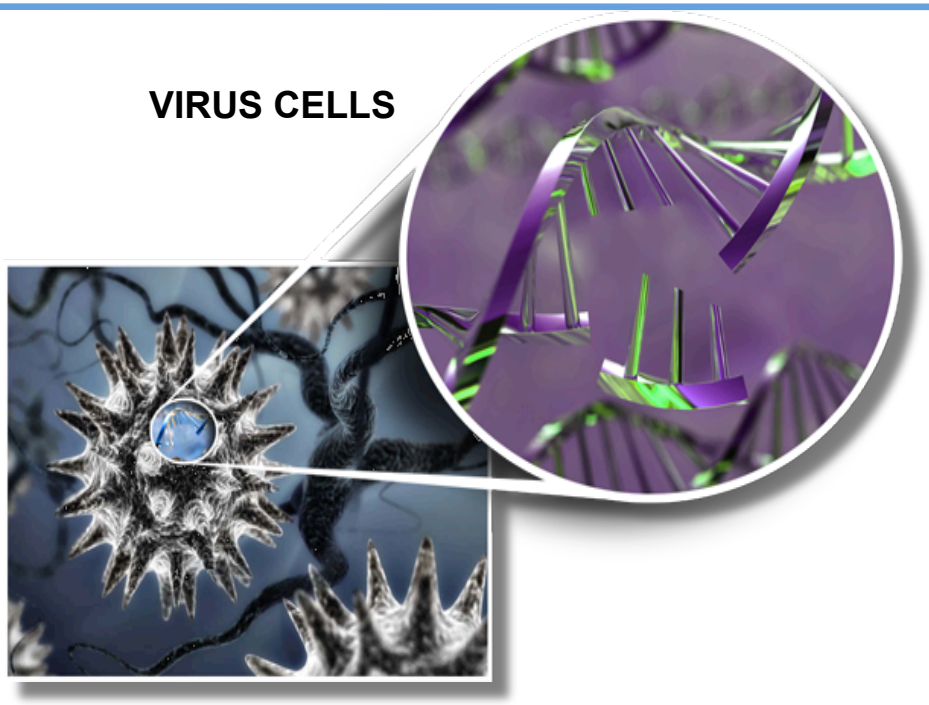
How does UV-C improve HVAC efficiency? - By Destroying Contaminants on the Coil…



UV-C breaks the DNA of contaminants, halting their ability to reproduce – Keeping Coils, Drains & air clean…..

We all agree – HVAC units with clean coils operate more efficiently than HVAC units with dirty coils!

- UV removes contaminants from HVAC coils,
- By eliminating biological growth from HVAC Coils – HVAC unit is restored to original spec performance.

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UV-C – URV Ratings

Use URV ratings to determine UV intensity for pathogen kill rates

URV	Dose µJ/cm2	Influenza (virus variant)	Smalpox (virus variant)	Tuberculosis (gram-positive bacteria)
1	1	0	0	0
2	10	1	2	2
3	20	2	3	4
4	30	3	4	6
5	50	6	7	10
6	75	9	11	15
7	100	11	14	19
8	150	16	20	27
9	250	26	32	41
10	500	45	53	66
11	1,000	69	78	88
12	1,500	83	90	96
13	2,000	91	95	99
14	3,000	97	99	100
15	4,000	99	100	100
16	5,000	100	100	100
17	6,000	100	100	100
18	8,000	100	100	100
19	10,000	100	100	100
20	20,000	100	100	100

Coil cleaning

EvergreenUV Standard

Ensuring proper UV intensity is crucial in order to achieve desired results

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UV – Benefits:

- ***UV Retrofits – Provide the 3 + 1 Benefits:***
  - **Coil Optimization**
    - Clean Coils = Energy Savings through Peak Performance
  - Preventative Maintenance
    - Clean Coils & Drain Pans w/o chemicals & labor
  - Indoor Air Quality Improvements
    - Health & Welfare (Liability control, productivity improvement)
  - OA Reduction (IAQP)
    - UV w/ PCO removes VOCs & eliminates airborne pathogens – satisfies IAQ Procedure requirements.
  -

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"…damp coil and drain pan conditions are excellent forums for growth of bacteria and mold. (these conditions) … *contribute to sick building syndrome and building-related illnesses* from mild irritation to the ***spread of infectious agents.*** "

2008 ASHRAE Handbook – HVAC Systems and Equipment

Air Handler Component Surface Disinfection; Chapter 16, page 6

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2008 ASHRAE Handbook – HVAC Systems and Equipment

Air Handler Component Surface Disinfection; Chapter 16, page 6

"UVGI reduces microbial levels on HVAC surfaces and in the air**. Coil pressure drop is reduced** and therefore **airflow is restored**. Because **heat transfer is restored**, this combination can **result in energy savings** which can be **significant**, with payback of possibly **less than 2 years**.

The associated improvements in air quality may **reduce respiratory distress symptoms** and thus **improve attendance and work performance** in all occupied spaces."

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Study Verifies Coil Cleaning Saves Energy

By Ross D. Montgomery, P.E., Member ASHRAE; and
Robert Baker, Member ASHRAE

1500 Broadway in NYC is the site of a coil cle

Although it's known theoretically that cleaning a coil can result in energy savings, little actual testing data and research exist to prove the point. As a result, building managers often ignore or reduce resources devoted to air-handler maintenance when faced with budget constraints. If proper maintenance is an important consideration in overall energy costs, conserving in that budget area can be self defeating.

Through our privately funded testing, monitoring and analysis, we believe we found a methodology and regimen that proves maintaining air-handler components in a clean condition can save energy dollars and improve other building parameter changes and efficiencies such as improved dehumidification and comfort, along with less mold and bacteria. Thus, we are encouraging IAQ environmental parameter improvements, better tenant satisfaction, and increased worker effectiveness.

It is difficult to find a building where such a study can be held. Fortunately, the owner and managers of a landmark 34-floor building on Times Square in New York City wanted to see what impact a dramatic change in coil cleaning nature and frequency might have. This building has only four large air handlers (SF-6, SF-7, SF-8, SF-9; 250 [880 kW], 123 [433 kW], 121 [425 kW] and 81 tons [285 kW], respectively) to service its 1.2 million ft^2 (111 500 m^2) of air-conditioned and heated space throughout the year.

The test project was perfo
building July through Septen
monitor and analyze the H
use before and after restora
air handlers, SF-8 (121 tons
and SF-9 (81 tons [285 k
are similar in their const
operation to the other two
in the building, and are loc
34th floor mechanical room.
four air handlers interact b
heating and cooling to the
the 34 floors of the buildi

About the Authors

Ross D. Montgomery, P.E., is pre
Honeywell Controls in Palmetto
Baker is founder and chairman o
mental Solutions in Tampa, Fla.

occurred Aug. 26 to 28). This represents a significant increase in latent heat transfer ability of the coil in the range of 10%. This indicates the ability of this coil "after cleaning" to being able to provide for *better* building dehumidification capacity control by delivering sub-dew-point air temperatures across the cooling coil.

In addition to the hard results presented in this article, many other "soft" positive results come out of cleaning and normal maintenance operations and its resultant energy savings and airflow increases. The HVAC system performance is increased and can more closely perform to its original intended specified operation (39,150 cfm [18 500 L/s] design data from 30 years before). After coil cleaning and regular maintenance, the HVAC systems are cleaner, and do not provide an environment for fungal, bacterial and microbial growth in their coils, ducts, and pipes. IAQ and the awareness of good IAQ are increased in the building, and the overall comfort and work effectiveness can be greatly enhanced. Overall tenant satisfaction with the building environment has been improved as evidenced by the property manager's communications and positive feedback.

Furthermore, not only will the owner benefit from the obvious energy savings and comfort increase, we also were able to help optimize some other building maintenance and operation processes and help enhance energy and maintenance effectiveness for years to come.

The building management had considered upgrading the environmental control systems to a modern building management system but could not clearly demonstrate an economic value to that investment. The data developed during this study allowed them to more accurately calculate a payback, so they scheduled this upgrade. In addition, consideration had not been given to conversion of the controls over the building supply and return fans from constant speed operation to VFD. The economic analysis allowed through this data has suggested that such a conversion might have significant economic value.

Good maintenance and operation practices including coil cleaning can significantly improve energy efficiency and IAQ performance of the HVAC&R systems in a building, such as reported here of 10% to 15%. More importantly, this study identified several key monitored and adjusted data points, such as pressure, humidity, and temperature, that can quickly and affordably provide a prediction of the potential for energy savings in any building. It is anticipated that such measurements will become a valuable tool for managing the economic impact of various building maintenance strategies.

A rich set of this study's data remains to be fully analyzed. It is possible that full analysis of all of this data will lead to even more additional opportunities for operational economy and improvements in this and other similar buildings.

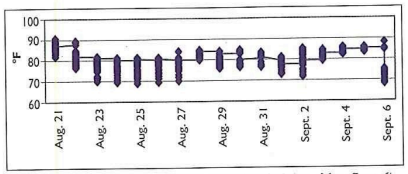

Figure 1: Outside air temperature (ECM period Aug. 21 to Sept. 6).

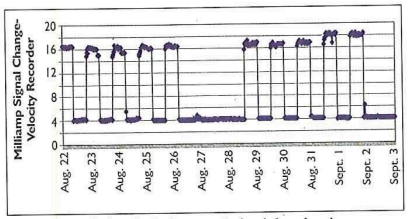

Figure 2: SF-9 air velocity increase before/after cleaning.

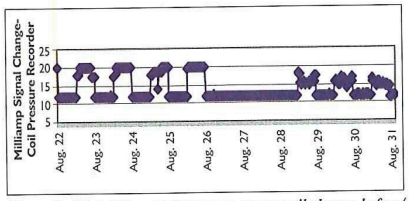

Figure 3: SF-8 differential pressure across coil change before/after cleaning.

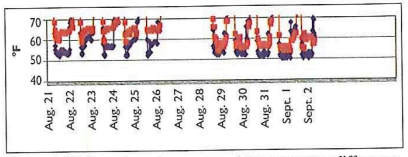

Figure 4: SF-9 supply water vs. consendate temperature differences.

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Acknowledgments

Professional Air Balancing Inc., 2005. Randall Saul, Owner. Ben O'Connor Technician. "NYC 1500 Broadway T&B," Clearwater Fla.

How Does UV Light Clean Coils?

- UV Light – eliminates airborne pathogens, but also surface contaminants:
  - Bio-Film
  - Mold
  - Bacteria
- Installing UV in AHU w/ dirty coils:
  - 2-6 weeks the coil will be cleaned
  - Bio-Film is in fact eliminated
  - Provides clean Air & also clean coil drain, and plenum surfaces
    -- Including multi-stack coils

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UV Rack Install:

Downstream – Entering Coil Side

- Capture Coil & Pan
- Prior to distribution to building
- Keeps Coil Clean
- Keeps Drain Pan Clean
- HVAC operates @ peak efficiency

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Dirty Coils – What we often see…

enUV
Disinfection

The Dirty ‘Truth’

EvergreenUV
Environmental Disinfection

Coils → Clean V. Dirty

Both units have not been Cleaned in over 7 years…. Only difference…. Unit on Right has UV

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UV-C/ECM's – Eliminate Dirty Coils

- Coil cleaning is typically a challenge for facilities… therefore many dont....
- Dirty Coils:
  - A layer of Bio-Film 0.002 inches (half thickness of a business card) insulates coil fins to reduce heat exchange and HVAC efficiency by up to 37% - ASHRAE Clean Coil Study

ASHRAE 2016

Field Study of Energy Use-Related Effects of Ultraviolet Germicidal Irradiation of a Cooling Coil

Joseph Firrantello, PE
Member ASHRAE

William Bahnfleth, PhD, PE
Fellow ASHRAE

Ross Montgomery, PE
Fellow ASHRAE

Paul Kremer

ABSTRACT

The energy use-related effects of ultraviolet germicidal irradiation (UVGI) to mitigate biological fouling (biofouling) of a chilled water cooling coil are investigated via a field study. A visibly bio-fouled cooling coil in an air-handling unit serving an operational building in a hot, humid climate is monitored for 5 months to establish a fouled coil baseline. Parameters monitored include air flow rate, airside pressure drop, air temperature and humidity upstream and downstream of the coil, chilled water flow rate, entering and leaving chilled water temperature, and waterside pressure drop. A UVGI coil irradiation system is installed on the downstream side of the coil following typical manufacturer guidelines, and the system is then passively monitored over a period of 14 months. The change in operation is estimated by comparing data from the baseline and post-irradiation periods. The 95% confidence intervals for average improvement of coil airside pressure drop and heat transfer coefficient are 11.07% to 11.13%, and 14.5% to 14.6%, respectively. Complexities of the physical phenomena involved, in particular, the combined effect of airflow and latent load on airside pressure drop, are taken into account.

INTRODUCTION

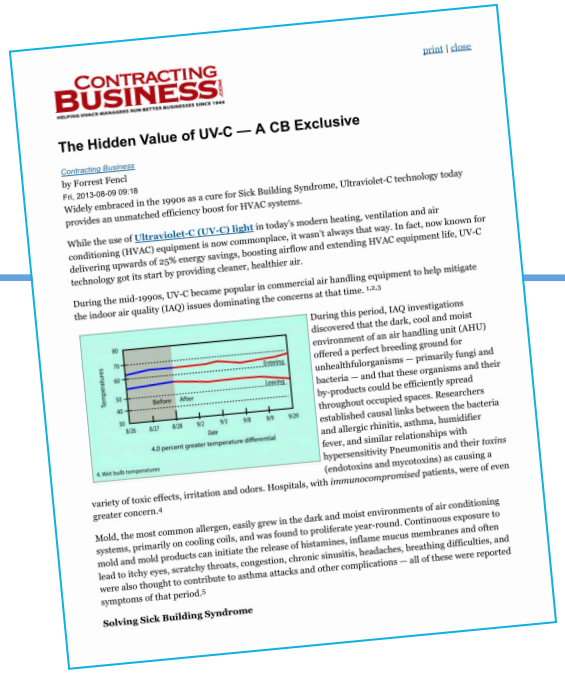
Finned tube cooling coils play a key role in the operation of air-conditioning systems. Coils are susceptible to fouling by particulate matter impinging on their closely spaced fins. Condensate that wets coil surfaces during operation helps to capture particles and also promotes microbial growth. Fouling increases airside pressure drop across a coil and decreases the air to water or refrigerant heat transfer coefficient. Both effects can increase energy use of an HVAC system significantly. This investigation considers the biofouling of chilled water coils and its mitigation by low power ultraviolet germicidal irradiation (UVGI) systems.

BACKGROUND

Airside Biofouling of Cooling Coils

Heat exchanger fouling is the buildup of organic and/or inorganic matter on the heat transfer surfaces. Cooling coils, due to the close spacing of fins on the air side (10 to 15 fins per inch or 4 to 6 per cm), can act as particulate

Joseph Firrantello is a doctoral candidate in the Department of Architectural Engineering, The Pennsylvania State University, University Park, PA. William Bahnfleth is a professor in the Department of Architectural Engineering and director of the Indoor Environment Center, The Pennsylvania State University. Ross Montgomery is owner of Quality Systems and Technologies, Parrish, FL. Paul Kremer is a Research Associate in the Department of Architectural Engineering, The Pennsylvania State University.



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CONTRACTING BUSINESS

The Hidden Value of UV-C — A CB Exclusive

Contracting Business
by Forrest Fencl
Fri, 2013-08-09 09:18
Widely embraced in the 1990s as a cure for Sick Building Syndrome, Ultraviolet-C technology today provides an unmatched efficiency boost for HVAC systems.

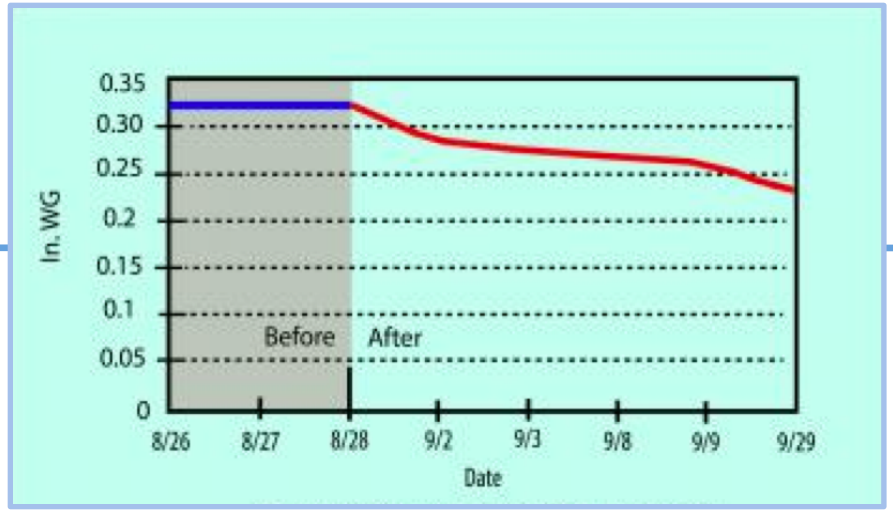
While the use of Ultraviolet-C (UV-C) light in today's modern heating, ventilation and air conditioning (HVAC) equipment is now commonplace, it wasn't always that way. In fact, now known for delivering upwards of 25% energy savings, boosting airflow and extending HVAC equipment life, UV-C technology got its start by providing cleaner, healthier air.

During the mid-1990s, UV-C became popular in commercial air handling equipment to help mitigate the indoor air quality (IAQ) issues dominating the concerns at that time. [1,2,3]

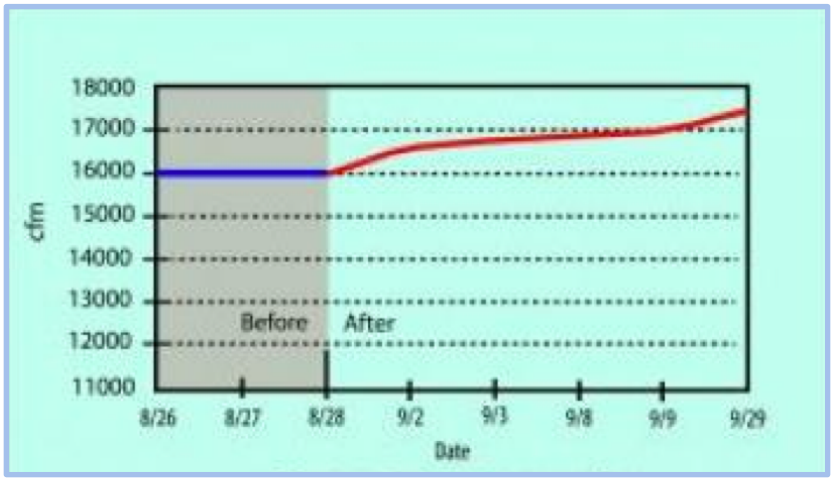
During this period, IAQ investigations discovered that the dark, cool and moist environment of an air handling unit (AHU) offered a perfect breeding ground for unhealthfulorganisms — primarily fungi and bacteria — and that these organisms and their by-products could be efficiently spread throughout occupied spaces. Researchers established causal links between the bacteria and allergic rhinitis, asthma, humidifier fever, and similar relationships with hypersensitivity Pneumonitis and their toxins (endotoxins and mycotoxins) as causing a variety of toxic effects, irritation and odors. Hospitals, with *immunocompromised* patients, were of even greater concern.[4]

Mold, the most common allergen, easily grew in the dark and moist environments of air conditioning systems, primarily on cooling coils, and was found to proliferate year-round. Continuous exposure to mold and mold products can initiate the release of histamines, inflame mucus membranes and often lead to itchy eyes, scratchy throats, congestion, chronic sinusitis, headaches, breathing difficulties, and were also thought to contribute to asthma attacks and other complications -- all of these were reported symptoms of that period.[5]

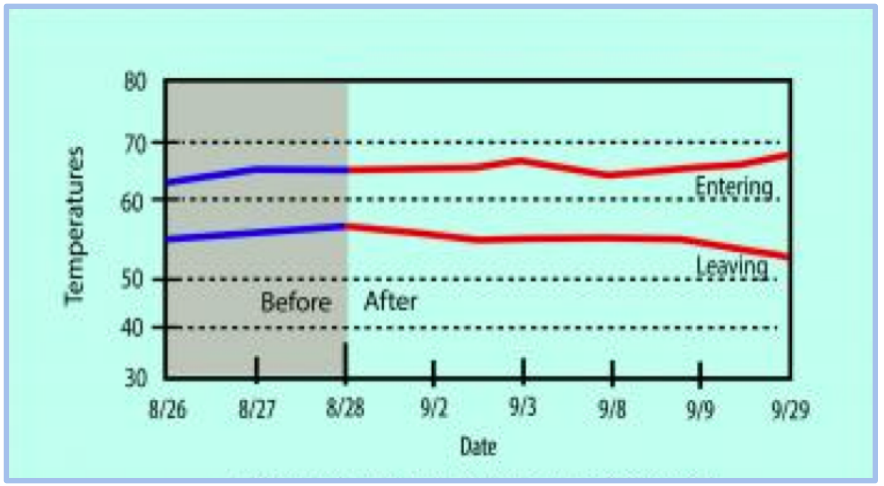
Solving Sick Building Syndrome



28% lower pressure drop across coil



8.6% increase in cfm



4.0% increase in temperature differential

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UV – 2016 – ECM & IAQ

- UV for Buildings – 2 'Options'
  - ***Coil Optimization*** (Coil Cleaning, Drain Pan & Plenum Cleaning)
    - **Primary Benefits: Energy Savings & PM (URV – 8)**
  - ***Indoor Air Quality*** – Involves UV in HVAC, Upper Air & Surface
    - (Healthcare, Labs, Clinics, Schools, Government/Correctional Facilities, Food Processing) (**URV – 13/14**)
      - **Primary Benefits: Improved IAQ, Energy Savings, PM**
      - **IAQP – OA Reduction**

Reduces Static Pressure
Maintains Thermal Transfer
Maintains Velocity
Eliminates Bio-Pathogens
Eliminates VOCs
O&M – PM for HVAC

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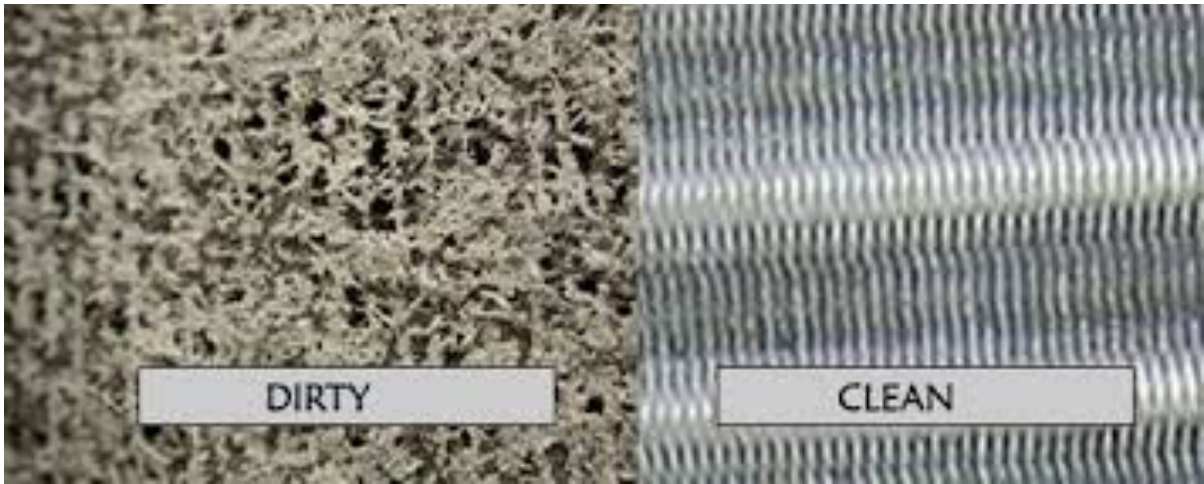

Evergreen UV – Custom Solutions

Small Profile Width – less than 4 inches
In order to retrofit into all AHUs.

Customer UV racks built to AHU specs

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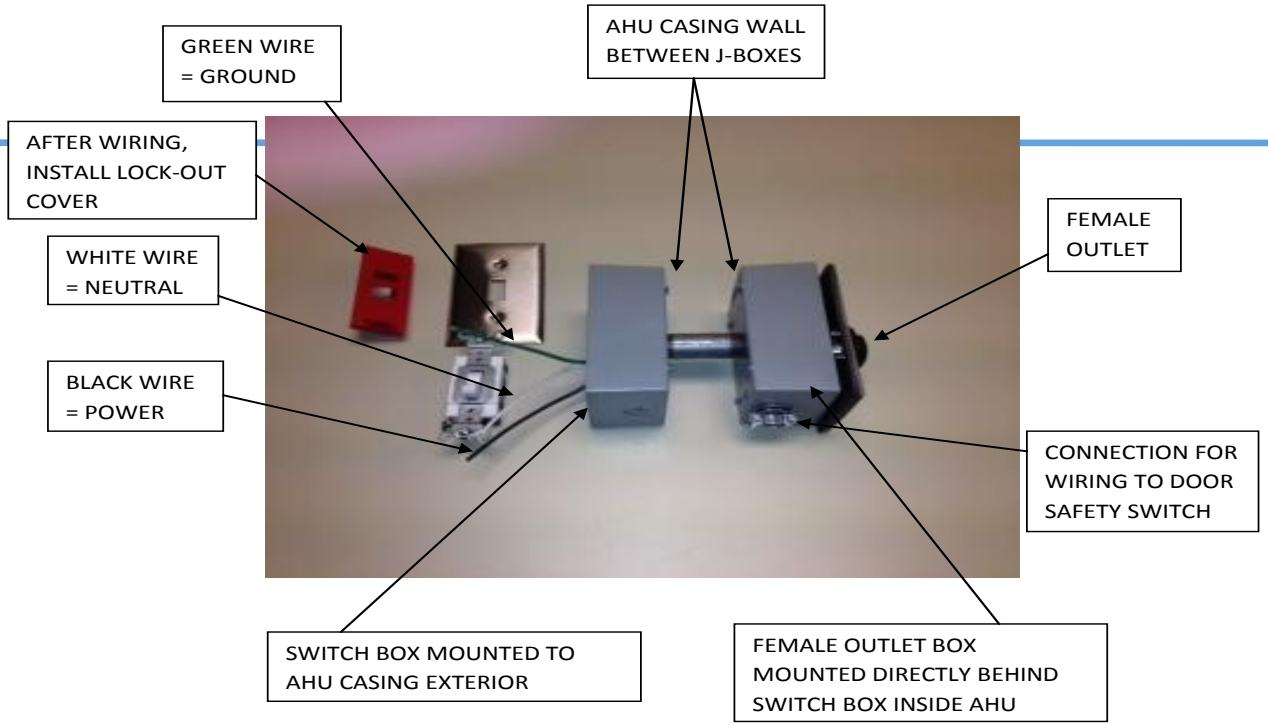
POWER J-BOXES FOR UV UNITS



1. Mount j-boxes in proximity to access door/panel as described above.
2. After securing j-boxes, route house wiring to exterior j-box, including toggle switch.
3. UV installer will route wiring from interior j-box to door safety switch.

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1931 Thomas Rd. Memphis, TN 38134

901-800-1709 **email@evergreenuv.com** **EPA Establishment No. 91347-TN-001**

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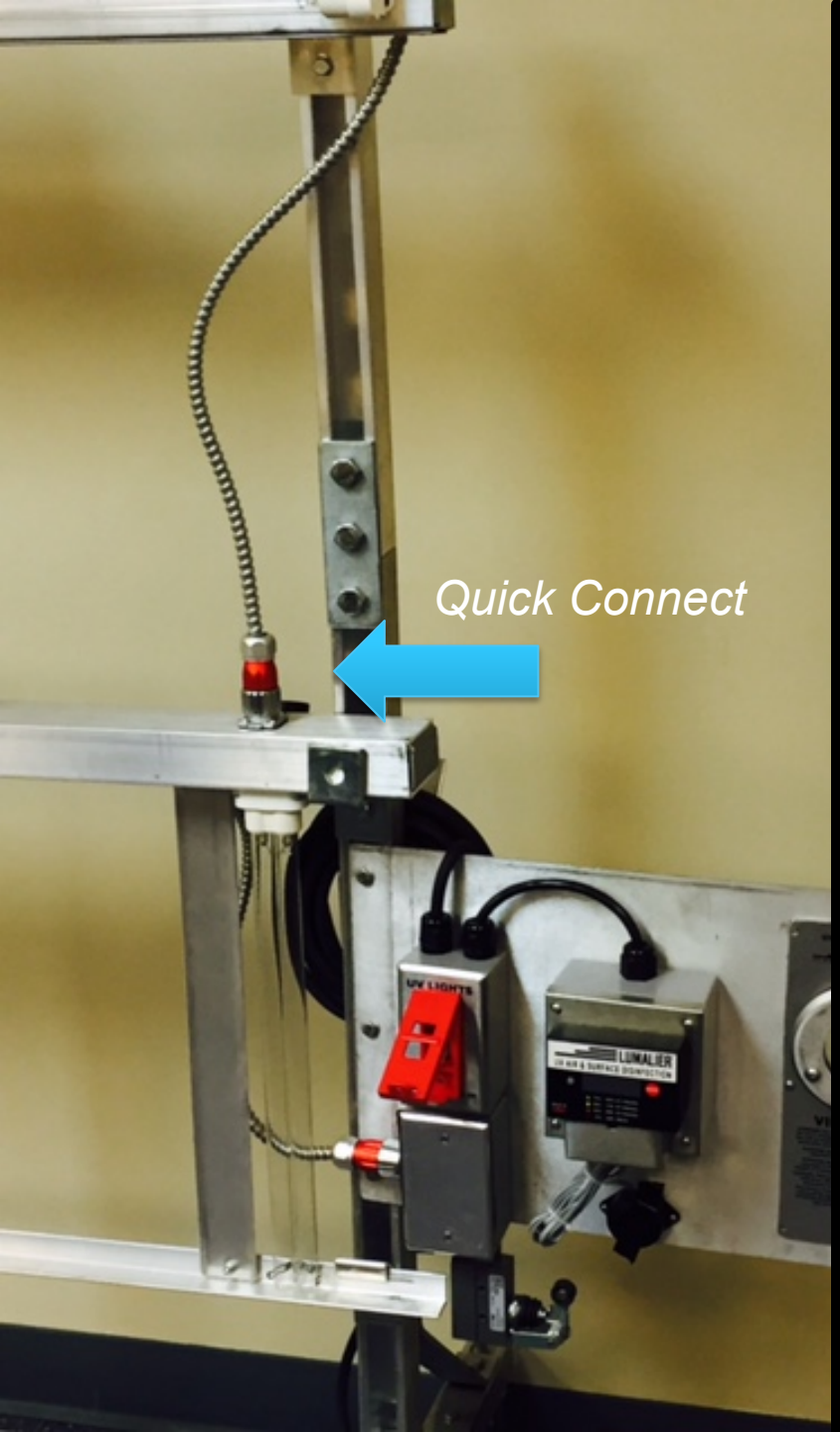
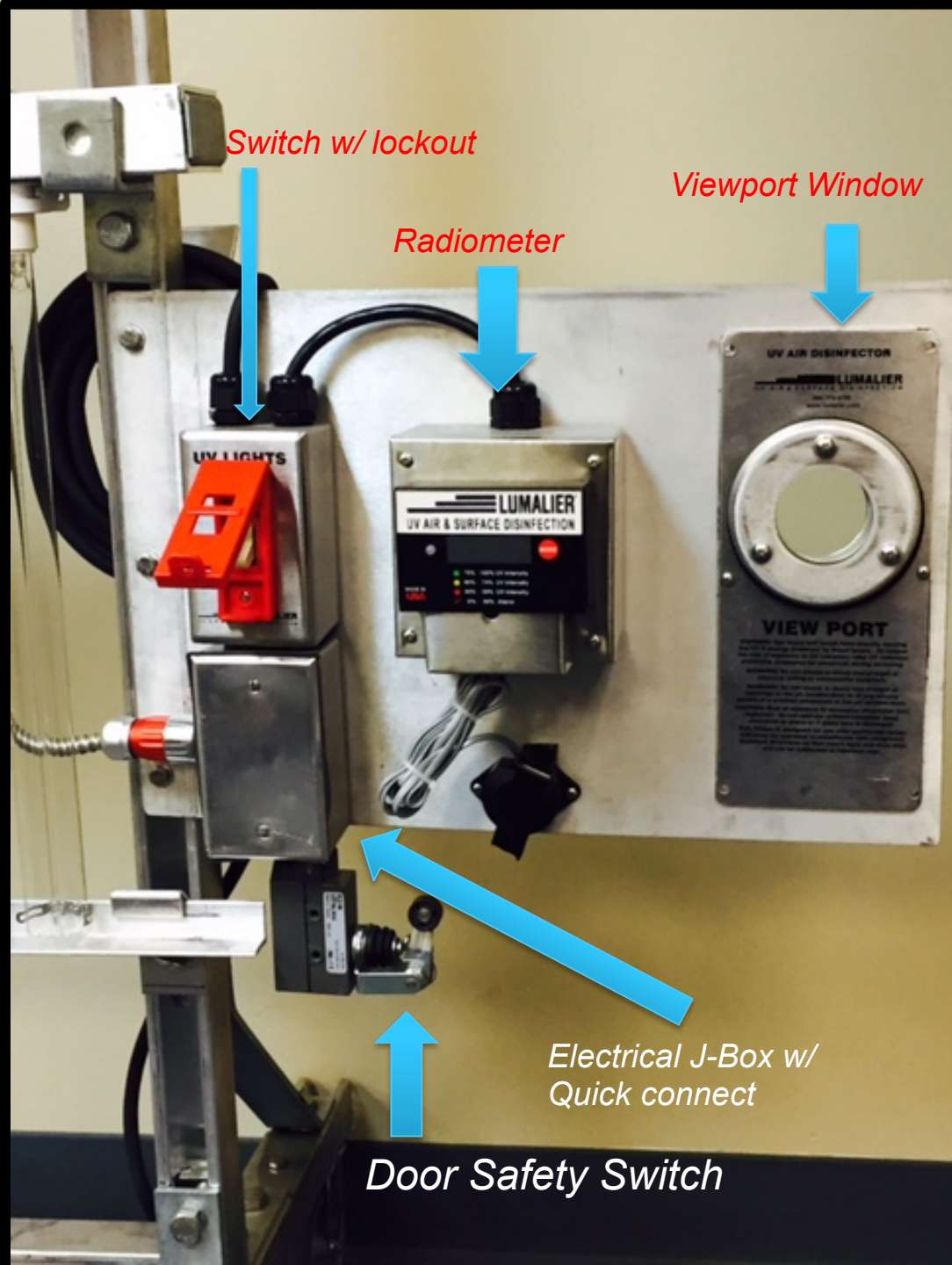

Quick Connect

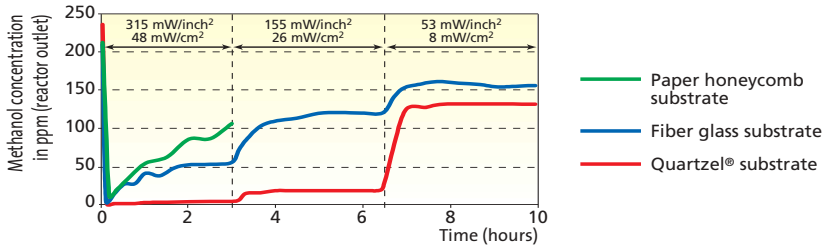

Switch w/ lockout
Viewport Window
Radiometer
UV LIGHTS
LUMALIER
UV AIR & SURFACE DISINFECTION
UV AIR DISINFECTOR
LUMALIER
VIEW PORT
Electrical J-Box w/
Quick connect
Door Safety Switch

IAQ-P Coil Disinfection & Air Purification

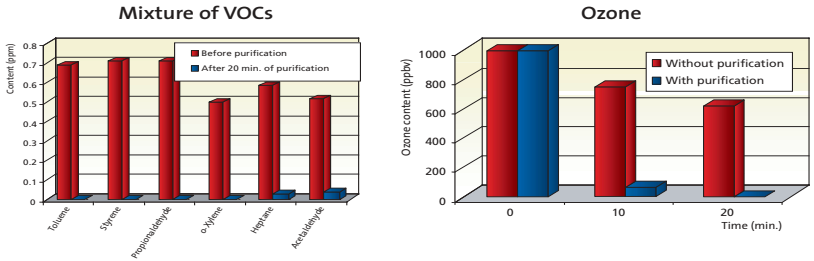
A proven effectiveness

➜ Laboratory tests on VOC

1/ Comparison of the abatement by Quartzel® PCO of a continuous flow of polluted air with 250 ppm of methanol (flow 64 ml/min – 2.10^{-3} CFM), compared to other media and for decreasing conditions of UV irradiation.

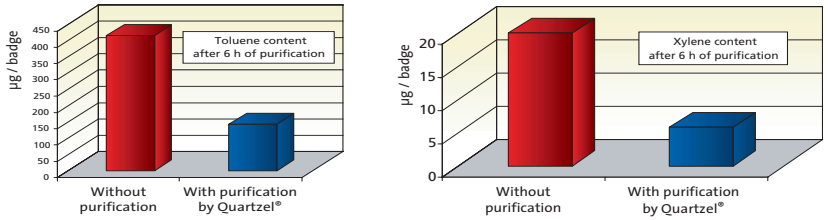


2/ Abatement of a mixture of VOCs and of Ozone in an enclosed box of 1 m³ (35 Ft³) by a purification system equipped with Quartzel® PCO.



➜ On site tests in partnership with various equipment suppliers

Example: Hystopathology laboratory with problems of VOC emissions (Toluene, Xylene).



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Studies Relate IAQ and Productivity
by U.S Green Building Council

Lawrence Berkeley National Laboratory quantified the **benefits of IAQ effects on health and productivity**:

- **SBS symptoms reduced by 20 to 50 percent**, with estimated savings of $10 to $100 billion
- **Asthma reduced by 8 to 25 percent**, with estimated savings of $1 to $4 billion
- **Respiratory illnesses reduced by 23 to 76 percent**, with estimated savings of $6 to $14 billion
- Office **worker productivity increased by 0.5 to 5 percent**, with estimated savings of $20 to $200 billion

William J. Fisk, "How IAQ Affects Health, Productivity," *ASHRAE Journal*, May 2002.

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