# SanUVAire Ultraviolet Technology Allowing Transit ridership to Breathe Safe

The Centers for Disease Control and Prevention (CDC) identifies tuberculosis (TB) as one of the world's deadliest diseases, with about one-third of the world's population infected. A 2011 study analyzing the risk factors for tuberculosis transmission identified an association between the use of public bus transportation and incidents of *Mycobacterium Tuberculosis* (MTB) onboard the Metropolitan Transit Authority (METRO) in Houston, Texas. Through collaboration with a late entrepreneur, one of the nation's largest bus fleets became the test site for an ultraviolet germicidal technology that stumbled upon benefits far beyond its intended scope.

## Identifying the Need

Every time you cough, you release thousands of droplets into the air; each sneeze emits up to 40,000 droplets. MTB is an airborne pathogen with an associated cough frequency that travels a short distance (1-2 meters), but it can remain infectious for days. In confined, public areas like buses, these droplets pose an even greater public health concern. Airborne to Surface pathogens.

MTB droplet nuclei are resistant to gravitational forces. In a shared environment with no air filtration, droplets can remain suspended in the air for up to nine hours, meaning people may come in contact with MTB long after the infected patient has reached his or her destination. Public transportation systems typically filter their air through an onboard heating, ventilation, and air conditioning (HVAC) system, however. So, the droplets could remain airborne for a longer period of time as they are repeatedly recycled and pushed back into the cabin. Filters, typically, can only trap very large particles, hence, all airborne viruses pass through it and are recirculated.

When a patient is diagnosed with TB, it is common for public health departments to conduct a contact investigation in an attempt to identify, inform, and treat people who may have been exposed to the disease. The constant recycling of infected droplet nuclei on a bus makes it possible for an undiagnosed individual to repeatedly share the same enclosed airspace with persons they would be unable to name in a contact investigation. As the outbreak of TB was the initial reason to drive the need, soon after the realization that the ridership was exposed to many other airborne infectious disease, not just TB (An extended list is provided below).

## Spores to Pathogens

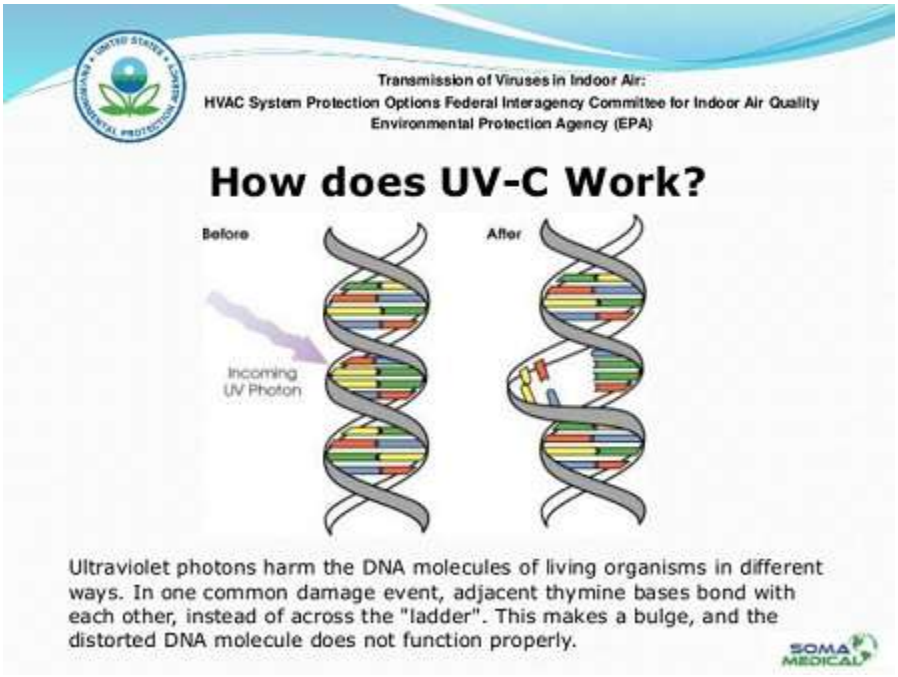
In 2003, the Chicago Transit Authority (CTA), like other agencies, were seeing their HVAC coils caked in mold and in need of professional cleaning several times each year. As the mold count grew, the cleaned air no longer came out clean. The system also had to work harder to push air out, causing reduced air flow. This created musty odors and harder working, less efficient bus components. As Lee Huston, the late entrepreneur, began examining possible air fresheners for buses, he discovered ultraviolet light.

The CTA hired Huston's company, then JKA Company, which assets are currently owned by SanUVAire, LLC, to mitigate the mold that was growing on the CTA's bus HVAC coils, creating a lingering odor when functioning.

Ultraviolet light has three light spectra: UV-A, which is used in tanning beds and black lights; UV-B, which is the cause of sunburns; and UV-C, which is the strongest form of UV light. UV-C has disinfecting properties that disrupt the DNA of microorganisms, leaving them unable to perform vital cellular functions (See Figure 1 below). UV-C has long been identified by the CDC, The National Institute for Occupational Safety and Health, and the World Health Organization as an effective agent for the cleansing of microorganisms that can sprout disease. It is also used to help control the spread of TB.

From this, JKA company created an adaptable ultraviolet germicidal irradiation (UVGI) system for transit buses called the "Breathe-Safe System," which latches onto the air conditioning unit of the bus and draws on the vehicle's direct current. Doing so ensures that the Breathe-Safe System can operate without increasing fuel consumption, emissions, or draining the battery.

**Figure 1.**



## IDEA Becomes Reality

JKA Company received support from the Transportation Research Board's Transit Innovations Deserving Exploratory Analysis (IDEA) program, which funds high-risk, high-payoff inventions that may not typically be candidates for usual government research programs, to further test the system. In 2007, JKA installed Breathe-Safe on 14 METRO buses and recorded findings over the course of six months.

The METRO has the largest bus fleet of any city without a rail service in the United States, with greater than 1,200 buses in operation. Of the 120 METRO bus routes, the 2011 study reported patients with TB rode on 99 different routes, and culture patients reported riding on 78 different routes. The study also cited ridership as having elevated risk factors known to be associated with TB transmission and TB disease—Including drug use, being HIV positive, and residing in a homeless shelter six months prior to diagnosis.

In addition to the potential for TB transmission, the initial tests identified 23 separate mold species in the air conditioners of the test buses, meaning the spores of 23 mold species are regularly cycled into the cabin.

Palm Tran—the transportation system of Palm Beach County, Florida—was one of the earliest users of the UVGI system, when they installed Breathe-Safe in response to public concern surrounding a flu outbreak.

Palm Tran now has UVGI systems on 110 of their buses, with plans to install the system on their next fleet of vehicles. Jon Kavaliunas, manager of maintenance at Palm Tran, said the system's low-maintenance costs and ease of use has made the technology an easy recommendation to his peers. "Breathe-Safe [UVGI] system improves the interior air quality, adds to the efficiency and maintenance of the air conditioning system, and has improved customer relations," he said.

## New Ownership – New Era of Technology Advancements

In January 2016, SanUVAire, LLC bought out JKA Company assets and brought with it a new refreshing and re-ignited focus on Indoor Air Quality and purification (IAQ), not just for Transit, but covering Commercial and Residential.

SanUVAire, also, made an investment in Transit Safety systems, that seem so simple but very effective and needed. "We want to be recognized as an innovative company that always focuses on providing products with purpose," said Chad Sleiman, CEO of SanUVAire. "We want to keep purchase costs down for our customers by providing affordable solutions that yield great benefits such as: operational and maintenance cost savings, safety, health, quick ROI and low Total Cost of Ownership (TCO)".

SanUVAire is consistently looking to expand their IAQ catalog and they will be announcing in the near future their new product addition, Electronic Air Purification Bi-polar Ionization. "We believe that there is a bigger picture to addressing IAQ, and we want to offer a comprehensive approach instead of just one. We have to do it from all angles," said Sleiman.

The Breathe-Safe UVGI system is undergoing new design and enhancements. Many new features, smart embedded technology and lamp enhancements are some of the few new updates that will be

implemented. “My vision is to have a smart system that customers can connect to, access the information needed, and is built on a platform that allows us to scale, issue upgrades and enables customers to integrate it with other information and analytics systems existing in the bus’s eco-system. We are in the age of Internet of Things – IOT, so we need to keep up or we will be viewed as another legacy product. You can’t manage what you don’t see, It’s all about data and performance. Very exciting things are coming, keep a look out for SanUVAire,” said Sleiman.

SanUVAire is the only company that holds the license for the UVGI solution for Transit.

## Health Benefits

Tests show the health benefits of the UVGI system on the germs and harmful pathogens listed below:

| **Germ/Pathogen** | **Tested Kill Rate** |
|---|---|
| 1. TB | 99.999% |
| 2. MTB | 99.999% |
| 3. Psdomonas Aeruginosa | 99.999% |
| 4. Staphylococcus Aureus | 99.999% |
| 5. MRSA (Methicillin-Resistand Staphylococcus Aureus) | 99.999% |
| 6. VRE (Vancomycin-Resistant Enterococcus Spp.) | 99.999% |
| 7. Legionella Pneumphia | 99.999% |
| 8. MS-2 Escherichia Coli (Surrogates Viral Pathogens) | 99.999% |
| 9. PRD-1 Salmonella Typhimurium (Surrogates Harmful Virus Pathogens) | 99.999% |
| 10. H1N1-ATCC VR1469 | 99.999% |
| 11. Poliovirus-L Sc Chat Strain VR 1562 | 99.999% |
| 12. Salmonella – Six Species (Surrogates Harmful Gram-Negative Bacteria) | 99.999% |
| 13. Small POX | 96.999% |
| 14. Anthrax | 96.999% |

An extended list of Airborne Germs/Pathogens UV System kills can be provided.

## Cost Savings Benefits

### *ABSENT DRIVER SAVINGS*

SanUVAire estimates the saving of just one day per year from driver illness based on an average yearly wage with benefits of $50,000.00 and a 200-work day year equals the loss of $250 per day for the driver plus the cost of a replacement driver at potentially time and a half wage rate or $375 per work day.

### *MAINTENANCE SAVINGS*

HVAC Evaporator Cleaning is estimated conservatively as follows:

1. 1 ½ hours per HVAC unit, $50.00 labor rate per hour equals $75.00.
2. Four (4) cleanings per year (x $75.00) equals **$300.00 per year per bus**.
3. Average cost of cleaning product $10.00 x 4 cleanings equals **$40.00 per year per bus**.

*FUEL SAVINGS*

Estimating a conservative average of 50,000 miles per vehicle per year as follows:

1. 200 days of operation at 250 miles per day and an estimated 4.0 miles per gallon diesel equals an average 62.5 gallons of diesel per day.
2. With an average 280-horse power engine, the A/C compressor requires approximately 10% of engine horse power for operation.
3. The compressor power requirement is reduced by 1 hour per day (10-hour day) through continuously clean evaporators for both heat and cooling which equals 10% x 62.5 gallons or 6.25 gallons of diesel fuel savings per day.
4. The yearly fuel savings: 6.25 gallons of diesel fuel savings per day times 200 days of operation (6.25 x 200) equals **$1,250.00 per year per bus savings**.

*TOTAL COST SAVING PER BUS ANNUALLY*

| | | |
|---|---|---|
| a. One day less driver absenteeism | | $250.00 |
| b. One day less driver replacement | | $350.00 |
| c. Labor cleaning evaporators | | $300.00 |
| d. Cleaning Material | | $40.00 |
| e. Fuel Saving | | $1250.00 |
| | **TOTAL** | **$2,190.00** |

Savings for A 100-bus fleet equipped with BREATHE-SAFE SYSTEMS:

**100 x 2190 = $219,000.00 Annually**

“The HVAC unit in the bus is responsible for many things—specifically the air circulation—but it’s also a major component to the lifecycle of the bus,” said Sleiman. “We needed to address, if not eliminate, the costs that transit agencies were incurring in maintenance fees year over year by hiring or outsourcing folks to service those units.”

The cleaner HVAC system also means that certain components on the bus don’t have to work as hard.

## Agencies using the Breathe-Safe system

Agencies from Dallas, Chicago, Orlando, San Diego, and other major markets use the SanUVAire product, with more planned installations in the near future. Over 2000 systems installed to date with multi-year contracts ongoing.

## Applications

Transit, institutional, commercial and residential facilities are currently enjoying the benefits of the Breathe-Safe system.


## Air Purification Technology Comparison matrix

| Unbiased Summary of each of the prevalent traditional technologies based on Actual Results | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TYPE & DESCRIPTION | | AIR PURIFICATION & FILTRATION SYSTEMS COMPARISON CHART | | | | | | | |
| | | SanUVAire Breathe-Safe UVGI | TRADITIONAL | HEPA / FINE GRAIN1 | CARBON | PLAZMA or ELECTRONIC AIR IONIZERS | PCO | CHEMICAL | BIO3 |
| OZONE GENERATOR | | N/A | No | No | No | "Yes" | No | No | No |
| TREATS RETURN AIR | | Yes | Yes | Yes | Rarely | Yes | Yes | No | No |
| TREATS EXHAUST AIR | | Yes | Rarely | No | Yes | Yes | Rarely | Yes | Yes |
| CAPITAL COSTS | | Low | Low | Medium | High | Low | High | Very High | Very High |
| PRESSURE DROP | | N/A | Minor | Large | Medium | Marginal | Medium | High | Very High |
| PARTICLE SIZE | | Any | Large ( > 5um ) | Small ( > 0.01um ) | N/A | Medium | Large | N/A | N/A |
| TREATS AIR IN ROOM | | When Circulated by HVAC | No | No | No | Yes - Short Range | No | No | No |
| TREATS MAKE-UP / SUPPLY AIR | | Yes | Yes | Yes | Yes | Yes - Short Range | Yes | No | No |
| ENERGY COSTS | | Low | Low | High | High | Low | Medium | High | High |
| O&M COSTS | | Low | Low | Low to Medium | High | Medium | High | Very High | Very High |
| DISPOSAL COSTS | | Low | Low | Depends on Contamination | High | Medium | High | High | High |
| SUCCESS RATES | | 99% | Minimal | 0 - 80% | Marginal | < 80% | Marginal | Marginal | Marginal |

In summary, bus fleets of urban and regional transportation systems such as METRO and Palm Tran have become testing grounds for ultraviolet germicidal technology and, ultimately, advocates because the

technology has yielded benefits that are beyond what scientists initially predicted. It is proven to combat mold build up, kill harmful pathogens, viruses, bacteria and other illnesses while reducing maintenance costs and fuel consumption. Hence, Breathe-Safe system has demonstrated to be the only tested, proven and effective air purification solution and should be adopted by all transit agencies.

## Reference Documents, Previous Research, Published Reports and Testing:


EPA 2006a. EPA 600/R-06/050. Technology Evaluation Report. Biological Inactivation Efficiency by HVAC InDuct Ultraviolet Light Systems. Dust Free Bio-Fighter 4Xtreme, model 21.

EPA 2006b. EPA 600/R-06/051 Biological Inactivation Efficiency by HVAC In-Duct Ultraviolet Light Systems Atlantic Ultraviolet Corporation Aerologic Model AD24-4. EPA.

EPA 2006c. EPA 600/R-06/055 Biological Inactivation Efficiency by HVAC In-Duct Ultraviolet Light Systems. Lumalier ADPL-60-8. EPA.

Biological Inactivation Efficiency by HVAC Ultraviolet Light Systems – Technology Evaluation Report – Office of Research and Development National Homeland Security Center Eric Koglin Project Officer, National Homeland Security research Center Office of Research and Development, US Environmental Protection Agency, Las Vegas, Nevada

Ultraviolet Germicidal Irradiation for Transit Buses HVAC Systems – Transportation Research Board, Transit IDEA Project 53, Lee Huston JKA Company, 2008

ANSI/ASHRAE (American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers). 1999. ANSI/ASHRAE Standard 52.2-1999, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, Section 5.16.2, Atlanta, GA.

UVC Under a New Light – Florida Hospitals Put HVAC Maintenance Under a New Light. Engineered Systems Magazine (2004) – Firouz Kiikavousi PE

Breaking the Mold – Mold and Moisture in HVAC Systems for Commercial Buildings – Engineered Systems (2005)

http://onlinepubs.trb.org/onlinepubs/archive/studies/idea/finalreports/transit/Transit53_Final_Report.pdf

Riley RL and Nardell EA. “Clearing the Air: The Theory and Application of Ultraviolet Air Disinfection." American Review of Respiratory Diseases. 1989;139(5):1286-94.

VanOsdell, D. and Foarde, K. Defining the Effectiveness of UV Lamps Installed in Circulating Air Ductwork - Final Report. Air-Conditioning and Refrigeration Technology Institute, Arlington, Virginia, 2002.

Xu, P., Peccia, J., Fabian, P., Martyny, J. W., Fennelly, K., Hernandez, M., and Miller, S. L., Efficacy of ultraviolet germicidal irradiation of upper-room air in inactivating bacterial spores and Mycobacteria in full-scale studies, Atmospheric Environment, 37: 405-419, 2003.

Xu P, Kujundzic E, Peccia J, Schafer MP, Moss G, Hernandez M, and Miller SL, “Impact of Environmental Factors on Efficacy of Upper-Room Air Ultraviolet Germicidal Irradiation for Inactivating Airborne Mycobacteria.” Environmental Science & Technology, 39:9656-9664, 2005.