THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**GENERAL VENTILATION AIR CLEANERS**		
APPLICATION:	**BIOLOGICAL INACTIVATION EFFICIENCY BY HVAC IN-DUCT ULTRAVIOLET LIGHT SYSTEMS**		
TECHNOLOGY NAME:	**DC24-6-120**		
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The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups, which consist of buyers, vendor organizations, permitters, and other interested parties; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Air Pollution Control Technology Verification Center (APCT Center) is operated by RTI International (RTI), in cooperation with EPA's National Risk Management Research Laboratory. The

APCT Center conducts verifications of technologies that clean air in ventilation systems, including in-duct ultraviolet (UV) light systems. This verification statement provides a summary of the test results for the American Ultraviolet Corporation DC24-6-120 Duct Sterilizer.

VERIFICATION TEST DESCRIPTION

All tests were performed in accordance with RTI's "Bioaerosol Inactivation Efficiency by HVAC In-Duct Ultraviolet Light Air Cleaner", a supplement to "Test/Quality Assurance Plan for Biological and Aerosol Testing of General Ventilation Air Cleaners" which was approved by EPA. Testing for biological inactivation was performed using three organisms – two bacteria (*Bacillus atrophaeus* and *Serratia marcescens*) and one bacterial virus (MS2). To model use in a heating, ventilation and air-conditioning (HVAC) system, RTI used a test duct designed for testing filtration and inactivation efficiencies of aerosol, bioaerosol, and chemical challenges.

The testing was conducted in the test duct operated following procedures in the ANSI/ASHRAE (American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers) Standard 52.2-1999, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. The air flow rate through the duct during this testing was 0.93 m^3/sec (1970 cfm). This flow creates a typical air velocity (492 fpm) in the duct, and has been used extensively in prior testing of air cleaning devices in this rig. The air temperature entering the device was approximately 23 °C. Air flow rate and temperature can have an impact on lamp performance, and the values used in this testing are consistent with vendor specifications. Prior to testing the device, the UV lamps were operated for a standard 100-hr "burn-in" period.

There are separate runs for each of the three challenge bioaerosols which were injected upstream of the device. The upstream challenge was ~ 2 x 10^4 CFU or PFU/ft^3. A no-light test was performed with the UV lights turned off, to determine the microorganism loss that would occur simply as the result of deposition in the test duct, and as the result of kill caused by the physical rigors of flowing through the device. The performance of the device was then reported as the device's efficiency in inactivating the organism with the light on, corrected to account for the loss of organisms observed in the absence of UV light.

Additional secondary measurements included:

- The direct total power consumption by the lamp and ballast, the pressure drop across the device (impacting air handler requirements), and the temperature rise through the unit, if any (impacting cooling coil energy consumption).

- A single measurement of the intensity of 254 nm UV radiation (μW/cm^2) at a point 161 cm (63 in.) upstream from the lamps, to demonstrate that the lamps were functioning and to provide a test reference value for the laboratory for documentation purposes.

Verification testing of the American Ultraviolet Corporation DC24-6-120 began on July 31, 2007 at the test facilities of RTI and was completed on August 21, 2007.

VERIFIED TECHNOLOGY DESCRIPTION

The American Ultraviolet Company's DC24-6-120 is part of the DC Series of in-line duct sterilizers that are designed to install into air duct sections to position high output UVC (short-wave ultraviolet radiation, in the "C" band - 200 to 280 nanometers) lamp(s) perpendicular to passing airflow for "pass-by" air sterilization purposes as well as surface sterilization. The ballast enclosure mounts directly to the duct

exterior with lamp(s) protruding into the duct section through a cutout in the duct wall. Type 304 stainless steel construction is utilized for long life. Outdoor ballast enclosures are available as an option. The SBL415 High Output UVC Lamp is used in the system.

VERIFICATION RESULTS

The American Ultraviolet Corporation DC24-6-120 achieved the biological inactivation efficiency tests presented in Table 1.

Table 1. Inactivation Efficiency, %

	Spore form of bacteria *(B. atrophaeus)*	Vegetative bacteria (S. *marcescens)*	Bacterial virus (MS2 bacteriophage)
Inactivation efficiency (UV light on), %	98	$\geq 99.5^{a}$	99

a – the value 99.5 represents a 95% confidence limit for S. *marcescens*. There were no downstream counts measured.

The irradiance was measured as 6290 µW/cm^2 at 161 cm (63 in.) upstream from the lamps with an airflow of 0.93 m^3/sec (1970 cfm). The mean dosage was calculated as 23,600 µW-s/cm^2 with a range of 19,900 – 29,000 µW-s/cm^2 . The system had six lamps that were burned in for 100 hours prior to measurements. The spore form of the bacteria *B. atrophaeus* is more resistant to being killed by UV light (irradiation) than the vegetative bacteria *S. marcescens*.

The APCT Center's quality manager reviewed the test results and the quality control data and concluded that the data quality objectives given in the approved test/QA plan were attained.

This verification statement addresses the biological inactivation efficiency. Users of this technology may wish to consider other performance parameters such as service life and cost when selecting an in-duct UV system for bioaerosol control.

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