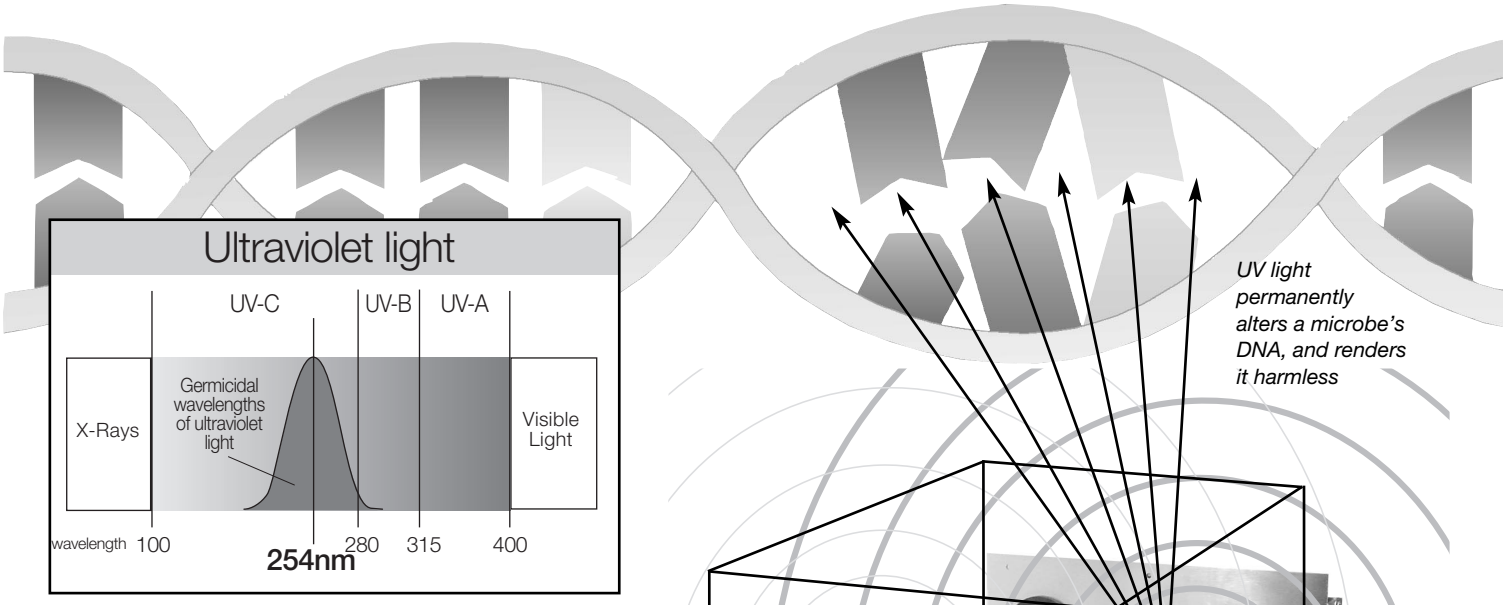
The Science of Ultraviolet™

What is Ultraviolet Light?

Ultraviolet light (UV) is electromagnetic energy, the same as visible light. However, UV wavelengths are not quite in the visible range for humans. UV is the range of frequencies just below that of visible light and it is split into three categories: UV-A, UV-B, and UV-C. It is in the UV-C range that the germicidal wavelengths are located, centered around 254 nanometers(nm). UV lamps generate a range of frequencies that include some visible wavelengths, but majority of the light emitted from a quality lamp is ultraviolet—and has its greatest intensity at 254nm.

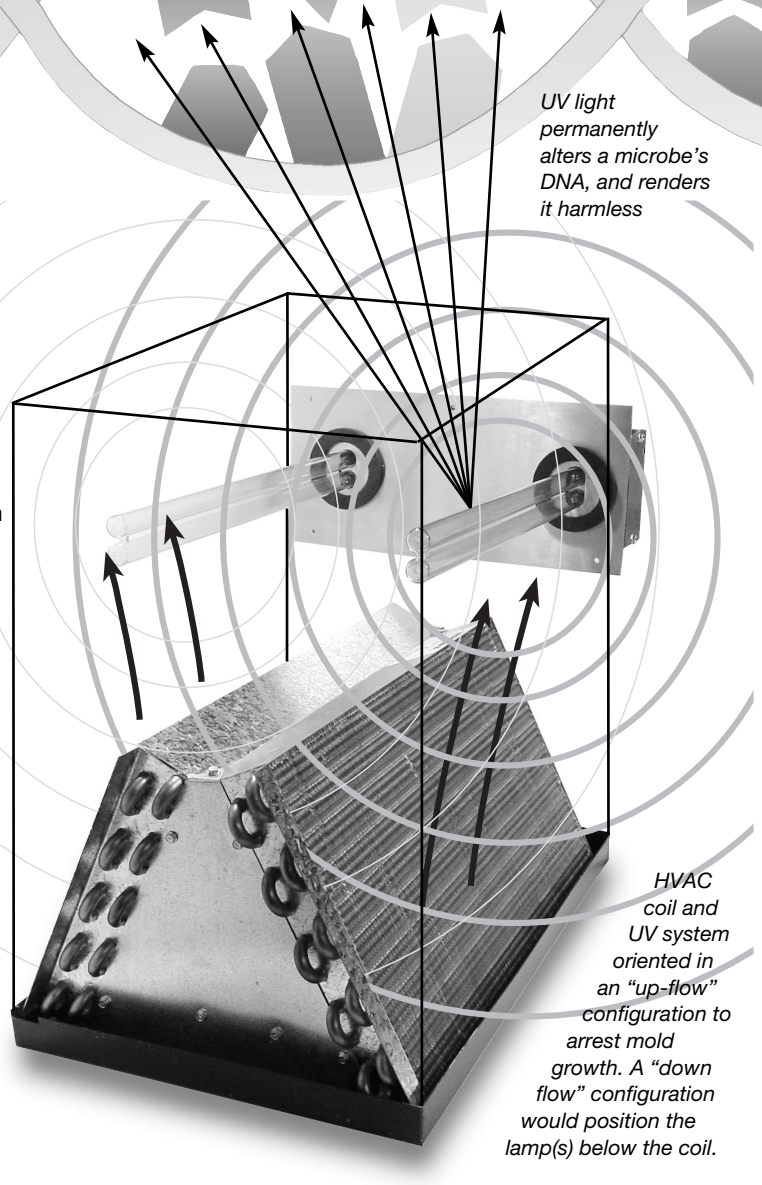


How does UV disinfect?

The wavelengths of UV-C in the 254nm area are germicidal because they physically penetrate microorganisms, much like x-rays. The energy of these wavelengths promotes a chemical reaction with DNA. The reaction permanently alters the structure and the molecular bonds of the DNA, which causes it to no longer react properly with the enzymes that initiate cell division or reproduction. The microorganism, without its ability to reproduce becomes harmless since it cannot colonize. Shortly after UV exposure it dies off leaving no offspring, and the population of the microorganism diminishes rapidly.

Natural disinfection from the sun

Populations of microorganisms in outdoor air are controlled by UV light emitted by the sun. While most of the sun's UV is filtered by the atmosphere, there is just enough to keep outdoor microorganism populations under control. It is indoors where microbes can propagate largely unchecked, especially if there is moisture present.



UV light permanently alters a microbe's DNA, and renders it harmless

HVAC coil and UV system oriented in an "up-flow" configuration to arrest mold growth. A "down flow" configuration would position the lamp(s) below the coil.

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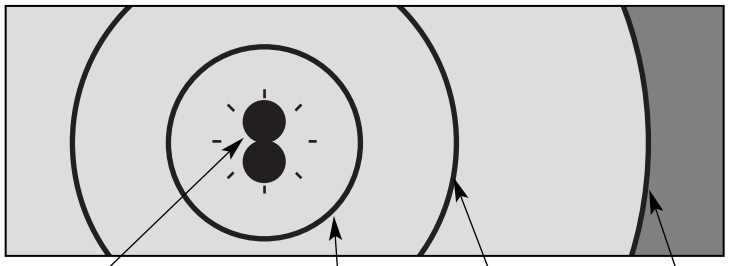
UV Intensity

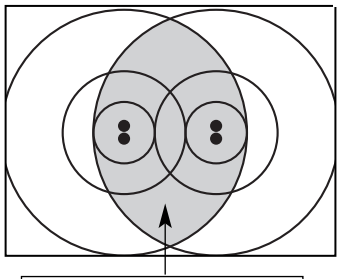
UV intensity is measured fundamentally in microwatts. UV intensity on the surface of the lamps is very high and any microbe that comes in contact with the lamp is eliminated virtually instantaneously. However, to determine how much UV intensity is reaching microorganisms and surfaces at various distances from lamps, the measurement is made in microwatts per centimeter squared or μw/cm². With this measurement the determination of the minimum UV dose that a microbe will be exposed to an installation can be made. The illustrations below show the distribution and intensity of the Philips® lamps that are used in most models of Ultravation equipment.

UV intensity at various distances from the UV lamp

PHILIPS

16" Compact Twin "U" shaped UV lamps





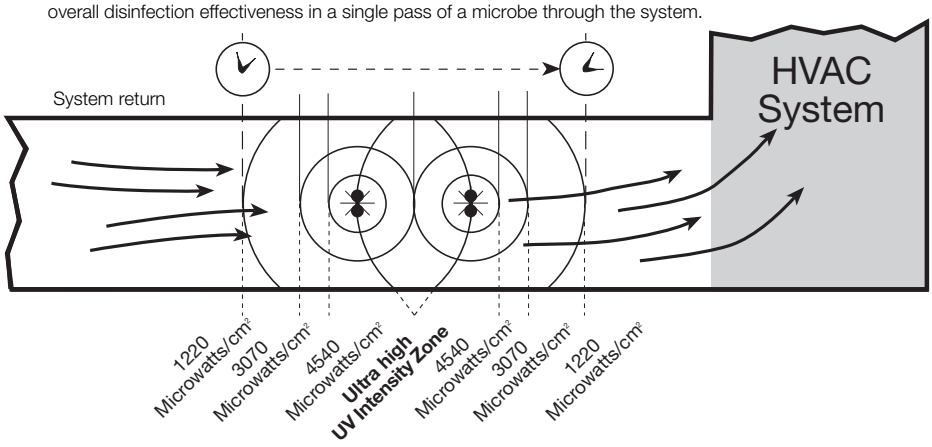
Lamp measurements obtained in accordance with the National Primary and Secondary Ambient Air Quality Standards, section 40 CFR part 50.

Lamp surface **30,000** microwatts/cm²	3 inches from lamp **4,540** microwatts/cm²	6 inches from lamp **3,070** microwatts/cm²	12 inches from lamp **1,220** microwatts/cm²	*A two lamp system creates ultra high intensity zones in areas between the lamps*

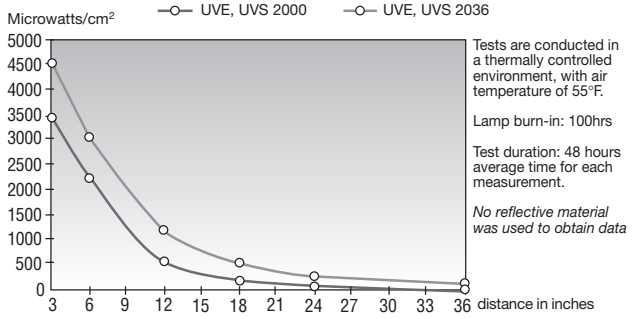
Time and temperature affect disinfection effectiveness

A high percentage of microbes may be eliminated in a single pass through the ultraviolet light. However, the actual number inactivated is dependent on the time of exposure to UV. As air is re-circulated through the HVAC system, surviving organisms receive additional ultraviolet exposure.

A twin lamp system installed as shown on the return of an HVAC system, would deliver a strong germicidal dose of UV. The velocity of the air through the system will determine the time of exposure and therefore the overall disinfection effectiveness in a single pass of a microbe through the system.



254nm UV-C output
in relation to distance from lamp



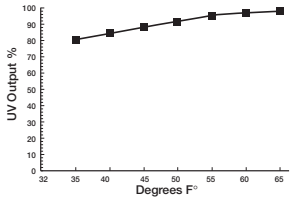
Tests are conducted in a thermally controlled environment, with air temperature of 55°F.

Lamp burn-in: 100hrs

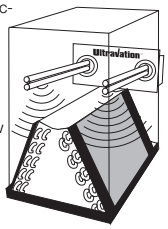
Test duration: 48 hours average time for each measurement.

No reflective material was used to obtain data

Air temperature vs output intensity



Since a UV system installed at the coil *consistently* bathes the coil with various intensities of UV, mold is very effectively eradicated, regardless of air temperature. High AC efficiency is maintained as the coil area remains free of bio-growth. New mold colonization cannot occur because the coil exposure is constant.



The ambient air temperature surrounding an operating UV lamp affects it output, and the effect of this should be considered when sizing a UV system. Air velocity also affects UV output, because the lamp operating temperature goes down as the velocity increases. UV equipment installed in a return will be operating in higher ambient temperatures, and is the optimum location for germicidal applications.

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