POOL & HOT TUB ALLIANCE

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FACT SHEET

Ultraviolet (UV) Light Pool Systems

Brought to you by the PHTA Recreational Water Quality Committee (RWQC)

I. INTRODUCTION

In recent years, the need for more sanitation for public pools classified as increased risk venues has become very clear. Keeping recreational water safe for bathers oftentimes requires more than the standard halogen-based sanitizer such as chlorine. Ultraviolet (UV) Light secondary disinfection systems have become more commonplace and are in wide use for many public pools. If used correctly, they can help provide safe recreational water to ensure bather safety from waterborne pathogens. Additionally, there is a new class of UV products now classified as "Water Conditioning Devices" that improve water and air quality of aquatic facilities. These new devices are being used predominantly with indoor pools to improve the indoor air quality but are neither secondary disinfection systems nor sanitizers.

II. SUMMARY OF CHARACTERISTICS

- Secondary Disinfection Systems: Disinfection processes or systems installed in addition to the required primary disinfection systems. Secondary Disinfection systems are required for "increased risk aquatic venues" (see Section III D below).
- Supplemental Treatment Systems: Systems or processes which are not required in an aquatic venue for health and safety reasons but may be used to improve water quality and/or enhance overall system performance (see Section III E below).
- Water Conditioning Device: In the context of UV systems, a "Water Conditioning Device" is defined as a UV device intended to treat swimming pool water and improve water and indoor air quality at aquatic venues without the introduction of additional chemicals (see Section III F below).

III. GENERAL DESCRIPTION

A. UV light is a range of short wavelength (10 – 400 nm, or nanometers) light that is invisible to the naked eye.

B. Medium-Pressure UV Light Systems

Medium-Pressure UV Light Systems are defined by the UV Light spectrum in which they operate. They operate in a wavelength range starting at approximately 250 nanometers (nm) to well over 600 nm. The lamps operate at temperatures in excess of 1500 °F. They were originally used for drinking water sanitation. UV light in this range of wavelengths can react with a wide variety of chemicals in the water and can deactivate chlorine sanitizers. This is a problem when used to treat swimming pool water, because

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it would require higher amounts of sanitizer and thus increase operating cost. These units are effective in removing chloramines through a process known as photolysis, a chemical reaction involving light.

C. Low-Pressure UV Light Systems

Low-Pressure UV Light Systems are defined by the light spectrum in which they operate. This operating wavelength range is very narrow, at approximately 190 nm to 254 nm. The wavelength of 254 nm is known as the "sweet spot" for chloramine destruction. This wavelength does not affect free chlorine and operates at approximately 140 °F. The low operating temperature and the non-destruction of chlorine make these systems very cost effective to operate.

D. Secondary Disinfection UV Light Systems

Secondary Disinfection UV Light Systems are required on "increased risk aquatic venues". They are defined in ANSI/APSP/ICC-11 2019 as *"An aquatic venue which has an increased risk of microbial contamination due to its primary users being children under the age of 5 and/or people more susceptible to infection, such as therapy patients with open wounds. Examples of increased risk aquatic venues include spray pads, wading pools, therapy pools, and other aquatic venues designed primarily for children under the age of 5."* The reason for this is that some pathogens are resistant to halogen-based sanitizers such as chlorine. UV Light Systems can inactivate the pathogens on a single pass through the UV reactor. This will help prevent many types of known infections and makes the recreational water safer for bathers. Medium-Pressure UV Light Systems are primarily used for Secondary Disinfection. Additionally, manufacturers have tested and received NSF/ANSI/CAN 50 approval for Low-Pressure UV Light Systems which may also be used. To qualify as a Secondary Disinfection System, a 3-Log 99.99% reduction of *Cryptosporidium* must be achieved.

E. Supplemental Disinfection UV Light Systems

Supplemental Disinfection UV Light Systems are not required on any aquatic venue. However, they may be installed on any aquatic venue other than an increased risk aquatic venue. These systems are certified to inactivate most waterborne pathogens other than *Cryptosporidium* in swimming pool recreation water. The majority of supplemental disinfection UV light systems are medium-pressure systems, which increase chlorine consumption, and therefore increase the operational cost.

F. Water Conditioning Device UV Light Systems

Water Conditioning Device UV Light Systems are the newest addition to UV light products. These systems are not sanitizers. Their purpose is to improve the water and air quality. They use low-pressure UV lamps and operate at the best wavelength of 254 nm. This wavelength has been proven to be most effective in chloramine destruction. As compared to Low-Pressure UV systems described above, Water Conditioning Devices are not intended to be used as either supplemental or secondary sanitizers. The industry has become more aware of the poor air quality an indoor pool can provide. There is substantial evidence that prolonged exposure to this type of air quality can produce many respiratory problems for bathers and/or anyone who has constant exposure to the poor air quality (See Reference 3, Reference 4).

G. UV Light Dosage is the Key.

Whether talking about a Secondary, Supplemental or a Water Conditioning device, the dosage is the most important factor. UV dosage is dependent on three key items. First: what is the Ultraviolet Transmittance (UVT) of the water? Certain contaminants, such as iron, disrupt the transmission of UV light through the water, even though the water may appear to be very clear. The second consideration is the power of the UV lamp itself, rated in millijoules per centimeter squared (mj/cm^2). The dosage needed to destroy monochloramines is 60 mj/cm^2 for indoor pools and 40 mj/cm^2 for outdoor pools. The third consideration is the flow rate of the water through the UV system. The slower the flow rate, the greater contact time at the point where the water is exposed to the UV light, thus a higher dosage is achieved. UV products are rated at dosages depending on the flow rate.

Various microorganisms require different dosages to deactivate them. In the majority of cases UV light reacts faster at deactivating microorganisms than the recommended amount of sanitizer (chlorine/bromine) in recreational water does. However, the common

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cold virus, for example, is resistant to UV Light and is easily deactivated by the recreational water sanitizer such as chlorine or bromine. Water flow rate affects the UV system dosage (see chart below). Therefore, balancing the use of UV Light Systems at required flow rates with appropriate amounts of sanitizers (chlorine/bromine) can help provide a safe swimming environment.

Microorganism Inactivation Charts with Dose Rates to Achieve a 4-Log Inactivation

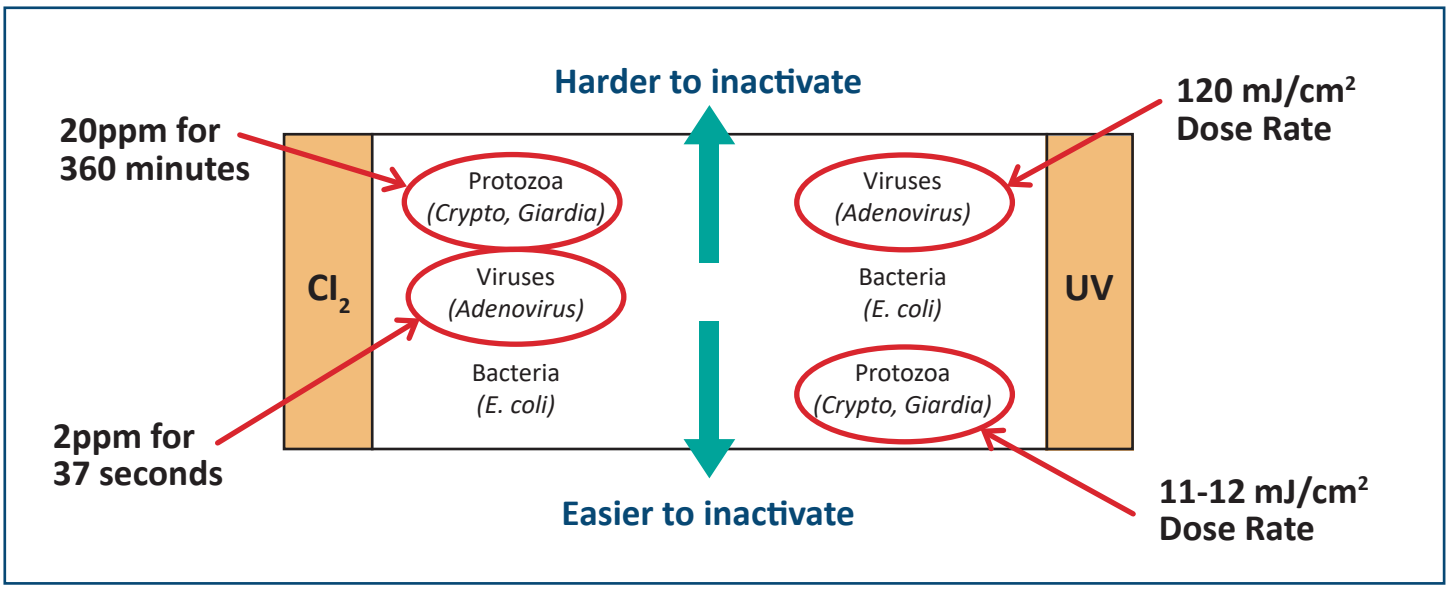
Pathogenic Bacteria	Dose Rate
Cholera	6.5 mJ/cm^2
Dysentery	4.2 mJ/cm^2
E. coli	8.4 mJ/cm^2
Legionella	4 mJ/cm^2
Salmonella	10 mJ/cm^2

Pathogenic Viruses	Dose Rate
Poliovirus	30 mJ/cm^2
Hepatitis A	21 mJ/cm^2
Adenovirus (40)	120 mJ/cm^2

Associated with common cold

Protozoan Cysts	Dose Rate
Giardia lamblia	11 mJ/cm^2
Cryptosporidium	12 mJ/cm^2

Effect of Flow Rates and Dose Rates



IV. APPLICATION

UV treatment is an extremely quick physical process. In a UV disinfection process, water is passed through a chamber containing a UV lamp. As the water flows through the chamber, microorganisms in the water are exposed to UV radiation generated by the mercury arc UV lamp. When UV radiation penetrates the cell wall of the microorganism, it destroys the cell's ability to reproduce by mutating/degrading its genetic material (DNA and RNA). When the genetic material is sufficiently damaged the microorganism cannot function or reproduce, which renders the microorganism harmless.

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Many local codes will require a "secondary UV light" system to be installed to ensure bather safety. Water Conditioning UV light systems are becoming increasingly common for indoor pools because they are proven to be effective in destroying problematic chloramines, helping to improve the air quality for bathers. Poor air quality is considered one of the most important dangers to bather health by most industry experts. UV Products are also commonly used with spray pads. This is because primarily young children use these facilities which are classified as "increased risk aquatic venues".

V. MAINTENANCE & PRECAUTIONS

- Maintenance is very important to ensure UV Light Products are working correctly. Medium-pressure units require the most care since they operate at such high temperatures – the glass sleeve that contains the UV lamp can become coated with calcium and other contaminants. These units sometimes include "wipers" to automatically clean the sleeves. Lamps also need to be replaced frequently. All required maintenance increases operating cost and energy consumption.
- Low-pressure UV Light products require much less care. The lamps can operate much longer than medium-pressure units before they require replacement. They cost less and their operating cost is less. Because they operate in a narrow wavelength range, they do not destroy free chlorine. They also operate directly at the 254 nm-wavelength which is the best for pathogen and chloramine destruction.
- When using UV equipment, it is necessary to follow all applicable electrical codes and precautions. Turn off power at the main source before servicing or making electrical connections. Always follow manufacturer's use instructions when operating and maintaining the UV system.
- UV light can cause serious damage to eyes and skin. Do not handle or stare at an operating UV lamp.

VI. REFERENCES

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