POOL WATER TREATMENT
ADVISORY GROUP

TECHNICAL NOTE

31 – Ultraviolet disinfection: specification, maintenance and validation

January 2016 [A4 revised 24 June 2016]

Ultraviolet radiation is a secondary disinfection process (used alongside a primary disinfectant, usually chlorine) in swimming and spa pools. It is recommended by PWTAG, both for its capacity to reduce chloramines and kill microorganisms – including chlorine-resistant *Cryptosporidium*. Its use can reduce the chlorine residual levels necessary to keep pool water healthy. It is increasingly used as an alternative to ozone (which similarly complements chlorination) as it is easier and cheaper to fit, especially to existing plant.

It is important that UV is specified, sized, installed, dosed, maintained and controlled in accordance with these guidelines. Validation of the processes is also an important consideration.

A. Equipment specification

1. The UV system should be designed to treat the full water flow through the pool circulation system.

2. If the system is to be selected on the basis of an assumed UV transmittance (UVT) that assumed value should be no greater than 94%, measured with 254nm UV light in a 1cm cell.

3. UV systems intended for the control of chloramines as well as microorganisms shall be equipped with medium-pressure lamps (broad spectrum between 200 and 320nm).

4. Low-pressure lamps (254nm only) are biocidal, but do not deal directly with di and tri-chloramines to the same extent that mediumpressure lamps do. They use less power than medium-pressure lamps but their lower output means that more lamps are needed. They have a larger footprint.

5. The system should be designed to achieve a minimum 3-log (99.9%) reduction in the number of infective *Cryptosporidium* parvum oocysts per pass through the UV system (see D3).

6. UV systems should be third-party validated (see D3).

7. The UV equipment should be provided with calibrated UV intensity sensors, which measure the output of all the UV lamps installed in a system. Where multiple lamps are fitted, sufficient sensors should be provided to monitor all lamps. Sensors should be checked every six months and re-calibrated annually.

8. The UV equipment should be able to display UV dose, expressed in units of energy per unit area.

9. The chamber and all its components should be designed to withstand a maximum operating temperature of 40°C, but also occasional brief temperatures as high as 60°C.

10. UV chambers should be fitted with high purity quartz sleeves/ thimbles (which can be doped) to separate the water passing through the chamber from the UV source.

11. The UV system should be designed to permit cleaning of the quartz sleeves/thimbles without mechanical disassembly. The cleaning system should preferably be an automatic one; if a manual system is selected (perhaps for a lightly-used pool) it must be operated at least twice daily.

12. A drain and vent should be provided on the chamber, which should be designed so that at least one end can be dismantled for general and physical cleaning.

13. If the pool is to be electro-chlorinated salt water, the UV manufacturer must be advised, as the corrosive nature of the water will require that the UV chamber be built from special grade steel alloys. (Super Duplex and SMO254 have been used successfully.)

B. Equipment installation

1. The UV system should be installed post-filtration, but before the heat exchanger, pH correction and residual chlorine dosing points.

2. A by-pass should be provided to allow continuous pool operation during maintenance of the UV system.

3. A strainer should be fitted downstream of the UV system to prevent any quartz shards entering the pool in the event of accidental breakage of the quartz sleeve.

4. The aperture size of the strainer shall be no more than 1mm.

5. Pipework adjacent to the UV unit should be of a suitable material, such as stainless steel or BS 3505 Class E grade UPVC. ABS should not be used.

C. Equipment maintenance

1. Contaminant should be routinely removed from the sleeves\ thimbles – automatically or manually at least twice a day, depending on water quality.

2. Wearing parts of the wiper system should be changed as often as once a year, but following manufacturers' instructions.

3. Quartz components (sleeves, thimbles and intensity sensor windows) and associated seals should be changed every two or three years, regardless of their state of cleanliness, but taking into account manufacturers' instructions. (The effects of UV progressively block short UV wavelengths and can induce brittleness.)

4. UV sensors should be checked during routine maintenance using a calibrated UV reference sensor.

5. UV lamps should normally be changed at least once a year – or earlier if the required UV dose for disinfection/de-chloramination is not being achieved. Medium-pressure lamps have end of lamp life (EOLL) ratings of 4,000-9,000 hours; low pressure, 8,000-16,000 hours.

6. Because of the extra number of lamps (and quartz sleeves, seals etc), lowpressure systems tend to have higher maintenance costs.

7. 7 If the control panel is fitted with cooling fan filters, the filter pads should be replaced at least once a year. Filter mats should be checked visually every three months and cleaned as required.

D. UV dose and validation

1. The UV dechloramination dose should be 60mJ/cm² average, based on the actual circulation flow.

2. This is a 'theoretical' dose, based on assumptions about intensity and time, so manufacturers should be able to demonstrate the use of two programmes:
   - software to map UV intensity in the UV vessel
   - computational fluid dynamics to verify the flow dynamics of the vessel.

3. Satisfactory disinfection of UV systems should be demonstrated by thirdparty validation using the US recreational water standard NSF/ ANSI 50, or other regulatory standards confirming 3-log reduction in the viability of *Cryptosporidium* parvum oocysts.

4. Dose values should be guaranteed by manufacturers throughout the life of the lamp.

E. Control requirements

1. UV can affect THM production both ways, depending on local factors , but it is generally accepted that the effect is in practice neutral – as long as the UV is not over-dosed. To prevent this, UV systems may be equipped with variable power controls.

2. Higher than necessary residual chlorine levels can also contribute to disinfection byproducts. Levels of between 0.5 and 2ppm should be sufficient with a UV system. Residual chlorine should be regulated amperometrically; if redox is used, it should be noted that UV does not oxidise.

3. Medium-pressure UV lamps can be driven by an energy efficient electronic power supply. These can provide infinitely variable power adjustment to the lamp, giving precise control of dose, minimising power consumption and prolonging lamp life.

4. UV systems should provide a readout of UV dose, UV intensity and flow rate.