Summary of Substantive Changes
between the 2018 and the 2019 editions of
NSF/ANSI 55 "Ultraviolet Microbiological Water Treatment Systems"

Presented to the IAPMO Standards Review Committee on April 12, 2021

General: The changes to this standard should not have an impact on currently listed products. The substantive change is:

- Added a new protocol to evaluate UV systems across a broader range of wavelengths, changes include expanding the scope, adding general and testing requirements (see Sections 1.2, 6.2.3.3, 6.9, 7.1, 7.2, and 7.3)

Section 1.2, Scope:

1.2 Scope

This Standard covers UV microbiological water treatment systems and components for point-of-use (POU) and point-of-entry (POE) applications. This Standard covers systems which use UV radiation within the range of 240 nm to 300 nm inclusive. Systems are intended to be used under the following specific conditions.

Section 6, Minimum performance requirements:

6.2.2 Class B systems

…….

6.2.3.3 Procedure

The following procedure shall be used to evaluate alarm performance:

a) Conduct all testing at the system's maximum flow rate.

b) Prepare the test system by cleaning it in accordance with the manufacturer's instructions. Measure the volume (V) of the reactor and associated plumbing from the injection point to the reactor. This equals to one void volume. Determine the time (T) it takes for that volume to pass through the reactor at maximum flow (F).

T = V/F

c) For continuous flow units, warm the system up according to manufacturers' instructions. For systems with an instant on, no warm-up shall be conducted.

d) The UV absorbant shall be Superhume® and vanillian formula as described in Section 7.3.1.4.2. If the system solely uses low pressure mercury UV lamp as the UV source (254 nm), then parahydroxybenzoic acid (PHBA) shall be used.

~~d~~e) Determine the injection pump setting that shall deliver a dose of ~~parahydroxybenzoic acid (PHBA)~~ UV absorbant into the feed stream sufficient to activate the alarm system. This is the "dose volume." Measure the UV absorbance, as referred to in Section 7.2.1.3.d, of the resulting challenge water.

~~e~~f) Reset the alarm and resume feeding the clean general test water in Section 7.2.2.4.1.

~~f~~g) Activate the injection pump to deliver the "dose volume" of ~~(PHBA) solution~~ UV absorbant. Verify alarm activation within the time it takes for three void volumes to pass through the system plus 3 s.

~~g~~h) Repeat steps e and f until the alarm has been activated 10 consecutive times.

NOTE — If the alarm fails to activate during the test, verify that there has been no increase in power to the unit and the challenge water UV absorbance has not changed. If these conditions have changed, restart from step b; if not, terminate the test.

6.2.3.4 Acceptance

The sensor / alarm system, as supplied with the system, shall activate 10 consecutive times, within the time specified in Section 6.2.3.3. ~~f~~g and at a UVT that is within ± 2% of the mean UVT measurement, in response to decreasing UV intensity.

6.4 Flow Control

An automatic fixed flow rate control shall be provided to prevent flow above the manufacturer's maximum rated flow over the manufacturer's recommended operating pressure range. The manufacturer's maximum rated flow for a POE system shall be equal or greater than 15 lpm (4 gpm) with an inlet pressure of 103 kPa (15 psig) when tested in accordance with Section 7.2.2.7 or 7.3.1.7.

6.9 Lamp replacement – Systems without UV sensor alarm

The recommended lamp replacement intervals for Class B systems without a UV sensor alarm that meets the requirements of Section 6.2.3 shall be verified by submittal of irradiance vs. time curves. ~~The irradiance shall be measured at 254 nm at a distance of 1.0 m (3.3 ft) from the lamp.~~ Lamp replacement shall be recommended to occur prior to the time 70% of the initial irradiance is reached.

Section 7, Elective performance claims – Test methods:

7.1 General

Systems ~~and components~~ covered under this Standard shall be designed to meet the microbiological ~~and structural~~ performance requirements at the manufacturer's recommended operating pressures and flow rates. Systems using solely low-pressure mercury lamps as the UV source shall be evaluated under Section 7.2. or 7.3 as requested by the manufacturer. Systems using alternate UV sources shall be evaluated under Section 7.3.

7.2 Microbiological performance – Low pressure mercury lamps only

Section 7.3, Microbiological performance:

7.3 Microbiological performance

7.3.1 Microbial performance testing

Component filters or other media that may interfere with the testing of a system shall be removed or bypassed during the test.

Microbiological methods for stock culture preparation, enumerations / analysis, storage, and stock challenge concentration for challenge test for Qβ coliphage shall be performed as specified in Annex N-2.

7.3.1.1 Class A systems

A Class A system shall deliver a UV dose to achieve a 4.00 log reduction of the challenge organism concentration in the influent at the alarm set point when the system is tested in accordance with Section 7.3.1.7 or 7.3.1.8 as applicable.

7.3.1.2 Class B systems

A Class B system which is evaluated with the UV source irradiance at normal output shall deliver a UV dose to achieve a 2.14 log reduction of the challenge organism concentration in the influent when the system is tested in accordance with Section 7.3.1.7 or 7.3.1.8 as applicable.

A Class B system which is evaluated with the UV source irradiance at 70% of normal output, or at the alarm set point, shall deliver a UV dose to achieve a 1.50 log reduction of the challenge organism

concentration in the influent when the system is tested in accordance with Section 7.3.1.7 or 7.3.1.8 as applicable.

7.3.1.3 Apparatus

The test units shall be installed and operated using the test apparatus shown in Figure 4. The test systems shall be plumbed in parallel to simulate normal installation. Manifolds shall be representative of household plumbing (2.0 to 6.5 cm [0.75 to 2.5 in] pipe sizes).

7.3.1.4 Test water

7.3.1.4.1 General test water

A chlorine-free water with the following characteristics shall be used:

pH	*7.5 ± 0.5*
UV transmittance	*98 ± 2%* *(prior to adding UV absorbant)*
turbidity	*< 1.0 NTU*
temperature	*20 ± 2.5 °C (68 ± 5 °F)*
TDS	*200 to 500 mg/L*

7.3.1.4.2 UV absorbant

The UV absorbant shall be comprised of vanillin (CAS# 121-33-5) and SuperHume®14. The vanillin and SuperHume® shall be combined while maintaining a ratio of 1.0 mg vanillin to 0.02 mL SuperHume®. These compounds shall be diluted as needed prior to addition to the test water with deionized water.

7.3.1.4.3 Challenge organism

The appropriate organism shall be added to the general test water:

Q β coliphage *ATCC #23631-B1*	*5 × 104 to 5 × 105 PFU/mL*

7.3.1.5 Determination of test operating conditions

7.3.1.5.1 Systems without UV sensor and alarm set point

For UV devices not equipped with an alarm set point mechanism, UV absorbant shall not be added to the test water.

7.3.1.5.2 Systems with UV sensor and alarm set point

Sufficient UV absorbant shall be added to reduce UV light transmission to the alarm set point in the device. No less than the quantity of UV absorbant required to give a mean UV absorption of 0.30 per cm (70% UVT) at 254 nm shall be used.

NOTE — Refer to Standard Methods for the Examination of Water and Wastewater, Method 5910 UV Absorbing Organic Constituents.

7.3.1.5.3 Configuring Class B systems for evaluation

Two methods are available to prepare a Class B system for evaluation. These methods both effectively simulate the UV source irradiance at end of life (70% of initial output at 100 hours). The procedure under Section 7.3.1.5.3.1 shall be the default procedure. Section 7.3.1.5.3.2 shall be utilized if the system is conducive to this procedure and is requested by the manufacturer.

7.3.1.5.3.1 Adjustment of Class B criteria to simulate UV source end of life

To simulate the UV irradiance at end of life for systems which are operated at the normal output, the reduction criteria shall be a log reduction greater than or equal to 2.14 when the system is evaluated under Section 7.3.1.7 or 7.3.1.8 using UV sources conditioned for 100 hours.

7.3.1.5.3.2 Measurement of normal output and establishment of 70% irradiance for Class B systems

The following procedure shall be used to measure the normal output:

a) Two UV sources and ballast components identical to the system's UV source and ballast component shall be obtained and prepared for irradiance measurement in accordance with the appropriate International Ultraviolet Association Testing Protocol for measurement of UV device output.15

b) A regulated voltage source shall be set at the manufacturer's minimum recommended voltage.

c) The UV source shall be operated for 100 hours and record the UV source irradiance (normal output).

d) The voltage to the UV source shall be reduced until the irradiance reaches 70 ± 1% of normal output measured at 100 hours. The voltage and irradiance shall be recorded.

e) The lower of the two voltage measurements shall be used to adjust the system to 70% of its normal output during the evaluation under Section 7.3.1.7 or 7.3.1.8.

f) Test shall be conducted with UV sources conditioned for 100 hours.

7.3.1.6 Analytical methods

The analytical methods shall be as specified in Section 2 and Annex N-2. All bacteriological samples shall be collected aseptically in sterile bottles without neutralizer.

7.3.1.7 Microbiological test method – Flow through systems

Table 7.2
Sampling for disinfection performance

Sampling point		***Influent***	***Effluent***
Day 0	*condition system*	*no sample*	*no sample*
Day 1	*start up*	*x*	*x1*
	4 h	*x*	*x2*
Day 2	*start up*	*x*	*x1*
	4h	*x*	*x2*
Day 3	*start up*	*x*	*x1*
	4h	*x*	*x2*
Day 4	*start up*	*x*	*x2*
	4h	*x*	*x2*
Days 5, 6	*48 to 72 h stagnation*	*no sample*	*no sample*
Day 7	*start up*	*x*	*x1*
	4 h	*x*	*x2*

1 Samples shall be collected at the start-up of each day following a minimum 16h stagnation according to the sampling requirements in Sections 7.3.2.7 and 7.3.2.8. Samples shall be of the first three unit void volumes (or minimum quantity required for analysis, whichever is larger) from the system or component. Sampling will be delayed until the plumbing downstream of the three-way valve and the sampling point has been purged.

2 Samples shall be collected after a minimum of 15 min of operation.

The following procedure shall be used as the disinfection test method for flow through systems:

a) Two systems shall be installed as shown in Figure 4, and each system shall be conditioned in accordance with the manufacturer's instructions using the general test water without the challenge organism. If a prefilter or postfilter is supplied with the system, the filter shall be removed before testing. A three-way valve shall be installed immediately prior to the test unit to allow the influent to

bypass the test unit. The flow rate of the test system shall be determined by subjecting the system to inlet pressures of 103 kPa (15 psig), 140 kPa (20 psig), 210 kPa (30 psig), 280 kPa (40 psig), 340 kPa (50 psig), 410 kPa (60 psig), 480 kPa (70 psig), 550 kPa (80 psig), 620 kPa (90 psig), 690 kPa (100 psig) and the system's maximum working pressure ± 5%, and measuring the flow rate at each sample point. The maximum flow rate observed shall be the evaluation service flow. The UV source shall be disabled during influent sampling.

b) Appropriate techniques of dilution and adequate mixing shall be used to prepare the general test water in Section 7.3.1.4.1.

c Before the test is started, the influent shall be analyzed for pH, total dissolved solids, turbidity, residual chlorine, and temperature. Other parameters may be used for purposes of future comparison and for documentation.

d) The UV absorbant shall be added at the concentration determined in Section 7.3.1.5 to achieve the desired UV absorbance in the test water.

e) The three-way valve installed immediately prior to the test system shall be set to bypass at the testing flow rate. The challenge organism referenced in Section 7.3.1.4.3 shall begin to be fed. Once the injection system has stabilized, the valve shall quickly be turned to feed the challenge to the test unit. The effluent samples shall be collected at the times specified in Table 7.2 at the sample point immediately following the test unit as shown in Figure 4.

f) Duplicates shall be generated from all collected microbiological samples. Effluent samples shall be collected first. Immediately after the effluent is collected, the UV lamp shall be shut off and a minimum of 5 unit void volumes allowed to pass through the unit. The effluent sample shall be collected downstream of the test unit to represent the influent. The system shall be operated only as long as required to collect the required samples. The system shall be energized with no flow between sample points.

g) Influent and effluent samples shall be collected aseptically in sterile bottles with no neutralizer. Samples shall be stored in the dark prior to analysis. For all microbiological samples, analysis shall be initiated within 1 h. See Annex N-2 for methods. Steps d through g shall be repeated for each sample point in Table 7.2. The test units shall be energized throughout the testing and the UV source shall only be manually deactivated during influent sampling.

7.3.1.8 Batch treatment systems

The following procedure shall be used as the disinfection test method for batch systems:

a) Two systems shall be tested. Each system shall be conditioned prior to the start of the test in accordance with the manufacturer's instructions, utilizing the general test water without challenge organism. The system shall be energized throughout the test.

b) The UV absorbant shall be added at the concentration determined in Section 7.3.1.5 to achieve the desired UV absorbance in the test water.

7.3.1.8.1 Sampling

Influent samples shall be collected by removing an aliquot from the midpoint of the raw water reservoir by pipette.

Day 1 – The system shall be started and operated for the recommended treatment time specified by the manufacturer. The complete batch shall be collected for analysis. The system shall be refilled with the general test water.

Days 2 to 4 – The system shall be spiked with the challenge organism into the general test water in the system from the previous day. The system shall be restarted and a batch generated for sampling. Systems shall be turned off and filled with general test water for next day's testing.

Days 5 to 6 – The systems shall remain stagnant for 48 h with challenge water remaining in the system.

Day 7 – The system shall be spiked with the challenge organism into the general test water in the system from Day 4. The system shall be restarted and a batch generated for sampling.

7.3.1.8.2 Acceptance

7.3.1.8.2.1 Class A systems

For Class A systems, the geometric mean of all Qβ coliphage plaques on influent samples minus the geometric mean of counts on all effluent samples shall demonstrate a log reduction greater than or equal to 4.00.

7.3.1.8.2.2 Class B systems

For a Class B system which is evaluated with the UV source irradiance at normal output, the geometric mean of all Qβ coliphage plaques on influent samples minus the geometric mean of counts on all effluent samples shall demonstrate a log reduction greater than or equal to 2.14.

For a Class B system which is evaluated with the UV source irradiance at 70% of normal output or at the alarm setpoint, the geometric mean of all Qβ coliphage plaques on influent samples minus the geometric mean of counts on all effluent samples shall demonstrate a log reduction greater than or equal to 1.50.

Section 8, Instructions and information:

Class A systems not installed downstream of a device tested for cyst reduction / inactivation in conformance to the appropriate NSF/ANSI Standard may claim reduction of Cryptosporidium oocysts and Giardia cysts only. Class A systems installed downstream of a device tested for cyst reduction / inactivation in conformance to the appropriate NSF/ANSI Standard may make a general cyst claim when used on untreated surface waters, or groundwater, or both, under the direct influence of surface water. Class B systems may not make individual or general cyst claims.

The units evaluated in this Standard shall not make claims of reduction or inactivation of MS-2 coliphage, Qβ coliphage, or T1 coliphage.

Figure 4, Example of test apparatus: New figure was added.

Normative Annex ~~A~~1 Ultraviolet water treatment systems microbial reduction – MS-2 and T1 procedures:
The title was revised to clarify application.

Normative Annex 2, Ultraviolet water treatment systems microbial reduction – Qβ procedures: New Normative Annex was added.