Testing and Certification of UV for Point of Use (POU) and Point of Entry (POE) Drinking Water Treatment

Rick Andrew
NSF International, Ann Arbor, Michigan

Introduction

One of the many established applications of low pressure mercury UV emission has been disinfection of drinking water. The UV radiation, when applied at sufficient dosage, can be highly effective with inactivation of pathogenic microorganisms of all three classes – bacteria, virus and protozoan cysts. Recognizing this application and the need for consensus standards to provide a rigorous and comprehensive tool for evaluation of these systems, NSF International has promulgated *NSF/ANSI 55 Ultraviolet Microbiological Water Treatment Systems*.

A Consensus Process

NSF/ANSI 55 is developed through a consensus process under the auspices of the NSF Joint Committee on Drinking Water Treatment Units. This committee is comprised of 33 individuals from three stakeholder groups:

- Manufacturers
- Public Health/Regulatory
- Users including testing and certification bodies

Procedures used by the committee are audited by ANSI, the American National Standards Institute, to assure that the process is indeed a consensus process. Consensus means that any minority opinions must be heard and addressed, and the outcome of the process is agreed upon by most, but not necessarily all, committee members.

Additionally, all standards developed by NSF International are approved by an independent oversight body called the Council of Public Health Consultants. This group is composed of public health experts who ensure that all NSF International standards are appropriately protective of human health.

Two Classes of POU and POE UV Systems

NSF/ANSI 55 includes two classes of UV systems – A and B. Class A systems are intended to inactivate microorganisms, including bacteria, viruses, *Cryptosporidium* oocysts and *Giardia* cysts, from contaminated water. There are limitations, however. These systems are not intended for the treatment of water that has an obvious contamination or intentional source, such as raw sewage. Also, Class A systems are not intended to convert wastewater to drinking water, and they are intended to be installed on visually clear water (not colored, cloudy or turbid).

Recognizing the research done regarding low pressure mercury UV emissions and disinfection of *Cryptosporidium* and *Giardia*, claims of reduction of *Cryptosporidium* oocysts and *Giardia* cysts may be made on Class A systems.

Class B UV systems, on the other hand, are intended to be used for supplemental bactericidal treatment of disinfected public drinking water or other drinking water that has been tested and deemed acceptable for human consumption by the state or local health agency having jurisdiction. They are intended to reduce normally occurring nonpathogenic nuisance microorganisms only, and are not intended for disinfection of microbiologically unsafe water. Microbiological health effects claims cannot be made on Class B systems.

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Table 1. Comparison of Class A and Class B UV Systems

Requirement	Class A	Class B
Material safety	Extraction testing with toxicological assessment	Extraction testing with toxicological assessment
Structural integrity	Hydrostatic pressure testing for all systems connected to a pressurized water supply, plus cyclic testing for open discharge systems	Hydrostatic pressure testing for all systems connected to a pressurized water supply, plus cyclic testing for open discharge systems
Minimum UV dosage	40 mJ/cm^2	16 mJ/cm^2
UV sensor and audible or visual alarm, or alarm that terminates the discharge of treated water	Required	Not required
Flow restrictor to assure biodosimetry testing at the highest achievable system flow rate	Required	Required
Test organism for biodosimetry testing	MS-2 Coliphage American Type Culture Collection (ATCC) 14 #15597-BI	S. cerevisiae ATCC #18824 or T1 Coliphage ATCC #11303
UV absorptive chemical for biodosimetry test	Parahydroxybenzoic acid (PHBA)	Parahydroxybenzoic acid (PHBA)
UV transmittance for biodosimetry test	Alarm set point or 70% at 254 nm, whichever is lower	70% per cm at 254 nm
Required statement in installation, operation and maintenance instructions	"This Class A system conforms to NSF/ANSI 55 for the disinfection of microbiologically contaminated water that meets all other public health standards. The system is not intended to convert wastewater or raw sewage to drinking water. The system is intended to be installed on visually clear water. NSF/ANSI 55 defines wastewater to include human and/or animal body waste, toilet paper and any other material intended to be deposited in a receptacle designed to receive urine and/or feces (blackwaste), and other waste materials deposited in plumbing fixtures (greywaste)."	"This Class B system or component conforms to NSF/ANSI 55 for the supplemental bactericidal treatment disinfected public drinking water or other drinking water that has been tested and deemed acceptable for human consumption by the state or local health agency having jurisdiction. The system is only designed to reduce normally occurring non-pathogenic nuisance microorganisms. Class B systems are not intended for treatment of contaminated water."
Required statement in installation, operation, and maintenance instructions - Class A system without a general cyst inactivation/reduction device in conformance to the appropriate NSF/ANSI standard	"If this system is used for the treatment of untreated surface waters or ground water under the direct influence of surface water, a device found to be in conformance for cyst reduction under the appropriate NSF/ANSI standard shall be installed upstream of the system."	N/A

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Comparison of Class A and Class B

Class A system requirements for UV dosage and fail-safe go above and beyond the requirements for Class B systems. Class A systems require a higher UV dosage, and they also must include a UV sensor and alarm to act as a fail-safe in case the system is not functioning in a manner to provide safe drinking water. Table 1 (page 20) includes a comparison of the requirements for Class A and Class B systems.

Additional requirements for both Class A and Class B systems include safety of materials in contact with drinking water and structural integrity of systems connected to a pressurized water supply. Class A and Class B systems both must include flow restrictors to assure that the UV biodosimetry testing is at the highest achievable flow rate for the system.

Note that NSF/ANSI 55 addresses only low-pressure mercury systems. Alternate technologies, such as LEDs and other types of UV emitters, are not currently addressed by NSF/ANSI 55, although efforts are currently underway to validate the biodosimetry protocol in NSF/ANSI 55 for other emission sources with emissions in the general range of 254nm.

A Basis in Sound Science and Rigorous Testing

While this discussion has focused specifically on UV systems, it highlights a cornerstone of the philosophy supporting all of the NSF/ANSI Drinking Water Treatment Unit standards. Sound science and rigorous testing are the foundation for requirements for testing contaminant reduction claims for health effects. This scientific approach with a high bar for conformity is necessary to protect human health, and it is also necessary to provide a sound basis for consumer confidence in products that are tested and certified for conformance.

UV systems play a very important role in disinfection of water for drinking purposes. Because adequate disinfection of drinking water is a critical element in protecting human health, it is paramount that the standard for evaluation of the capabilities of this technology be one that we can have complete confidence in. With its fail-safe criteria and strict requirements, NSF/ANSI 55 is indeed such a standard.

Summary

NSF/ANSI 55 Ultraviolet Microbiological Water Treatment Systems is the American National Standard for evaluation of POU and POE low-pressure mercury drinking water treatment systems. A rigorous standard covering safety of materials for contact with drinking water, structural integrity, and UV dosage through biodosimetry, it includes two classes of systems – A and B. Class A systems are those intended for inactivation of microorganisms, including bacteria, viruses, *Cryptosporidium* oocysts and *Giardia* cysts, from contaminated water. Class B systems are intended to be used for supplemental bactericidal treatment of disinfected public drinking water or other drinking water that has been tested and deemed acceptable for human consumption by the state or local health agency having jurisdiction. This standard, developed by the NSF Joint Committee on Drinking Water Treatment Units through a consensus process, provides a sound basis for evaluation and qualification of this technology for drinking water treatment applications.

Author biography

Rick Andrew is NSF's director of Global Business Development – Water Systems. Previously, he served as general manager of NSF's Drinking Water Treatment Units (POU/POE), ERS (Protocols) and Biosafety Cabinetry Programs. Andrew has a bachelor's degree in chemistry and an MBA from the University of Michigan. He can be reached at 800.NSF.MARK or email at Andrew@nsf.org. ■