



*NSF International Standard /  
American National Standard*

## NSF/ANSI 55 - 2009

Ultraviolet Microbiological  
Water Treatment Systems



*NSF International, an independent, not-for-profit, non-governmental organization, is dedicated to being the leading global provider of public health and safety-based risk management solutions while serving the interests of all stakeholders.*

*This Standard is subject to revision.  
Contact NSF to confirm this revision is current.*

Users of this Standard may request clarifications and interpretations, or propose revisions by contacting:

Chair, Joint Committee on Drinking Water Treatment Units  
c/o NSF International  
789 North Dixboro Road, P. O. Box 130140  
Ann Arbor, Michigan 48113-0140 USA  
Phone: (734) 769-8010 Telex: 753215 NSF INTL  
FAX: (734) 769-0109  
E-mail: [info@nsf.org](mailto:info@nsf.org)  
Web: <http://www.nsf.org>

NSF International Standard/  
American National Standard  
for Drinking Water Treatment Units –

**Ultraviolet microbiological  
water treatment systems**

Standard Developer  
**NSF International**

**NSF International**

**Designated as an ANSI Standard**  
August 27, 2009  
**American National Standards Institute**

Prepared by  
**The NSF Joint Committee on Drinking Water Treatment Units**

Recommended for Adoption by  
**The NSF Council of Public Health Consultants**

Adopted by  
**The NSF Board of Directors**  
**May 1991**

Revised January 2000  
Revised January 2002  
    Addendum, June 2002  
    Addendum, February 2004  
Revised October 2004  
Revised October 2007  
Revised August 2009

Published by

**NSF International**  
**PO Box 130140, Ann Arbor, Michigan 48113-0140, USA**

For ordering copies or for making inquiries with regard to this Standard, please reference the designation “NSF/ANSI 55 – 2009.”

Copyright 2009 NSF International  
Previous editions © 2007, 2004, 2002, 2000, 1991

Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from NSF International.

Printed in the United States of America.

## Disclaimers<sup>1</sup>

NSF International (NSF), in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of NSF represent its professional judgment. NSF shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. NSF shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

NSF Standards provide basic criteria to promote sanitation and protection of the public health. Provisions for mechanical and electrical safety have not been included in this Standard because governmental agencies or other national standards-setting organizations provide safety requirements.

Participation in NSF's Standards development activities by regulatory agency representatives (federal, local, state) shall not constitute their agency's endorsement of NSF or any of its Standards.

Preference is given to the use of performance criteria measurable by examination or testing in NSF Standards development when such performance criteria may reasonably be used in lieu of design, materials, or construction criteria.

The illustrations, if provided, are intended to assist in understanding their adjacent standard requirements. However, the illustrations may not include **all** requirements for a specific product or unit, nor do they show the only method of fabricating such arrangements. Such partial drawings shall not be used to justify improper or incomplete design and construction.

Unless otherwise referenced, the annexes are not considered an integral part of NSF Standards. The annexes are provided as general guidelines to the manufacturer, regulatory agency, user, or certifying organization.

---

<sup>1</sup> The information contained in this Disclaimer is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Disclaimer may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

This page is intentionally left blank.

## Contents

1	General	1
1.1	Purpose	1
1.2	Scope	1
1.3	Variance from minimum requirements	2
1.4	Alternate materials	2
2	Normative references	2
3	Definitions	3
4	Materials	5
4.1	Materials in contact with drinking water	5
4.2	Materials evaluation	6
4.3	Gas chromatography/mass spectroscopy (GC/MS) analysis	7
	Table 1 – Extraction testing parameters	8
	Table 2 – Formulation-dependent extraction testing parameters	10
	Table 3 – Materials listed in U. S. Code of Federal Regulations,	12
	Table 4 – Non-specific extraction testing parameters	12
5	Structural performance	13
5.1	Structural integrity	13
	Table 5 – Structural integrity testing requirements	17
6	Minimum performance requirements	18
6.1	General	18
6.2	Performance indication	18
6.3	Elements	19
6.4	Flow control	19
6.5	Waste connections	20
6.6	Product water dispensing outlets	20
6.7	Hazards	20
6.8	Lamp operation indication	20
6.9	Electrical requirements	20
6.10	Lamp replacement	20
6.11	Maintenance	20
6.12	Temperature resistance	20
6.13	Corrodible materials	20
6.14	Gaskets, o-rings, shaft seals, and packing materials	20
6.15	Dissimilar metals	21
6.16	Insulating fittings	21
6.17	Plastics	21
6.18	Welding	21
7	Elective performance claims – test methods	21
7.1	General	21
7.2	Microbiological performance	21
	Table 6 – Sampling for disinfection performance	28
8	Instructions and information	30
8.1	Installation, operation, and maintenance instructions	30
8.2	Data plate	31
8.3	Replacement components	32
8.4	Performance data sheet	33

Annex A .....	A1
A.1 Summary .....	A1
A.2 Equipment .....	A1
A.3 Microorganisms .....	A1
A.4 Supplies .....	A1
A.5 Reagents .....	A2
A.6 Safety precautions and hazards .....	A2
A.7 Growth medium .....	A2
A.8 Culture of challenge organisms .....	A4
A.9 Drinking water treatment unit challenge organism suspension preparation .....	A6
A.10 Analysis of influent and effluent samples .....	A7
A.11 Challenge verification .....	A7
 Annex B .....	 B1
B.1 Marking the product .....	B1
B.2 Listing certified companies .....	B1
B.3 Annual audits .....	B1
B.4 Testing .....	B2
B.5 Toxicological evaluation of materials formulations .....	B2
B.6 Corrective action .....	B2
B.7 Enforcement .....	B2
B.8 Administrative review .....	B2
B.9 Appeals .....	B2
B.10 Complaints .....	B3
B.11 Advertising .....	B3
B.12 Records .....	B3
B.13 Public notice .....	B3
B.14 Confidentiality .....	B3



## Foreword<sup>2</sup>

The purpose of this Standard is to establish minimum requirements for the reduction of microorganisms using ultraviolet radiation (UV). UV water treatment systems covered by this Standard are intended for water that may be either microbiologically safe or microbiologically unsafe. This Standard also specifies the minimum product literature and labeling information that a manufacturer shall supply to authorized representatives and system owners, as well as the minimum service-related obligations that the manufacturer shall extend to system owners. Systems covered by this Standard are in keeping with the *Report of Task Force on Guide Standard and Protocol for Testing Microbiological Water Purifiers*, April, 1987.<sup>3</sup>

It is recognized that the federal, state and local objectives are to provide safe water supplies without user treatment. However, many users are faced with the presence of contaminants of both aesthetic and health concern in their water supplies, and need guidance as to the availability of tested and certified point-of-entry and point-of-use ultraviolet water treatment systems. This Standard will help to meet this need but cannot be expected to address claims beyond those covered in this Standard.

Since it was not economically feasible to mount a routine testing program using all of the target microorganisms, e. g., bacteria, viruses, and protozoan cysts, an equivalent "disinfection" set of tests and requirements was developed for point-of-use and point-of-entry ultraviolet disinfection systems.

A virus reduction of 4 log against a poliovirus and rotavirus challenge and a bacteriological reduction of 6 logs against a challenge of a coliform bacteria (*Klebsiella terrigena*) has been recommended by Schaub and an expert task force (1987).<sup>4</sup>

The technical and health protection problems (laboratory staff) and the inherent cost of establishing and maintaining a live virus test program preclude its routine application in a multipurpose standards testing laboratory. Consequently, an alternate means of assuring virus efficacy was developed.

Survival data for poliovirus and rotavirus (Chang, 1985)<sup>5</sup> show that between a 3- and 4-log reduction in both poliovirus and rotavirus may be accomplished by a UV dosage of 30,000  $\mu\text{W}\cdot\text{sec}/\text{cm}^2$  while a greater than 6-log reduction of *Escherichia coli* may be projected. Additional data (Harris, 1986)<sup>6</sup> show a 5-log reduction of poliovirus at 40,000  $\mu\text{W}\cdot\text{sec}/\text{cm}^2$ . In NSF/ANSI 55 2000, a minimum UV dosage of 38,000  $\mu\text{W}\cdot\text{sec}/\text{cm}^2$  at the failsafe setpoint was set as an equivalent 4-log virus reduction requirement. To be consistent with International Standards, the minimum UV dose in NSF/ANSI 55 2002 was changed to 40  $\text{mJ}/\text{cm}^2$  (40,000  $\mu\text{W}\cdot\text{sec}/\text{cm}^2$ ) at the alarm set point.

---

<sup>2</sup> The information contained in this Foreword is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

<sup>3</sup> *Guide Standard and Protocol for Testing Microbiological Water Purifiers*, Report of Task Force, submitted by Steven A. Schaub to the USEPA, April 1987

<sup>4</sup> *Ibid.* p. 7

<sup>5</sup> "UV Inactivation of Pathogenic and Indicator Microorganisms," Chang, J.C., Johnson, J. Doald, et al. *Journal of Applied Environmental Microbiology*, Vol. 49, pp. 1361–1365, 1985

<sup>6</sup> "UV Inactivation of Selected Bacteria and Viruses With Photoreactivation of the Bacteria," Harris, D. George, Adams, Dean, et al., *Water Resources*, Vol. 21, pp. 687–692, 1986

Prior to the late 1990s, it was thought that ultraviolet light had limited cysticidal ability, which required information for the user as to the need for a prefilter complying with NSF/ANSI 53: *Drinking water treatment units – Health effects* for cyst reduction. Survival data for *Cryptosporidium* (Clancy, 2000)<sup>7</sup> and *Giardia* (Craik, 2000)<sup>8</sup> show that a minimum 3- to 4-log reduction in both *Cryptosporidium* and *Giardia* may be accomplished by a UV dosage of 10 mJ/cm<sup>2</sup>.

Where drinking water is considered to be free of disease causing pathogenic organisms and has a turbidity level within acceptable drinking water standards, ultraviolet treatment may be useful for the supplemental treatment of this drinking water. It would be suitable for the reduction of normally occurring microbiological flora (non-spore forming heterotrophic bacteria) commonly found in drinking water. Survival data (Chang, 1985)<sup>9</sup> show that a greater than 2-log reduction of non-spore forming heterotrophic bacteria may be accomplished by an ultraviolet dosage of 16,000  $\mu$ W-sec/cm<sup>2</sup>. The yeast organism *Saccharomyces cerevisiae* was chosen as the test challenge to allow for a reasonable influent concentration and an easily measured reduction in the effluent. Most vegetative bacteria, including coliform species, are too susceptible to UV radiation at the dose range of 16,000  $\mu$ W-sec/cm<sup>2</sup> to allow for measurable testing.

This version of the Standard contains the following revisions:

#### Issue 31

The revision in this issue revised the procedure for extraction testing with and without media.

This Standard was developed by the NSF Joint Committee on Drinking Water Treatment Units using the consensus process described by the American National Standards Institute.

Suggestions for improvement of this Standard are welcome. Comments should be sent to Chair, Joint Committee on Drinking Water Treatment Units, c/o NSF International, Standards Department, P.O. Box 130140, Ann Arbor, Michigan 48113-0140, USA.

---

<sup>7</sup> "Using UV to Inactivate *Cryptosporidium*," Clancy, J. L., et al. *Journal of American Water Works*, Vol 92, Issue 9, pp. 97-104, 2000

<sup>8</sup> "Inactivation of *Giardia Muris* Cysts Using Medium-Pressure Ultraviolet Radiation in Filtered Drinking water," Craik, S. A., et al. *Water Resources*, Vol. 34, No. 18, pp 4325-4332, 2000

<sup>9</sup> Ibid. p. 1362

# NSF/ANSI Standard for Drinking Water Treatment Units –

## Ultraviolet microbiological water treatment units

### 1 General

#### 1.1 Purpose

The purpose of this Standard is to establish minimum requirements for the reduction of microorganisms using ultraviolet radiation (UV). UV water treatment systems covered by this Standard are intended for water that may be either microbiologically safe or microbiologically unsafe. This Standard also specifies the minimum product literature and labeling information that a manufacturer shall supply to authorized representatives and system owners, as well as the minimum service-related obligations that the manufacturer shall extend to system owners.

#### 1.2 Scope

This Standard covers ultraviolet microbiological water treatment systems and components for point-of-use and point-of-entry applications. Systems are intended to be used under the following specific conditions.

##### 1.2.1 Class A systems

Class A point-of-entry and point-of-use systems covered by this Standard are designed to inactivate and/or remove microorganisms, including bacteria, viruses, *Cryptosporidium* oocysts, and *Giardia* cysts, from contaminated water. Systems covered by this Standard are not intended for the treatment of water that has an obvious contamination or intentional source, such as raw sewage, nor are systems intended to convert wastewater to drinking water. The systems are intended to be installed on visually clear water (not colored, cloudy, or turbid).

Class A systems not installed downstream of a device tested for cyst reduction/inactivation in conformance to the appropriate NSF/ANSI standard may claim *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 and/or ground water under the direct influence of surface water.

NOTE – Current data support that *Cryptosporidium* oocysts and *Giardia* cysts are inactivated by ultraviolet treatment.

##### 1.2.2 Class B systems or components

Class B point-of-entry and point-of-use systems covered by this Standard are designed 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. The system is designed to reduce normally occurring nonpathogenic nuisance microorganisms only. The Class B system is not intended for the disinfection of microbiologically unsafe water and may not make individual or general cyst claims. Class B systems shall not make microbiological health effects claims.