



*NSF International Standard /
American National Standard*

NSF/ANSI 55 - 2015

Ultraviolet Microbiological Water Treatment Systems



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

Ultraviolet microbiological water treatment systems

Standard Developer

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Foreword²

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, 1987.³

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).⁴

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)⁵ 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)⁶ 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 mJ/cm^2 (40,000 $\mu\text{W}\cdot\text{sec}/\text{cm}^2$) at the alarm set point.

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)⁷ and

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

⁴ Ibid. p. 7

⁵ "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

⁶ "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

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

Giardia (Craig, 2000)⁸ show that a minimum 3- to 4-log reduction in both *Cryptosporidium* and *Giardia* may be accomplished by a UV dosage of 10 mJ/cm².

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)⁹ show that a greater than 2-log reduction of non-spore forming heterotrophic bacteria may be accomplished by an ultraviolet dosage of 16,000 µW-sec/cm². 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 µW-sec/cm² to allow for measurable testing.

This version of the Standard contains the following revisions:

Issue 40

This revision added clarification regarding the maximum number of samples exposed in the Materials evaluation under section 4.

It is the intent of the Joint Committee to eliminate the use of *S. cerevisiae* as a challenge organism for Class B devices from the Standard after September 2017, a period of five years from the adoption of using T1 Coliphage as a challenge organism for Class B devices.

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. This Standard is maintained on a Continuous Maintenance schedule and can be opened for comment at any time. Comments should be sent to Chair, Joint Committee on Drinking Water Treatment Units at standards@nsf.org or, c/o NSF International, Standards Department, P.O. Box 130140, Ann Arbor, Michigan 48113-0140, USA.

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

⁹ 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.

1.3 Variance from minimum requirements

Variations from the minimum requirements specified in 4, 5, 6, and 7 may be permitted provided that they give the system or component the same or greater resistance to corrosion, wear, and physical damage, or that they improve the general operation or performance of the system or component. Proposed variations shall be accepted by the testing agency prior to use. Systems with components or functions covered under existing NSF standards or criteria shall conform to the applicable requirements therein.

1.4 Alternate materials

If specific materials are mentioned, other materials that provide at least equal performance and sanitation shall be acceptable.

2 Normative references

The following documents contain provisions that, through reference, constitute provisions of this NSF/ANSI Standard. At the time this Standard was balloted, the editions listed below were valid. All documents are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the documents indicated below. The most recent published edition of the document shall be used for undated references.

APHA, Standard Methods for the Examination of Water and Wastewater, twentieth edition⁴

NSF/ANSI 53. Drinking water treatment units – Health effects

NSF/ANSI 58. Reverse osmosis drinking water treatment systems

NSF/ANSI 61. Drinking water system components – Health effects

NSF/ANSI 62. Drinking water distillation systems

USEPA-600/4-84-053. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, June 1984⁵

USEPA-600/4-84-053. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, June 1984⁵

USEPA 600/479020. Methods for the Chemical Analysis of Water and Wastes, March 1983⁵

USEPA 600/R94/111. Methods for the Determination of Metals in Environmental Samples, Supplement 1, May 1994⁵

USEPA 600/488/039. Methods for the Determination of Organic Compounds in Drinking Water, December 1988⁵

USEPA 600/490/020. Methods for the Determination of Organic Compounds in Drinking Water – Supplement 1, July 1990⁵

USEPA National Primary Drinking Water Regulations, 40 CFR Part 143⁶

⁴ American Public Health Association (APHA), 800 I Street, NW, Washington, DC 20001 <www.apha.org>.

⁵ U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268 <www.epa.gov>.

⁶ Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 <www.gpo.gov>.

USEPA National Secondary Drinking Water Regulations, 40 CFR Part 143⁶

USFDA Code of Federal Regulations, Title 21, (Food and Drugs) Direct Food Additive Substances Parts 170 through 199, April 1, 1992⁶

3 Definitions

Terms used in this Standard that have a specific technical meaning are defined in NSF/ANSI 330.

4 Materials

4.1 Materials in contact with drinking water

4.1.1 POE drinking water treatment units shall conform to the protocol and criteria in NSF/ANSI 61.

4.1.2 POU drinking water treatment units shall conform to the protocol and criteria in this section.

4.1.3 Acceptance criteria

4.1.3.1 Materials in contact with drinking water shall not impart levels of target compounds or Tentatively Identified Compounds (TICs) that exceed the Total Allowable Concentration (TAC), Maximum Contaminant Levels (MCL), or Maximum Acceptable Concentration (MAC) criteria specified in tables 1, 2 and 3 or specified in NSF/ANSI 61 Annex D and E. Any extractable contaminants not listed in the referenced tables shall be reviewed and shall not exceed criteria developed in accordance with NSF/ANSI 61 Annex A.

4.1.3.2 TIC identification and quantitation shall be conducted in accordance with section 4.3.1.2. Additional TIC identification and quantitation should be verified using a standard of the compound in question or an alternate approved analytical method. Additional TIC identification and quantitation is recommended when the contaminant is a health risk or when the “Probability Based Matching” process in section 4.3.1.2 is inconclusive. When possible, the product manufacturer should assist and support the testing laboratory in the identification of a standard for the compound and an appropriate analytical method, if applicable, so that confirmatory identification and quantification can be performed. If a standard and an adequate alternative analytical method are not available to verify the identification and quantitation of the compound, the TIC shall be evaluated according to section 4.3.1.2.

NOTE: Manufacturers may not be privy to formulation information, so they may not be able to assist a testing laboratory to identify a standard for the compound that extracted. Refer to Section 4.3.1.2 when the manufacturer does not have material formulation information.

4.1.3.3 Unknown contaminants detected by GC/MS analysis for which identification is unable to be made after performing the steps in 4.3.1 shall be reported in accordance to 4.1.4.2.

4.1.3.4 Whole-system or component assembly extraction testing may be waived if components, when separately tested, meet the requirements of this Standard and are assembled in a manner that does not introduce any new components or materials, increase the surface area-to-volume ratio of previously evaluated components, or present potential concern based on cumulative factors. The reported extractable concentrations for components shall be arithmetically added to ensure that the whole-system or component assembly meets the allowable levels in accordance with tables 1, 2, and 3 and Annex A, D, and E of NSF/ANSI 61.

4.1.4 Data reporting

4.1.4.1 All contaminants identified and detected at or above the reporting limit shall be reported with the identification of the contaminant, the concentration, and whether it exceeds the acceptance criteria as required in Section 4.1.3. Contaminants detected below the reporting limit shall be reported to the manufacturer as less than the reporting limit's value.

Example: If the lab's reporting limit is 1.0 mg/L for analyte "X" and the concentration was detected at 0.5 mg/L, the lab shall report less than 1.0 mg/L or <1.0 mg/L.

4.1.4.2 If the extractable contaminant cannot be identified following the procedures in 4.3.1 the laboratory shall supply the manufacturer with the approximate molecular weight along with any additional information about the compound.

4.2 Materials evaluation

Complete formulation information on any material not certified as specifically compliant with the sections of the U. S. Code of Federal Regulations, Title 21, listed in table 4, shall be reviewed to determine whether the material presents a health effects concern in contact with drinking water and to assess the material's potential for contributing contaminants to the drinking water. As a minimum level of information for those materials requiring submission of formulation information, the complete chemical identity and proportion by weight (in some cases approximate weights or proportions may suffice) and ingredient sources of supply shall be provided.

The following additional information is required when available:

- a list of the known or suspected impurities within the product or material and the maximum percent or parts by weight of each impurity;
- the water solubility, hydrolysis products, and extraction rates of chemicals within the product or material; and
- a list of toxicological studies relevant to the chemicals and impurities present in the product, component, or material.

4.2.1 Analytical methods

All analyses shall be conducted in accordance with the applicable method(s) referred to in 2.

4.2.1.1 The laboratory shall validate the analytical method to the reporting limit (RL) concentration following the procedures established in the referenced method. The laboratory shall evaluate its method detection limit (MDL) in reference to the RL. In all cases, the RL shall be equal or greater than the MDL. When preparing its calibration standards, the lowest calibration point shall be at or less than the RL.

4.2.1.2 For extracted techniques (e.g., USEPA Method 625), regarding the concentration of the lowest calibration point, the laboratory shall apply the concentration factor due to sample preparation. For example, a sample one liter extracted, and the extract concentrated to 1.0 milliliter, for a factor of 1000, if the RL is set to 0.2 ug/L, then the lowest calibration point would be at or less than 0.2 mg/L.

NOTE – See Annex C for additional information on GC/MS and other alternative methods.

4.2.2 Exposure water

Systems and components shall be exposed to locally available tap water that has been adjusted to contain 50 ± 5 mg/L total dissolved solids, 0.5 ± 0.05 mg/L free available chlorine, and to have a pH of 6.75 ± 0.25 . Exposure water used to evaluate systems or components shall be 23 ± 2 °C (73 ± 3 °F). Any

existing concentrations of extraction testing parameters listed in Tables 1, 2, and 3 found to be present in the exposure water shall be subtracted from the values obtained in the analysis of the extractant water.

4.2.3 Exposure

NOTE – The lamp shall be on during exposure testing, when appropriate.

4.2.3.1 The system or component(s) of a system shall be installed, flushed, and conditioned in accordance with the manufacturer's instructions using the exposure water specified in 4.2.2 at an initial inlet static pressure of 340 kPa (50 psig).

4.2.3.2 The system or component(s) shall be refilled with the exposure water specified in 4.2.2 and maintained for 24 h at an ambient temperature of 23 ± 2 °C (73 ± 3 °F). A 2-L water sample shall then be collected in accordance with 4.2.3.3. The system or component(s) shall be flushed according to the manufacturer's instructions, refilled, and maintained for another 24 h at an ambient temperature of 23 ± 2 °C (73 ± 3 °F). A second 2-L water sample shall be collected in accordance with 4.2.3.3. The system or component(s) shall again be flushed according to the manufacturer's instructions, refilled, and maintained for a third period of 24 h at an ambient temperature of 23 ± 2 °C (73 ± 3 °F). A third 2-L water sample shall be collected in accordance with 4.2.3.3.

4.2.3.3 A minimum sample volume of 2 L shall be collected at each sample point. If the water holding volume of the product is greater than 2 L, the entire volume shall be collected in a suitable collection vessel, and a 2-L subsample obtained from this volume. If the water holding volume of the product is less than 2 L, sufficient products shall be exposed to provide the required 2-L volume of extractant water. The maximum number of samples exposed shall not exceed 16 with 125 mL of extractant water drawn from each sample. If the components with a water-holding volume that is less than 250 mL and is able to be identified as one that will only occur once in the flow path of dispensed treated water (such as diverters, faucets, RO shutoff valves, or specialty components) then a volume of 250 mL shall be drawn from each sample using a maximum number of 8 samples.

4.2.3.4 All samples collected shall be composited and analyzed in accordance with 4.2.1.

4.2.3.5 Systems with adsorptive or absorptive media shall be tested with and without the media. Testing without media shall include removal of any granular adsorptive or absorptive media, and removal of any adsorptive or absorptive replacement elements.

4.3 Gas chromatography/mass spectroscopy (GC/MS) analysis

4.3.1 General requirements for GC/MS analysis

When determined to be required following a product-specific formulation review, USEPA Analytical Methods for semi-volatiles and volatiles that include mass spectral libraries shall be performed on products or components, and shall include full-range mass spectral libraries to monitor for non-target compounds.

Testing for semi-volatiles (e.g. USEPA Method 625 or 528 or 525.2) and volatiles (e.g. USEPA Method 524.2 or 524.3) shall be conducted using the required target compounds in Tables 2 and 3 and the laboratory's RL shall be no greater than the RL's listed in Tables 2 and 3.

4.3.1.1 Target compounds shall be validated in accordance with the requirements of the referenced method. USEPA Methods 524.2 and 625 have specific validation requirements including precision and accuracy requirements as well as demonstration of sensitivity (Method Detection Limit Study or MDL).

For USEPA Method 625, the minimum instrument operation requirements for GC/MS analysis shall be in accordance with those protocols as defined by the method with the following modifications:

- To guard against significant drift from an initial instrument calibration to subsequent instrument batches, the average chromatographic peak area of each internal standard in the calibration curve shall be determined. The chromatographic peak area of each internal standard in the continuing calibration shall be greater than 50% and not more than 200% of that average;
- Due to the number of characteristics of the analytes associated with method 625, while a continuing calibration check (CCC) is performed, concentrations of 10% of the target compounds for each analysis (e. g., base/neutral, base/neutral/acid, acid) shall be allowed to fall outside the range of 70% to 130% (outlier) of the true value. None of the concentrations shall be allowed to fall below 50% or above 200% of the true value. If a positive sample analyte result is identified for any outlier, a second CCC shall be performed. If the second CCC determines the sample analyte result no longer to be an outlier, the sample shall be reanalyzed. However, if the second CCC also determines the analyte to be an outlier, a new calibration curve shall be determined and the sample shall be reanalyzed;

NOTE - At the laboratory's discretion, a calibration may be performed specifically for the compound in question, with the reporting of its data from this second calibration. It should be understood, that if the laboratory utilizes this approach (calibrating for the specific analyte) all method requirements as specified by 625 shall be achieved.

4.3.1.2 TICs are identified by comparison of the spectrum of the unknown to the mass-spectral reference library utilizing "Probability Based Matching" (as available from instrument manufacturers) as well as interpretation by the analyst. The laboratory shall report the TIC with the best match factor (the match factor shall not be reported) except in the following circumstances:

- a) Due to the complex nature of GCMS interpretation and identification, when reviewing the list of possible matches for any particular TIC peak, the laboratory has the authority to assign the identification to a compound "hit" with a lower numeric match factor from the library search algorithm.
- b) The laboratory may determine that none of the returned compounds by the automated search algorithm is a good match for the unknown peak. In this case the compound is reported as an "Unknown."
- c) The laboratory may utilize manual spectral interpretation to identify the peak in question.
- d) All TICs detected at a concentration greater than or equal to 3.0 ppb shall be reported.

The library used during the analysis shall be NIST 2007 or most current version. Additional spectra libraries may be used to assist in the identification of unknown compounds. For TICs, the concentration is estimated by comparison of its total ion area response to the total ion area response of the nearest internal standard. For TIC's, a response factor of "1" (one) shall be utilized for the purposes of calculating the TICs estimated concentration.

NOTE - It should be understood that when utilizing mass-spectrometer library searches to identify unknown chromatographic peaks (sometimes called "TICs") that the concentration is estimated assuming that the response of the TIC is the same as the internal standard. However, for example, when analyzing for traditional semi volatile compounds by USEPA method 625, the range of response factors is typically 0.1 to 2. Because the response factor is used as a reciprocal, and assuming that the response for the TIC falls within the range of the compounds for which the system is typically calibrated, the true concentration for this TIC would range up to 10 times greater to one half the reported TIC concentration.

4.3.1.3 Unknown Compounds - contaminants detected by GC/MS analysis but are not identified and quantified against a known mass spectrum or standard shall be evaluated as follows:

- a) The molecular weight shall be reported or, if no molecular ion is identifiable, a minimum value for the molecular weight (for example, if the highest mass ion for the TIC has a m/z of 143, then report MW >=143).

- b) The chemical class information shall be reported if this determination is possible.
- c) The laboratory shall report the presence of the common halogens chlorine and bromine utilizing their characteristic “M+2” patterns.
- d) The product material formulation(s) shall be reviewed for potential identification of the unknown contaminant(s) as an ingredient or byproduct;
- e) The manufacturer shall be notified and requested to provide supporting information that enables identification of the unknown contaminant(s);
- f) Structure activity relationships (SAR) shall be utilized when sufficient structural identification of the unknown contaminant(s) can be made; and
- g) Alternative methods of analysis that may identify the unknown contaminant(s) shall be considered, such as classifying the unknown into a chemical class.

Contaminants that are identified after performing one or more of the above steps shall be evaluated in accordance with 4.1.3.2 and 4.1.3.3. The product manufacturer, laboratory toxicologist and laboratory chemist shall assist the testing laboratory in the identification of a standard for the compound and an appropriate analytical method, if applicable, so that confirmatory identification and quantification can be performed when needed. Standard validation is needed when the identified compound is not reported in the formulation review conducted in 4.2

NOTE – Items “b” and “c” above may be automated utilizing software available from NIST with their mass-spectral database

4.3.1.4 Contaminants detected by GC/MS analysis for which no identification can be made after performing the above steps shall not be considered in the determination of product compliance to this Standard. When unknown contaminants are detected in the extractant water, the testing laboratory shall report the analytical results.

Table 1 – Extraction testing parameters

Parameter	Total Allowable Concentration (TAC) mg/L	Drinking water regulatory level (MCL/MAC) mg/L	Maximum Reporting Limit (RL) mg/L	USEPA method(s)
aluminum	0.5		0.1	200.7, 200.8
antimony		0.006	0.001	200.8, 200.9
arsenic		0.010	0.001	200.8, 200.9
barium		2	0.2	200.7, 200.8
beryllium		0.004	0.001	200.7, 200.8, 200.9
cadmium		0.005	0.001	200.8, 200.9
chromium		0.1	0.01	200.7, 200.8, 200.9
copper		1.3	0.1	200.7, 200.8
lead		0.010	0.001	200.8, 200.9
manganese	0.3		0.01	200.7, 200.8
mercury		0.002	0.001	200.8, 245.1
nickel	0.1		0.01	200.7, 200.8
selenium		0.05	0.005	200.8, 200.9
thallium		0.002	0.001	200.8, 200.9

– concluded –

Table 2 – Extraction testing parameters (Semi-Volatiles)

Analyte	CAS Number	TAC ¹ (mg/L)	Drinking water regulatory level (MCL/MAC) (mg/L)	Maximum Reporting Limit (RL) (mg/L)	Reference Method(s)
2,4,6-Trichlorophenol	88-06-2	0.005		0.001	525.2, 528, 625
2,4-Dichlorophenol	120-83-2	0.003		0.001	525.2, 528, 625
2,4-Dimethylphenol	105-67-9	0.1		0.01	525.2, 528, 625
2,6-Di-tert-butyl-4-methoxyphenol	489-01-0	0.003		0.003	525.2, 528, 625
2-Methylnaphthalene	91-57-6	0.03		0.003	525.2, 528, 625
2-Nitrophenol	88-75-5	0.003*		0.001	525.2, 528, 625
2-Phenyl-2-propanol	617-94-7	0.05		0.005	525.2, 528, 625
3,3-Dichlorobenzidine	91-94-1	0.0008		0.001	525.2, 528, 625
3-and 4-Methylphenol, m&p-cresol	106-44-5 108-39-4	0.003*		0.001	525.2, 528, 625
4-Chloro-3-methylphenol	59-50-7	0.7		0.07	525.2, 528, 625
4-tert-Butylphenol or p-tert-Butylphenol	98-54-4	0.5		0.05	525.2, 528, 625
Acenaphthene	83-32-9	0.003*		0.004	525.2, 528, 625
Acenaphthylene	208-96-8	0.003		0.0004	525.2, 528, 625
Acetophenone	98-86-2	0.2		0.02	525.2, 528, 625
Anthracene	120-12-7	0.003*		0.0003	525.2, 528, 625
Benzo(a)pyrene	50-32-8		0.002	0.0002	525.2, 528, 625
Benzothiazole	95-16-9	0.003		0.003	525.2, 528, 625
Bis(2-ethylhexyl)adipate	103-23-1		0.4	0.04	525.2, 528, 625
Bis(2-ethylhexyl)phthalate	117-81-7		0.006	0.001	525.2, 528, 625
Butyl benzyl phthalate	85-68-7	1*		0.1	525.2, 528, 625
Chrysene	218-01-9	0.003*		0.003	525.2, 528, 625
Diethyl phthalate	84-66-2	6		0.6	525.2, 528, 625
Dimethyl phthalate	131-11-3	0.003		0.001	525.2, 528, 625
Di-n-butyl phthalate	84-74-2	0.7		.07	525.2, 528, 625
Fluoranthene	206-44-0	0.003		0.0003	525.2, 528, 625
Isophorone	78-59-1	0.4		0.04	525.2, 528, 625