NSF International Standard /
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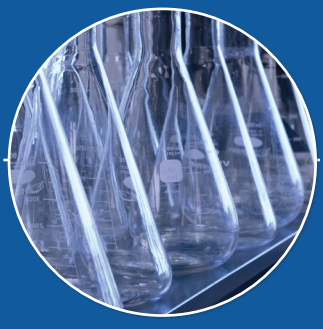
NSF/ANSI 53 - 2013

Drinking Water Treatment Units - Health Effects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NSF International Standard/
American National Standard
for Drinking Water Treatment Units —

Drinking water treatment units – Health effects

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Contents

Foreword[2]

The purpose of this Standard is to establish minimum requirements for materials, design and construction, and performance of drinking water treatment systems that are designed to reduce specific health-related contaminants in public or private water supplies. NSF/ANSI 53 specifies minimum product literature requirements that manufacturers must provide to authorized representatives and owners.

This edition of the Standard contains the following revisions:

Issue 79

This issue incorporates test protocols to evaluate personal hand held DWTUs under all applicable sections of elective performance claims methods under section 7. The test method for evaluating mouth drawn DWTUs has been added under Annex F and the method for evaluating squeeze-type bottles has been added under Annex G. A structural integrity test method for all personal hand held devices has also been added under section 5.

Issue 82

This revision addresses tentatively identified compounds (TICs) and unknown compounds that are found during extraction testing under section 4 and clarifies the analytical method(s) to be used to evaluate these compounds under Annex E.

Issue 90

Individual sample point limits for the chloroform surrogate test for VOC reduction was added under section 7. This issue also specifies methanol as the acceptable solvent for organic chemical and VOC reduction testing,

Issue 91

This revision addresses premature clogging of filters during testing under section 7 and clarifies what is and is not allowed with regards to pre-filtering the challenge water of products if requested by the manufacturer. Annex H specifies acceptable procedures that may be used.

Issue 93

The following errors were corrected: Section 6.13 was inadvertently left in NSF/ANSI 53 when the filter media test was removed from the Standard in 2011. Under section 7.3.3 Turbidity Reduction Challenge, section 7.3.3.1.2 was inadvertently left in NSF/ANSI 53 when the test dust option for cyst reduction was removed in 1999.

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.

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NSF/ANSI Standard
for Drinking Water Treatment Units —

Drinking water treatment units — Health effects

1 General

1.1 Purpose

It is the purpose of this Standard to establish minimum requirements for materials, design and construction, and performance of point-of-use and point-of-entry drinking water treatment systems that are designed to reduce specific health-related contaminants in public or private water supplies. Such systems include point-of-entry drinking water treatment systems used to treat all or part of the water at the inlet to a residential facility or a bottled water production facility, and includes the material and components used in these systems. 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

The point-of-use and point-of-entry systems addressed by this Standard are designed to be used for the reduction of specific substances that may be present in drinking water (public or private). These substances are considered established or potential health hazards. They may be microbiological, chemical, or particulate (including filterable cysts) in nature. It is recognized that a system may be effective in controlling one or more of these contaminants, but systems are not required to control all. Activated carbon filter systems covered by this Standard are not intended to be used with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.

1.3 Minimum requirements

A system as defined in this standard shall meet the applicable requirements of 4, 5, 6, and 8, plus at least one performance claim as described in 7.

A component as defined in this standard shall meet the requirements of 4 and 8. If the component is pressure-bearing, it shall also meet the applicable requirements of 5.

A commercial modular system as defined in this standard shall meet the applicable requirements of 4, 5, 6, and 8, plus at least one performance claim as described in 7. Manifolds of commercial modular systems shall meet the requirements of 4, 5 (if pressure bearing), and 8, and shall be evaluated as stand-alone components. Manifolds shall have a minimum internal diameter such that the water velocity in the manifold will not exceed 3 m (10 ft) per second (which can be calculated based upon the system flow rate and the manifold internal diameter). Individual modular elements evaluated as a manifold and modular element combination shall meet the applicable requirements of 4, 5, 6, and 8, plus at least one performance claim as described in 7.

1.4 Chemical and mechanical reduction performance claims

1.4.1 All performance claims shall be verified and substantiated by test data generated under the requirements of this Standard.

1.4.2 When performance claims are made for substances not specifically addressed in the scope of this Standard or for those substances not specifically addressed but falling under the scope of NSF/ANSI 53, those claims not specifically addressed in the Standard shall be so identified.

1.5 Standard review

This Standard shall be reviewed at least once every five years. The review shall be conducted by the NSF Joint Committee on Drinking Water Treatment Units.

2 Normative references

The following documents contain provisions that constitute requirements of this Standard. At the time of publication, the indicated editions were valid. All standards are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the standards 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 edition[3]

NSF/ANSI 42 – *Drinking water treatment units — Aesthetic effects*

NSF/ANSI 51 – *Food Equipment Materials*

NSF/ANSI 60 – *Drinking water treatment chemicals — Health effects*

NSF/ANSI 61 – *Drinking water system components — Health effects*

SAE Standard J726 – June 1993. Air Cleaner Test Code[4]

USEPA–100.1. *Analytical Method for Determination of Asbestos Fibers in Water*, formerly USEPA-600/4-83-043[5]

USEPA–600/4 – 79/020. *Methods for the Chemical Analysis of Water and Wastes*, March 1983[5]

USEPA–600/4 – 84/053. *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater*, June 1984[5]

USEPA–600/4 – 91/010. *Methods for the Determination of Metals in Environmental Samples*, June 1993[5]

USEPA–600/4 – 88/039. *Methods for the Determination of Organic Compounds in Drinking Water*, December 1988[5]

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

[4] Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096 <www.sae.org>.

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

USEPA–600/4 – 90/020. *Methods for the Determination of Organic Compounds in Drinking Water* – Supplement 1, July 1990[5]

USEPA *National Primary Drinking Water Regulations*, 40 CFR Part 14[6]
USEPA *National Primary Drinking Water Regulations*, 40 CFR Part 136[6]

USEPA *National Secondary Drinking Water Regulations*, 40 CFR Part 143[6]

USEPA ICR Protozoan Method for the Detecting *Giardia* Cysts and *Cryptosporidium* Oocysts in Water by a Fluorescent Antibody Procedure, EPA/814-B-95-003, June 1995[6]

USFDA Code of Federal Regulations, Title 21, (Food and Drugs) *Direct Food Additive Substances Parts 170 through 199*, April 1, 1992[6]

3 Definitions

The following terms are used in this document:

3.1 absorption: The physical process occurring when one substance actually penetrates the structure of another substance, termed the absorbent.

3.2 accessible: Fabricated to be exposed for cleaning and inspection using simple tools (e. g., screwdriver, pliers, open-end wrench).

3.3 active agent: A substance or medium, added to or involved in the treatment process, that requires direct or sacrificial release of the agent or degraded product to reduce specific contaminants in the water.

3.4 additive: A substance added to water, directly or indirectly, during a drinking water treatment process.

3.5 adsorption: The physical process occurring when liquids, gases, or dissolved or suspended matter adhere to the surface of, or in the pores of, an adsorbent medium. Adsorption is a physical process that occurs without chemical reaction.

3.6 advisory concentration: The minimum concentration attainable for a given substance using good manufacturing practices and appropriate process controls. In some cases, the advisory concentration is equal to the limit of detection of the preferred analytical method for the substance.

3.7 aesthetic: Pertaining to factors such as taste, odor, color, and appearance that affect drinking water and, therefore, may deter acceptance of public and private drinking water.

3.8 air gap: An unobstructed vertical distance of 2 pipe diameters or 25 mm (1 in), whichever is greater, through the free atmosphere between the outlet of the waste pipe and the flood level rim of the receptacle into which it is discharging.

3.9 backwash: The upflow or counter-current flow of water through a filter medium, for the purpose of thoroughly expanding the medium to remove foreign particulate matter accumulated during the service cycle and flushing it to the drain.

3.10 bed volume: Total volume of the media including the void spaces between the medium particles.

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

3.11 bypass: (verb) To flow around a water treatment system or its media. (noun) A valve system that allows water to flow around the water treatment system while the system is being regenerated or serviced.

3.12 capacity: The rated service cycle, expressed as a function of time or volume, of water treated by a system, between servicing of the media (cleaning, regeneration, or replacement), as specified by the manufacturer.

3.13 chemical reduction: The reduction in the quantity of one or more specified organic or inorganic contaminants in drinking water.

3.14 clean system: A unit that has not been subjected to an influent challenge containing a specified contaminant(s).

3.15 commercial modular system: A system consisting of multiple modular elements attached to a manifold, produced specifically for food service applications, installed by an authorized plumber or authorized agent of the manufacturer, and not intended for use in residential applications.

3.16 component: A separate or distinct part of a drinking water treatment system.

3.17 contaminant: Any undesirable physical, chemical, or microbiological substance in drinking water that may have an adverse health or aesthetic effect, or both.

3.18 cyst: The resistant stage in the life cycle of waterborne protozoa that may be found in surface drinking water supplies and includes oocysts of *Cryptosporidium* and *Toxoplasma* and cysts of *Giardia* and *Entamoeba.*

3.19 degradation product: A product of an active agent or additive that has been altered by biological, chemical, or physical interaction.

3.20 disposable pressure vessel: A pressure vessel that is to be replaced at the end of each rated service cycle and has an estimated service life of one year or less.

3.21 drinking water: Water that is intended for human consumption.

3.22 exposure water: Water having definitive characteristics, prior to contact with a system or component(s) in extraction procedures.

3.23 extractant water: Water that has been in contact with a system or component(s) for a specified duration.

3.24 fiber: A particle with a length three or more times its width or diameter (excludes organisms).

3.25 filter: (verb) To pass water containing particles through a semi-permeable material (e. g., charcoal, fabric, filament) to separate the particles from the water. (noun) A system for carrying out the process of filtration; it consists of the filter medium and suitable hardware for constraining and supporting the filter medium in the path of the water.

3.26 filter area: The effective area at which water first contacts the filter medium.

3.27 filter medium: The semi-permeable material used to separate particulate matter from water.

3.28 filtration: The process by which particles are separated from water by passing water through a permeable material.

3.29 flow rate: The volume of water that passes through a system in a specified amount of time.

3.30 influent challenge: The mixture of water and contaminants entering a system.

3.31 initial dynamic pressure: The pressure as measured at a pressure gauge immediately preceding connection to the system being tested (see figure 1) when the system is filled with water and flowing.

3.32 maximum contaminant concentration (MCC): The maximum permissible concentration of a contaminant in drinking water as established by a recognized regulatory agency, such as the USEPA or Health Canada.

3.33 maximum contaminant level (MCL): The maximum permissible concentration of a contaminant or substance in drinking water, as established in the *National Primary Drinking Water Regulations*.

3.34 maximum drinking water level (MDWL): The maximum concentration of a contaminant or substance in drinking water that a system is allowed to contribute to the effluent, as established in this Standard.

3.35 mechanical filtration system: A system that mechanically separates particulate matter from water.

3.36 medium (media): The selected material in a system that forms a water-permeable barrier to the passage of certain contaminants.

3.37 medium migration: The entrainment of a fraction of the medium into the effluent.

3.38 microbiologically unsafe water: Water that (1) is known to contain disease-causing bacteria, viruses, protozoa, or other disease-causing microbiological agents; (2) shows a positive test for an indicator organism; or (3) is determined unsafe by an appropriate health or regulatory agency.

3.39 modular element: A replaceable filtration or treatment element designed and sold as a component for use in commercial modular systems.

3.40 open discharge system: A system not subject to line pressure during the off mode.

3.41 point-of-entry (POE) system: A drinking water treatment unit with a minimum initial clean-system flow rate of not less than 15 L/min at 103 kilopascals pressure drop and 18 ± 5 °C water temperature (not less than 4 gal/min at 15 psig pressure drop and 65 ± 10 °F water temperature) used to treat the water supply at a building or facility for drinking and for washing, flushing, or for other non-consumption water supply purposes in addition to the drinking water supply.

3.42 point-of-use (POU) system: A plumbed-in or faucet-mounted drinking water treatment unit used to treat the drinking and/or cooking water at a single tap or multiple taps but not used to treat the majority of water used for washing and flushing or other non-consumption purposes at a building or facility. Any batch system or device not connected to the plumbing system is considered a point-of-use system.

3.43 pressure drop: The difference between the inlet and outlet pressures of a system at the rated service flow rate.

3.44 pressure vessel: A component of a system intended to hold water under pressure higher than atmospheric pressure.

3.45 product water: Water that has been treated by a system.

3.46 rated service cycle: The capacity of a system expressed as a function of time, or volume of water to be treated, between cleaning replacement or regeneration of the media, as specified by the manufacturer.

3.47 rated service flow: The flow rate at which the system will deliver treated water of acceptable quality, as claimed by the manufacturer. Flow rate is expressed as liters (gallons) per minute, or liters (gallons) per day.

3.48 raw water: Untreated water or any influent water before it enters a specific water treatment component or system.

3.49 readily accessible: Fabricated to be exposed for cleaning and inspection without using tools.

3.50 readily (or easily) removable: Capable of being separated from the system without using tools.

3.51 refrigerator filter: A filter system incorporated into a residential refrigerator appliance.

3.52 regeneration: The maintenance process that restores a medium to perform its water treatment function(s).

3.53 replacement component: A replaceable, preformed, or prepackaged component containing a medium (media).

3.54 secondary maximum contaminant level (SMCL): The maximum permissible level of a contaminant or substance in drinking water, as established in the *National Secondary Drinking Water Regulations*.

3.55 system: A complete water treatment device, including all components needed to connect it to a potable water supply.

3.56 total dissolved solids (TDS): The remaining solids from a filtrate evaporated to dryness and dried to a constant weight at 180 °C (356 °F) after passing through a glass fiber filter.

3.57 turbidity: A condition caused by the presence of suspended matter, or colloidal matter, or both, which results in the scattering and absorption of light rays.

3.58 unit void volume: Total water holding volume with the filter medium, components, or both in place.

3.59 unit volume: Total water holding volume without the filter medium, components, or both, in place.

3.60 watertight: Having such precision of construction and fit as to be impermeable to water.

3.61 weepage: The formation of bubbles or droplets of water on the outside of a fiber glass tank during the initial phase of a pressure test, due to the expression of water that was trapped between the tank liner and the fiberglass wrap during the tank manufacturer's testing.

3.62 working pressure: Feedwater or inlet water pressure to a system.

3.62.1 maximum working pressure: The maximum operating pressure recommended by the manufacturer.

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.

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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 The concentration of active agents or additives used in the drinking water treatment process shall be evaluated in the product water as specified in 6.10. The concentration of active agents or additives used in the drinking water treatment process shall not be evaluated during extraction testing.

4.1.3.5 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) referenced 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 X 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 and 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

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 a 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 a 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 a 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 samples shall be exposed to provide the required 2-L volume of extractant water.

4.2.3.4 All samples collected shall be composited and analyzed in accordance the applicable methods referenced in 2.

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;

– If commercially available mass spectral libraries are utilized, a minimum size of 100,000 compounds shall be required.

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.

4.4 Materials in contact with the user’s mouth

Materials not in contact with water but in contact with the user’s mouth during normal use shall meet the requirements of NSF/ANSI Standard 51 for food zone materials.

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		0.07	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
Naphthalene	91-20-3	0.4		0.04	525.2, 528, 625

Analyte	CAS Number	TAC[1] mg/L	Drinking water regulatory level (MCL/MAC) mg/L	Maximum Reporting Limit (RL) mg/L	Reference Method(s)
N-Nitroso-di-n-butylamine	924-16-3	0.00006		0.0006	525.2, 528, 625
N-Nitroso-di-n-propylamine	621-64-7	0.00005		0.0005	525.2, 528, 625
N-Nitrosodiphenylamine	86-30-6	0.07		0.007	525.2, 528, 625
o-Cresol or 2-methylphenol	95-48-7	0.003*		0.001	525.2, 528, 625
Pentachlorophenol	87-86-5		0.001	0.0005	525.2, 528, 625
Phenanthrene	85-01-8	0.003		0.0003	525.2, 528, 625
Phenol	108-95-2	2		0.2	525.2, 528, 625
Phenyl sulfone	127-63-9	0.003*		0.002	525.2, 528, 625
Pyrene	129-00-0	0.003		0.0006	525.2, 528, 625

[1]TAC values have been evaluated using qualitative or quantitative risk assessment methods. If contaminants extract above these levels, an evaluation in accordance of with Annex A of NSF/ANSI 61 may be used to determine a higher allowable level.

– concluded –

Table 3 – Extraction testing parameters (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)
1,1,1,2-Tetrachloroethane	630-20-6	0.01		0.001	524.2, 524.3
1,1,1-Trichloroethane	71-55-6		0.2	0.02	524.2, 524.3
1,1,2,2-Tetrachloroethane	79-34-5	0.002		0.0005	524.2, 524.3
1,1,2-Trichloroethane	79-00-5		0.005	0.0005	524.2, 524.3
1,1-Dichloroethene	75-35-4		0.007*	0.0007	524.2, 524.3
1,1-Dichloropropene	563-58-6	0.003*		0.0005	524.2, 524.3
1,2,3-Trichlorobenzene	87-61-6	0.003		0.0005	524.2, 524.3
1,2,3-Trichloropropane	96-18-4	0.04		0.004	524.2, 524.3
1,2,4-Trichlorobenzene	120-82-1		0.07	0.007	524.2, 524.3
1,2-Dibromo-3-chloropropane	96-12-8		0.0002	0.0002	524.2, 524.3
1,2-Dibromoethane	106-93-4	0.0002		0.0002	524.2, 524.3
1,2-Dichlorobenzene	95-50-1		0.6	0.06	524.2, 524.3
1,2-Dichloroethane	107-06-2		0.005	0.0005	524.2, 524.3
1,2-Dichloropropane	78-87-5		0.005	0.0005	524.2, 524.3
1,3,5-Trimethylbenzene	108-67-8	0.003*		0.0005	524.2, 524.3
1,3-Dichlorobenzene	541-73-1		0.6	0.06	524.2, 524.3
1,4-Dichlorobenzene	106-46-7		0.075	0.007	524.2, 524.3
2-Butanone	78-93-3	4		0.4	524.2, 524.3
2-Chlorotoluene	95-49-8	0.1*		0.01	524.2, 524.3
2-ethyl-1-hexanol	104-76-7	0.05		0.005	524.2, 524.3
4-Chlorotoluene	106-43-4	0.003		0.0005	524.2, 524.3
4-Isopropyltoluene	99-87-6	0.003		0.0005	524.2, 524.3
4-Methyl-2-pentanone	108-10-1	7		0.7	524.2, 524.3
Acetone	67-64-1	6		0.6	524.2, 524.3
Acetophenone	98-86-2	0.2		0.02	524.2, 524.3
Acrylonitrile	107-13-1	0.0006*		0.0006	524.2 SIM
Benzene	71-43-2		0.005	0.0005	524.2, 524.3
bis(2-Chloroethyl)ether or Di-(2-chloroethyl) ether	111-44-4	0.0003		0.0003	524.2, 524.3

Analyte	CAS Number	TAC[1] mg/L	Drinking water regulatory level (MCL/MAC) mg/L	Maximum Reporting Limit (RL) mg/L	Reference Method(s)
Bromobenzene	108-86-1	0.003		0.0005	524.2, 524.3
Bromochloromethane	74-97-5		0.09	0.009	524.2, 524.3
Bromodichloromethane	75-27-4		See TTHMs	0.001	524.2, 524.3
Bromoform	75-25-2		See TTHMs	0.001	524.2, 524.3
Bromomethane	74-83-9	0.01		0.001	524.2, 524.3
Carbon disulfide	75-15-0	0.7		0.7	524.2, 524.3
Carbon tetrachloride	56-23-5		0.005	0.0005	524.2, 524.3
Chlorobenzene	108-90-7		0.1	0.01	524.2, 524.3
Chloroform	67-66-3		See TTHMs	0.001	524.2, 524.3
Chloromethane	74-87-3	0.03*		0.003	524.2, 524.3
cis-1,2-Dichloroethene	156-59-2		0.07	0.007	524.2, 524.3
Cyclohexanone	108-94-1	30		1.0	524.2, 524.3
Dibromochloromethane	124-48-1		See TTHMs	0.001	524.2, 524.3
Dichlorodifluoromethane	75-71-8		0.003	0.0005	524.2, 524.3
Ethyl acrylate	140-88-5	0.01		0.001	524.2, 524.3
Ethylbenzene	100-41-4		0.7	0.07	524.2, 524.3
Methyl acrylate	96-33-3	0.003		0.001	524.2, 524.3
Methyl methacrylate	80-62-6	10		0.1	524.2, 524.3
Methyl tert-butyl ether	1634-04-4	0.002		0.0005	524.2, 524.3
Methylene chloride	75-09-2		0.005	0.0005	524.2, 524.3
n-Butyl acrylate	141-32-2	0.01		1.0	524.2, 524.3
n-Butylbenzene	104-51-8	0.003		0.0005	524.2, 524.3
sec-Butylbenzene	135-98-8	0.003		0.0005	524.2, 524.3
Styrene	100-42-5		0.1	0.01	524.2, 524.3
t-Butyl alcohol or t-butanol or tert-butanol	75-65-0	9		0.1	524.2, 524.3
Tetrachloroethene	127-18-4		0.005	0.0005	524.2, 524.3
Tetrahydrofuran	109-99-9	0.05		5.0	524.2, 524.3
Toluene	108-88-3		1	0.1	524.2, 524.3
Xylenes (Total) o-Xylene [2] or 1,2-Xylene, m-xylene, p-xylene	95-47-6 106-42-3 108-38-3		10	0.1	524.2, 524.3

Analyte	CAS Number	TAC[1] mg/L	Drinking water regulatory level (MCL/MAC) mg/L	Maximum Reporting Limit (RL) mg/L	Reference Method(s)
trans-1,2-Dichloroethene	156-60-5		0.1	0.01	524.2, 524.3
Dichloropropene (Total) Cis-1,3- Trans-1,3	542-75-6 10061-01-5 10061-02-6	0.004		0.0005	524.2, 524.3
Trichloroethene or Trichloroethylene	79-01-6		0.005	0.0005	524.2, 524.3
Trichlorofluoromethane	75-69-4	2		0.2	524.2, 524.3
Total Trihalomethanes (TTHMs) Bromodichloromethane Bromoform Chloroform Dichlorobromomethane			0.080	0.001	524.2, 524.3
Vinyl chloride	75-01-4		0.002	0.0002	524.2, 524.3

[*] TAC values have been evaluated using qualitative or quantitative risk assessment methods. If contaminants extract above these levels, an evaluation in accordance of with Annex A of NSF/ANSI 61 may be used to determine a higher allowable level.

Table 4 – Materials listed in U. S. Code of Federal Regulations, Title 21, not requiring formulation review

Sections	Material
172.880 178.3700	petrolatum
172.888 178.3720	synthetic petroleum wax
172.878	white mineral oil
172.884	odorless white petroleum hydrocarbons
172.886 178.3710	petroleum wax
173.25	Ion exchange resins – provided that the sub-section stating the composition of the resin is specified.
173.65	divinyl benzene copolymer
178.3620	mineral oil
Part 184	Direct food substances affirmed as generally recognized as safe – when used in accordance with any conditions of use specified for the substance.
solvents	Solvents that may be considered for solvent bonding without review are limited to acetone, methyl ethyl ketone, cyclohexanone, and tetrahydrofuran. Mixtures such as solvent cements shall be evaluated against NSF/ANSI 61 or shall be subject to formulation review. NOTE – Solvent bonding is not recommended, as solvents soak into synthetic materials and leach back out into water at relatively high levels for long periods of time. In addition, solvents can contaminate the work area and can be adsorbed by carbon in the work area. Solvents that have been reprocessed or recycled shall not be used.

5 Structural performance

5.1 Structural integrity

The purpose for testing structural integrity performance is to evaluate the materials, design, and fabrication quality of the complete water treatment system.

5.2 Acceptance

Each test of structural integrity (cyclic pressure and hydrostatic pressure) shall be performed on a separate system. If the complete water treatment system is tested, a separate test of the system pressure vessel is not required.

Complete systems, pressure vessels, and components shall be tested for structural integrity in accordance with 5.4 at the pressures specified in Table 5. When more than one pressure is specified in Table 5, testing shall be done at the higher pressure.

Complete systems, pressure vessels, and components shall be watertight when tested for structural integrity under 5.4.

NOTE – Weepage shall be considered acceptable at the beginning of a test, but weepage shall not begin in the middle of a test.

Table 5 – Structural integrity testing requirements

Complete systems	Hydrostatic pressure test[1]	Cyclic pressure test[1]
complete systems with pressure vessels having a diameter < 203 mm (8 in)	3 x maximum working pressure or 2,070 kPa (300 psig)	100,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure
complete systems with pressure vessels having a diameter of ≥ 203 mm (8 in)	1.5 x maximum working pressure or 1,040 kPa (150 psig)	100,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure
complete systems designed for open discharge[2]	1.5 x maximum working pressure or 1,040 kPa (150 psig)	10,000 cycles at 0 to 345 kPa (0 to 50 psig)
complete portable systems pressurized by user[3]	1.5 x maximum working pressure	none
metallic pressure vessels having a diameter < 203 mm (8 in)[4]	3 x maximum working pressure or 2,070 kPa (300 psig)	100,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure
metallic pressure vessels having a diameter of ≥ 203 mm (8 in)[4]	1.5 x maximum working pressure or 1,040 kPa (150 psig)	100,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure
nonmetallic pressure vessels having a diameter < 203 mm (8 in)	3 x maximum working pressure or 2,070 kPa (300 psig)	100,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure
nonmetallic pressure vessels having a diameter of ≥ 203 mm (8 in)	1.5 x maximum working pressure or 1,040 kPa (150 psig)	100,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure
disposable pressure vessels and components	3 x maximum working pressure or 2,070 kPa (300 psig)	10,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure
valves and controls[5]	none	100,000 cycles at 0 to 1,040 kPa (0 to 150 psig) or maximum working pressure

[1] When a choice is given in the Table, testing shall be done at the greater pressure.

[2] Components downstream of the system on/off valve that are not subject to pressure under the off mode, and that either contain no media subject to plugging or are not designed to contain media, shall be exempt from the hydrostatic pressure test, but shall be watertight in normal use. Components that are downstream of the system on/off valve, but upstream of media subject to clogging, shall meet the requirements of this section.

[3] Portable systems designed to utilize only atmospheric pressure or gravity flow shall be exempt from the hydrostatic pressure test, but shall be watertight in normal use.

[4] Metallic pressure vessels require measurement of circumference and head deflection. The pressure vessel circumference shall not exhibit a permanent increase of more than 0.2% when measured at the midsection and at 30-cm (12-in) intervals. The top and bottom head deflection of the pressure vessel shall not exhibit a permanent deflection exceeding 0.5% of the vessel diameter.

[5] Subject to line pressure and tested as separate components

5.3 Working pressure

5.3.1 The pressure vessel(s) and all other components of a water treatment system that are subject to line pressure shall be designed and constructed to maintain structural integrity at a pressure of 690 kPa (100 psig) or the maximum working pressure, whichever is greater.

5.3.2 Portable systems not designed for direct connection to a pressurized supply line shall be designed and constructed to maintain structure under the maximum pressure of the intended end-use.

5.4 Structural integrity test methods

5.4.1 Apparatus

An enclosure shall be provided for each system tested to prevent injury to personnel or property damage if the system fails. An apparatus that may be used for the cyclic and hydrostatic test is shown schematically in figure 1. Pressure measuring instruments shall have a precision and accuracy of 2% at the point of measurement.

5.4.2 Hydrostatic pressure test – complete systems

Systems designed to operate only at atmospheric pressure shall be exempt from the hydrostatic pressure test but shall be watertight in normal use. Components downstream of the system on/off valve that are not subject to pressure under the off mode, and that either contain no media subject to plugging or are not designed to contain media, shall be exempt from the hydrostatic pressure test but shall be watertight in normal use. Components that are downstream of the system on/off valve but upstream of media subject to clogging shall meet the requirements of this section. The following procedure shall be used for the hydrostatic pressure testing of other complete systems:

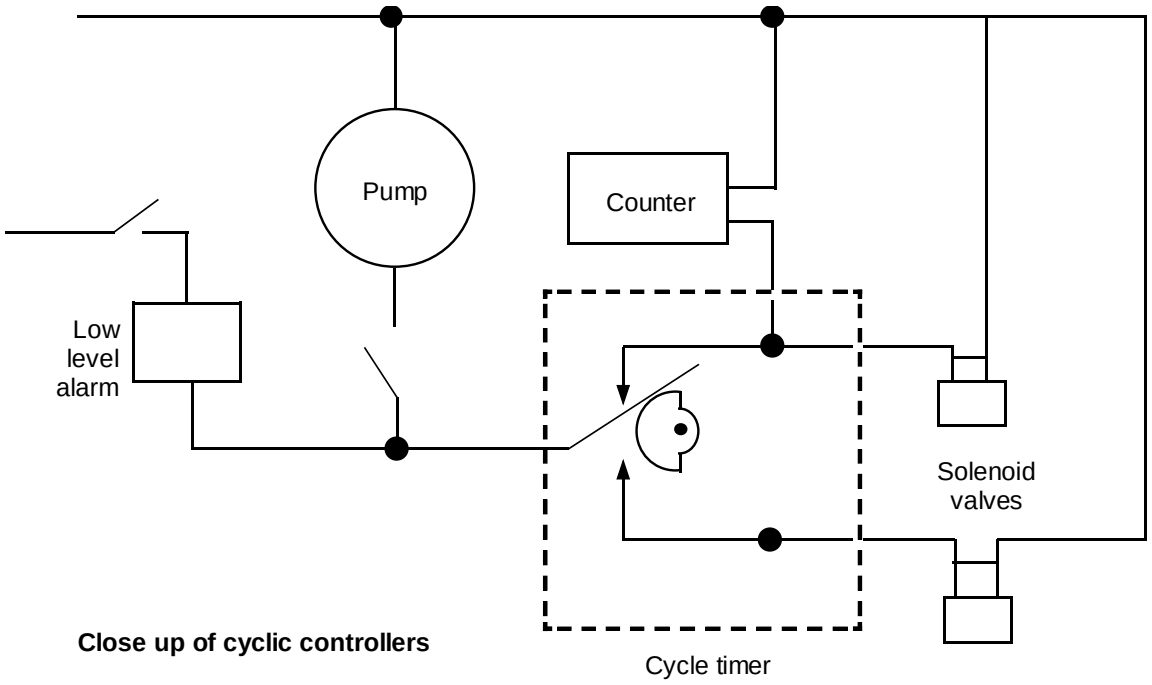
1) Use a water temperature of 13 to 24 °C (55 to 75 °F). Adjust the test water to a temperature at which condensation will not form on the surface of the test unit.

2) Connect the inlet of the test system to the apparatus shown in figure 1. The system shall be in conformance with its normal state of use, with the option of plugging drain lines.

3) Fill the test system with water. Flush to purge air from the system.

4) Raise the hydrostatic pressure at a constant rate so that the test pressure specified in Table 5 is reached within 5 min. The rate of pressure increase shall not be more than 690 kPa (100 psig) per second.

5) Maintain the test pressure for 15 min. Inspect the system periodically through the end of the test period to check if the system is watertight.



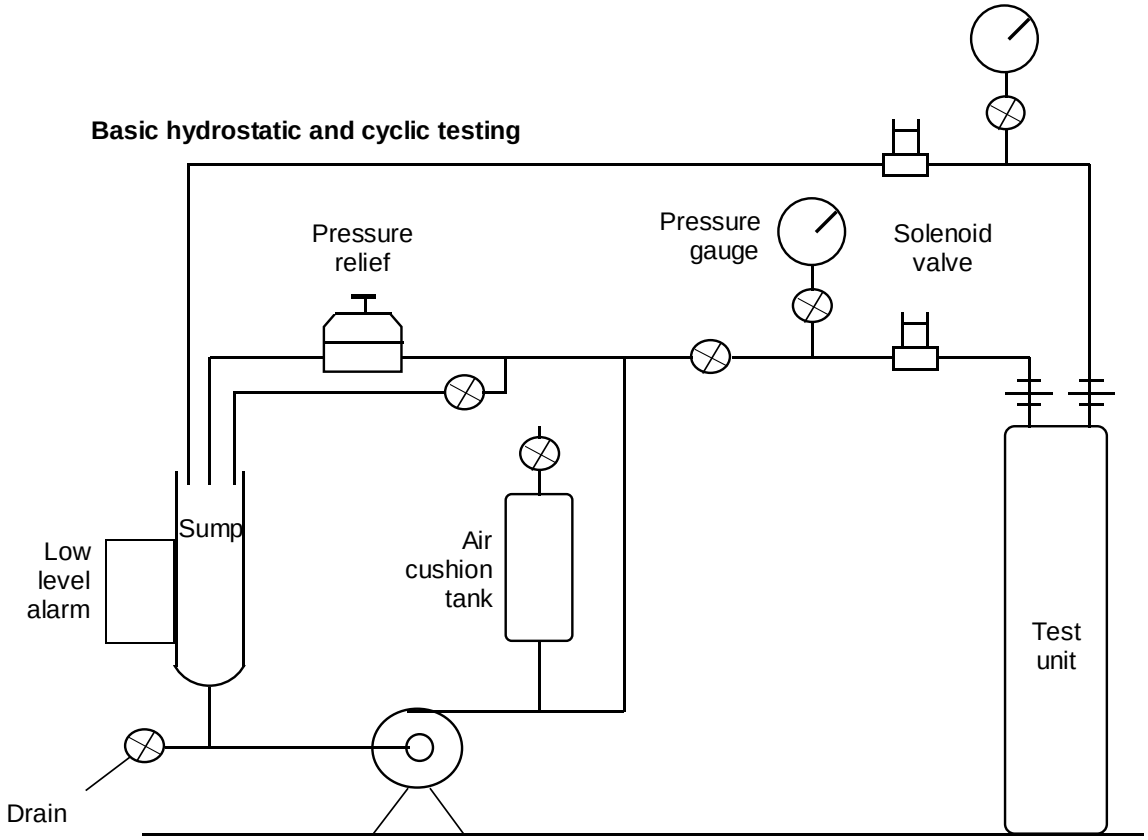


Figure 1 – Structural testing apparatus

5.4.3 Hydrostatic pressure test – metallic pressure vessels

The permanent increase in the circumference of the pressure vessel shall not be more than 0.2% of the original circumference when the vessel is tested in accordance with the procedures below. The circumference shall be measured at the midpoint of the side wall of the vessel and at 30-cm (12-in) intervals. The top or bottom head deflection of the pressure vessel shall not exhibit a permanent deflection exceeding 0.5% of the vessel diameter.

The test rig for metal tanks shall allow the installation of the instrumentation required to measure the change in tank circumference and the deflection of the top and bottom heads. This may require elevating the tank. Distance-measuring instruments or methods shall be accurate to 0.0025 cm (0.001 in).

The following procedure shall be used for the hydrostatic pressure testing of metallic pressure vessels:

1) Install the test unit on the elevated rack or stand. Prepare and fill the test unit as specified in 5.4.2, steps 1), 2), and 3).

2) Install an appropriate measuring device, such as an extensometer or dial micrometer, vertically against the tank bottom head. Solidly mount either the tank top head, top-mounted control valve, or another component to the tank top.

3) Install an appropriate measuring device, such as an extensometer or periphery tape, around the tank perpendicular to its axis and 15 cm (6 in) above its bottom. Place additional measurement devices, vertically spaced not more than 30 cm (12 in) apart, up the side sheet of the tank. Place the uppermost device within 30 cm (12 in) of the tank top head. If the tank length is less than 61 cm (24 in), a measuring device should be placed at the midsection. When using extensometers, wrap the flexible wire once around the tank perpendicular to its axis and 15 cm (6 in) above its bottom. Fasten one end of the wire to a solid post at the same elevation. Fasten the other end to a second post at the same elevation by means of a spring so as to keep the wire taut. Fasten the blocks to each end of the wire, adjacent to the tank, so that they are spaced 15 to 20 cm (6 to 8 in) apart. For larger tanks, the spacing shall be permitted to be increased to avoid contact between the blocks and the tank. Attach blocks to each wire wrap as previously specified.

4) Take initial readings from the measurement devices before pressurizing the test unit. When using extensometers, measure the distance between the blocks on each wire with a micrometer caliper.

5) Pressurize the test unit as specified in 5.4.2, steps 4) and 5).

6) Take final readings from the extensometers or measurement devices with no pressure on the unit.

7) The difference between the readings of each measurement device is the measure of permanent deformation of either the tank bottom or top head. The difference in measurement around the tank is the increase in tank circumference.

5.4.4 Cycle test

The following procedure shall be used for the cyclic testing:

1) Use a water temperature of 20 ± 3 °C (68 ± 5 °F) throughout the test. Adjust the test water to a temperature at which condensation will not form on the surface of the test unit.

2) Connect inlet of the test system to the test apparatus as shown in figure 1. The system shall be in conformance with its normal state of use, with the option of plugging drain lines.

3) Fill the test system with water. Flush to purge air from the system.

4) Set the counter to zero, or record its initial reading, and initiate pressure cycling. The pressure rise shall be ≥ 1 s and the pressure in the test unit shall return to < 14 kPa (2 psig) before the initiation of another cycle.

5) The pressure shall be cycled as specified in Table 5. The system shall be inspected periodically through the end of the test period to check whether the system is watertight.

5.4.5 Personal hand-held devices

Personal hand held devices that do not meet the definition of a squeeze bottle shall be exempt from structural integrity testing but shall be watertight during all testing.

5.4.5.1 Cycle test – squeeze bottles

Structural integrity performance for squeeze bottles shall be evaluated by applying 20 ± 1 kg of force in 5 second intervals. The outlet of the bottle shall be plugged.

The following procedure shall be used for testing:

1) Use a water temperature of 20 ± 3 °C (68 ± 5 °F) throughout the test. Adjust the test water to a temperature at which condensation will not form on the surface of the test unit.

2) The test bottle shall be evaluated at the following fill volumes: 95%, 75%, 50%, and 25% of the total unit void volume. For each fill volume, fill the test bottle with water and plug the outlet.

3) Connect the test bottle to the mechanical hand apparatus shown in Figure 4. The apparatus shall be positioned around the center of the test bottle unless an alternate location to grip the bottle is specified in the manufacturer's literature.

4) The volume (mL) per squeeze of the test bottle shall be measured to determine the number of squeezes that shall be applied to the bottle during the test (volume dispensed from a ½ full bottle during a 5 second squeeze with 20 ± 1 kg of force). The total number of squeezes shall be evenly divided among each fill volume, so that each fill volume is being run for 25% of the test. The test bottle shall be evaluated as follows:

a) For devices with replaceable cartridges, the test bottle shall be tested to 400% capacity of the cartridge life.

b) For single-use, disposable devices, the test bottle shall be tested to 200% capacity of the cartridge life.

5) The bottle shall be operated with 20 ± 1 kg of force applied by the mechanical hand for 5 ± 0.5 seconds. The force rise at the initiation of each cycle shall be 1.5 ± .5 second. Each squeeze shall be followed by a minimum 5 second rest period with <0.5 kg of force applied to the bottle. This operational cycle shall be performed for the required number of squeezes at each bottle fill volume.

6) The system shall be inspected for watertightness periodically throughout the test, prior to each change in fill volume, and at the end of the test.

6 Minimum performance requirements

6.1 Performance indication of chemical reduction capacity

6.1.1 If the system includes a performance indication device, the device shall provide an automatic, effective means to warn the user when the system is not performing its chemical reduction functions. The performance indication device shall be an integral part of the system and shall activate within -20% to +10% of the manufacturer's claimed capacity (i. e., the acceptable activation range). The activation of the performance indication device shall be a distinct event within the acceptable activation range, or the transition to the warning indication shall begin and finish within the acceptable activation range. Information describing the operation of the indicating device shall be included in the installation, operation, and maintenance instructions.

The performance indication device shall be fully automatic in its operation with one allowed exception, the user may be required to inform the performance indication device that a replacement element has been installed. Examples of this include pushing a reset button, replacing batteries, or operating a switch. The user shall not have control of the operation of the performance indication device in any other manner including the setting of the activation range, tallying each batch, or other operation not required for the normal use of the system.

NOTE – Examples of "effective means to warn the user" include, but are not limited to, the following:

- termination of the discharge of treated water;
- reduction in the flow rate by 75% of the clean system flow rate;
- the sounding of an alarm connected to an acceptable power source; or
- a flashing light connected to an acceptable power source.

The "effective means to warn the user" shall be an event that can be easily recognized by the user of the product without the use of tools.

6.1.2 Systems with performance indication devices shall be tested to 120% of their estimated capacity for chemical reduction claims.

6.1.3 Systems without performance indication devices shall be tested to 200% of their estimated capacity for chemical reduction claims.

6.1.4 Performance indication device verification test

6.1.4.1 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

6.1.4.2 General test water

A public water supply shall be used with the following specific characteristics maintained throughout the test for contaminant reduction claims:

pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
total organic carbon (TOC)	> 1.0 mg/L
turbidity	< 1 NTU

6.1.4.3 Test methods

Performance indication devices that are used in non-batch systems shall be evaluated by 6.1.4.3.1. Devices that are activated by a batch system shall be evaluated by 6.1.4.3.2.

NOTE – Performance indication devices may be evaluated during chemical reduction testing using the chemical challenge water if the testing requirements for the applicable test method, 6.1.4.3.1 or 6.1.4.3.2, are met during the challenge testing.

6.1.4.3.1 Flow test method

a) The test systems shall be conditioned following the manufacturer's instructions.

b) The systems shall be tested with general test water as specified in 6.1.4.2.

c) Two systems shall be installed on the test rig in accordance with the manufacturer's instructions, with a calibrated flow meter in line. Faucet mounted systems shall be installed downstream of the solenoid valve.

d) The flow rate shall be measured at the beginning of the test. The flow rate shall be monitored continuously for systems that use flow reduction as a performance indicator.

e) The test systems shall be operated at 410 ± 20 kPa (60 ± 3 psig) initial dynamic pressure, with a 50%-on / 50%-off cycle, 20-min cycle length.

f) The test systems shall be operated at the highest attainable flow rate.

g) The test systems shall be run 16 h per 24-h period until the warning device activates.

h) The volume required to reach the activation point shall be recorded. If the warning device uses a gradual change in state, the volume where the transistion began and where it completed shall be recorded.

6.1.4.3.2 Batch test method

1) The systems shall be conditioned following the manufacturer's instructions.

2) Two systems shall be operated according to the manufacturer's instructions until the performance indication device is activated using general test water as specified in 6.1.4.2.

3) The volume required to reach the activation point shall be recorded. If the warning device uses a gradual change in state, the volume where the transition began and where it completed shall be recorded.

6.2 Elements

Cartridges, filters, and similar replacement components shall be readily removable.

6.3 Flow control

6.3.1 If the performance of a system is dependent on a specified flow rate, an automatic fixed flow-rate control shall be provided as an integral part of the system to prevent excessive flow.

6.3.2 Refrigerator filters may have an automatic fixed flow-rate control that is external to the system. For refrigerator filters that do not include an integral automatic fixed flow-rate control as part of the system, where the performance of the system is dependent on a specific flow rate, an automatic fixed flow-rate control shall be included within the refrigerator plumbing to prevent excessive flow.

6.4 Waste connections

Waste connections or drain outlets, if provided, shall be designed and constructed to provide for connection to the sanitary waste system through an air gap of 2 pipe diameters or 25 mm (1 in), whichever is larger.

6.5 Product water dispensing outlets

Product water dispensing outlets, if provided, shall be designed, constructed, and located so that the discharge orifice is directed downward, and the lower edge of the outlet shall be at an elevation not less than 51 mm (2 in) above the flood rim of the waste receptacle.

6.5.1 Drinking fountain outlets

6.5.1.1 The drinking water outlet shall be protected by a guard designed to (1) prevent a user from directly contacting the outlet while drinking from the system, and (2) prevent foreign matter from dropping vertically into the outlet. The guard shall be of such width, height, and design that the user's mouth or lips cannot readily touch the outlet. Spaces between the outlet and the guard shall be readily accessible for cleaning.

6.5.1.2 The outlet and guard shall be designed to discourage hose connections or other improper uses.

6.5.1.3 The drinking fountain outlet shall be set to direct water flow at an angle from the vertical to prevent water in a jet from returning to the outlet. The flow from the outlet shall not touch the guard.

6.5.1.4 The lower edge of the drinking water outlet shall be at least 51 mm (2 in) above the flood rim of the waste receptacle.

6.6 Hazards

All component parts shall be free of nonfunctional rough or sharp edges, and other hazards that may cause injury to persons adjusting, servicing, or using the system.

6.7 Systems used in bottled water plants

Systems shall have a redundant filtration element sealing mechanism such as 222 and 226 double o-ring seals.

6.8 Operation temperature

The complete system shall be designed to operate at a maximum temperature no higher than 38 °C (100 °F).

6.9 POE rated pressure drop

6.91 Without built-in flow control

POE systems shall have no more than 105 kPa (15 psig) initial pressure drop at the rated service flow with an inlet pressure of 210 kPa (30 psig) and a water temperature of 20 ± 3 °C (68 ± 5 °F). The rated service flow shall be greater than or equal to 15 L/min (4 gpm).

6.9.2 With built-in flow control

POE systems with built-in flow control shall have no more than 103 kPa (15 psig) initial pressure drop at a flow rate equal to or greater than 15 L/min (4 gpm) with an inlet pressure of 210 kPa (30 psig) and a water temperature of 20 ± 3 °C (68 ± °5 F).

6.10 Minimum service flow

The minimum initial clean-system flow rates specified in Table 6 shall be attainable by the system at an inlet pressure of 210 kPa (30 psig) and a water temperature of 20 ± 3 °C (68 ± 5 °F), with a fully open outlet.

Table 6 – Minimum service flow

Type of system	Minimum service flow rate
Point of use systems connected to a pressurized line:	
counter top connected to sink faucet with diverter	0.8 L/min (0.2 gpm)
faucet mount with diverter	0.8 L/min (0.2 gpm)
faucet mount without diverter	1.9 L/min (0.5 gpm)
plumbed in	1.9 L/min (0.5 gpm)
plumbed in to separate tap with reservoir	7.6 L/day (2 gpd)
plumbed in to separate tap without reservoir	0.8 L/min (0.2 gpm)
special systems (e.g., glass filler and ice maker for refrigerator, systems designed for non-home use)	exempt
Point of use systems not designed for direct connection to a pressurized supply line (batch systems):	
counter top manual fill with or without internal pump	exempt
pour through	exempt

6.11 Rated service flow

For systems connected to a pressurized line, the rated service flow shall be equal to or less than the minimum initial clean-system flow rate obtained during contaminant reduction testing at an inlet pressure of 410 ± 20 kPa (60 ± 3 psig) and a water temperature of 20 ± 3 °C (68 ± 5 °F). For systems with an internal pump, the rated service flow rate shall be equal to or less than the minimum initial clean-system flow rate obtained during contaminant reduction testing. For manual fill- or pour-through systems, the rated service flow rate shall be equal to or less than the minimum initial clean-system flow rate obtained during contaminant reduction testing.

A system shall not have a rated service flow that is less than the applicable value specified in Table 6.

6.12 Active agents and additives

Where an active agent or additive is used in the drinking water treatment process, the product water shall not contain that substance (or its degradation products) at a concentration of toxicological significance as given by the USEPA *Primary Drinking Water Regulations,* by the Health Canada Maximum Acceptable Concentrations[7], by any U. S. Federal regulatory agency, or at a concentration that exceeds constituent limits of the USEPA *Secondary Drinking Water Regulations* for all sample points. If the substance does not have a maximum drinking water concentration established by USEPA or Health Canada, a Total Allowable Concentration (TAC) shall be established according to the requirements of NSF/ANSI 61, Annex A.

Collection of product water samples for the analysis of active agents or their degradation products shall be in accordance with the sampling schedule(s) for the verification of specific reduction claims or as

[7] http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index_e.html

otherwise specified in this Standard. At least one sample shall be collected immediately after a rest period of at least 8-h duration.

Sampling for an active agent or additive shall be performed using the performance test procedure that is likely to result in the highest potential extraction of the active agent or additive. Determination of the appropriate test procedure shall consider the following parameters:

– the chemical composition of the challenge water used in the performance test; and

– the durations of the rest periods prior to the specified sampling points in the performance test.

NOTE – The performance test used to evaluate extraction of an active agent or additive may be a test other than that performed to verify other performance claim(s) made by the manufacturer. Some examples are provided in the following Table:

Type of active agent	Recommended test protocol for active agent evaluation
copper/zinc media	NSF/ANSI 42 for chlorine reduction
silver	NSF/ANSI 42 for bacteriostasis

7 Elective performance claims – test methods

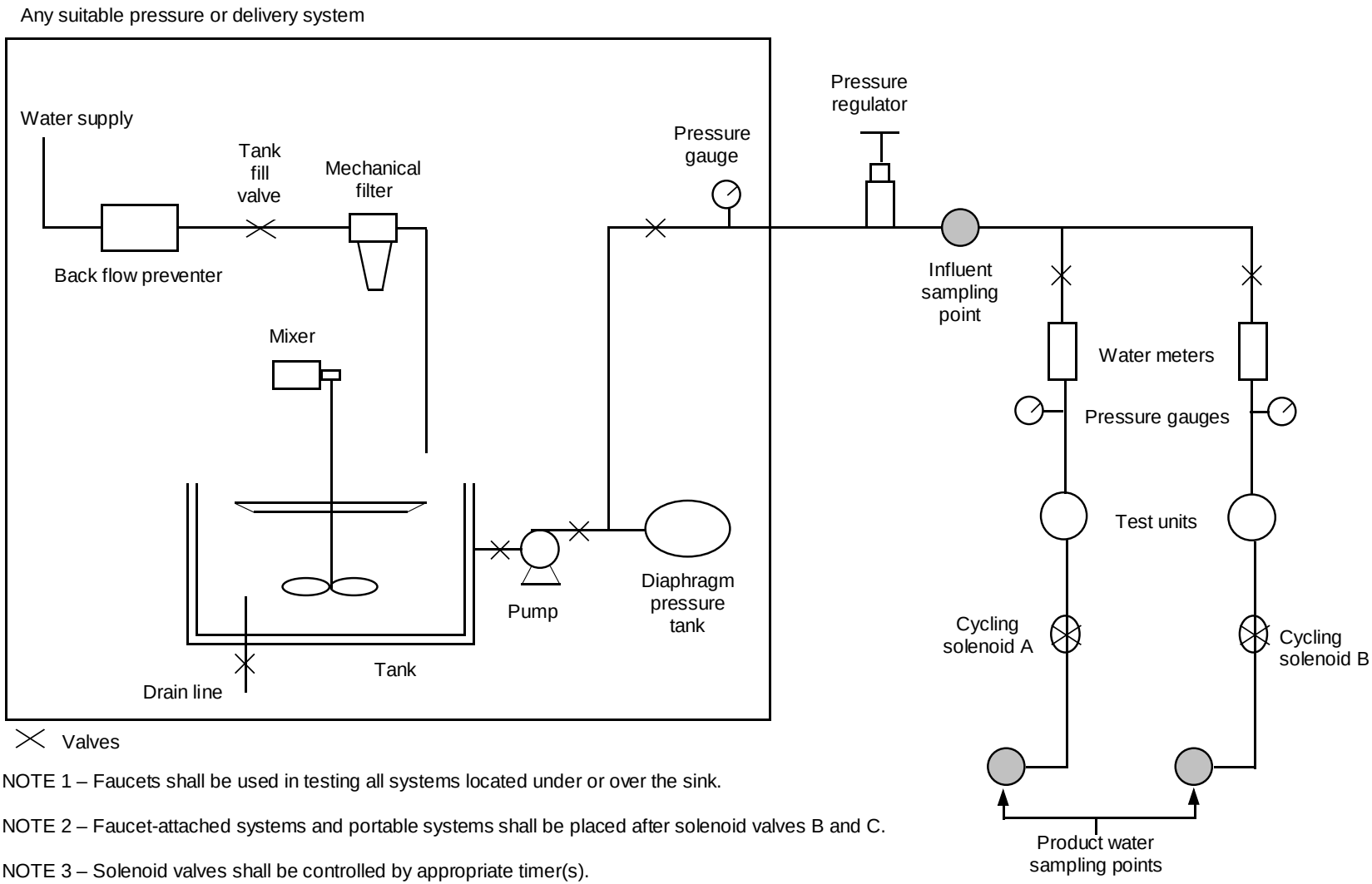
7.1 General requirements

7.1.1 Aesthetic effects claims

Claims for bacteriostasis, taste, odor, and other aesthetic effects shall not be verified under this Standard. Such claims shall be tested for conformance to NSF/ANSI 42.

7.1.2 Apparatus

A test apparatus capable of providing specified flow rates and pressures shall be used. Refer to figure 2 for an example of the test apparatus. The use of extraneous plumbing or any device between the pressure measurement point and the tested device shall be minimized. The diameter of downstream equipment and plumbing (including faucets) used in testing shall be equal to or greater than the diameter at the connection to the tested device.



NOTE 1 – Faucets shall be used in testing all systems located under or over the sink.

NOTE 2 – Faucet-attached systems and portable systems shall be placed after solenoid valves B and C.

NOTE 3 – Solenoid valves shall be controlled by appropriate timer(s).

NOTE 4 – Pressure gauges shall be located directly ahead of test units.

NOTE 5 – Diameter of plumbing and equipment after test units shall not be less than the diameter at the connection to the tested unit.

Figure 2 - Example test apparatus

7.2 Chemical reduction claims

7.2.1 Organic chemical reduction testing

7.2.1.1 Organic chemical reduction claims

Claims for chemical reduction may be made for the group of organic chemicals shown in Table 7 when tested in accordance with 7.2.1.

Table 7 – Chemical reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)[8]
alachlor	0.04 ± 40%	0.04 ± 10%	0.002	505
atrazine	0.009 ± 40%	0.009 ± 10%[b]	0.003	505
benzene	0.015 ± 30%	0.015 ± 10%[b]	0.005	502.2, 524.2, 524.3
carbofuran	0.08 ± 45%	0.08 ± 10%[a]	0.04	531.1
carbon tetrachloride	0.015 ± 30%	0.015 ± 10%[b]	0.005	502.2, 524.2, 524.3
chlordane	0.04 ± 30%	0.04 ± 10 %	0.002	505
chlorobenzene	2.0 ± 30%	2.0 ± 10%	0.1	502.2, 524.2, 524.3
2,4-D	0.210 ± 30%	0.210 ± 10%[b]	0.07	515.3
dibromochloropropane	0.004 ± 50%	0.004 ± 10%	0.0002	504.1
o-dichlorobenzene	1.8 ± 30%	1.8 ± 10%[b]	0.6	502.2, 524.2, 524.3
p-dichlorobenzene	0.225 ± 30%	0.225 ± 10%[b]	0.075	502.2, 524.2, 524.3
1,2-dichloroethane	0.015 ± 30%	0.015 ± 10%[b]	0.005	502.2, 524.2, 524.3
1,1-dichloroethylene	0.021 ± 30%	0.021 ± 10%[b]	0.007	502.2, 524.2, 524.3
cis-1,2-dichloroethylene	1.4 ± 30%	1.4 ± 10%	0.07	502.2, 524.2, 524.3
trans-1,2-dichloroethylene	2.0 ± 30%	2.0 ± 10%	0.1	502.2, 524.2, 524.3
1,2-dichloropropane	0.015 ± 30%	0.015 ± 10%[b]	0.005	502.2, 524.2, 524.3
dinoseb	0.021 ± 30%	0.021 ± 10%[b]	0.007	515.3
endrin	0.006 ± 40%	0.006 ± 10%[b]	0.002	505
ethylbenzene	2.1 ± 30%	2.1 ± 10%[b]	0.7	502.2, 524.2, 524.3
ethylene dibromide	0.001 ± 50%	0.001 ± 10%	0.00005	504.1
heptachlor (H-34, heptox)	0.08 ± 40%	0.08 ± 10%	0.0004	505
heptachlor epoxide	0.004 ± 40%	0.004 ± 10%	0.0002	505
hexachlorocyclopentadiene	0.15 ± 40%	0.15 ± 10%[b]	0.05	505
lindane	0.002 ± 40%	0.002 ± 10%[a]	0.0002	505
methoxychlor[3]	0.12 ± 40%	0.12 ± 10%[b]	0.04	505

Table 7 – Chemical reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)[8]
methyl *tert*-butyl ether (MTBE)[4]	0.015 ± 40%, 0.015 ± 50%[5]	0.015 ± 20%	0.005	502.2[6], 524.2, 524.3
pentachlorophenol	0.01 ± 30%	0.01 ± 10% [a]	0.001	515.3
polychlorinated biphenyls (PCBs, Aroclor 1260)	0.01 ± 40%	0.01 ± 10%	0.0005	505
simazine	0.012 ± 40%	0.012 ± 10%[b]	0.004	525.2
styrene	2.0 ± 30%	2.0 ± 10%	0.1	502.2, 524.2, 524.3
2,4,5-TP (silvex)	0.15 ± 30%	0. 15 ± 10%[b]	0.05	515.3
tetrachloroethylene	0.015 ± 30%	0.015 ± 10% [b]	0.005	502.2, 524.2, 524.3
toluene	3.0 ± 30%	3.0 ± 10% [b]	1	502.2, 524.2, 524.3
toxaphene	0.015 ± 40%	0.015 ± 10%	0.003	505
1,2,4-trichlorobenzene	0.21± 30%	0.21± 10%[b]	0.07	502.2, 524.2, 524.3
1,1,1-trichloroethane	0.6 ± 30%	0.6 ± 10%[b]	0.2	502.2, 524.2, 524.3
1,1,2-trichloroethane	0.015 ± 30%	0.015 ±10%[b]	0.005	502.2, 524.2, 524.3
trichloroethylene	0.300 ± 30%	0.300 ± 10%	0.005	502.2, 524.2, 524.3
TTHM [7] (as chloroform)	0.45 ± 30%	0.45 ± 20%	0.080	502.2, 524.2, 524.3
xylenes	30 ± 30%	30 ± 10%[b]	10	502.2, 524.2, 524.3

Table 7 – Chemical reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)[8]

[1]Equals average influent challenge concentration variability plus one of the following, in order of availability:
1. Acceptable Continuing Calibration Verification (CCV) limits stated in the appropriate USEPA method.
2. Acceptable spike recoveries as stated in the appropriate USEPA method.
3. Opinion of laboratory professionals – no guidance available in USEPA method.

[2] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria is used to select challenge concentrations:

[1] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P<0.05] that 95 percent of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[2] The concentration obtained by multiplying the USEPA's published maximum contaminant level by three. This concentration will not be adequate when USEPA MCL is very low.

[3] It is recognized that the reported solubility of methoxychlor is 0.04 mg/L. Under simulated test conditions the highest influent concentration attainable shall be used.

[4] The maximum effluent value is based on the taste and odor threshold. Due to lack of occurrence data, the influent challenge has been set to three times the maximum effluent concentration.

[5] The first limits apply to analysis conducted according to the first USEPA method, and the second limits apply to analysis conducted according to the 524.2 or 524.3 USEPA method.

[6] MTBE may be quantified using method 502.2 when all quality control procedures for 502.2 are followed.

[7] For test purposes, chloroform shall be added to the influent water and shall be analyzed in the influent and product waters.

[8] When more than one method is cited, either method may be used for analysis.

– concluded –

7.2.1.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.2.1.3 Analytical methods

All analyses shall be conducted in accordance with the applicable methods referenced in 2.

7.2.1.4 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.2, H.3, H.4, H.5 and H.6.

7.2.1.5 General test water

A public water supply shall be used with the following specific characteristics maintained throughout the test for contaminant reduction claims:

pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
total organic carbon (TOC)	> 1.0 mg/L
turbidity	< 1 NTU

Methanol shall be used as the solvent when needed to introduce a contaminant to the test water.

7.2.1.6 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

7.2.1.7 Methods

7.2.1.7.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.2.1.5. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable by setting an initial dynamic pressure of 410 ± 20 kPa (60 ± 3 psi). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The operating cycle specified in 7.2.1.6 shall be used.

7.2.1.7.1.1 Refrigerator filters without integral flow control

Chemical reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.2.1.7.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any chemical reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.2.1.7.2 Plumbed-in systems with reservoirs

The method specified in 7.2.1.7.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.2.1.6, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.2.1.7.3 Nonplumbed pour-through-type batch treatment systems

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.2.1.7.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.2.1.5 with the test contaminant present.

7.2.1.7.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.2.1.5 with the test contaminant present.

7.2.1.8 Sampling

For systems with performance-indication devices, during the "on" portion of the cycle, influent and effluent samples shall be collected at the start of the test (after the passage of 10 unit volumes of influent challenge) and at 25%, 50%, 75%, 100%, and 120% of the estimated capacity. For systems without performance indication devices, the system shall be tested to 200% of the estimated capacity. Samples shall be collected at startup (after the passage of 10 unit volumes) and at 50%, 100%, 150%, 180%, and 200% of the estimated capacity. Samples for each system shall be at least one unit volume.

7.2.2 Inorganic reduction testing

7.2.2.1 Inorganic reduction claims

Claims for chemical reduction may be made for the group of inorganic chemicals shown in Table 8 when tested in accordance with 7.2.2.

Table 8 – Chemical reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)
fluoride	8.0 ± 25%	8.0 ± 10%	1.5	340.2
nitrate plus nitrite (as N)	30 ± 20%	30 ± 10% [b] added as 27 mg/L NO_3 [as N] and 3 mg/L NO_2 [as N]	10[3]	300

Table 8 – Chemical reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)

[1] Equals average influent challenge concentration variability plus one of the following, in order of availability:
1. Acceptable Continuing Calibration Verification (CCV) limits stated in the appropriate USEPA method.
2. Acceptable spike recoveries as stated in the appropriate USEPA method.
3. Opinion of laboratory professionals – no guidance available in USEPA method.

[2] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria is used to select challenge concentrations:

[a] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P<0.05] that 95 percent of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[b] The concentration obtained by multiplying the USEPA's published maximum contaminant level by three. This concentration will not be adequate when USEPA MCL is very low.

[3] Of the 10 mg/L nitrate as N, not more than 1 mg/L shall be NO_2 as N.

7.2.2.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.2.2.3 Analytical methods

All analyses shall be conducted in accordance with the applicable methods referenced in 2.

7.2.2.4 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.2, H.3, H.4 and H.6.

7.2.2.5 General test water

A public water supply shall be used with the following specific characteristics maintained throughout the test for contaminant reduction claims:

pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
total organic carbon (TOC)	> 1.0 mg/L
turbidity	< 1 NTU

7.2.2.6 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

7.2.2.7 Methods

7.2.2.7.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.2.2.5. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable by setting an initial dynamic pressure of 410 ± 20 kPa (60 ± 3 psi). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The operating cycle specified in 7.2.2.6 shall be used.

7.2.2.7.1.1 Refrigerator filters without integral flow control

Chemical reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.2.2.7.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any chemical reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.2.2.7.2 Plumbed-in systems with reservoirs

The method specified in 7.2.2.7.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.2.2.6, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.2.2.7.3 Nonplumbed pour-through-type batch treatment systems

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.2.2.7.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.2.2.5 with the test contaminant present.

7.2.2.7.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.2.2.5 with the test contaminant present.

7.2.2.8 Sampling

For systems with performance-indication devices, during the "on" portion of the cycle, influent and effluent samples shall be collected at the start of the test (after the passage of 10 unit volumes of influent

challenge) and at 25%, 50%, 75%, 100%, and 120% of the estimated capacity. For systems without performance indication devices, the system shall be tested to 200% of the estimated capacity. Samples shall be collected at startup (after the passage of 10 unit volumes) and at 50%, 100%, 150%, 180%, and 200% of the estimated capacity. Samples for each system shall be at least one unit volume.

7.2.3 Radon reduction testing

7.2.3.1 Radon reduction method

This protocol evaluates the performance characteristics of a POU activated carbon water treatment system for the reduction of Radon^{222} (Rn^{222}). Systems evaluated using this protocol shall not be used on waters with a radon activity greater than 4000 pCi/L. The reduction capacity of the system over its rated life shall be based on testing to establish the Adsorption/Decay Steady State Constant (K_{ss}) using the following equation:

$$K_{ss} = -[\ln (C_t/C_o)]T$$

where:

K_{ss} = adsorption/decay steady state constant;
C_t = radon activity at time t in pCi/L;
C_o = initial radon activity in pCi/L;
T = the empty bed detention time with the filter in h; and
$T = V_f/L/h$

where:

V_f = volume of the filter bed in liters; and
L/h = flow rate in liters per hour.

7.2.3.1.1 Radon reduction claims

Claims for radon reduction may be made for POU activated carbon water treatment devices. POU systems shall treat a minimum of 8 L/d (2 gal/d) and shall meet the requirements of this section. Claims for radon reduction shall not be made for POE devices (see Table 9).

7.2.3.1.2 Calculation of progeny activity at end of life

The USEPA's Carbdose v.4.0 computer program shall be used to calculate the total activity of Lead^{210} (Pb^{210}), Polonium^{210} (Po^{210}), and Bismuth^{210} (Bi^{210}) on the filter at the end of one year of use at the maximum flow rate.

Table 9 – Radon reduction requirements

Substance	Influent challenge[1] mg/L	Maximum effluent concentration mg/L	USEPA method(s)
radon	4000 ± 1000 pCi/L	300 pCi/L	7500-Rn, ASTM D 5072-98

[1] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria is used to select challenge concentrations:

[a] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P<0.05] that 95 percent of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[b] The concentration obtained by multiplying the USEPA's published maximum contaminant level by three. This concentration will not be adequate when USEPA MCL is very low.

NOTE – The system shall reduce the influent activity of radon from 4000 ± 1000 pCi/L to an activity not exceeding 300 pCi/L at each sampling point when tested in accordance with 7.2.3.

7.2.3.2 Retention of radon decay products

The activity of lead^{210} (Pb^{210}) in the product water shall be less than or equal to 3.0 pCi/L when the system is tested in accordance with 7.2.3.6.

7.2.3.3 Gamma radiation exposure

At the end of the testing period specified in 7.2.3.6, the gamma radiation exposure from the system shall be less than 0.034 mR/h based on an 8 h per 24-h period exposure for 365 d per year when measured in accordance with 7.2.3.6.

7.2.3.4 Progeny activity at end of life

The total activity of Lead^{210} (Pb^{210}), Polonium^{210} (Po^{210}), and Bismuth^{210} (Bi^{210}) shall not exceed 2000 pCi/g of carbon for one year of use at the manufacturer's recommended flow rate when calculated using the USEPA Carbdose program v4.0[8] and the steady state K_{ss} value (see 7.2.3.6).

7.2.3.5 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.2.3.6 Analytical methods

7.2.3.6.1 Radon analysis

Radon analysis shall be performed using liquid scintillation counting in accordance with either 7500-Rn in *Standard Methods for the Examination of Water and Wastewater* or ASTM D5702-98 *Standard Test Method for Radon in Drinking Water* by the American Society for Testing and Materials. Testing organizations shall be required to achieve a minimum quantifiable radon activity of 100 pCi/L.

[8] This software program is available for download at <http://www.epa.gov/region01/eco/software/d5b_load.html>.

7.2.3.6.2 Gamma radiation emittance

Gamma radiation emittance shall be measured using a survey meter with a gamma/beta probe, or equivalent, with an accuracy of ± 10% between 10% and 100% of the full scale, and a minimum response below 0.034 mR/h.

7.2.3.6.3 Radon progeny analysis

Radon progeny shall be measured using Pb^{210} as an indicator. The analysis shall be performed using the method described by Case and McDowell[9], which uses a trioctylphosphine oxide (TOPO) extractive scintillator and a Photon Electron Rejecting Alpha Liquid Scintillation (PERALS) spectrometer. Testing organizations shall be required to achieve a minimum quantifiable Pb^{210} activity of 1.0 pCi/L.

7.2.3.7 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.2 and H.3.

7.2.3.8 Radon challenge water

A natural water source with a radon activity of 3000 to 5000 pCi/L shall be used. The radon source may be naturally occurring in the source water or may be generated and added to the source water.

The following water quality parameters shall be characterized for the radon challenge water:

pH	measure and record
temperature	measure and record
total dissolved solids (TDS)	< 500 mg/L
total organic carbon (TOC)	measure and record
turbidity	< 1 NTU
silica	measure and record
iron	measure and record
manganese	measure and record

Analysis for pH, temperature, and TOC shall be performed and recorded throughout the test for radon reduction.

7.2.3.9 Cycle time

The system shall be cycled four times over a 12-h period per day. Each cycle shall consist of a minimum of 25% of the manufacturer's daily production rate at the maximum flow rate attainable at a dynamic pressure of 410 kPa (60 psig) or greater, if specified by the manufacturer.

7.2.3.10 Method

Two systems shall be conditioned for 21 d or until steady state K_{ss} is reached, in accordance with the manufacturer's instructions using the radon challenge water specified in 7.2.3.8. The steady state K_{ss} shall be determined when the K_{ss} values measured on three consecutive days do not differ by more than

[9] Talanta Vol. 29, 1982, pp. 845-848

5%. The K_{ss} shall be established during the conditioning period. The system shall be tested using the radon challenge water specified in 7.2.3.8 at the maximum flow rate attainable using a dynamic pressure of 410 kPa (60psig) or greater, if specified by the manufacturer, and the operating cycle specified in 7.2.3.9.

7.2.3.11 Sampling

7.2.3.11.1 Radon analysis

For the first 14 d of the conditioning period, influent and effluent samples from each test unit shall be collected for radon analysis during 1 test cycle per day. For the last 7 d of the conditioning period, influent and effluent samples from each test unit shall be collected for radon analysis during the first and last cycles daily. The samples shall be collected after the passage of a minimum of 1 unit void volume from the device.

7.2.3.11.2 Retention of radon decay products

During the last 7 d of the conditioning period, a sample shall be collected during the last test cycle daily for Pb^{210} analysis as an indicator of radon progeny retention. The sample shall be collected immediately after the start of the "on" cycle.

7.2.3.11.3 Gamma radiation exposure

Gamma radiation exposure rate measurements shall be taken at the end of testing at a distance of 15 cm (6 in) from the system when it is filled with water. Gamma radiation measurements shall be collected as a 1-h integration with a survey meter.

7.2.4 Volatile organic chemical (VOC) reduction – surrogate organic chemical testing

7.2.4.1 VOC reduction claims

Claims for chemical reduction may be made for the group of organic chemicals shown in Table 10 when tested in accordance with 7.2.4. The system shall reduce the arithmetic mean of the influent concentrations of chloroform at 300 ± 30 µg/L at each sample point by at least 95%.

NOTE – The use of chloroform as the surrogate is limited to systems using an activated carbon filter component to accomplish the organic chemical reduction.

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge mg/L	USEPA method(s)[2]
Chloroform	0.300 ± 30%	0.300 ± 10%	502.2, 524.2, 524.3

[1]Equals average influent challenge concentration variability plus one of the following, in order of availability:
1. Acceptable Continuing Calibration Verification (CCV) limits stated in the appropriate USEPA method.
2. Acceptable spike recoveries as stated in the appropriate USEPA method.
3. Opinion of laboratory professionals – no guidance available in USEPA method.

[2]When more than one method is cited, either method may be used for analysis.

Table 10 – Organic chemicals included by surrogate testing

Chemical	Drinking water regulatory level[1] (MCL/MAC) mg/L	Influent challenge concentration[2] mg/L	Chemical reduction percent	Maximum product water concentration mg/L
alachlor	0.002	0.050	> 98	0.001[3]
atrazine	0.003	0.100	> 97	0.003[3]
benzene	0.005	0.081	> 99	0.001[3]
carbofuran	0.04	0.190	> 99	0.001[3]
carbon tetrachloride	0.005	0.078	98	0.0018[4]
chlorobenzene	0.1	0.077	> 99	0.001[3]
chloropicrin	—	0.015	99	0.0002[3]
2,4-D	0.07	0.110	98	0.0017[4]
dibromochloropropane (DBCP)	0.0002	0.052	> 99	0.00002[3]
o-dichlorobenzene	0.6	0.080	> 99	0.001[3]
p-dichlorobenzene	0.075	0.040	> 98	0.001[3]
1,2-dichloroethane	0.005	0.088	95[5]	0.0048[5]
1,1-dichloroethylene	0.007	0.083	> 99	0.001[3]
cis-1,2-dichloroethylene	0.07	0.170	> 99	0.0005[3]
trans-1,2-dichloroethylene	0.1	0.086	> 99	0.001[3]
1,2-dichloropropane	0.005	0.080	> 99	0.001[3]
cis-1,3-dichloropropylene	—	0.079	> 99	0.001[3]
dinoseb	0.007	0.170	99	0.0002[4]
endrin	0.002	0.053	99	0.00059[4]
ethylbenzene	0.7	0.088	> 99	0.001[3]
ethylene dibromide (EDB)	0.00005	0.044	> 99	0.00002[3]
haloacetonitriles (HAN)				
bromochloroacetonitrile	—	0.022	98	0.0005[3]
dibromoacetonitrile	—	0.024	98	0.0006[3]
dichloroacetonitrile	—	0.0096	98	0.0002[3]
trichloroacetonitrile	—	0.015	98	0.0003[3]
haloketones (HK):				
1,1-dichloro-2-propanone	—	0.0072	99	0.0001[3]
1,1,1-trichloro-2-propanone	—	0.0082	96	0.0003[3]
heptachlor (H-34, Heptox)	0.0004	0.025	> 99	0.00001
heptachlor epoxide	0.0002	0.0107[6]	98	0.0002[6]
hexachlorobutadiene	—	0.044	> 98	0.001[3]
hexachlorocyclopentadiene	0.05	0.060	> 99	0.000002[3]
lindane	0.0002	0.055	> 99	0.00001[3]
methoxychlor	0.04	0.050	> 99	0.0001[3]
pentachlorophenol	0.001	0.096	> 99	0.001[3]
simazine	0.004	0.120	> 97	0.004[3]
styrene	0.1	0.150	> 99	0.0005[3]
1,1,2,2-tetrachloroethane	—	0.081	> 99	0.001[3]
tetrachloroethylene	0.005	0.081	> 99	0.001[3]
toluene	1	0.078	> 99	0.001[3]
2,4,5-TP (silvex)	0.05	0.270	99	0.0016[4]
tribromoacetic acid	—	0.042	> 98	0.001[3]

Table 10 – Organic chemicals included by surrogate testing

Chemical	Drinking water regulatory level[1] (MCL/MAC) mg/L	Influent challenge concentration[2] mg/L	Chemical reduction percent	Maximum product water concentration mg/L
1,2,4-trichlorobenzene	0.07	0.160	> 99	0.0005[3]
1,1,1-trichloroethane	0.2	0.084	95	0.0046[4]
1,1,2-trichloroethane	0.005	0.150	> 99	0.0005[3]
trichloroethylene	0.005	0.180	> 99	0.0010[3]
trihalomethanes (includes):				
chloroform (surrogate chemical) bromoform bromodichloromethane chlorodibromomethane	0.080	0.300	95	0.015
xylenes (total)	10	0.070	> 99	0.001[3]

[1] These harmonized values were agreed upon by representatives of USEPA and Health Canada for the purpose of evaluating products to the requirements of this Standard.

[2] Influent challenge levels are average influent concentrations determined in surrogate qualification testing.

[3] Maximum product water level was not observed but was set at the detection limit of the analysis.

[4] Maximum product water level is set at a value determined in surrogate qualification testing.

[5] Chemical reduction percent and maximum product water level calculated at chloroform 95% breakthrough point as determined in surrogate qualification testing.

[6] The surrogate test results for heptachlor epoxide demonstrated a 98% reduction. These data were used to calculate an upper occurrence concentration that would produce a maximum product water level at the MCL.

– concluded –

7.2.4.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.2.4.3 Analytical methods

All analyses shall be conducted in accordance with the applicable methods referenced in 2.

7.2.4.4 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.2, H.3, H.4 and H.6.

7.2.4.5 General test water

A public water supply shall be used with the following specific characteristics maintained throughout the test for contaminant reduction claims:

pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
total organic carbon (TOC)	> 1.0 mg/L
turbidity	< 1 NTU

Methanol shall be used as the solvent for chloroform when introduced to the test water.

7.2.4.6 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

7.2.4.7 Methods

7.2.4.7.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.2.4.5. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable by setting an initial dynamic pressure of 410 ± 20 kPa (60 ± 3 psi). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The operating cycle specified in 7.2.4.6 shall be used.

7.2.4.7.1.1 Refrigerator filters without integral flow control

Chemical reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.2.4.7.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any chemical reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.2.4.7.2 Plumbed-in systems with reservoirs

The method specified in 7.2.4.7.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.2.4.6, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.2.4.7.3 Nonplumbed pour-through-type batch treatment systems

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.2.4.7.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.2.4.5 with the test contaminant present.

7.2.4.7.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.2.4.5 with the test contaminant present.

7.2.4.8 Sampling

For systems with performance indication devices, during the "on" portion of the cycle, influent and effluent samples shall be collected at the start of the test (after the passage of 10 unit volumes of influent challenge) and at 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, 110%, and 120% of the estimated capacity. For systems without performance indication devices, the system shall be tested to 200% of the estimated capacity. Samples shall be collected at startup (after the passage of 10 unit volumes) and at 20%, 40%, 60%, 80%, 100%, 120%, 140%, 160%, 180%, and 200% of the estimated capacity.

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NOTE – All influent samples shall be analyzed. Effluent samples collected at 20%, 40%, 60%, 80%, and 110% (40%, 80%, 120%, and 160% for systems without performance indication devices) shall be stored and analyzed only if necessary to establish the capacity if different from originally estimated.

7.3 Mechanical filtration reduction claims

7.3.1 Asbestos reduction testing

7.3.1.1 Asbestos reduction claims

The system shall reduce the influent asbestos fiber concentration in the range of 10^7 to 10^8 fibers per liter by at least 99% when tested in accordance with 7.3.1. The asbestos reduction shall be for fibers exceeding 10 µm in length.

NOTE – Claims for capacity or rated service cycle shall not be made for mechanical filtration systems because of the broad variation in the quality and quantity of particulate matter found in drinking water.

7.3.1.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus. Cycling solenoid valves shall be of a design that are rapid opening and closing (full actuation < 0.2 seconds), anti-water hammer and contain minimal dead volume. Recommended valve types are angle seat valves (such as Burkert 2000 or Asco 8290 series) or pneumatic diaphragm valves. The valve shall be sized so that the C_v of the valve shall be equal or greater than the clean system flow rate of the unit under test.

7.3.1.3 Analytical methods

Analysis for asbestos fibers shall be by transmission electron microscopy (TEM), or X-ray diffraction as an alternative, to the USEPA method 100.1 entitled *Analytical Method for Determination of Asbestos Fibers in Water*.

7.3.1.4 Test water

7.3.1.4.1 General test water

hardness (as $CaCO_3$)	not more than 170 mg/L
pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
turbidity	< 1 NTU

7.3.1.4.2 Test dust loading water

Test dust shall be added to the general test water specified in 7.3.1.4.1 to achieve a minimum of 10 NTU. The test dust shall have a nominal 0 to 5 µm size classification and shall have 96% (by volume percent) of its particles within this range and 20 to 40% (by volume percent) of its particles greater than 2.5 µm.[10]

7.3.1.4.3 Influent challenge – asbestos

A 50-50 blend of chrysotile and anthophyllite asbestos shall be added to the general test water specified in 7.3.1.4.1 to produce a chrysotile and anthophyllite asbestos fiber concentration in the range of 10^7 to 10^8 fibers per liter. Only fibers greater than 10 µm shall be counted to confirm challenge.

7.3.1.5 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle with a 20-min cycle, for 16 h per 24-h period, followed by an 8-h rest under pressure.

NOTE – If the sample period occurs near the end of the 16 h of operation and the sample collection would extend beyond the 16-h period, the collection of the sample may be delayed until the start of the next 16-h period.

7.3.1.6 Methods

7.3.1.6.1 Plumbed-in systems without reservoirs

Two systems shall be conditioned in accordance with the manufacturer's instructions, using the general test water specified in 7.3.1.4.1 without the asbestos fibers. The systems shall be tested using the general test water in 7.3.1.4.1 at the maximum flow rate attainable by setting an initial dynamic inlet pressure of 410 ± 20 kPa (60 ± 3 psig). The cycle time specified in 7.3.1.5 shall be used. The asbestos suspension specified in 7.3.1.4.3 shall be added to the water just prior to the sample point. The asbestos suspension specified feed shall be of a volume equal to 10 min of initial unit flow, or 10 empty bed volumes, whichever is greater.

NOTE – The cyst test shall be performed prior to the asbestos reduction test.

7.3.1.6.1.1 Refrigerator filters without integral flow control

Refrigerator filter asbestos reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

[10] A test dust that meets these specifications is available from Powder Technologies, Inc., P.O. Box 1464, Burnsville, MN 55337 <www.powdertechusa.com>.

7.3.1.6.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any asbestos reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.1.6.2 Plumbed-in systems with reservoirs

The method specified in 7.3.1.6.1 shall be followed except that where the design of the system does not lend itself to the operating cycle in 7.3.1.5, such as an extended recovery time, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.3.1.6.2.1 Refrigerator filters without integral flow control

Refrigerator filter asbestos reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.3.1.6.2.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any asbestos reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.1.6.3 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.3.1.4.1 without the test contaminant present.

7.3.1.6.4 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.3.1.4.1 without the test contaminant present.

7.3.1.7 Sampling

Influent and effluent samples shall be collected at the beginning of the "on" cycle at the start of the test (beginning with the 4th cycle) and after each "off" cycle when the original flow from the system has decreased 25%, 50%, and 75%. The volume of the system downstream of the mechanical filtration element shall be determined. Samples shall be collected after the introduction of the challenge test water when the effluent from the previous cycle has been flushed from the system downstream of the mechanical filtration element and the sample apparatus. Sample size shall be 1 L.

7.3.2 Cyst reduction

The system shall be tested using one of the following options:

- live *Cryptosporidium parvum* oocysts (see 7.3.2.1); or
- polystyrene microspheres (see 7.3.2.2).

7.3.2.1 Live *Cryptosporidium parvum* oocyst reduction

7.3.2.1.1 Live *Cryptosporidium parvum* oocyst reduction claim

The system shall reduce the number of live *Cryptosporidium parvum* oocysts from an influent challenge of at least 50,000 (5×10^4) oocysts per liter by at least 99.95% when tested in accordance with 7.3.2.1. The *Cryptosporidium parvum* oocysts shall be from a calf source. The viability shall be greater than 50% determined by excystation.[11] The oocysts shall be stored with 1,000 I. U. / mL penicillin and 1,000 µg/mL streptomycin at 4 °C (39 °F) and shall be used within eight weeks of collection. The live *Cryptosporidium* parvum oocysts shall not be inactivated by any means including chemical or UV irradiation prior to passing through the test system.

NOTE – It has been reported that the oocyst wall of viable oocysts may deform. Excystation is performed as an indication of the potential of the oocyst wall to deform and is not done to measure the infectivity of the organism.

The live *Cryptosporidium parvum* oocyst reduction shall not be used when testing systems intended for use in bottled water plants because of laboratory personnel safety concerns.

7.3.2.1.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus. Cycling solenoid valves shall be of a design that are rapid opening and closing (full actuation < 0.2 seconds), anti-water hammer and contain minimal dead volume. Recommended valve types are angle seat valves (such as Burkert 2000 or Asco 8290 series) or pneumatic diaphragm valves. The valve shall be sized so that the C_v of the valve shall be equal or greater than the clean system flow rate of the unit under test.

7.3.2.1.3 Analytical methods

Analysis shall be in accordance with Annex A.

7.3.2.1.4 Test water

7.3.2.1.4.1 General test water

hardness (as $CaCO_3$)	not more than 170 mg/L
pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
turbidity	< 1 NTU

7.3.2.1.4.2 Test dust loading water

Test dust shall be added to the general test water specified in 7.3.2.1.4.1 to achieve a minimum of 10 NTU. The test dust shall have a nominal 0 to 5 µm size classification and shall have 96% (by volume percent) of its particles within this range and 20 to 40% (by volume percent) of its particles greater than 2.5 µm.

[11] The in vitro excystation method is specified in *Development of a Test to Assess Cryptosporidium parvum Oocysts Viability: Correlation with Infectivity Potential,* American Water Works Association Research Foundation, 6666 West Quincy Avenue, Denver, CO 80235 <www.waterresearchfoundation.org>.

7.3.2.1.4.3 Influent challenge

The oocyst challenge water shall contain live *Cryptosporidium parvum* oocysts as specified in 7.3.2.1.1 added to the general test water specified in 7.3.2.1.4.1 to achieve at least 50,000 (5×10^4) oocysts per liter. Concentrate solutions of live *Cryptosporidium* parvum oocysts shall contain 0.01% polyoxyethylene sorbitan mono-oleate to enhance the mono-dispersion of oocysts in the test water.

7.3.2.1.5 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle with a 20-min cycle, for 16 h per 24-h period, followed by an 8-h rest under pressure.

NOTE – If the sample period occurs near the end of the 16 h of operation and the sample collection would extend beyond the 16-h period, the collection of the sample may be delayed until the start of the next 16-h period.

7.3.2.1.6 Methods

7.3.2.1.6.1 Plumbed-in systems without reservoirs

Two systems shall be conditioned in accordance with the manufacturer's instructions, using the general test water specified in 7.3.2.1.4.1. The systems shall be tested at the maximum flow rate attainable by setting an initial dynamic inlet pressure of 410 ± 20 kPa (60 ± 3 psig). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The cycle time in 7.3.2.1.5 shall be used.

7.3.2.1.6.1.1 Refrigerator filters without integral flow control

Refrigerator filter cyst reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.3.2.1.6.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any cyst reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.2.1.6.1.3 *Cryptosporidium parvum* oocyst challenge procedure

The *Cryptosporidium parvum* oocyst challenge procedure shall be performed as follows:

1) The challenge test water specified in 7.3.2.1.4.3 shall be used until the end of the eighth cycle.

2) The challenge test water shall be stopped and the test dust loading water, specified in 7.3.2.1.4.2, shall be used until the flow rate is reduced by 25%.

3) The test dust loading water shall be stopped and the general test water without challenge, specified in 7.3.2.1.4.1, shall be used for two cycles.

4) The general test water shall be stopped and the challenge test water, specified in 7.3.2.1.4.3, shall be used for four cycles.

5) The challenge test water shall be stopped and the test dust loading water shall be used until the flow rate is reduced by 50% from the original flow rate. Steps 3) and 4) shall then be repeated.

6) The challenge test water shall be stopped and the test dust loading water shall be used until the flow rate is reduced by 75% from the original flow rate. Steps 3) and 4) shall then be repeated.

7.3.2.1.6.2 Plumbed-in systems with reservoirs

The method specified in 7.3.2.1.6.1 shall be followed except that where the design of the system does not lend itself to the operating cycle in 7.3.2.1.5, such as an extended recovery time, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.3.2.1.6.2.1 Refrigerator filters without integral flow control

Refrigerator filter cyst reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.3.2.1.6.2.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any cyst reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.2.1.6.3 Batch treatment systems

Two systems shall be conditioned by completely filling the raw water reservoir with the general test water specified in 7.3.2.1.4.1. The challenge water shall be allowed to filter until it reaches its natural level in the raw and treated water reservoirs. A filling cycle shall be established based on the time required for half the water to filter through the initial cycle. The filling schedules shall be maintained 16 h per 24-h period followed by an 8-h rest period. The systems shall be filled completely each cycle with a measured volume. Treated water shall be discarded as necessary.

NOTE – If the sample period occurs near the end of the 16 h of operation and the sample collection would extend beyond the 16-h period, the collection of the sample may be delayed until the start of the next 16-h period.

7.3.2.1.6.4 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.3.2.1.4.1 without the test contaminant present.

7.3.2.1.6.5 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.3.2.1.4.1 without the test contaminant present.

7.3.2.1.6.3.1 *Cryptosporidium parvum* oocyst challenge procedure

The *Cryptosporidium parvum* oocyst challenge procedure shall be performed as follows:

1) The challenge test water, specified in 7.3.2.1.4.3, shall be used until the end of the eighth cycle.

2) The test dust loading water, specified in 7.3.2.1.4.2, shall be used until the time required to complete one cycle has increased by 133% of the original cycle time.

3) The general test water without challenge, specified in 7.3.2.1.4.1, shall be used for two cycles.

4) The challenge test water, specified in 7.3.2.1.4.3, shall be used for four cycles.

5) The test dust loading water shall be used until the time required for one filling cycle has increased by 200% from the original cycle time. Steps 3) and 4) shall then be repeated.

6) The test dust loading water shall then be used until the time required for 1 filling cycle has increased by 400% from the original cycle time. Steps 3) and 4) shall then be repeated.

7.3.2.1.7 Sampling

7.3.2.1.7.1 Plumbed-in systems without reservoir and plumbed-in systems with reservoir

The influent and effluent samples shall be collected and measured at the eighth cycle, 25%, 50%, and 75% flow reduction points. The volume of the system downstream of the mechanical filtration element shall be determined. Samples for the 25%, 50%, and 75% flow reduction points shall be collected at the beginning of the fourth cycle after the introduction of the challenge test water when the effluent from the previous cycle has been flushed from the system downstream of the mechanical filtration element and the sample apparatus. The samples shall be collected at the beginning of the flow to the test unit to include any particles that may be released from the sudden increase in flow to the test unit.

7.3.2.1.7.2 Batch treatment systems

Influent (aliquot is removed by inserting a pipette to the midpoint of the raw water reservoir) and effluent samples shall be collected:

– at the beginning of the “on” portion of the eighth cycle; and

– at the beginning of the “on” portion of the fourth batch of challenge test water introduced when the original filling time of the system has increased by 133%, 200%, and 400%.

7.3.2.2 Polystyrene microsphere reduction for systems other than those used in bottled water plants

7.3.2.2.1 Polystyrene microsphere reduction claim for systems other than those used in bottled water plants

The polystyrene latex microspheres shall have 95% of particles in the range of 3.00 ± 0.15 µm. The size variation of the polystyrene microspheres shall be confirmed by electron microscopy. The spheres shall have a surface charge content of less than 2 uEq/g. The microspheres shall contain a fluorescein isothiocyanate (FITC) dye or equivalent. The system shall reduce the number of polystyrene microspheres from an influent challenge of at least 50,000 (5×10^4) polystyrene microspheres per liter by at least 99.95% when tested in accordance with 7.3.2.2.

7.3.2.2.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus. Cycling solenoid valves shall be of a design that are rapid opening and closing (full actuation < 0.2 seconds), anti-water hammer and contain minimal dead volume. Recommended valve types are angle seat valves (such as Burkert 2000 or Asco 8290 series) or pneumatic diaphragm valves. The valve shall be sized so that the C_v of the valve shall be equal or greater than the clean system flow rate of the unit under test.

7.3.2.2.3 Analytical methods

Analysis shall be in accordance with Annex B.

7.3.2.2.4 Test water

7.3.2.2.4.1 General test water

hardness (as $CaCO_3$)	not more than 170 mg/L
pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
turbidity	< 1 NTU

7.3.2.2.4.2 Test dust loading water

Test dust shall be added to the general test water specified in 7.3.2.2.4.1 to achieve a minimum of 10 NTU. The test dust shall have a nominal 0 to 5 µm size classification and shall have 96% (by volume percent) of its particles within this range and 20 to 40% (by volume percent) of its particles greater than 2.5 µm.

7.3.2.2.4.3 Influent challenge

The polystyrene microsphere challenge water shall contain 3.00 µm polystyrene microspheres as specified in 7.3.2.2.1, added to the general test water specified in 7.3.2.2.4.1 to achieve at least 50,000 (5×10^4) microspheres per liter. Concentrate solutions of polystyrene microspheres shall contain 0.01% polyoxyethylene sorbitan mono-oleate to enhance the mono-dispersion of oocysts in the test water.

7.3.2.2.5 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle with a 20-min cycle, for 16 h per 24-h period, followed by an 8-h rest under pressure.

> NOTE – If the sample period occurs near the end of the 16 h of operation and the sample collection would extend beyond the 16-h period, the collection of the sample may be delayed until the start of the next 16-h period.

7.3.2.2.6 Methods

7.3.2.2.6.1 Plumbed-in systems without reservoirs

Two systems shall be conditioned in accordance with the manufacturer's instructions, using the general test water specified in 7.3.2.2.4.1. The systems shall be tested at the maximum flow rate attainable by setting an initial dynamic inlet pressure of 410 ± 20 kPa (60 ± 3 psig). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The cycle time in 7.3.2.2.5 shall be used.

7.3.2.2.6.1.1 Refrigerator filters without integral flow control

Refrigerator filter cyst reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.3.2.2.6.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any cyst reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.2.2.6.1.3 Polystyrene microsphere challenge procedure

The polystyrene microsphere challenge procedure shall be performed as follows:

1) The challenge test water specified in 7.3.2.2.4.3 shall be used until the end of the eighth cycle.

2) The challenge test water shall be stopped and the test dust loading water, specified in 7.3.2.2.4.2, shall be used until the flow rate is reduced by 25%.

3) The test dust loading water shall be stopped and the general test water without challenge, specified in 7.3.2.2.4.1, shall be used for two cycles.

4) The general test water shall be stopped and the challenge test water, specified in 7.3.2.2.4.3, shall be used for four cycles.

5) The challenge test water shall be stopped and the test dust loading water shall be used until the flow rate is reduced by 50% from the original flow rate. Steps 3) and 4) shall then be repeated.

6) The challenge test water shall be stopped and the test dust loading water shall be used until the flow rate is reduced by 75% from the original flow rate. Steps 3) and 4) shall then be repeated.

7.3.2.2.6.2 Plumbed-in systems with reservoirs

The method specified in 7.3.2.2.6.1 shall be followed except that where the design of the system does not lend itself to the operating cycle in 7.3.2.2.5, such as an extended recovery time, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.3.2.2.6.2.1 Refrigerator filters without integral flow control

Refrigerator filter cyst reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.3.2.2.6.2.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any cyst reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.2.2.6.3 Batch treatment systems

Two systems shall be conditioned by completely filling the raw water reservoir with the general test water specified in 7.3.2.2.4.1. The challenge water shall be allowed to filter until it reaches its natural level in the raw and treated water reservoirs. A filling cycle shall be established based on the time required for half the water to filter through the initial cycle. The filling schedules shall be maintained 16 h per 24-h period followed by an 8-h rest period. The systems shall be filled completely each cycle with a measured volume. Treated water shall be discarded as necessary.

NOTE – If the sample period occurs near the end of the 16 h of operation and the sample collection would extend beyond the 16-h period, the collection of the sample may be delayed until the start of the next 16-h period.

7.3.2.2.6.3.1 Polystyrene microsphere challenge procedure

The polystyrene microsphere challenge procedure shall be performed as follows:

1) The challenge test water, specified in 7.3.2.2.4.3, shall be used until the end of the eighth cycle.

2) The test dust loading water, specified in 7.3.2.2.4.2, shall be used until the time required to complete one cycle has increased by 133% of the original cycle time.

3) The general test water without challenge, specified in 7.3.2.2.4.1, shall be used for two cycles.

4) The challenge test water, specified in 7.3.2.2.4.3, shall be used for four cycles.

5) The test dust loading water shall be used until the time required for one filling cycle has increased by 200% from the original cycle time. Steps 3) and 4) shall then be repeated.

6) The test dust loading water shall then be used until the time required for one filling cycle has increased by 400% from the original cycle time. Steps 3) and 4) shall then be repeated.

7.3.2.2.6.4 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.3.2.2.4.1 without the test contaminant present.

7.3.2.2.6.5 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.3.2.2.4.1 without the test contaminant present.

7.3.2.2.7 Sampling

7.3.2.2.7.1 Plumbed-in systems without reservoir and plumbed-in systems with reservoir

The influent and effluent samples shall be collected and measured at the eighth cycle, 25%, 50%, and 75% flow reduction points. The volume of the system downstream of the mechanical filtration element shall be determined. Samples for the 25%, 50%, and 75% flow reduction points shall be collected at the beginning of the fourth cycle after the introduction of the challenge test water when the effluent from the previous cycle has been flushed from the system downstream of the mechanical filtration element and the sample apparatus. The samples shall be collected at the beginning of the flow to the test unit to include any particles that may be released from the sudden increase in flow to the test unit.

7.3.2.2.7.2 Batch treatment systems

Influent (aliquot is removed by inserting a pipette to the midpoint of the raw water reservoir) and effluent samples shall be collected:

– at the beginning of the "on" portion of the eighth cycle; and

– at the beginning of the "on" portion of the fourth batch of challenge test water introduced when the original filling time of the system has increased by 133%, 200%, and 400%.

7.3.2.3 Polystyrene microsphere reduction for systems used in bottled water plants

7.3.2.3.1 Polystyrene microsphere reduction claim

The polystyrene latex microspheres shall have 95% of particles in the range of 3.00 ± 0.15 µm. The size variation of the polystyrene microspheres shall be confirmed by electron microscopy. The spheres shall have a surface charge content of less than 2 uEq/g. The microspheres shall contain a fluorescein isothiocyanate (FITC) dye or equivalent. The system shall reduce the number of polystyrene microspheres from an influent challenge of at least 50,000 (5×10^4) polystyrene microspheres per liter by at least 99.95% when tested in accordance with 7.3.2.2.

7.3.2.3.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.3.2.3.3 Analytical methods

Analysis shall be in accordance with Annex B.

7.3.2.3.4 Test water

7.3.2.3.4.1 General test water

hardness (as $CaCO_3$)	not more than 170 mg/L
pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
turbidity	< 1 NTU

7.3.2.3.4.2 Test dust loading water

Test dust shall be added to the general test water specified in 7.3.2.3.4.1 to achieve a minimum of 10 NTU. The test dust shall have a nominal 0 to 5 µm size classification and shall have 96% (by volume percent) of its particles within this range and 20 to 40% (by volume percent) of its particles greater than 2.5 µm.

7.3.2.3.4.3 Influent challenge

The polystyrene microsphere challenge water shall contain 3.00 µm polystyrene microspheres as specified in 7.3.2.3.1, added to the general test water specified in 7.3.2.3.4.1 to achieve at least 50,000 (5×10^4) microspheres per liter. Concentrate solutions of polystyrene microspheres shall contain 0.01% polyoxyethylene sorbitan mono-oleate to enhance the mono-dispersion of oocysts in the test water.

7.3.2.3.5 Cycle time

The systems shall be tested for up to 16 h per 24-h period under constant flow conditions, followed by an 8-h rest under pressure, except as provided for in 7.3.2.3.6.

7.3.2.3.6 Methods

7.3.2.3.6.1 Polystyrene microsphere reduction

Two systems shall be conditioned in accordance with the manufacturer's instructions, using the general test water specified in 7.3.2.3.4.1. The systems shall be tested using the polystyrene microsphere challenge water specified in 7.3.2.3.4.3 at the rated service flow specified by the manufacturer using a dynamic test manifold inlet pressure of up to 620 kPa (90 psig) and the cycle time specified in 7.3.2.3.5. The manufacturer's rated service flow ± 10% shall be maintained throughout the test using a control valve located downstream of the unit.

7.3.2.3.6.2 Challenge water introduction

The polystyrene microsphere challenge water as specified in 7.3.2.3.4.3 shall be introduced until the collection of the start-up sample is completed. The polystyrene microsphere challenge shall be stopped. The test dust loading water as specified in 7.3.2.3.4.2 shall be introduced until the 25% pressure drop point is reached. The test dust loading water shall be terminated, and general test water specified in 7.3.2.3.4.1 shall be introduced for 10 min. The polystyrene microsphere challenge water shall be introduced for 20 min. At the end of the 20-min period, a pressure pulse shall be administered to the system, which shall be collected in the effluent sample. After sampling, the polystyrene microsphere challenge shall be terminated, and the test dust loading water shall be introduced until the next sampling point where the procedure shall be repeated.

7.3.2.3.7 Sampling

The influent and effluent samples shall be collected and measured at the start of the test and at 25%, 50%, 75%, 100%, and 150% ± 10% of the manufacturer's recommended maximum pressure drop at the rated service flow. Immediately prior to collection of the effluent samples, a pressure pulse shall be administered to the systems under test by causing a rapid interruption and resumption of flow typical of a fast-acting valve located downstream of the unit. For filtration elements that have maintenance procedures, which include re-use, backwashing, cleaning, sterilization, etc., the manufacturer's maintenance procedures shall be followed, the filtration elements(s) returned to service, and the test repeated. In addition to the collection of the influent and effluent samples specified, a sample of effluent shall be collected immediately upon resumption of flow to the systems under test.

7.3.3 Turbidity reduction challenge

7.3.3.1 Turbidity reduction claims

The system shall reduce the influent challenge level of 11 ± 1 NTU (nephelometric turbidity unit) to not more than 0.5 NTU when tested in accordance with 7.3.3. This level of turbidity reduction shall be maintained at all sampling points during testing.

7.3.3.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus. Cycling solenoid valves shall be of a design that are rapid opening and closing (full actuation < 0.2 seconds), anti-water hammer and contain minimal dead volume. Recommended valve types are angle seat valves (such as Burkert 2000 or Asco 8290 series) or pneumatic diaphragm valves. The valve shall be sized so that the C_v of the valve shall be equal or greater than the clean system flow rate of the unit under test.

7.3.3.3 Analytical methods

Analysis shall be in accordance with USEPA Method 180.1.

7.3.3.4 Test water

7.3.3.4.1 General test water

hardness (as $CaCO_3$)	not more than 170 mg/L
pH	7.5 ± 0.5
temperature	20 ± 2.5 °C (68 ± 5 °F)
total dissolved solids (TDS)	200 – 500 mg/L
turbidity	< 1 NTU

7.3.3.4.2 Test dust loading water

Test dust shall be added to the general test water specified in 7.3.3.4.1 to achieve a minimum of 10 NTU. The test dust shall have a nominal 0 to 5 µm size classification and shall have 96% (by volume percent) of its particles within this range and 20 to 40% (by volume percent) of its particles greater than 2.5 µm.

7.3.3.4.3 Influent challenge – turbidity

Test dust shall be added to the general test water specified in 7.3.3.4.1 to achieve a turbidity of 11 ± 1 NTU. The test dust shall have a nominal 0 to 5 µm size classification and shall have 96% (by volume percent) of its particles within this range and 20% to 40% (by volume percent) of its particles greater than 2.5 µm.

7.3.3.5 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

7.3.3.6 Methods

7.3.3.6.1 Plumbed-in systems without reservoirs

Two systems shall be conditioned in accordance with the manufacturer's instructions, using the general test water specified in 7.3.3.4.1. The systems shall be tested using the challenge water in 7.3.3.4.3 at the maximum flow rate attainable by setting an initial dynamic inlet pressure of 410 ± 20 kPa (60 ± 3 psig). The cycle time specified in 7.3.3.5 shall be used.

7.3.3.6.1.1 Refrigerator filters without integral flow control

Refrigerator filter turbidity reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.3.3.6.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any turbidity reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.3.6.2 Plumbed-in systems with reservoirs

The method specified in 7.3.3.6.1 shall be followed except that where the design of the system does not lend itself to the operating cycle in 7.3.3.5, such as an extended recovery time, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.3.3.6.2.1 Refrigerator filters without integral flow control

Refrigerator filter turbidity reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.3.3.6.2.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any turbidity reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.3.3.6.3 Batch treatment systems

Two systems shall be conditioned by completely filling the raw water reservoir with the general test water specified in 7.3.3.4.1. The systems shall be tested using the challenge water in 7.3.3.4.3. The water shall be allowed to filter until it reaches its natural level in the raw and treated water reservoirs. A filling cycle shall be established based on the time required for half the water to filter through the initial cycle.

The filling schedules shall be maintained 16 h per 24-h period followed by an 8-h rest period. The systems shall be filled completely each time with a measured volume. Treated water shall be discarded as necessary.

7.3.3.6.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer's instructions using the approprate general test water specified in 7.3.3.4.1 without the test contaminant present.

7.3.3.6.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.3.3.4.1 with the test contaminant present.

7.3.3.7 Sampling

7.3.3.7.1 Plumbed-in systems without reservoir and plumbed-in systems with reservoir

Influent and effluent samples shall be collected at the beginning of the "on" cycle at the start of the test (beginning with the 4th cycle) and after each "off" cycle when the original flow from the system has decreased 25%, 50%, and 75%. The volume of the system downstream of the mechanical filtration element shall be determined. Samples shall be collected after the introduction of the challenge test water when the effluent from the previous cycle has been flushed from the system downstream of the mechanical filtration element and the sample apparatus. Sample size shall be 250 mL.

7.3.3.7.2 Batch treatment systems

Influent (aliquot removed by inserting pipette to midpoint of raw water reservoir) and effluent samples shall be collected at the beginning of the "on" portion of the fourth cycle and after each "on" cycle when the original filling time of the system has increased by 133%, 200%, and 400%.

7.4 Metals reduction testing

7.4.1 Arsenic reduction testing

There are two forms of arsenic: pentavalent arsenic (also called As(V), As(+5), and arsenate) and trivalent arsenic (also called As(III), As(+3), and arsenite). Arsenic reduction is often species dependent. Trivalent arsenic is generally more difficult to reduce from drinking water than pentavalent arsenic. Trivalent arsenic, however, can be converted to pentavalent arsenic in the presence of an effective oxidant such as free chlorine. Other technologies are also capable of oxidizing trivalent arsenic to pentavalent arsenic.[12]

Claims may be made for pentavalent only and for arsenic reduction (trivalent and pentavalent).

7.4.1.1 Pentavalent arsenic reduction claims

The manufacturer of a water treatment system with a claim for pentavalent arsenic reduction only shall provide consumer information that limits the use of the system to water supplies meeting one of the following criteria:

- a residual free chlorine concentration is detectable at the treatment system inlet; or
- the water at the treatment system inlet has been demonstrated to contain only pentavalent arsenic.

Table 11 – Chemical reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)	Compound
arsenic	0.050 ±	0.050 ±	0.010	200.7[5],	Na_2HAsO_4·

[12] Laboratory Study on the Oxidation of Arsenic III to Arsenic V, EPA/600/R-01/021, March 2001

Table 11 – Chemical reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)	Compound
(pentavalent) (As[V])	20%[4] 0.050 ± 25%[4]	10%[3]		200.8, 200.9	$7H_2O$
arsenic (pentavalent) (As[V])	0.30 ± 20%[4] 0.30 ± 25%[4]	0.30 ± 10%[3]	0.010	200.7[5], 200.8 200.9	Na_2HAsO_4. $7H_2O$

[1] Equals average influent challenge concentration variability plus one of the following, in order of availability:
1. Acceptable Continuing Calibration Verification (CCV) limits stated in the appropriate USEPA method.
2. Acceptable spike recoveries as stated in the appropriate USEPA method.
3. Opinion of laboratory professionals – no guidance available in USEPA method.

[2] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria is used to select challenge concentrations:

[a] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P<0.05] that 95 percent of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[b] The concentration obtained by multiplying the EPA's published maximum contaminant level by three. This concentration will not be adequate when EPA MCL is very low.

[3] The manufacturer may choose to have a system tested with either an influent of 0.30 mg/L or with an influent of 0.050 mg/L. The influent concentration of 0.050 mg/L was determined through review of arsenic occurrence in drinking water sources, and represents the 97% occurrence level for all sources. The 0.30 mg/L influent concentration was determined through review of arsenic occurrence in drinking water sources that exceed 0.050 mg/L, and represents a majority of the sources above the 0.050 mg/L level. It is also a challenge concentration established in NSF/ANSI 58 for arsenic reduction.

[4] The first limits apply to analysis conducted according to USEPA method 200.7, and the second limits apply to analysis conducted according to USEPA method 200.8 or 200.9

[5] USEPA Method 200.7 shall be used for analysis of influent sample concentrations only.

7.4.1.1.1 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.4.1.1.2 Analytical methods

All analyses shall be conducted in accordance with the applicable methods referenced in 2.

7.4.1.1.3 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.3 and H.6.

7.4.1.1.4 Pentavalent arsenic reduction test water

The pentavalent arsenic reduction test shall be performed at pH 6.5 and 8.5. The test waters shall be prepared as follows:

1) A water supply shall be treated by reverse osmosis, then shall be treated by deionization (RO/DI water) and shall have a conductivity of less than 2 µS/cm. A test tank shall be filled with the RO/DI water.

2) All chemical additions shall take place after the test tank is filled with the RO/DI water, or while the test tank is being filled. Use reagent grade chemicals for all additions to adjust the RO/DI water to meet the following specific characteristics:

Parameter	Target value	Overall average tolerance	Single point tolerance
Mg^{2+}	12 mg/L	± 20% average	± 30%
NO_3^- – N	2.0 mg/L	± 20% average	± 30%
F^-	1 mg/L	± 20% average	± 30%
SiO_2	20 mg/L	± 20% average	± 30%
PO_4^{3-} – P	0.04 mg/L	± 25% average	± 50%
Ca^{2+}	40 mg/L	± 20% average	± 30%
As(V)	0.050 mg/L or 0.30 mg/L	± 10% average	± 20%
temperature	20°C ± 2.5°C (68°F ± 5°F)		
turbidity	< NTU		
free available chlorine	0.25 – 0.75 mg/L		
pH	6.5 ± 0.25 and 8.5 ± 0.25		

3) Dissolve enough sodium silicate ($Na_2SiO_3 \cdot 9H_2O$) in DI water to achieve a test tank concentration of 93 mg/L $Na_2SiO_3 \cdot 9H_2O$. Stir the solution and transfer it to the test tank.

4) Dissolve enough sodium bicarbonate ($NaHCO_3$) in DI water to achieve a test tank concentration of 250 mg/L $NaHCO_3$. Stir the solution and transfer it to the test tank.

5) Adjust the pH of the test tank solution using hydrochloric acid (HCl) or sodium hydroxide (NaOH) to 6.5 ± 0.25 for the low pH test, and to pH 8.5 ± 0.25 for the high pH test.

6) Separately dissolve enough magnesium sulfate ($MgSO_4 \cdot 7H_2O$), sodium nitrate ($NaNO_3$), and sodium fluoride (NaF) in DI water to achieve test tank concentrations of 128 mg/L, 12 mg/L, and 2.2 mg/L respectively.

7) Dissolve enough sodium phosphate ($NaH_2PO_4 \cdot H_2O$) in DI water to achieve a test tank concentration of 0.18 mg/L $NaH_2PO_4 \cdot H_2O$. Stir and transfer to the test tank.

8) Dissolve enough calcium chloride ($CaCl_2$) in DI water to achieve a test tank concentration of 111 mg/L $CaCl_2$. Stir and transfer to the test tank.

NOTE – Due to the tendency of anhydrous calcium chloride to absorb water, it is recommended that the calcium chloride be dried prior to addition to the DI.

9) Add sodium hypochlorite (NaClO) until a free available chlorine concentration in the range of 0.25 – 0.75 mg/L is reached. Stir the tank for at least 2 min.

10) If required, adjust the pH of the solution using HCl or NaOH to 6.5 ± 0.25 for the low pH test and to pH 8.5 ± 0.25 for the high pH test.

11) Dissolve sodium arsenate ($Na_2HAsO_4 \cdot 7H_2O$) in DI water prior to addition to the test tank. Determine the amount of sodium arsenate by the desired challenge concentration (0.050 mg/L or 0.30 mg/L as arsenic). For the 0.050 mg/L challenge, a concentration of 0.21 mg/L sodium arsenate shall be achieved. For the 0.30 mg/L challenge, a concentration of 1.28 mg/L sodium arsenate shall be achieved.

12) Mix and measure the final pH, and adjust as needed. Minimize mixing thereafter throughout the duration of the test.
13) Analyze the influent challenge for the specified water parameters for each tank of water prepared. Analyze chlorine and pH at each sampling point. It is recommended that a tank of challenge water not be used for longer than 24 h.

NOTE – When intermediate sampling and analysis of chlorine and pH values indicate that the challenge water is drifting out of the target range for these parameters, adjustments may be made to the challenge water.

7.4.1.1.5 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

For pentavalent arsenic reduction, the total volume of treated water produced during the on cycle shall be no less than six bed volumes.

7.4.1.1.6 Methods

7.4.1.1.6.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the test water specified in 7.4.1.1.4. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable by setting an initial dynamic pressure of 410 ± 20 kPa (60 ± 3 psi). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The operating cycle specified in 7.4.1.1.5 shall be used.

7.4.1.1.6.1.1 Refrigerator filters without integral flow control

Chemical reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.4.1.1.6.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any chemical reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.4.1.1.6.2 Plumbed-in systems with reservoirs

The method specified in 7.4.1.1.5.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.4.1.1.4, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.4.1.1.6.3 Nonplumbed pour-through-type batch treatment systems

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.4.1.1.6.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.4.1.1.4 with the test contaminant present.

7.4.1.1.6.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.4.1.1.4 with the test contaminant present.

7.4.1.1.7 Sampling

For systems tested to 120% of the estimated capacity, influent and effluent samples shall be collected during the "on" portion of the cycle at the start of the test (after the passage of 10 bed volumes of influent challenge) and at 25%, 50%, 75%, 100%, and 120% of the estimated capacity. For systems tested to 200% of the estimated capacity, samples shall be collected at startup (after the passage of 10 bed volumes) and at 50%, 100%, 150%, 180%, and 200% of the estimated capacity. Effluent samples shall be collected after the passage of a minimum of five bed volumes following the start of the "on" cycle, and shall be at least one unit volume in size. Following an overnight rest or any other period of non-use longer than 2 h, effluent samples shall not be collected prior to the passage of a minimum of 100 bed volumes (based on the bed volume of the arsenic reduction component only).

> NOTE – Effluent samples may be subject to a temporary recovery of the arsenic treatment capacity when sampled immediately following an overnight rest or other significant period of non-use.

7.4.1.2 Arsenic reduction claims

To qualify for an arsenic reduction claim, a water treatment system shall pass the test for pentavalent arsenic reduction in accordance with 7.4.1.1, and shall pass a separate test for trivalent arsenic reduction in accordance with this section. A claim for trivalent arsenic reduction only shall not be made.

Table 12 – Arsenic reduction requirements (Trivalent challenge)

Substance	Individual influent sample point limits mg/L[1]	Average influent challenge[2] mg/L	USEPA method(s)	Compound
arsenic (trivalent) (As[III])	0.050 ± 20%[3] 0.050 ± 25%[3]	0.050 ± 10%[4]	200.7[5], 200.8, 200.9	$NaAsO_2$
arsenic (trivalent) (As[III])	0.300 ± 20%[3] 0.300 ± 25%[3]	0.300 ± 10%[4]	200.7[5], 200.8, 200.9	$NaAsO_2$

[1] Equals average influent challenge concentration variability plus one of the following, in order of availability:
1. Acceptable Continuing Calibration Verification (CCV) limits stated in the appropriate USEPA method.
2. Acceptable spike recoveries as stated in the appropriate USEPA method.
3. Opinion of laboratory professionals – no guidance available in USEPA method.

[2] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria is used to select challenge concentrations:

[a] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P < 0.05] that 95 % of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[b] The concentration obtained by multiplying the EPA's published maximum contaminant level by three. This concentration will not be adequate when EPA MCL is very low.

[3] The first limits apply to analysis conducted according to USEPA method 200.7, and the second limits apply to analysis conducted according to USEPA method 200.8 or 200.9.

[4] The manufacturer may choose to have a system tested with either an influent of 0.300 mg/L or with an influent of 0.050 mg/L. The influent concentration of 0.050 mg/L was determined through review of arsenic occurrence in drinking water sources, and represents the 97% occurrence level for all sources. The 0.300 mg/L influent concentration was determined through review of arsenic occurrence in drinking water sources that exceed 0.050 mg/L, and represents a majority of the sources above the 0.050 mg/L level. It is also a challenge concentration established in NSF/ANSI 58 for arsenic reduction.

[5] USEPA Method 200.7 may be used for analysis of influent sample concentrations only.

7.4.1.2.1 Trivalent arsenic test requirements

7.4.1.2.1.1 Apparatus

A test apparatus capable of providing specified flow rates and static pressures shall be used. Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.4.1.2.1.2 Analytical methods

All analyses shall be conducted in accordance with the applicable methods referenced in 2.

All effluent samples collected from the treatment systems shall be analyzed for arsenic.

7.4.1.2.1.3 Trivalent arsenic reduction test water

The trivalent arsenic reduction test shall be performed at pH 6.5 and 8.5. The test waters shall be prepared as follows:

1) A water supply shall be treated by reverse osmosis, then shall be treated by deionization (RO/DI water) and shall have a conductivity of less than 2 µS/cm. A test tank shall be filled with the RO/DI water.

2) All chemical additions shall take place after the test tank is filled with the RO/DI water, or while the test tank is being filled. Use reagent grade chemicals for all additions to adjust the RO/DI water to meet the following specific characteristics:

Parameter	Target value	Overall average tolerance	Single point tolerance
Mg^{2+}	12 mg/L	± 20% average	± 30%
NO_3^- – N	2.0 mg/L	± 20% average	± 30%
F^-	1 mg/L	± 20% average	± 30%
SiO_2	20 mg/L	± 20% average	± 30%
PO_4^{3-} – P	0.04 mg/L	± 25% average	± 50%
Ca^{2+}	40 mg/L	± 20% average	± 30%
As(III)	0.050 mg/L or 0.30 mg/L	± 10% average	± 30%
temperature	20°C ± 2.5°C (68°F ± 5°F)		
turbidity	< 1 NTU		
pH	6.5 ± 0.25 and 8.5 ± 0.25		
dissolved oxygen	< 0.5 mg/L		

3) Dissolve enough sodium silicate ($Na_2SiO_3 \cdot 9H_2O$) in DI water to achieve a test tank concentration of 93 mg/L $Na_2SiO_3 \cdot 9H_2O$. Stir the solution and transfer it to the test tank.

4) Dissolve enough sodium bicarbonate ($NaHCO_3$) in DI water to achieve a test tank concentration of 250 mg/L $NaHCO_3$. Stir the solution and transfer it to the test tank.

5) Adjust the pH of the test tank solution using hydrochloric acid (HCl) or sodium hydroxide (NaOH) to 6.5 ± 0.25 for the low pH test, and to pH 8.5 ± 0.25 for the high pH test.

6) Separately dissolve enough magnesium sulfate ($MgSO_4 \cdot 7H_2O$), sodium nitrate ($NaNO_3$), and sodium fluoride (NaF) in DI water to achieve test tank concentrations of 128 mg/L, 12 mg/L, and 2.2 mg/L respectively. Stir the solution and transfer it to the test tank.

7) Dissolve enough sodium phosphate ($NaH_2PO_4 \cdot H_2O$) in DI water to achieve a test tank concentration of 0.18 mg/L $NaH_2PO_4 \cdot H_2O$. Stir and transfer to the test tank.

8) Dissolve enough calcium chloride ($CaCl_2$) in DI water to achieve a test tank concentration of 111 mg/L $CaCl_2$. Stir and transfer to the test tank.

NOTE – Due to the tendency of anhydrous calcium chloride to absorb water, it is recommended that the calcium chloride be dried prior to addition to the DI.

9) Adjust the pH of the solution using HCl or NaOH to 6.5 ± 0.25 for the low pH test, and to pH 8.5 ± 0.25 for the high pH test.

10) Adjust the dissolved oxygen to < 0.5 mg/L by a method that does not significantly affect the other parameters of the solution. One acceptable method is purging with an inert gas such as nitrogen or argon.

11) Dissolve sodium arsenite ($NaAsO_2$) in DI water prior to addition to the test tank. Determine the amount of sodium arsenite by the desired challenge concentration (0.050 mg/L or 0.30 mg/L as arsenic). For the 0.050 mg/L challenge, a concentration of 0.087 mg/L sodium arsenite shall be achieved. For the 0.30 mg/L challenge, a concentration of 0.52 mg/L sodium arsenite shall be achieved.

12) Mix the tank and measure the pH. Adjust the pH as needed. Mix the tank before any sampling is done and minimize mixing thereafter throughout the duration of the test.

13) Analyze the influent challenge water for the specified water parameters for each tank of water prepared. Analyze pH and dissolved oxygen at each sampling point. It is recommended that a tank of challenge water not be used for longer than 24 h.

NOTE – When intermediate sampling and analysis of pH values indicate that the challenge water is drifting out of the target range for this parameter, adjustments may be made to the challenge water. Annex D provides an example method for the speciation of arsenic to confirm the oxidation state of the challenge compound.

7.4.1.2.1.4 Cycle time

The systems shall be operated on a 50%-on/50%-off cycle basis with a 15- to 40-min cycle, 16 h/d, followed by an 8-h rest under pressure (a 10%-on/90%-off cycle may be used if requested by the manufacturer).

The total volume of treated water produced during the on cycle shall be no less than six bed volumes.

7.4.1.2.1.5 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.3 and H.6.

7.4.1.2.1.6 Methods

7.4.1.2.1.6.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.4.1.2.1.3. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable using a dynamic pressure of 410 ± 20 kPa (60 ± 3 psig) and the operating cycle specified in 7.4.1.2.1.4. The pressure shall not be readjusted although the system may experience some change in dynamic pressure.

7.4.1.2.1.6.1.1 Refrigerator filters without integral flow control

Chemical reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.4.1.2.1.6.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any chemical reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.4.1.2.1.6.2 Plumbed-in systems with reservoirs

The method specified in 7.4.1.2.1.6.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.4.1.2.1.4, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.4.1.2.1.6.3 Nonplumbed pour-through-type batch treatment system

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.4.1.2.1.6.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.4.1.2.1.3 with the test contaminant present.

7.4.1.2.1.6.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.4.1.2.1.3 with the test contaminant present.

7.4.1.2.1.7 Sampling

All influent arsenic samples shall be collected at a location immediately prior to the test unit plumbing connection.

For systems tested to 120% of the estimated capacity, influent and effluent samples shall be collected during the "on" portion of the cycle at the start of the test (after the passage of 10 bed volumes of influent challenge) and at 25%, 50%, 75%, 100%, and 120% of the estimated capacity. For systems tested to 200% of the estimated capacity, samples shall be collected at startup (after the passage of 10 bed volumes) and at 50%, 100%, 150%, 180%, and 200% of the estimated capacity. Effluent samples shall be collected after the passage of a minimum of five bed volumes following the start of the “on” cycle, and shall be at least one unit volume in size. Following an overnight rest or any other period longer than 2 h, no effluent samples shall be collected until 100 bed volumes (based on the bed volume of the arsenic reduction component only) have passed through the system.

> NOTE – Effluent samples may be subject to a temporary recovery of the arsenic treatment capacity when sampled immediately following an overnight rest or other significant period of non-use.

All effluent samples collected from the treatment systems shall be analyzed for arsenic.

7.4.2 General metals reduction

7.4.2.1 General metals reduction testing

Claims for chemical reduction may be made for the specific metal contaminants shown in Table 12 when tested in accordance with 7.4.2.1. To qualify for a metal reduction claim, the system shall reduce the influent concentration(s) so that all effluent concentrations are less than or equal to the maximum effluent concentrations shown in Table 13.

Table 13 – General metals reduction requirements

Substance	Individual influent sample point limits[1] mg/L	Average Influent challenge[2] mg/L	Maximum effluent concentration mg/L	USEPA method(s)	Compound
barium	10.0 ± 25%	10.0 ± 10%	2	200.8	$BaCl_2$
cadmium	0.03 ± 25%	0.03 ± 10%	0.005	200.8	$CdCl_2$
chromium (hexavalent)	0.3 ± 25%	0.3 ± 10%[b] (added as hexavalent)	0.1	SM3500-CrD	$Na_2Cr_2O_7 \cdot 2\ H_2O$
chromium (trivalent)	0.3 ± 30%	0.3 ± 10%[b] (added as trivalent)	0.1	200.8[3]	$CrCl_3 \cdot 6\ H_2O$
chromium (hexavalent and trivalent)	0.3 ± 25%	0.3 ± 10%[b] (added as 0.15 mg/L hexavalent and 0.15 mg/L trivalent)	0.05 (for each species)	SM3500-CrD and 200.8[3]	
copper	3.0 ± 25%	3.0 ± 10%[b]	1.3	200.8	$CuSO_4 \cdot 5\ H_2O$
mercury	0.006 ± 25%	0.006 ± 10%[b] (added as inorganic mercury)	0.002	200.8	$Hg(NO_3)_2 \cdot H_2O$
selenium	0.10 ± 25%	0.10 ± 10% (added as 0.05 selenite and 0.05 selenate)	0.05	200.8	50/50 mix Na_2SeO_3/Na_2SeO_4

[1] Equals average influent challenge concentration variability plus one of the following, in order of availability:
1. Acceptable Continuing Calibration Verification (CCV) limits stated in the appropriate USEPA method.
2. Acceptable spike recoveries as stated in the appropriate USEPA method.
3. Opinion of laboratory professionals – no guidance available in USEPA method.

[2] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria is used to select challenge concentrations:

[a] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P<0.05] that 95 percent of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[b] The concentration obtained by multiplying the USEPA's published maximum contaminant level by three. This concentration will not be adequate when USEPA MCL is very low.

[3] Measured as total chromium by USEPA method 200.8 minus hexavalent chromium as measured by Standard Methods 3500-CrD.

NOTE 1 – Contaminants not listed in this Table shall be added in their molecular form.

NOTE 2 – Metal salts using alternate counter ions may be used if interferences and synergistic effects are avoided.

7.4.2.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.4.2.3 Analytical methods

All analyses shall be conducted in accordance with the applicable methods referenced in 2.

7.4.2.4 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.3 and H.6.

7.4.2.5 Metals reduction test waters

A public water supply shall be used and the following specific characteristics shall be maintained throughout the test for metals reduction claims:

	low pH	high pH
alkalinity (as $CaCO_3$)	10 – 30 mg/L	100 – 250 mg/L
hardness (as $CaCO_3$)	10 – 30 mg/L	100 – 200 mg/L
pH	6.5 ± 0.25	8.5 ± 0.25
polyphosphate (as P)	< 0.5 mg/L	< 0.5 mg/L
TDS	< 100 mg/L	200 – 500 mg/L
temperature	20 ± 2.5 °C (68 ± 5 °F)	20 ± 2.5 °C (68 ± 5 °F)
turbidity	< 1 NTU	< 1 NTU

NOTE – Where precipitation of the metals occurs, deionized water shall be used instead of water from a public water supply. Appropriate calcium salts, or magnesium salts, or both, shall be added to provide the desired TDS (refer to table of standard Ksp values). The pH adjustment required shall not cause precipitation of the metals.

7.4.2.6 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

7.4.2.7 Methods

7.4.2.7.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.4.2.5. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable by setting an initial dynamic pressure of 410 ± 20 kPa (60 ± 3 psi). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The operating cycle specified in 7.4.2.6 shall be used.

7.4.2.7.1.1 Refrigerator filters without integral flow control

Chemical reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.4.2.7.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any chemical reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.4.2.7.2 Plumbed-in systems with reservoirs

The method specified in 7.4.2.7.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.4.2.6, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.4.2.7.3 Nonplumbed pour-through-type batch treatment systems

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.4.2.7.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.4.2.5 with the test contaminant present.

7.4.2.7.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.4.2.5 with the test contaminant present.

7.4.2.8 Sampling

For systems with performance-indication devices, during the "on" portion of the cycle, influent and effluent samples shall be collected at the start of the test (after the passage of 10 unit volumes of influent challenge) and at 25%, 50%, 75%, 100%, and 120% of the estimated capacity. For systems without performance indication devices, the system shall be tested to 200% of the estimated capacity. Samples shall be collected at startup (after the passage of 10 unit volumes) and at 50%, 100%, 150%, 180%, and 200% of the estimated capacity. Samples for each system shall be at least one unit volume.

7.4.3 Lead reduction testing

7.4.3.1 Lead reduction claims

To qualify for a lead reduction claim, all systems shall meet the requirements of 7.4.3 for the lead pH 6.5 and lead pH 8.5 reduction testing. If, during the lead pH 8.5 reduction testing, the flow rate through the system is reduced by 75% of the initial clean flow rate after reaching 100% of the rated capacity and the

lead effluent concentrations are less than or equal to the maximum effluent concentration shown in Table 14, the system shall qualify for the lead reduction claim.

Table 14 – Lead reduction requirements

Substance[5]	Influent challenge[1]	Overall average tolerance	Single point tolerance	Maximum effluent conc. mg/L	USEPA method	Compound
lead [Pb_t]	0.15 mg/L	± 10%	± 20%	0.010	200.8, 200.9[4]	$Pb(NO_3)_2$
lead %[Pb_{tp}][2]	30 %	± 10%[3]	± 20%[3]	n/a	200.8, 200.9[4]	
lead %[Pb_f][2]	≥ 20 %	n/a	n/a	n/a	200.8, 200.9[4]	

[1] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria may be used to select challenge concentrations:

[1a] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P<0.05] that 95 percent of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[1b] The concentration obtained by multiplying the USEPA's published maximum contaminant level by three. This concentration will not be adequate when USEPA MCL is very low.

[2] Requirements for the lead pH 8.5 test only. A maximum of one sample point (influent and effluents if present) may be discarded if these requirements are not met; the discarded sample point cannot be the final capacity sample point of the test (120 or 200 percent).

[3] Percentage variance allowed; for example, total particulate lead (Lead %[Pb_{tp}]) is allowed an overall average tolerance of 20 – 40% (30 ± 10%).

[4] USEPA Method 200.7 may be used for analysis of influent sample concentrations only.

[5] Pb_t is total lead, Pb_{tp} is total particulate lead, and Pb_f is the portion of total particulate lead that is between 0.1 and 1.2 microns in size (fine).

7.4.3.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.4.3.3 Analytical methods

7.4.3.3.1 All analyses shall be conducted in accordance with the applicable methods referenced in 2.

7.4.3.3.2 Determination of particulate lead in pH 8.5 testing

Influent lead samples shall be collected from a non-glass sampling vessel. A portion representing the total lead [Pb_t] sample shall be transferred immediately to a non-glass sample bottle that contains adequate nitric acid to lower the pH of the sample to below 2.0.

A second portion of the same influent collected from the non-glass sampling vessel shall be immediately passed through a 0.1 micron absolute filter (see Filtration procedure below) and collected into a non-glass sample bottle that contains adequate nitric acid to lower the pH of the sample below 2.0. This sample is the 0.1 micron filtrate lead sample [$fPb_{0.1}$].

A third portion of the same influent collected from the non-glass sampling vessel shall be immediately passed through a 1.2 micron absolute filter (see Filtration procedure below) and collected into a non-glass bottle that contains adequate nitric acid to lower the pH of the sample below 2.0. This sample is the 1.2 micron filtrate lead sample [$fPb_{1.2}$].

The total particulate lead [Pb_{tp}] shall be calculated as follows:

$$[Pb_{tp}] = [Pb_t] – [fPb_{0.1}]$$

The percent of total particulate lead %[Pb_{tp}] shall be calculated as follows:

$$\%[Pb_{tp}] = \{[Pb_t] – [fPb_{0.1}]\} \div [Pb_t] \times 100$$

Fine particulate lead [Pb_f] shall be the portion of particulate lead between 0.1 and 1.2 micron, and shall be calculated as follows:

$$[Pb_f] = [fPb_{1.2}] – [fPb_{0.1}]$$

Percent of fine particulate lead %[Pb_f] shall be calculated as follows:

$$\%[Pb_f] = \{[Pb_f] \div [Pb_{tp}]\} \times 100$$

Filtration procedure

The filter apparatus for particulate lead sample preparation shall consist of a polypropylene syringe attached to a 0.1 or 1.2 micron absolute disposable syringe filter (Pall Acrodisc® supor® membrane, 32 mm[13] or Millipore Millex-VV® PVDF membrane[14]). Filtration shall be performed by filling the syringe without the syringe filter in place, installing the syringe filter, and then pushing the plunger to dispense the filtrate into the sample bottle. Filtration shall be conducted under moderate pressure with a minimum delivery rate of 1 mL/sec. An alternate syringe filter may be used if it has been validated by the analysis of a minimum of seven sample pairs of the lead test water in parallel with one of the recommended filter membranes. The filtered and unfiltered sample pairs for each membrane type shall be evaluated using a statistical paired two samples for means t-test at 95% confidence, n=7 (or greater), and hypothesized mean difference of zero (no statistical difference). A successful result is achieved when there is no statistically significant difference between the membrane types at 95% confidence.

NOTE – Disposable syringe filters are meant for single-use only and shall not be reused. Reuse of the syringe filter has been shown to significantly affect the filter's performance, due to the fact that any particulate collected on the syringe filter can dissolve back into solution.

7.4.3.4 Servicing of components

If clogging occurs, systems with separate mechanical filtration components shall have the mechanical filtration components replaced or serviced in accordance with the manufacturer's instructions to maintain the test flow rate.

[13] Pall Corporation, 2200 Northern Boulevard, East Hills, NY 11548 <www.pall.com>.

[14] Millipore, 290 Concord Road, Billerica, MA 01821 <www.millipore.com>.

7.4.3.5 Metals reduction waters for lead

7.4.3.5.1 Test water for lead pH 6.5 testing

A public water supply shall be used and the following specific characteristics shall be maintained throughout the test for metals reduction claims:

alkalinity (as $CaCO_3$)	10 – 30 mg/L
hardness (as $CaCO_3$)	10 – 30 mg/L
pH	6.5 ± 0.25
polyphosphate (as P)	< 0.5 mg/L
TDS	< 100 mg/L
temperature	20 ± 2.5 °C (68 ± 5 °F)
turbidity	< 1 NTU

NOTE – Where precipitation of the metals occurs, deionized water shall be used instead of water from a public water supply. Appropriate calcium salts, or magnesium salts, or both, shall be added to provide the desired TDS (refer to table of standard Ksp values). The pH adjustment required shall not cause precipitation of the metals.

7.4.3.5.2 Test water for lead pH 8.5 testing

The lead pH 8.5 test water shall be prepared following the prescribed procedure in order to control the formation of a specific amount of particulate lead. The formation of particulate lead is sensitive to the cleanliness of the equipment, the design of the equipment, and exact methods used. The amount of total particulate lead [Pb_t] and fine particulate lead [Pb_f] in the test water is determined as described in 7.4.3.3.2.

7.4.3.5.2.1 Demonstration of laboratory capability

The test equipment used and the procedures employed for conducting the test shall demonstrate the capability of meeting the requirements for the lead pH 8.5 test. Each type of test equipment or apparatus (refer to 7.1.2, figure 2) used for lead pH 8.5 testing shall be validated under this section.

Each type of test equipment used for lead pH 8.5 testing shall be validated against this procedure prior to testing. The test water shall be prepared as required under 7.4.3.5.2.3 three times for each type of test equipment. The test equipment shall deliver the test water to the test unit connection points and maintain the total and particulate lead percentages over a minimum of 24 h for each test water preparation as follows:

Total Lead Concentration (ug/L) [Pb_t]	All influent samples shall be within 10% of the mean over 24 h.
Total Percent Particulate Lead %[Pb_{tp}]	Average 20 – 40%, all sample points within 10 – 50%.
Percent Fine Particulate Lead %[Pb_f]	Minimum of 20% for all sample points.

Samples shall be collected 20 min, 4 h, 8 h, and 24 h after the completion of test water preparation. Samples shall be collected from the test unit connection (or dispensing) points on the test equipment.

7.4.3.5.2.2 Test equipment cleaning and conditioning

The test equipment shall have all surfaces in contact with the test water cleaned prior to testing to remove excess particulate and biological material. Test equipment that is used exclusively for lead pH 8.5

reduction can conduct several tests sequentially if the particulate levels specified in 7.4.3.5.2.1 are maintained.

NOTE 1 – Experience in the laboratory has suggested that a dedicated tank should not be used for longer than 21 days without cleaning. This is highly dependent on the construction of the tank system as well as the cleaning method.

NOTE 2 – Fine lead particulate is highly sensitive to the presence of iron, aluminum, or zinc corrosion in any of the test equipment or vessels that come into contact with any of the solutions or test water. If any of these corrosion products are present, the fine particulate will increase in size until no fine lead particulate is present in the test water.

7.4.3.5.2.2.1 Test equipment cleaning

The test equipment shall be cleaned using an acid wash to remove excess particulate from the test equipment. This shall be accomplished by filling the equipment with a 0.003 N HCl solution and recirculating through the tank and plumbing for 2 h. A RO/DI rinse shall be completed after the acid wash. Other acidic solutions may be used if they are shown to clean the test rig properly without adversely affecting the formation of particulate lead.

7.4.3.5.2.2.2 Test equipment conditioning

The test equipment shall be conditioned after cleaning by adding 150 ppb lead from the acidified stock to RO/DI water for a minimum of 8 h (pH below 7.5). The lead solution shall be circulated through the tank and plumbing to condition all of the wetted surfaces. Modification of the conditioning procedure may be made if it is demonstrated that the modifications improve the stability or formation of total and particulate lead.

7.4.3.5.2.3 Lead pH 8.5 reduction test water

The lead pH 8.5 reduction test water shall be prepared as follows:

1) A water supply shall be treated by reverse osmosis and then shall be treated with deionization (RO/DI water) and shall have a conductivity of less than 2 μS/cm. A test equipment tank shall be filled with the RO/DI water.

2) Use reagent grade chemicals for all additions to adjust the RO/DI water to meet the following specific characteristics:

Parameter	Target Value	Overall Average Tolerance	Single Point Tolerance
hardness (as $CaCO_3$)	100 mg/L	± 10%	± 20%
alkalinity (as $CaCO_3$)	100 mg/L	± 10%	± 20%
total chlorine	0.50 mg/L	± 0.25 mg/L	± 0.25 mg/L
pH	8.5	8.30 – 8.60	8.25 – 8.75
temperature	20.0 ^{o}C	± 2.5 ^{o}C	± 2.5 ^{o}C

7.4.3.5.2.3.1 Solution preparation

The solutions for generating the lead pH 8.5 test water shall be prepared as follows:

– Calcium Chloride Solution

Add Calcium Chloride ($CaCl_2 \bullet 2H_2O$) to RO/DI H_2O to obtain a solution concentration of 38 g/L.

– Magnesium Sulfate Solution

Add Magnesium Sulfate ($MgSO_4 \bullet 7H_2O$) to RO/DI H_2O to obtain a solution concentration of 32 g/L.

– Sodium Bicarbonate Solution

Add Sodium Bicarbonate ($NaHCO_3$) to RO/DI H_2O to obtain a solution concentration of 63 g/L.

– Sodium Hypochlorite Solution

Commercial grade bleach solution may be used with a concentration between 5 – 7% NaClO.

– Soluble Lead Stock Solution

4 mL 1:1 diluted concentrated Nitric Acid to 1 L RO/DI H_2O; then add 3.6 g $Pb(NO_3)$. Store the solution in a plastic container for no more than 90 days.

– Insoluble Lead Stock Solution

Add 1.6 g $Pb(NO_3)$ to 1 L RO/DI H_2O (RO/DI pH should be already below 6.5; if it is not, let the water sit with exposure to the atmosphere until its pH is below 6.5). Store the solution in a plastic container for no more than 30 days.

7.4.3.5.2.3.2 Method of test water preparation

1) Mix tank during all additions. Mix the solution adequately after the addition of all chemicals prior to pH adjustment to ensure a homogeneous solution.

2) Mix the tank again after each pH adjustment or lead addition to ensure homogeneity.

NOTE – Length and type of mixing may affect the amount of total particulate lead and the relative amounts of fine and coarse particulate lead. High-speed vortex mixing of the tank for extended periods of time should be avoided. Mixing should be minimized after the initial formation of lead particulate to improve the stability of the fine particulate.

3) Do not mix tank excessively during use; only mix enough to ensure a homogeneous challenge. It is recommended that mixing occur at a maximum of 5 min/h.

4) Do not use the tank of test water for longer than 24 h.

5) Add chemicals and make adjustments in order as listed in the Table below. Use the exact chemical formula as indicated. Adjustments may be made in the amount added to meet the specific characteristics under 7.4.3.5.2.3. Sequence and method of additions must be adhered to for the proper formation of particulate lead. The procedure may be scaled up or down depending on the volume requirements of the test.

Action	Chemical Name	Formula	Per 380 L (100 gal)
fill tank with RO/DI water	RO/DI water	H_2O	380 L
add magnesium solution	magnesium sulfate (32 g/L)	$MgSO_4 \bullet 7H_2O$	1.0 L
add calcium solution	calcium chloride (38 g/L)	$CaCl_2 \bullet 2H_2O$	1.0 L
add bicarbonate solution	sodium bicarbonate (63 g/L)	$NaHCO_3$	1.0 L
add bleach solution	sodium hypochlorite (6% bleach)	NaClO	4 mL
adjust pH of solution	sodium hydroxide or hydrochloric acid	NaOH or HCl	as needed
verify temperature			
verify total chlorine			
add soluble lead stock solution	lead stock solution – soluble[1]	$Pb(NO_3)_2$	20 mL[1]
add insoluble lead stock – see preparation method	lead stock solution – insoluble[2]	$Pb(NO_3)_2$	20 mL[2]

[1] Add directly to tank.
[2] Insoluble Lead Preparation:

1) Use a plastic container that is sized no larger than 100 times (100x) the volume of stock solution required for the volume of test water being prepared (example: if 20 mL of insoluble lead stock is used, a container no larger than 2L shall be used).

2) Fill the container with prepared tank water (after temperature and chlorine are verified) to a volume that is equal to 50 times (50x) the volume of insoluble lead stock solution required for the volume of test water being prepared (example: if 20 mL of insoluble lead stock is used, 1,000 mL of prepared tank water is added).

3) Place the plastic container on a stir plate with a PTFE coated stir bar. Turn the stir plate speed up until the solution is mixing rapidly and a strong vortex to the bottom of the container is formed.

4) Measure out the required volume of insoluble lead stock solution in a non-glass measuring vessel and add the stock solution all at once to the mixing solution in the container.

5) Allow the solution to mix for 60 s and then immediately pour the solution into the entire tank volume.

7.4.3.6 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

7.4.3.7 Methods

7.4.3.7.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the test water specified in 7.4.3.5. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable by setting an initial dynamic pressure of 410 ± 20 kPa (60 ± 3 psi). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The operating cycle specified in 7.4.3.6 shall be used.

7.4.3.7.1.1 Refrigerator filters without integral flow control

Chemical reduction testing for refrigerator filters without an integral automatic fixed flow-rate control shall be performed at a controlled flow rate that is equal to or greater than the rated service flow of the refrigerator filter system and refrigerator plumbing.

7.4.3.7.1.2 Refrigerator filters without integral flow control, with water dispenser and ice maker

If the refrigerator filter does not include an integral automatic fixed flow-rate control, and supplies water to both a water dispenser and an ice maker, then any chemical reduction testing shall be performed at a controlled flow rate equal to or greater than the tested flow rate of the icemaker or the tested flow rate of the water dispenser, whichever is greater.

7.4.3.7.2 Plumbed-in systems with reservoirs

The method specified in 7.4.3.7.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.4.3.6, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.4.3.7.3 Nonplumbed pour-through-type batch treatment systems

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.4.3.7.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate test water specified in 7.4.3.5 with the test contaminant present.

7.4.3.7.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.4.3.5 with the test contaminant present.

7.4.3.8 Sampling

During performance of the lead pH 8.5 test, in addition to total lead [Pb_t] for each sample, total percent particulate %[Pb_{tp}] and percent fine particulate [Pb_f] shall be determined at each influent sample point.The pH of the influent shall be analyzed prior to each influent sample point and verified to meet the requirements in 7.4.3.5.2.3. All reported test sample points shall meet the requirements in Table 13.

For systems with performance-indication devices, during the "on" portion of the cycle, influent and effluent test samples shall be collected at the start of the test (after the passage of 10 unit volumes of influent challenge) and at 25%, 50%, 75%, 100%, and 120% of the estimated capacity. For systems without performance indication devices, the system shall be tested to 200% of the estimated capacity. Test Samples shall be collected at startup (after the passage of 10 unit volumes) and at 50%, 100%, 150%, 180%, and 200% of the estimated capacity. Samples for each system shall be collected in the last half of the “on” portion of the cycle. Batch systems shall have the sample collected from the entire batch volume.

7.4.4 Mercury reduction testing

7.4.4.1 Mercury reduction claim

Claims for mercury reduction may be made when tested in accordance with 7.4.4.1. To qualify for a mercury reduction claim, the system shall reduce the influent concentration(s) so that all effluent concentrations are less than or equal to the maximum effluent concentrations shown in Table 15.

Table 15 – Mercury reduction requirements

Substance	Influent challenge[1] mg/L	Maximum effluent concentration mg/L	USEPA method(s)	Compound
mercury	0.006 ± 10% [1b] (added as inorganic mercury)	0.002	200.8	$Hg(NO_3)_2 \cdot H_2O$

[1] Reason for influent challenge levels: challenge concentrations should be selected to simulate what a system will be challenged with in the field and/or to provide an accurate and reproducible indicator of performance. The following sequence of criteria is used to select challenge concentrations:

[a] The upper percentile concentration of available occurrence data (the concentration for which there is high probability [P < 0.05] that 95% of the population will be exposed to waters of lower concentration). Occurrence data shall come from national monitoring programs administered by the USEPA or the USGS. Other occurrence data shall be accepted by the Joint Committee on Drinking Water Treatment Units.

[b] The concentration obtained by multiplying the USEPA's published maximum contaminant level by three. This concentration will not be adequate when USEPA MCL is very low.

7.4.4.2 Apparatus

Refer to 7.1.2, figure 2, for an example of the test apparatus.

7.4.4.3 Analytical methods

All analyses shall be conducted in accordance with the applicable methods referenced in 2.

7.4.4.4 Premature filter plugging

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Applicable actions to remediate premature filter plugging for this test method are contained in Annex H, Sections H.1, H.3 and H.6.

7.4.4.5 Mercury reduction test waters

A public water supply or RO/DI water (if premature clogging is of concern) shall be used and the following specific characteristics shall be maintained throughout the test for mercury reduction claims:

	low pH	high pH
alkalinity (as $CaCO_3$)	10 – 30 mg/L	100 – 250 mg/L
hardness (as $CaCO_3$)	10 – 30 mg/L	100 – 200 mg/L
pH	6.5 ± 0.25	8.5 ± 0.25
polyphosphate (as P)	< 0.5 mg/L	< 0.5 mg/L
TDS	< 100 mg/L	200 – 500 mg/L
temperature	20 ± 2.5 °C (68 ± 5 °F)	20 ± 2.5 °C (68 ± 5 °F)

turbidity	< 1 NTU	< 1 NTU

7.4.4.5.1 Mercury reduction pH 8.5 test waters

Appropriate calcium, or magnesium salts, or both, shall be added to provide the desired TDS (refer to table of standard Ksp values). The pH adjustment required shall not cause precipitation of the metals.

7.4.4.6 Cycle time

The systems shall be operated on a 50%-on / 50%-off cycle basis with a 15- to 40-min cycle, 16 h per 24-h period, followed by an 8-h rest under pressure (a 10%-on / 90%-off cycle may be used if requested by the manufacturer).

7.4.4.7 Methods

7.4.4.7.1 Plumbed-in systems without reservoirs and all faucet-mounted systems

Two systems shall be conditioned in accordance with the manufacturer's instructions using the appropriate general test water specified in 7.4.4.5. The systems shall be tested using the appropriate influent challenge water at the maximum flow rate attainable by setting an initial dynamic pressure of 410 ± 20 kPa (60 ± 3 psi). The pressure shall not be readjusted although the system may experience some change in dynamic pressure. The operating cycle specified in 7.4.4.6 shall be used.

7.4.4.7.2 Plumbed-in systems with reservoirs

The method specified in 7.4.4.7.1 shall be followed except that where the design of the system does not lend itself to the operating cycle specified in 7.4.4.6, the operating cycle shall be a repetitive complete filling and emptying of the reservoir. This cycle may be continued for 24 h/d.

7.4.4.7.3 Nonplumbed pour-through-type batch treatment systems

Two systems shall be tested using the appropriate challenge and influent water after establishment of the manufacturer's recommended use pattern, with automatic cycling. If there is not a recommended use pattern, the systems shall be operated on the basis of four times the bed volume per batch. The cycle shall include a rest period of 15 to 60 s between batches, timed from the cessation of streamed flow.

7.4.4.7.3.1 Mouth drawn drinking water treatment units

Products meeting the definition for mouth drawn drinking water treatment unit shall be evaluated using the method specified in Annex F.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.4.4.5 with the test contaminant present.

7.4.4.7.3.2 Squeeze bottle drinking water treatment units

Products meeting the definition for squeeze drawn drinking water treatment unit shall be evaluated using the method specified in Annex G.

Two units shall be conditioned in accordance with the manufacturer’s instructions using the appropriate general test water specified in 7.4.4.5 with the test contaminant present.

7.4.4.8 Sampling

For systems with performance-indication devices, during the "on" portion of the cycle, influent and effluent samples shall be collected at the start of the test (after the passage of 10 unit volumes of influent

challenge) and at 25%, 50%, 75%, 100%, and 120% of the estimated capacity. For systems without performance indication devices, the system shall be tested to 200% of the estimated capacity. Samples shall be collected at startup (after the passage of 10 unit volumes) and at 50%, 100%, 150%, 180%, and 200% of the estimated capacity. Samples for each system shall be at least one unit volume.

8 Instruction and information

8.1 Installation, operation, and maintenance instructions

8.1.1 Information setting forth complete, detailed instructions for installation, operation, and maintenance shall be provided with each system. Specific instructions shall include:

– complete name, address, and telephone number of manufacturer;

– model number and trade designation;

– flushing and conditioning procedures;

– rated service flow in L/min or L/day (gpm or gpd);

– maximum working pressure in kPa (psig);
– maximum operating temperature in degrees C (degrees F);

– detailed installation instructions including an explanation or schematic diagram of proper connections to the plumbing system;

– operation and maintenance requirements (including user responsibility, parts, and service);

– sources of supply for replaceable components;

– statement noting the need for the system and installation to comply with state and local laws and regulations;

– statement noting that the system is to be supplied only with cold water;

– statement noting that the system conforms to NSF/ANSI 53 for the specific performance claims verified and substantiated by test data;

– for systems used in bottled water plants, a statement noting the redundant filtration element sealing mechanism, such as 222 and 226 double o-ring seals; and

– statement for arsenic reduction systems:

> "This system has been tested for the treatment of water containing pentavalent (also known as As(V), As(+5), or arsenate) and trivalent arsenic (also known as As(III), As(+3), or arsenite) at concentrations of [0.050 mg/L or 0.30 mg/L] or less. This system reduces both forms of arsenic below EPA MCL. Please see the Arsenic Facts section of the Performance Data Sheet for further information."

8.1.2 Where applicable and appropriate, the following information shall also be included:

– model number(s) of replacement components;

– rated capacity / rated service life in liters (gallons);

NOTE – Each unique model designation shall claim a capacity no greater than the least reduction capacity that has been verified through testing to NSF/ANSI 42, NSF/ANSI 53, or NSF/ANSI 58 section for VOC reduction.

– minimum working pressure in kPa (psig);

– minimum operating temperature in degrees C (degrees F);

– electrical requirements;

– statement for activated carbon systems: “Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.” Additional statement for activated carbon systems claiming cyst reduction: “Systems certified for cyst reduction may be used on disinfected waters that may contain filterable cysts.”;

– explicit instructions explaining how the performance indicator functions;

– diagram showing proper air gap installation to waste connections;

– for systems claiming radon reduction, a statement that the system shall not be used on water sources with a radon activity greater than 4000 pCi/L and the manufacturer’s recommended replacement schedule for the carbon filter (to a maximum of one year);

– for systems claiming cyst reduction: The percentage of cyst reduction shall be included in the claim if the claim is described as cyst removal; and

– for systems claiming radon reduction, a statement that the system treats radon from drinking water only and does not reduce radon from indoor air.

– for products meeting the definition for personal hand held devices, a statement that these devices are for individual use only.

8.1.3 Where appropriate and applicable, and where product packaging contains information for the prospective purchaser, the following information shall be included on the product packaging in a location visible to the purchaser:

– statement for pentavalent arsenic reduction systems: “This system has been tested for the treatment of water containing pentavalent arsenic (also known as As(V), As(+5), or arsenate) at concentrations of [0.050 mg/L or 0.30 mg/L] or less. This system reduces pentavalent arsenic, but may not reduce other forms of arsenic. This system is to be used on water supplies containing a detectable free chlorine residual or on water supplies that have been demonstrated to contain only pentavalent arsenic. Treatment with chloramine (combined chlorine) is not sufficient to ensure complete conversion of trivalent arsenic to pentavalent arsenic. Please see the Arsenic Facts section of the Performance Data Sheet for further information.” and

– for systems claiming cyst reduction: The percentage of cyst reduction shall be included in the claim if the claim is described on the packaging as cyst removal.

8.2 Data plate

8.2.1 A permanent plate or label shall be affixed in a readily accessible location on each system, and shall contain, at a minimum, the following information:

– model number;

– name and address of manufacturer;

– functional description of system (e. g., chemical reduction or mechanical reduction, or both);

– maximum operating temperature in degrees C (degrees F);

– maximum working pressure in kPa (psig); and

– statement noting that the system conforms to NSF/ANSI 53 for the specific performance claims verified and substantiated by test data.

Components that have been evaluated only for design and construction, materials, or both, shall be exempt from this requirement.

8.2.2 Commercial modular manifolds shall have a permanent plate or label affixed in a readily accessible location on the system that shall contain, at a minimum, the following information:

– general system name;

– the statements “Not for residential use. Food service applications only. To be installed by an authorized plumber or an authorized representative of the manufacturer only”;

– statement that this modular element is NOT for use in residental applications;

– name and address of manufacturer;

– maximum working pressure in kPa (psig); and

– maximum operating temperature in degrees C (degrees F).

8.2.3 Where applicable and appropriate, the following information shall also be included:

– model number(s) of replacement components;

– electrical requirements;

– statement for activated carbon systems: “Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.” Additional statement for activated carbon systems claiming cyst reduction: “Systems certified for cyst reduction may be used on disinfected waters that may contain filterable cysts”;

NOTE – Where the physical size of the system does not permit affixing the caution statement, the statement shall be prominently displayed in the literature accompanying the system.

– statement for systems claiming VOC reduction: "Conforms to NSF/ANSI 53 for VOC reduction. See performance data sheet for individual contaminants and reduction performance.";

NOTE – Manufacturers may reference individual chemicals from Table 16 on labels, manuals, or promotional materials if such information conforms to the following:

– percent reductions, if specified, are either less than or equal to those specified in Table 10, or additional testing is completed to justify the claim for a higher percent reduction.

– reference to individual chemicals from Table 16 shall not imply that specific testing for the chemical was conducted if only the surrogate test was completed.

– for systems claiming radon reduction, the manufacturer's recommended replacement schedule for the carbon filter (to a maximum of one year);

– statement for systems claiming pentavalent arsenic reduction: "Conforms to NSF/ANSI 53 for pentavalent arsenic reduction. See performance data sheet and Arsenic Facts section for an explanation of reduction performance.";
– for systems claiming cyst reduction: The percentage of cyst reduction shall be included in the claim if the claim is described as cyst removal; and

– statement for systems claiming arsenic reduction: "Conforms to NSF/ANSI 53 for arsenic (pentavalent and trivalent) reduction. See performance data sheet and Arsenic Facts section for an explanation of reduction performance."

8.2.4 Modular elements shall have a permanent plate or label affixed in a readily accessible location on the modular element that shall contain, at a minimum, the following information:

– modular element model number;

– functional description of modular element (e. g., chemical reduction or mechanical reduction, or both);

– statement that the modular element conforms to NSF/ANSI 42 or 53 for the specific performance claims verified and substantiated by test data;

– statement that this modular element is NOT for use in residential applications; and

– the manufacturer-specific standard head or manifold to which the element can be inserted.

8.2.5 Where applicable and appropriate, the following information shall also be included:

– rated capacity/rated service life in liters (gallons). If applicable rated capacity/rated service life in liters (gallons) is not included on the modular element data plate, a statement indicating that rated capacity/rated service life in liters (gallons) may be found on the performance data sheet shall be included;

> NOTE – Each unique model number designation shall not claim a capacity or service life greater than the least reduction capacity or service life that has been verified through testing to NSF/ANSI 42 or 53.

– operating or exchange steps; and

– statement for activated carbon systems: "Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system."

8.3 Replacement components

8.3.1 The packaging of components specifically for replacement purposes shall be labeled with the following information:

– model number or name of component;
– model number of system(s) in which the component is to be used; and
– name and address of manufacturer.

8.3.2 Where applicable, the following information shall also be stated:

– rated capacity/rated service life in liters (gallons);

NOTE – Each unique model designation shall not claim a capacity or service life greater than the least reduction capacity or service life that has been verified through testing to NSF/ANSI 53.

– operating or exchange steps;

– statement noting that the system(s) conform(s) to NSF/ANSI 53 for the specific performance claims as verified and substantiated by test data;

– statement for systems claiming VOC reduction: "Conforms to NSF/ANSI 53 for VOC reduction. See performance data sheet for individual contaminants and reduction performance.";

NOTE – Manufacturers may reference individual chemicals from Table 16 on labels, manuals, or promotional materials if such information conforms to the following:

– percent reductions if specified are either less than or equal those specified in Table 10 or additional testing is completed to justify the claim for a higher percent reduction.

– reference to individual chemicals from Table 16 shall not imply that specific testing for the chemical was conducted if only the surrogate test was completed.

– statement for systems claiming pentavalent arsenic reduction: “Conforms to NSF/ANSI 53 for pentavalent arsenic reduction. See performance data sheet and Arsenic Facts section for an explanation of reduction performance”;

– statement for activated carbon systems: “Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.” Additional statement for activated carbon systems claiming cyst reduction: “Systems certified for cyst reduction may be used on disinfected waters that may contain filterable cysts”;

NOTE – Where the physical size of the component does not permit affixing the caution statement, the statement shall be prominently displayed in the literature accompanying the system.

– for systems used in bottled water plants, a statement noting the redundant filtration element sealing mechanism, such as 222 and 226 double o-ring seals;

– for systems claiming radon reduction, the manufacturer’s recommended replacement schedule for the carbon filter (to a maximum of one year);

– for systems claiming cyst reduction: The percentage of cyst reduction shall be included in the claim if the claim is described on the replacement element packaging as cyst removal; and

– statement for systems claiming arsenic reduction: “Conforms to NSF/ANSI 53 for arsenic (pentavalent and trivalent) reduction. See performance data sheet and Arsenic Facts section for an explanation of reduction performance.”

8.4 Performance data sheet

8.4.1 A performance data sheet shall be available to potential buyers for each system and shall include the following information:

– complete name, address, and telephone number of manufacturer;

– model number and trade designation;

– statement for claims: “This system has been tested according to NSF/ANSI 53 for reduction of the substances listed below. The concentration of the indicated substances in water entering the system was reduced to a concentration less than or equal to the permissible limit for water leaving the system, as specified in NSF/ANSI 53.”

NOTE 1 – Minimum substance reductions per NSF/ANSI 53 shall be listed using the values in Tables 16, 17, and 18.

NOTE 2 – In addition to this statement, advertising materials may show the average percent reduction determined during verification.

NOTE 3 – Average concentrations shall be the arithmetic mean of all reported influent challenge or product water concentrations (the detection limit value shall be used for any nondetectable concentrations). The specified percent reduction shall not be greater than the reduction calculated using the arithmetic means of the influent challenge and the product water concentrations respectively.

Table 16 – Performance data sheet reduction claims

Substance	Influent challenge concentration mg/L	Maximum permissible product water concentration mg/L
alachlor	0.04 ± 10%	0.002
arsenic (pentavalent)	0.050 ± 10%	0.010
arsenic (pentavalent)	0.30 ± 10%	0.010
atrazine	0.009 ± 10%	0.003
barium	10 ± 10%	2
benzene	0.015 ± 10%	0.005
cadmium	0.03 ± 10%	0.005
carbofuran	0.08 ± 10%	0.04
carbon tetrachloride	0.015 ± 10%	0.005
chlordane	0.04 ± 10%	0.002
chlorobenzene	2.0 ± 10%	0.1
chromium (hexavalent)	0.3 ± 10%	0.1
chromium (trivalent)	0.3 ± 10%	0.1
chromium (hexavalent and trivalent)	0.3 ± 10%	0.05 (hexavalent) and 0.05 (trivalent)
copper	3.0 ± 10%	1.3
2,4-D	0.210 ± 10%	0.07
dibromochloropropane	0.004 ± 10%	0.0002
o-dichlorobenzene	1.8 ± 10%	0.6
p-dichlorobenzene	0.225 ± 10%	0.075
1,2-dichloroethane	0.015 ± 10%	0.005
1,1-dichloroethylene	0.021 ± 10%	0.007
cis-1,2-dichloroethylene	1.4 ± 10%	0.07
trans-1,2-dichloroethylene	2.0 ± 10%	0.1
1,2-dichloropropane	0.015 ± 10%	0.005
dinoseb	0.021 ± 10%	0.007
endrin	0.006 ± 10%	0.002
ethylbenzene	2.1 ± 10%	0.7
ethylene dibromide	0.001 ± 10%	0.00005
fluoride	8.0 ± 10%	1.5
heptachlor (H-34, heptox)	0.08 ± 10%	0.0004
heptachlor epoxide	0.004 ± 10%	0.0002
hexachlorocyclopentadiene	0.15 ± 10%	0.05
lead	0.15 ± 10%	0.010
lindane	0.002 ± 10%	0.0002
mercury	0.006 ± 10%	0.002
methoxychlor	0.12 ± 10%	0.04
methyl *tert*-butyl ether	0.015 ± 20%	0.005
nitrate plus nitrite nitrate nitrite	30 ± 10% 27 ± 10% 3 ± 10%	10 10 1
pentachlorophenol	0.01 ± 10%	0.001
polychlorinated biphenyls (PCBs, aroclor 1260)	0.01 ± 10%	0.0005
radon	4000 ± 1000 pCi/L	300 pCi/L

Table 16 – Performance data sheet reduction claims

Substance	Influent challenge concentration mg/L	Maximum permissible product water concentration mg/L
selenium	0.10 ± 10%	0.05
simazine	0.012 ± 10%	0.004
styrene	2.0 ± 10%	0.1
2,4,5-TP(silvex)	0.15 ± 10%	0.05
tetrachloroethylene	0.015 ± 10%	0.005
toluene	3.0 ± 10%	1
toxaphene	0.015 ± 10%	0.003
1,2,4-trichlorobenzene	0.21 ± 10%	0.07
1,1,1-trichloroethane	0.6 ± 10%	0.2
1,1,2-trichloroethane	0.015 ± 10%	0.005
trichloroethylene	0.300 ± 10%	0.005
TTHM (as chloroform)	0.45 ± 20%	0.080
xylenes	30 ± 10%	10.0
turbidity	11 ± 1 NTU	0.5 NTU

– concluded –

Table 17 – Performance data sheet reduction claims for organic chemicals included by surrogate testing

Substance	Influent challenge concentration mg/L	Maximum permissible product water concentration mg/L
alachlor	0.050	0.001
atrazine	0.100	0.003
benzene	0.081	0.001
carbofuran	0.190	0.001
carbon tetrachloride	0.078	0.0018
chlorobenzene	0.077	0.001
chloropicrin	0.015	0.0002
2,4-D	0.110	0.0017
dibromochloropropane (DBCP)	0.052	0.00002
o-dichlorobenzene	0.080	0.001
p-dichlorobenzene	0.040	0.001
1,2-dichloroethane	0.088	0.0048
1,1-dichloroethylene	0.083	0.001
cis-1,2-dichloroethylene	0.170	0.0005
trans-1,2-dichloroethylene	0.086	0.001
1,2-dichloropropane	0.080	0.001
cis-1,3-dichloropropylene	0.079	0.001
dinoseb	0.170	0.0002
endrin	0.053	0.00059
ethylbenzene	0.088	0.001
ethylene dibromide (EDB)	0.044	0.00002

Table 17 – Performance data sheet reduction claims for organic chemicals included by surrogate testing

Substance	Influent challenge concentration mg/L	Maximum permissible product water concentration mg/L
haloacetonitriles (HAN):		
bromochloroacetonitrile	0.022[1]	0.0005
dibromoacetonitrile	0.024	0.0006
dichloroacetonitrile	0.0096	0.0002
trichloroacetonitrile	0.015	0.0003
haloketones (HK):		
1,1-dichloro-2-propanone	0.0072	0.0001
1,1,1-trichloro-2-propanone	0.0082	0.0003
heptachlor	0.025	0.00001
heptachlor epoxide	0.0107	0.0002
hexachlorobutadiene	0.044	0.001
hexachlorocyclopentadiene	0.060	0.000002
lindane	0.055	0.00001
methoxychlor	0.050	0.0001
pentachlorophenol	0.096	0.001
simazine	0.120	0.004
styrene	0.150	0.0005
1,1,2,2-tetrachloroethane	0.081	0.001
tetrachloroethylene	0.081	0.001
toluene	0.078	0.001
2,4,5-TP (silvex)	0.270	0.0016
tribromoacetic acid	0.042	0.001
1,2,4-trichlorobenzene	0.160	0.0005
1,1,1-trichloroethane	0.084	0.0046
1,1,2-trichloroethane	0.150	0.0005
trichloroethylene	0.180	0.0010
trihalomethanes (includes): chloroform (surrogate chemical) bromoform bromodichloromethane chlorodibromomethane	0.300	0.015
xylenes (total)	0.070	0.001

– concluded –

Table 18 – Performance data sheet performance claims for percent reduction

Substance	Influent challenge concentration	Reduction requirement
asbestos	10^7 to 10^8 fibers/L; fibers greater than 10 µm in length	99%
cyst	minimum 50,000/L	99.95%

– statement for systems claiming pentavalent arsenic reduction: “Conforms to NSF/ANSI 53 for pentavalent arsenic reduction. See performance data sheet and arsenic facts section for an explanation of reduction performance.”;

– rated service flow rate in L/min or L/day (gpm or gpd);

– rated capacity/rated service life in liters (gallons);

NOTE – Each unique model designation shall not claim a capacity or service life greater than the least reduction capacity or service life that has been verified through testing to NSF/ANSI 53.

– maximum working pressure in kPa (psig);

– maximum operating temperature in degrees C (degrees F);

– general installation conditions and needs;

– general operation and maintenance requirements including, but not limited to:

  – suggested frequency of component change or service to the system;
  – user responsibility; and
  – parts and service availability.

– manufacturer's limited warranty; and

– statement that while testing was performed under standard laboratory conditions, actual performance may vary.

8.4.2 For commercial systems, in addition to the requirements set forth in 8.4.1, additional considerations are as follows:

– a performance data sheet may be developed for each modular element of the system, and/or for a group of modular elements; and

– the performance data sheet shall include all of the configurations, providing the following information for each:

  – tested performance claims;

  – rated service flow in L/min or L/day (gpm or gpd);

  – rated capacity/rated service life in L (gal) (if applicable);

  – maximum working pressure in kPa (psig); and

  – maximum operating temperature in degrees C (degrees F).

8.4.3 Where applicable and appropriate, the following information shall also be included:

– model number of replacement component;

– electrical requirements;

– pressure drop of new system in kPa (psig) at rated flow (POE and bottled water systems only);

– minimum working pressure in kPa (psig);

– minimum operating temperature in degrees C (degrees F);

– statement for activated carbon systems: “Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.” Additional statement for activated carbon systems claiming cyst reductions: “Systems certified for cyst reduction may be used on disinfected waters that may contain filterable cysts.”;

– statement for pentavalent arsenic reduction systems: “This system has been tested for the treatment of water containing pentavalent arsenic (also known as As(V), As(+5), or arsenate) at concentrations of [0.050 mg/L or 0.30 mg/L] or less. This system reduces pentavalent arsenic, but may not reduce other forms of arsenic. This system is to be used on water supplies containing a detectable free chlorine residual or on water supplies that have been demonstrated to contain only pentavalent arsenic. Treatment with chloramine (combined chlorine) is not sufficient to ensure complete conversion of trivalent arsenic to pentavalent arsenic. Please see the Arsenic Facts section of the Performance Data Sheet for further information.”

– statement for arsenic reduction systems: “This system has been tested for the treatment of water containing pentavelent and trivalent arsenic at concentrations of [0.050 mg/L or 0.30 mg/L] or less. This system reduces both pentavalent arsenic (also known as As(V), As(+5), or arsenate) and trivalent arsenic (also known as As(III), As(+3), or arsenite)] trivalent arsenic below EPA MCL. Please see the Arsenic Facts section of the Performance Data Sheet for further information.”

– for pentavalent arsenic reduction systems, explanation of the pentavalent arsenic claim in a separate section titled “Arsenic Facts,” in at least 10 point font, at a minimum describing the following:

– the occurrence and forms of arsenic in water and a general statement of the difference in their health effects;

– explanation of methods or procedures for determining whether the consumer’s source water contains pentavalent arsenic and whether the system is effectively removing arsenic following installation;

– the specific arsenic removal claim for which the system has been evaluated, the influent concentration for which the system was tested, and the treatment capacity;

– conditions under which the pentavalent arsenic removal performance of the system may be limited (iron-containing water or other water quality conditions, etc.); and

– information identifying the arsenic removal component of the system, the frequency of replacement of the removal component of the system, and sources of replacement components.

NOTE – Examples of these performance data sheet requirements are available in Annex C. Where the above information requirements are presented in other sections of the product data sheet, they need not be repeated, but should be referenced.

– for systems claiming radon reduction, a statement that the system shall not be used on water sources with a radon activity greater than 4000 pCi/L and the manufacturer’s recommended replacement schedule for the carbon filter (to a maximum of one year);

– for systems claiming radon reduction, a statement that the system treats radon from drinking water only, and does not reduce radon from indoor air;

– for systems claiming radon reduction, the maximum water volume treated per day during testing;

– for systems claiming cyst reduction: The percentage of cyst reduction shall be included in the claim if the claim is described as cyst removal; and

– explanation of how the performance indicator functions.

Annex A
(normative)

Test method for detecting and enumerating *Cryptosporidium parvum* oocysts

A.1 Summary of method

An appropriate volume of sample shall be passed through a membrane filter, directly stained with fluorescent antibody, and examined under an epifluorescence microscope.

In recognition of advances that are occurring in analytical technology, certain options shall be permitted to improve detection or lower the costs of measurements, provided that all quality control acceptance criteria are met. If an analytical technique other than the techniques specified in this method is used, that technique shall have a specificity equal to or better than the specificity of the techniques in this method for *Cryptosporidium parvum* in the sample of interest. Specificity shall be defined as producing results that are equivalent to the results produced by this method for *Cryptosporidium parvum* in drinking water, and that meet all of the quality control (QC) acceptance criteria stated in this method.

A.2 Equipment

– mixer, vortexer;

– vacuum source;

– membrane, filter holder, 10 place filter manifold with collection box and stainless steel wells;

– incubator, 37 ^{o}C (99 °F), or slide warmer;

– epifluorescence microscope with filters for fluorescein isothiocyanate (FITC) dye, magnification 200x or 400x, and 1000x;

– pH meter;

– plastic sample bottles, 1 L;

– slides, glass microscope 1 in x 3 in cover slips, 25 mm^2 (1 in^2) No. 11/2;

– filters, cellulose acetate, 0.2 µm pore size, 25 mm (1 in) diameter;

– support filters, ethanol-compatible membrane, any pore size, 25 mm (1 in);

– fingernail polish, clear;

– splinter forceps;

– blunt-end filter forceps;

– latex gloves;

– 1-L PFA polytetrafluoroethylene (PTFE) separation funnel; and

– well slide, 12-mm diameter.

A.3 Reagents

– formaldehyde solution, 37% w/w;

– ethanol, 95%;

– glycerol;

– phosphate buffered saline (PBS) — a stock solution shall be prepared by dissolving 80 g sodium chloride (NaCl), 2 g potassium dihydrogen phosphate (KH_2PO_4), 29 g hydrated disodium hydrogen phosphate ($Na_2HPO_4 \cdot 12H_2O$), and 2 g potassium chloride (KCl) in water to a final volume of 1 L. A working solution shall be prepared from the stock solution by diluting 1 volume of the stock with 9 volumes of water. The pH shall be adjusted using a pH meter to 7.4 with 0.1 N HCl or 0.1 N NaOH before use;

– ethanol/glycerol series — a series of solutions shall be prepared in a 5% glycerol/reagent water solution so that the final ethanol concentration is 10%, 20%, 40%, 80%, and 90.2% (see Table A.1);

– DABCO-glycerol mounting medium (2%) — 2 g 1,4 diazabicyclo [2.2.2] octane shall be added to 95 mL of prewarmed glycerol using a magnetic stirring bar on a heating stir plate. The final volume shall be adjusted to 100 mL with additional glycerol. This solution shall be dated and stored at room temperature and shall be discarded after six months;

– bovine serum albumin (1%) — 1.0 g bovine serum albumin (BSA) shall be sprinkled into 85 mL PBS working solution, pH 7.4. The crystals shall be allowed to fall before stirring into solution with a magnetic stir bar. The volume shall be adjusted to 100 mL with PBS after the crystals have dissolved. This solution shall be dated and stored at 4 °C (39 °F) and shall be discarded after 6 months;

– normal goat serum (NGS);

– a 5-carboxy-fluorescein-labeled monoclonal antibody for *Cyrptosporidium* oocysts;

– *Cryptosporidium parvum* oocysts (live) — at least 50% viability shall be verified by the supplier. The oocysts shall be stored with 1000 I. U. / mL penicillin and 1000 µg/mL streptomycin at 4 °C (39 °F) and shall be used within eight weeks of collection; and

– polyoxyethylene sorbitan mono-oleate (0.01%).

A.4 Safety

A.4.1 The biohazard associated with, and the risk of infection from, oocysts is high in this method because live organisms are handled. This method does not purport to address all the safety problems associated with its use. It is the responsibility of the laboratory to establish appropriate safety and health practices prior to the use of this method. In particular, the analyst/technician must know and observe the safety procedures required in a microbiology laboratory that handles pathogenic organisms while preparing, using, and disposing of sample concentrates, reagents, and materials, and while operating sterilization equipment.

A.4.2 The toxicity or carcinogenicity of each compound or reagent used in this method has not been precisely determined. Each chemical compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level. The laboratory is responsible for maintaining a current awareness file of Occupational Safety and Health Administration regulations

regarding the safe handling of the chemicals specified in this method. A reference file of material safety data sheets should be made available to all personnel involved in these analyses.

A.4.3 Samples may contain high concentrations of biohazards and toxic compounds and must be handled with gloves and opened in a biological safety cabinet to prevent exposure. Reference materials and standards containing oocysts must be handled with gloves, and the analyst/technician must never place gloves in or near the face after exposure to solutions known or suspected to contain oocysts. DO NOT MOUTH PIPETTE.

A.4.4 Laboratory personnel must change gloves after handling filters and other equipment and reagents that may be contaminated. Gloves must be removed or changed before touching any other laboratory surfaces or equipment.

A.5 Enumeration of stock oocyst suspension

A.5.1 Procedure using well slides

1) The stock oocyst suspension shall be vortexed, and 10 µL of an appropriate dilution (80-120 oocysts) shall be applied to 10 wells.

2) 10 µL of a positive antigen (approximately enough for 200 oocysts) shall be applied to the positive well.

3) 75 µL of the working solution of PBS shall be applied to the negative well.

4) The wells shall be dried at 42 °C (108 °F) for 1 to 2 h.

5) After drying, 50 µL of anhydrous methanol shall be applied to each well and allowed to evaporate for 3 to 5 min.

6) A 5-carboxy-fluorescein-labeled monoclonal antibody for *Cyrptosporidium* oocysts stain shall be prepared according to the manufacturer's instructions.

7) 50 µL of a 5-carboxy-fluorescein-labeled monoclonal antibody for *Cyrptosporidium* oocysts stain shall be applied to the 12 wells and shall be incubated in a humid chamber for 45 to 60 min.

8) The wells shall be washed with the working solution of PBS three times.

9) The wells shall be mounted with 10 µL of DABCO-glycerol mounting medium.

10) The slides shall be stored at 4 °C (39 °F) in the dark until enumerated.

11) The slides shall be enumerated, and the concentration of the stock suspension shall be determined using the mean of the counts from the 10 wells.

A.6 Procedure

A.6.1 Sample collection

Influent samples shall be collected in 1-L bottles containing 1 mL 1.0% polyoxyethylene sorbitan mono-oleate (0.01%) and 20 mL 37% formaldehyde solution as a disinfectant and shall be refrigerated until analyzed. Influent samples shall be collected in triplicate.

3 L of the effluent shall be collected. The first liter of effluent shall be used as the test sample. The test samples shall be collected in 1-L bottles containing 1 mL 1.0% polyoxyethylene sorbitan mono-oleate (0.01%) and 20 mL 37% formaldehyde solution as a disinfectant and shall be refrigerated until analyzed. The second and third liters of effluent shall be used for quality control samples. The second and third liters of effluent shall be composited and poured into two 1-L bottles each containing 1 mL 1.0% polyoxyethylene sorbitan mono-oleate (0.01%) and 20 mL 37% formaldehyde solution as a disinfectant and shall be refrigerated until analyzed.

Samples shall be stained and mounted within 24 h of collection.

A.6.2 Filtration manifold preparation

The filtration manifold assembly shall be prepared by referencing the manufacturer's diagrams and instructions. The filtration manifold shall be connected to the vacuum supply using a vacuum tube containing a T-shaped tubing connector. A screw clamp shall be attached to 4 to 6 cm of latex tubing, and the latex tubing shall be attached to the stem of the "T" connector. The screw clamp shall be used as a bleeder valve to regulate the vacuum to 50 to 100 mm (2 to 4 in) of mercury.

The manifold valves shall be closed and the vacuum fully opened. The applied vacuum shall be adjusted to 50 to 100 mm (2 to 4 in) of mercury using the bleeder valve on the vacuum tubing. The bleeder valve shall not be readjusted during filtration. If necessary, the vacuum shall be turned on and off during filtration at the vacuum source.

A.6.3 Membrane filter preparation

One 25-mm (1-in) compatible membrane filter and support filter shall be used for each sample. The required number of each type of filter shall be presoaked for a minimum of 1 min in the working solution of PBS in a separate petri dish for each filter type before use. The filters shall be dropped one by one flat onto the surface of the buffer using blunt-end filter forceps. Once wetted, the filters shall be pushed under the fluid surface with the forceps and shall be allowed to soak for a minimum of 1 min before use.

The filtration manifold vacuum source shall be turned on. While all the manifold well support valves are closed, one support filter shall be placed on each manifold support screen. One 25-mm (1-in) membrane filter shall be placed on top of each support filter, adjusting with a rubber policeman if necessary. The manifold well support valves shall be opened to flatten the filter membranes. It shall be verified that no bubbles are trapped and that no creases or wrinkles are present on any of the filter membranes. One filter position shall be used for each sample volume to be assayed, including a minimum of one positive control and one negative control each time the manifold is used. The filter wells shall be positioned firmly over each filter.

The manifold and wells shall be cleaned between each set of samples following the procedure in EPA-ICR method 814-B-95-003[6], Annex A.

A.6.4 Sample size

A.6.4.1 The size of the sample shall be governed by expected oocyst density. An ideal sample volume shall yield 10 to 200 oocysts on a membrane filter surface. The samples shall be analyzed by filtering the

appropriate volume, depending on the expected oocyst density. Table A.2 contains suggested sample volumes.

A.6.4.2 When less than 10 mL of sample is filtered, 10 mL of DI water shall be added to the funnel before filtration to aid in dispersion of the oocysts over the entire filtering surface. If a pipette is used for transferring, it shall be rinsed five times with 0.01% polyoxyethylene sorbitan mono-oleate (0.01%) solution to ensure transfer of all oocysts.

A.6.4.3 When 1 L or more of sample is filtered, 1 L of sample shall be poured into a separation funnel and gradually added to the filtration manifold. When larger volumes are filtered, the sample bottle shall be weighed before and after filtration to determine the volume filtered. The sample bottle and separation funnel shall be rinsed five times with 0.01% polyoxyethylene sorbitan mono-oleate (0.01%) solution to ensure transfer of all oocysts.

A.6.5 Sample application

1) The sample shall be well mixed and added to the manifold well.

2) Test rig blank samples shall be collected prior to the introduction of oocysts. These samples shall be analyzed if oocyst(s) are detected in the eighth cycle effluent test samples.

3) An effluent matrix spike sample containing 50 to 100 *Cryptosporidium parvum* oocysts shall also be analyzed for each test run following the procedure specified in A.6.4.

4) A positive antigen control containing 50 to 200 oocysts shall be analyzed with each set of samples.

5) 1.0 mL PBS working solution shall be added to a well for a negative control (blank).

6) Each manifold well shall be rinsed with 2-mL blocking agents (PBS containing 1% BSA and 5 to 10% normal goat serum). The manifold valve shall then be closed under each membrane filter.

A.6.6 Direct fluorescent antibody staining

1) The antibody shall be diluted according to the manufacturer's instructions. 0.5 mL of diluted, prepared antibody shall be pipetted onto each membrane filter and allowed to remain in contact with the filter for 60 to 90 min. At the end of the contact period, the manifold valve shall be opened and the contents drained.

2) Each well and filter shall be rinsed five times with 2 mL PBS working solution.

3) The membrane filters in each well shall be dehydrated by sequentially applying 1.0 mL of 10%, 20%, 40%, 80%, and 90.2% ethanol solutions containing 5% glycerol. The solution shall be allowed to drain thoroughly with the manifold valve open before applying the next in the series.

A.6.7 Filter mounting

1) Glass slides shall be labeled for each filter and placed on a slide warmer in an incubator calibrated to 37 °C (99 °F).

2) 75 µL of 2% glycerol mounting medium shall be added to each slide on the slide warmer or in the incubator to allow to warm for 20 to 30 min.

3) The top cellulose acetate filter shall be layered over the correspondingly labeled glycerol-mounting medium slide (sample application side up) using fine-tip forceps. If the entire filter is not

wetted by the glycerol mounting medium, the membrane filter shall be lifted using the same forceps and a little more mounting medium shall be applied to the slide under the filter.

NOTE – A clean pair of forceps shall be used to handle each membrane filter. Used forceps shall be soaked in a beaker of diluted detergent cleaning solution.

4) 20 µL glycerol mounting medium shall be applied to the top center of each membrane filter and the slide shall be covered with a 25 mm x 25 mm cover glass.

5) The edge of each cover glass shall be sealed to the slide with clear fingernail polish.

6) The slides shall be stored in a covered container (dry box) with desiccant. A dry box consists of a covered plastic container to which anhydrous calcium sulfate is added and covered with paper towels.

7) The slides shall be stored at 4 °C (39 °F).

8) The slides shall be examined microscopically within 5 d of preparation.

A.6.8 Computing and reporting counts

1) The EPA-ICR method 814-B-95-003,[6] Chapter 6, shall be consulted to determine the oocyst counts on membrane filters. The filter shall be scanned at 20x magnification from left to right, top to bottom, with the aid of stage scale values to eliminate any confusion between rows. If necessary, the magnification shall be increased to 40x to verify the character of the oocysts.

2) The entire filter shall be scanned. The count shall be multiplied by the appropriate factor to determine the total count per liter of sample. The following calculation shall be used to determine oocyst concentration:

$$\text{number of oocysts / L} = \frac{\text{count}}{\text{volume filtered (L)}} \text{ x } \frac{\text{total sample volume (L)}}{\text{total sample volume (L)} - 0.021}$$

3) The 99.95% reduction endpoint shall be calculated by multiplying the individual influent sample point concentration (oocysts/L) by 0.0005.

4) If the enumeration of the effluent sample is less than the 99.95% reduction endpoint but greater than the 99.95% reduction endpoint MDL as determined in A.7.3, evaluation of the quality control effluent sample shall be performed. The following is an example of the calculation, where:

- influent concentration is 50,000 oocysts/L; and
- MDL is 12 oocysts/L.

To calculate the 99.95% reduction endpoint (step 3):

50,000 x 0.0005 = 25 oocysts/L.

To calculate whether the samples must be duplicated (step 4):

25 – 12 = 13.

Therefore, for any effluent sample in the range of 13 to 24 oocysts/L, the sample shall be analyzed in duplicate.

A.7 Quality control

A.7.1 Minimum requirements

Each laboratory that uses this method is required to operate a formal quality assurance (QA) program. The minimum requirements of this program shall consist of an initial demonstration of laboratory capability, analysis of spiked samples to evaluate and document data quality, and analysis of blanks as tests of continued performance. Laboratory performance shall be compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method (see Table A.3).

A.7.1.1 A test of the microscope used for detection of oocysts shall be performed prior to examination of slides. This test is referenced in EPA-ICR method 814-B-95-003.[6]

A.7.1.2 In recognition of advances that are occurring in analytical technology, certain options shall be permitted to improve detection or lower the costs of measurements, provided that all quality control acceptance criteria are met. If an analytical technique other than the techniques specified in this method is used, that technique shall have a specificity equal to or better than the specificity of the techniques in this method for *Cryptosporidium parvum* in the sample of interest. Specificity shall be defined as producing results that are equivalent to the results produced by this method for *Cryptosporidium parvum* in drinking water and that meet all of the quality control (QC) acceptance criteria stated in this method.

A.7.1.2.1 Each time a modification is made to this method, the analyst shall repeat the initial demonstration of laboratory capability test in A.7.3.1 to demonstrate that the modification produces results equivalent or superior to results produced by this method.

A.7.1.2.2 The laboratory shall maintain records of modifications made to this method.

A.7.1.3 The laboratory shall, on an ongoing basis, demonstrate through analysis of the effluent matrix spike sample (see A.7.6) that the analysis system is in control.

A.7.1.4 The laboratory shall maintain records to define the quality of data that is generated.

A.7.2 Micropipette calibration

A.7.2.1 Micropipettes shall be sent to the manufacturer for calibration annually. Alternatively, a qualified independent technician specializing in micropipette calibration shall be used. Documentation on the precision of the recalibrated micropipette shall be obtained from the manufacturer or technician.

A.7.2.2 Internal and external calibration records shall be kept on file in the laboratory's QA logbook.

A.7.2.3 If a micropipette calibration problem is suspected, the laboratory shall tare an empty weighing boat on the analytical balance and pipette the following volumes of reagent water into the weigh boat using the pipette in question: 100% of the maximum dispensing capacity of the micropipette, 50% of the capacity, and 10% of the capacity. If the weight of the water records within 1% of the desired weight (mL), the pipette shall be acceptable for use.

A.7.2.4 If the weight of the reagent water is outside the acceptable limits, the manufacturer's instruction manual troubleshooting section shall be consulted and the steps described in A.7.2.3 shall be repeated. If problems with the pipette persist, the laboratory shall send the pipette to the manufacturer for recalibration.

A.7.3 Initial demonstration of laboratory capability

A.7.3.1 Method detection limit (MDL)

To establish the ability to detect *Cryptosporidium parvum* oocysts, the laboratory shall determine the MDL in reagent water per the procedure in 40 *CFR* 136,[6] appendix B, using the apparatus, reagent, and standard that will be used in the practice of this method.

A.7.3.2 Initial precision and recovery

To establish the ability to demonstrate control over the analysis system and to generate acceptable precision and accuracy, the laboratory shall perform the following operations:

1) Using results of the MDL analyses, compute the average percent recovery (X) for *Cryptosporidium parvum.*

2) Compare the MDL and X with the corresponding limits for precision and recovery in Table A.3. If the MDL and X meet the acceptance criteria, system performance is acceptable and the analysis of blanks and samples may begin. However, if any individual X falls outside the range for recovery, or if the MDL exceeds the precision limit, system performance is unacceptable for *Cryptosporidium parvum.* In this event, the problem shall be corrected and the test shall be repeated (see A.7.3.1).

A.7.4 Matrix spike

The laboratory shall spike and analyze a separate sample aliquot to determine the effect of the matrix on the method's recovery efficiency. A duplicate effluent sample shall be spiked with the appropriate volume of the enumeration oocyst stock solution as specified in A.5 to obtain 50 to 100 oocysts/L. The matrix spike shall be analyzed as described in A.6.

A.7.4.1 Compute the percent recovery (R) of the oocysts using the following equation:

$$R = 100 \times (N_{sp} - N_s)/T$$

where:

R is the percent recovery;
N_{sp} is the number of oocysts detected in the spiked sample (oocysts/L);
N_s is the number of oocysts detected in the unspiked sample (oocysts/L); and
T is the spike concentration of the oocysts (oocysts/L).

A.7.4.2 The oocyst recovery shall be compared with the corresponding limits in Table A.3 until 20 recovery analyses are available, at which time the laboratory shall establish its own control limits. If the recovery for *Cryptosporidium parvum* falls outside its limit, method performance for that sample is unacceptable. Corrective action shall be taken and duplicate effluent samples shall be analyzed.

When 20 internal performance recovery data are available, control limits shall be developed from the mean percent recovery (x) and standard deviation (s) of the percent recovery. These data shall be used to generate upper and lower control limits:

- upper control limit = $x + 3s$;
- lower control limit = $x - 3s$.

These control limits shall not exceed those in Table A.3. After every ten data points, new control limits shall be generated using the most recent twenty data points. If the recovery falls outside the control limits,

method performance for that sample is unacceptable. Corrective action shall be taken, and duplicate effluent samples and an additional matrix spike shall be analyzed.

A.7.5 Blank (negative control sample)

If any *Cryptosporidium parvum* oocysts or any potentially interfering organism or material is found in the blank, analysis of additional samples shall be halted until the source of contamination is eliminated and a blank shows no evidence of contamination. Any sample in a batch associated with a contaminated blank that shows the presence of one or more oocysts shall be assumed to be contaminated and shall be collected again. Any sample in which oocysts are not detected shall be assumed to be uncontaminated.

A.7.6 Ongoing precision and recovery

The recovery shall be compared with the limits for recovery in Table A.3 until laboratory control limits are established as specified in A.7.4.2. If the recovery meets the acceptance criteria, system performance shall be considered acceptable. If, however, the recovery falls outside the range given, system performance shall be considered unacceptable. In this event, a problem with the microscope or with the filtration systems shall be investigated. Corrective action shall be taken, and duplicate effluent samples and an additional matrix spike shall be analyzed.

A minimum of one matrix spike sample shall be analyzed and shall meet the recovery criteria in Table A.3 for each performance test.

A.7.7 Positive antigen control

The positive control slide shall be scanned using epifluorescence at no less than 200x total magnification for apple-green fluorescence of *Cryptosporidium parvum* oocyst shapes. The background fluorescence of the membrane shall be very dim or nonexistent. *Cryptosporidium parvum* oocysts may or may not show evidence of oocyst wall folding, which is characterized under epifluorescence by greater concentrations of FITC along surface fold lines. If no apple-green fluorescing *Cryptosporidium parvum* oocyst shapes are observed, then the fluorescent staining did not work or the positive control oocyst preparation was faulty. Corrective action shall be taken, and duplicate effluent samples and an additional matrix spike shall be analyzed.

A.8 Analyst verification

A.8.1 At least once in each month in which microscopic examinations are to be performed, the principal analyst/supervisor shall prepare a slide containing 40 to 100 oocysts. The total number of oocysts determined by each analyst shall be within 10% of the number determined by the principal analyst/supervisor. If the number is not within this range, the principal analyst/supervisor and the analyst shall resolve how to identify and enumerate oocysts, and the principal analyst/supervisor shall prepare a new slide and the test shall be repeated.

A.8.2 The laboratory shall document the date, name of principal analyst/supervisor, name(s) of analyst(s), number of total oocysts placed on the slide, number determined by the principal analyst/supervisor, number determined by the analyst(s), whether the test was passed/failed for each analyst, and the number of attempts prior to passage.

A.8.3 Only after an analyst has passed the criteria in A.8.1 shall oocysts in blanks, standards, and samples be identified and enumerated.

Table A1 – Ethanol/glycerol series

95% Ethanol	Glycerol	Reagent water	Final volume	Final % ethanol
10 mL	5 mL	80 mL	95 mL	10
20 mL	5 mL	70 mL	95 mL	20
40 mL	5 mL	50 mL	95 mL	40
80 mL	5 mL	10 mL	95 mL	80
95 mL	5 mL	0 mL	100 mL	90.2

Table A2 – Suggested sample volumes for 25 mm membrane filters

Expected sample density	Volume (x) to be filtered (mL)				
	0.1	1	10	100	1000
influent (10^5 – 10^6/L)	x	x			
influent (10^3 – 10^4/L)			x	x	
effluent (10^2 – 10^3/L)				x	x
effluent (< 100/L)					x

Table A3 – Quality control acceptance criteria for performance tests for Cryptosporidium parvum

Performance test	Acceptance criteria
precision (as MDL)	≤ 20 oocysts/L
recovery (percent)	50 – 100

Annex B
(normative)

Test method for detecting and enumerating polystyrene microspheres

B.1 Summary of method

A 1-L sample shall be collected and an appropriate volume shall be passed through a membrane. The fluorescent microspheres deposited on the membrane shall be counted by scanning the membrane under an epifluorescence microscope.

In recognition of advances that are occurring in analytical technology, certain options shall be permitted to improve detection or lower the costs of measurements, provided that all quality control acceptance criteria are met. If an analytical technique other than the techniques specified in this method is used, that technique shall have a specificity equal to or better than the specificity of the techniques in this method for microspheres in the sample of interest. Specificity shall be defined as producing results that are equivalent to the results produced by this method for microspheres in drinking water and that meet all of the quality control (QC) acceptance criteria stated in this method.

B.2 Equipment

– fluorescent microspheres with fluorescein isothiocyanate (FITC) dye or equivalent (3 µm diameter);

– epifluorescence microscope with filters for FITC dye, 200x and 400x magnification;

– 0.45 µm 25 mm membrane filter;

– forceps;

– vacuum filtration apparatus;

– 1,000 mL glass separation funnel;

– autopipettes to dispense 0.10, 1.0, and 10.0 mL accurately;

– 75 mm x 50 mm glass slides;

– 1-L plastic sample bottles with caps;

– nail polish;

– hemocytometer chamber; and

– 10-place filter with manifold collection box and stainless steel wells.

B.3 Reagents

– polyoxyethylene sorbitan mono-oleate.

B.4 Enumeration of stock microspheres

B.4.1 Procedure using well slides

1) The stock microsphere suspension shall be vortexed, and 10 µL of an appropriate dilution (80 to 120 microspheres) shall be applied to all wells.

2) The wells shall be dried at 42 °C (108 °F) for 1 to 2 h.

3) The wells shall be mounted with 10 µL of DABCO-glycerol mounting medium.

4) The slides shall be enumerated and the concentration of the stock suspension shall be determined using the mean counts from the slides.

B.5 Procedure

B.5.1 Sample collection

Influent samples shall be collected in 1-L bottles containing 1 mL 1.0% polyoxyethylene sorbitan mono-oleate solution as a dispersant. The sample shall be refrigerated before filtering to prevent any bacterial growth. Influent samples shall be collected in triplicate.

3 L of the effluent shall be collected. The first liter of effluent shall be used as the test sample. The test samples shall be collected in 1-L bottles containing 1 mL 1.0% polyoxyethylene sorbitan mono-oleate solution as a dispersant. The sample shall be refrigerated before filtering to prevent any bacterial growth. The second and third liters of effluent shall be used for quality control samples. The second and third liters of effluent shall be composited and poured into two 1-L bottles each containing 1 mL 1.0% polyoxyethylene sorbitan mono-oleate and shall be refrigerated until analyzed.

The samples shall be prepared within 5 d of collection.

B.5.2 Filtration manifold preparation

The filtration manifold assembly shall be prepared by referring to the manufacturer's diagrams and instructions. The filtration manifold shall be connected to the vacuum supply using a vacuum tube containing a T-shaped tubing connector. A screw clamp shall be attached to 4 to 6 cm of latex tubing, and the latex tubing shall be attached to the stem of the "T" connector. The screw clamp shall be used as a bleeder valve to regulate the vacuum to 50 to 100 mm (2 to 4 in) of Hg.

The manifold valves shall be closed and the vacuum fully opened. The applied vacuum shall be adjusted to 50 to 100 mm (2 to 4 in) of Hg using the bleeder valve on the vacuum tubing. The bleeder valve shall not be readjusted during filtration. If necessary, the vacuum shall be turned on and off during filtration at the vacuum source.

The manifold and wells shall be cleaned with hot water and detergent between each set of samples.

B.5.3 Membrane filter preparation

The filtration manifold vacuum source shall be turned on. While all the manifold well support valves are closed, one filter shall be placed on each manifold support screen. One filter position shall be used for each sample volume to be assayed, including a minimum of one positive control and one negative control each time the manifold is used. The filter wells shall be positioned firmly over each filter.

B.5.4 Sample size

B.5.4.1 The size of the sample shall be governed by expected microsphere density. An ideal sample volume shall yield 10 to 200 microspheres and not more than 500 microspheres on a membrane filter surface. The samples shall be analyzed by filtering the appropriate volume depending on the expected microsphere density. Table B.1 of this Annex contains suggested sample volumes.

B.5.4.2 When less than 10 mL of sample is filtered, 10 mL of DI water shall be added to the funnel before filtration to aid in dispersion of the microspheres over the entire filtering surface. If a pipette is used for transferring, it shall be rinsed 5 times with 0.01% polyoxyethylene sorbitan mono-oleate solution to ensure transfer of all microspheres.

B.5.4.3 When 1 L or more of sample is filtered, 1 L of sample shall be poured into a separation funnel and gradually added to the filtration manifold. When filtering larger volumes, the sample bottle shall be weighed before and after filtration to determine the volume filtered. The sample bottle and separation funnel shall be rinsed five times with 0.01% polyoxyethylene sorbitan mono-oleate solution to ensure transfer of all microspheres.

B.5.5 Sample application

1) The sample shall be well mixed and added to the manifold well.

2) Test rig blank samples shall be collected prior to the introduction of microspheres. These samples shall be analyzed if microspheres are detected in the eighth cycle effluent test samples.

3) A effluent matrix spike sample containing 50 to 100 microspheres shall also be analyzed for each test run following the procedure specified in B.6.4.

4) 1.0 mL PBS working solution shall be added to a well for a negative control (blank).

B.5.6 Filter mounting

1) The membrane filter shall be removed with a clean forceps and be applied to a 75 mm x 50 mm glass slide.

2) The membrane shall be affixed to the slide using clear nail polish. The sample number and the volume filtered shall be affixed to the slide.

3) The membrane shall air dry in a covered container.

4) The slides shall be examined microscopically within 5 d of preparation using an epifluorescence microscope equipped with appropriate filters for FTIC dye.

B.5.7 Computing and reporting counts

1) The EPA-ICR method 814-B-95-003,[6] Chapter 6, shall be consulted to determine the microspheres counts on membrane filters. The filter shall be scanned at 20x magnification from left to right, top to bottom, with the aid of stage scale values to eliminate any confusion between rows. If necessary, the magnification shall be increased to 40x to verify the character of the microspheres.

2) The entire filter shall be scanned. The count shall be multiplied by the appropriate factor to determine the total count per liter of sample. The following calculation shall be used to determine microsphere concentration:

$$\text{number of microspheres \ L} \frac{\text{count}}{\text{volume filtered (L)}} X \frac{\text{total sample volume (L)}}{\text{total sample volume (L) - 0.001}}$$

3) The 99.95% reduction endpoint shall be calculated by multiplying the individual influent sample point concentration (microspheres/L) by 0.0005.

4) If the enumeration of the effluent sample is less than the 99.95% reduction endpoint but greater than (99.95% reduction – MDL), as determined in B.6.3.1, evaluation of the duplicate effluent sample shall be performed.

For example, where:

– influent concentration is 50,000 microspheres/L; and
– MDL is 12 microspheres/L.

To calculate the 99.95% reduction endpoint (step 3):

(50,000) x (0.0005) = 25 microspheres/L.

To calculate the whether the samples must be duplicated (step 4):

25 – 12 = 13.

Therefore for any effluent sample in the range of 13 to 24 microspheres/L, the sample shall be analyzed in duplicate.

B.6 Quality control

B.6.1 Minimum requirements

Each laboratory that uses this method is required to operate a formal quality assurance (QA) program. The minimum requirements of this program shall consist of an initial demonstration of laboratory capability, analysis of spiked samples to evaluate and document data quality, and analysis of blanks as tests of continued performance. Laboratory performance shall be compared to established performance criteria to determine whether the results of analyses meet the performance characteristics of the method (see Table B.2).

B.6.1.1 A test of the microscope used for detection of microspheres shall be performed prior to examination of slides. This test is referenced in EPA-ICR method 814-B-95-003.[6]

B.6.1.2 In recognition of advances that are occurring in analytical technology, certain options shall be permitted to improve detection or lower the costs of measurements provided that all quality control acceptance criteria are met. If an analytical technique other than the techniques specified in this method is used, that technique shall have a specificity equal to or better than the specificity of the techniques in this method for microspheres in the sample of interest. Specificity shall be defined as producing results equivalent to the results produced by this method for microspheres in drinking water and that meet all of the quality control (QC) acceptance criteria stated in this method.

B.6.1.2.1 Each time a modification is made to this method, the analyst shall repeat the initial demonstration of laboratory capability test in B.6.3 to demonstrate that the modification produces results equivalent to or superior to results produced by this method.

B.6.1.2.2 The laboratory shall maintain records of modifications made to this method.

B.6.1.3 The laboratory shall, on an ongoing basis, demonstrate through analysis of the effluent matrix spike sample that the analysis system is in control.

B.6.1.4 The laboratory shall maintain records to define the quality of data that is generated.

B.6.2 Micropipette calibration

B.6.2.1 Micropipettes shall be sent to the manufacturer for calibration annually. Alternatively, a qualified independent technician specializing in micropipette calibration shall be used. Documentation on the precision of the recalibrated micropipette shall be obtained from the manufacturer or technician.

B.6.2.2 Internal and external calibration records shall be kept on file in the laboratory's QA logbook.

B.6.2.3 If a micropipette calibration problem is suspected, the laboratory shall tare an empty weighing boat on the analytical balance and pipette the following volumes of reagent water into the weigh boat using the pipette in question: 100% of the maximum dispensing capacity of the micropipette, 50% of the capacity, and 10% of the capacity. If the weight of the water records within 1% of the desired weight (mL), the pipette shall be acceptable for use.

B.6.2.4 If the weight of the reagent water is outside the acceptable limits, the manufacturer's instruction manual troubleshooting section shall be consulted, and the steps described in B.6.2.3 shall be repeated. If problems with the pipette persist, the laboratory shall send the pipette to the manufacturer for recalibration.

B.6.3 Initial demonstration of laboratory capability

B.6.3.1 Method detection limit (MDL)

To establish the ability to detect microspheres, the laboratory shall determine the MDL in reagent water per the procedure in 40 *CFR* 136,[6] appendix B, using the apparatus, reagent, and standard that will be used in the practice of this method.

B.6.3.2 Initial precision and recovery

To establish the ability to demonstrate control over the analysis system and to generate acceptable precision and accuracy, the laboratory shall perform the following operations:

1) Using results of the MDL analyses, compute the average percent recovery (X) for microspheres.

2) Compare the MDL and X with the corresponding limits for precision and recovery in Table B.2. If the MDL and X meet the acceptance criteria, system performance is acceptable and the analysis of blanks and samples may begin. However, if any individual X falls outside the range for recovery, or if the MDL exceeds the precision limit, system performance is unacceptable for microspheres. In this event, correct the problem and repeat the test (see B.6.3.1).

B.6.4 Matrix spike

The laboratory shall spike and analyze a separate sample aliquot to determine the effect of the matrix on the method's recovery efficiency. A duplicate effluent sample shall be spiked with the appropriate volume of the enumeration microsphere stock solution as specified in B.4 to obtain 50 to 100 microspheres/L. The matrix spike shall be analyzed as described in B.5

B.6.4.1 Compute the percent recovery (R) of the microspheres using the following equation:

$$R = 100 \times (N_{sp} - N_s)/T$$

where:

R is the percent recovery;
N_{sp} is the number of microspheres detected in the spiked sample (microspheres/L);
N_s is the number of microspheres detected in the unspiked sample (microspheres/L); and
T is the spike concentration of the microspheres (microspheres/L).

B.6.4.2 The microsphere recovery shall be compared with the corresponding limits in Table B.2 until twenty recovery analyses are available, at which time the laboratory shall establish its own control limits. If the recovery for microspheres falls outside its limit, method performance for that sample is unacceptable. Corrective action shall be taken, and duplicate effluent samples shall be analyzed.

When 20 internal performance recovery data are available, control limits shall be developed from the mean percent recovery (x) and standard deviation (s) of the percent recovery. These data shall be used to generate upper and lower control limits:

– upper control limit = $x + 3s$; and
– lower control limit = $x - 3s$.

These control limits shall not exceed those in Table B.2. After every ten data points, new control limits shall be generated using the most recent twenty data points. If the recovery fall outside the control limits, method performance for that sample is unacceptable. Corrective action shall be taken, and duplicate effluent samples and an additional matrix spike sample shall be analyzed.

B.6.5 Blank (negative control sample)

If any microspheres are found in the blank, analysis of additional samples shall be halted until the source of contamination is eliminated and a blank shows no evidence of contamination. Any sample in a batch associated with a contaminated blank that shows the presence of one or more microspheres shall be assumed to be contaminated and shall be recollected. Any sample in which microspheres are not detected shall be assumed to be uncontaminated.

B.6.6 Ongoing precision and recovery

The recovery shall be compared with the limits for recovery in Table B.2 until laboratory control limits are established as specified in B.6.4.2. If the recovery meets the acceptance criteria, system performance shall be considered acceptable. If, however, the recovery falls outside the range given, system performance shall be considered unacceptable. In this event, a problem with the microscope or with the filtration systems shall be investigated. Corrective action shall be taken, and duplicate effluent samples and an additional matrix spike sample shall be analyzed.

A minimum of one matrix spike sample shall be analyzed and shall meet the recovery criteria in Table B.2 for each performance test.

B.7 Analyst verification

B.7.1 At least once in each month during which microscopic examinations are to be performed, the principal analyst/supervisor shall prepare a slide containing 40 to 100 microspheres. The total number of microspheres determined by each analyst shall be within 10% of the number determined by the principal analyst/supervisor. If the number is not within this range, the principal analyst/supervisor and the analyst

shall resolve how to identify and enumerate microspheres, and the principal analyst/supervisor shall prepare a new slide and the test shall be repeated.

B.7.2 The laboratory shall document the date, name of principal analyst/supervisor, name(s) of analyst(s), number of total microspheres placed on the slide, number determined by the principal analyst/supervisor, number determined by the analyst(s), whether the test was passed/failed for each analyst, and the number of attempts prior to passage.

B.7.3 Only after an analyst has passed the criteria in B.7.1 shall microspheres in blanks, standards, and samples be identified and enumerated.

Table B1 – Suggested sample volumes for 25 mm membrane filters

Expected sample density	Volume (x) to be filtered (mL)				
	0.1	1	10	100	1000
influent (10^5 – 10^6/L)	x	x			
influent (10^3 – 10^4/L)			x	x	
effluent (10^2 – 10^3/L)				x	x
effluent (< 100/L)					x

Table B2 – Quality control acceptance criteria for performance tests for microspheres

Performance test	Acceptance criteria
precision (as MDL)	≤ 20 microspheres/L
recovery (percent)	50 – 100

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Annex C[15]
(informative)

C.1 Example fact section for pentavalent arsenic treatment systems

Arsenic (As) is a naturally occurring contaminant found in many ground waters. It generally occurs in two forms (valences or oxidation states): pentavalent arsenic (also known as As(V), As(+5), and arsenate) and trivalent arsenic (also known as As(III), As(+3), and arsenite). In natural ground water, arsenic may exist as trivalent arsenic, pentavalent arsenic, or a combination of both. More information about arsenic and its toxicity can be found at the agency for Toxic Substances and Disease Registry Toxicological Profile on Arsenic website at http://www.atsdr.cdc.gov/toxprofiles/phs2.html, and at the U. S. Environmental Protection Agency website at http://www.epa.gov/safewater/arsenic.html.

Arsenic does not generally impart color, taste, or smell to water; therefore, it can only be detected by a chemical analytical test. Public water supplies are required to monitor delivered water for arsenic (trivalent arsenic plus pentavalent arsenic) and the results are available to the public from the utility. Consumers using private water sources will need to make arrangements for testing. An arsenic test usually costs about $15-30 and it is recommended that the test be conducted by a certified laboratory. Local health departments or environmental protection agencies can help provide consumers with a list of certified laboratories. Some laboratories may also be able to analyze specifically for (speciate) the form(s) of arsenic present in a water sample if requested.

Trivalent arsenic is generally more difficult to reduce from drinking water than pentavalent arsenic. Trivalent arsenic can be converted to pentavalent arsenic in the presence of an effective oxidant such as free chlorine. The arsenic in water containing detectable free chlorine or that has been treated with another effective oxidant will be in the pentavalent arsenic form.[16] Treatment with chloramine (combined chlorine) is not sufficient to ensure complete conversion of trivalent arsenic to pentavalent arsenic.

Consumers using public water supplies can contact their utility to verify whether free chlorine treatment chemicals are being used. Private water supplies and waters that do not have detectable free chlorine residuals should be analyzed to determine the form(s) of arsenic present and the potential need for oxidation of trivalent arsenic to pentavalent arsenic.

This system [Model number] is designed to reduce only pentavalent arsenic. This treatment system is not designed to convert trivalent arsenic to pentavalent arsenic. The system has not been evaluated for the removal of trivalent arsenic, but it may reduce some trivalent arsenic.

This treatment system was tested under laboratory conditions as defined in NSF/ANSI 53: Drinking Water Treatment Units – Health Effects, and was found to reduce [influent arsenic challenge concentration, either 0.30 mg/L or 0.050 mg/L] of pentavalent arsenic in the test water to less than 0.010 mg/L, for [tested treatment capacity] gallons of delivered water, the life of the system under standard testing conditions. Actual performance of the system may vary depending on specific water quality conditions at the consumer's installation. Following installation of this system, the consumer should have the delivered water tested for arsenic to verify that arsenic reduction is being achieved and the system is functioning properly.

The arsenic removal component of this system must be replaced at the end of its useful life of [tested treatment capacity]. The replacement component, [replacement component identification], can be

[15] The information contained in this annex 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 annex 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.

[16] Laboratory Study on the Oxidation of Arsenic III to Arsenic V, EPA/600/R-01/021, March 2001 (available online at <http://www.epa.gov/ORD/publications/ordpubs.html>).

purchased from the original source of this system (retailer or distributor), from other sources of this treatment system, or directly from the manufacturer at [contact information].

C.2 Example fact section for arsenic treatment systems

Arsenic (As) is a naturally occurring contaminant found in many ground waters. It generally occurs in two forms (valences or oxidation states): pentavalent arsenic (also known as As(V), As(+5), and arsenate) and trivalent arsenic (also known as As(III), As(+3), and arsenite). In natural ground water, arsenic may exist as trivalent arsenic, pentavalent arsenic, or a combination of both. More information about arsenic and its toxicity can be found at the Agency for Toxic Substances and Disease Registry Toxicological Profile on Arsenic website at http://www.atsdr.cdc.gov/toxprofiles/phs2.html, and at the U. S. Environmental Protection Agency website at http://www.epa.gov/safewater/arsenic.html.

Arsenic does not generally impart color, taste, or smell to water; therefore, it can only be detected by a chemical analytical test. Public water supplies are required to monitor delivered water for arsenic (trivalent arsenic plus pentavalent arsenic) and the results are available to the public from the utility. Consumers using private water sources will need to make arrangements for testing. An arsenic test usually costs about $15-30, and it is recommended that the test be conducted by a certified laboratory. Local health departments or environmental protection agencies can help provide consumers with a list of certified laboratories. Some laboratories may also be able to analyze specifically for (speciate) the form(s) of arsenic present in a water sample if requested.

This system [Model number] is designed to reduce arsenic: both pentavalent and trivalent forms of arsenic. This treatment system was tested under laboratory conditions as defined in NSF/ANSI 53 Drinking Water Treatment Units – Health Effects and was found to reduce [influent arsenic challenge concentration, either 0.30 mg/L or 0.050 mg/L] arsenic consisting of either pentavalent or trivalent arsenic in the test water to less than 0.010 mg/L, for [tested treatment capacity] gallons of delivered water, the life of the system under standard testing conditions. Actual performance of the system may vary depending on specific water quality conditions at the consumer's installation. Following installation of this system, the consumer should have the treated water tested for arsenic to verify that arsenic reduction is being achieved and the system is functioning properly.

The arsenic removal component of this system must be replaced at the end of its useful life of [tested treatment capacity]. The replacement component, [replacement component identification], can be purchased from the original source of this system (retailer or distributor), from other sources of this treatment system, or directly from the manufacturer at [contact information].

Annex D[17]
(informative)

Key elements of a certification program for drinking water treatment systems and components

A certification program for drinking water treatment systems and components should contain the following program elements.

D.1 Marking the product

Requirements for product marking including:

– certified systems should bear a registered trademark of the certifying organization;

– certified components intended to be used with other components to make a complete functional system, as defined by NSF/ANSI 53, should bear a component mark;

– each system should have a model designation; and

– each system should bear a statement of claims verified through the certifying organization and substantiated by test data.

D.2 Listing certified companies

A published listing of all certified systems and components. The listing format should include at least the following information:

– company name and address;

– product description;

– trademark/model designation;

– flow rate;

– rated capacity or service cycle; and

– each contaminant reduction claim that has been successfully evaluated and is supported by test data.

D.3 Annual audits

Actual physical audits of all facilities and production locations of the certified company at least annually.

[17] The information contained in this annex 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 annex 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.

D.4 Testing

– testing in accordance with all applicable NSF/ANSI 53 requirements prior to certification; and
– a retest program that includes re-evaluation and retesting at least once every five years.

D.5 Toxicological evaluation of materials formulations

Formulation information of each material used in the fabrication of the system and/or components shall be provided to, and maintained on file by, the certifying organization. The formulation information should include, at a minimum:

– each ingredient's complete chemical identity or proportion by weight;

– each ingredient's sources of supply;

– documentation regarding the health effects concern of each ingredient in the material; and

– documentation regarding the suitability of each ingredient for use in a potable water contact material.

D.6 Corrective action

Corrective action for all items of noncompliance found during audits and re-evaluation, including:

– provisions for review and authorization for modifications to designs;
– modifications to certified system and/or components; and
– documentation and authorization of the modification maintained on file.

D.7 Enforcement

To preserve the integrity of the registered trademark of the certifying organization and protect public health, enforcement action by the certifier for the following:

– use of the registered trademark of the certifying organization on a non-certified product;
– general noncompliance;
– unauthorized change to a certified product;
– unauthorized shipment or disposal of product placed on hold; and
– bribes.

D.8 Administrative review

Provisions for an administrative review as requested by any party directly affected by a decision or action of the certifier.

D.9 Appeals

Provisions for an appeals process as requested by any party directly affected by a decision or action of the certifier resulting from an administrative review.

D.10 Complaints

– provisions for investigation of complaints related to certified products, misuse of the registered trademark of the certifying organization by a certified company, and use/misuse of the registered trademark of the certifying organization by a non-certified company; and

– certified company retention and disclosure of complaint records and remedial actions for certified products.

D.11 Advertising

Requirement of proper use of the registered trademark of the certifying organization on sales literature, technical publications, promotional materials, packaging, catalogs, and advertising.

D.12 Records

Provisions for verification of complete certified company records, including:

– installation and service for fabricators and distributors;
– purchased materials and components; and
– production, shipment, and inventory.

D.13 Public notice

Provisions for issuing a public notice for noncompliance with any requirement of certification.

D.14 Confidentiality

A strict policy of non-disclosure of any confidential information supplied to the certifier by the company regarding the product, including formulations, components, processes, ingredients, or the identity of the company's suppliers and distributors.

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Annex E[18]
(informative)

USEPA Method 625 is a GCMS method developed in the early 1980's for analysis of surface water samples for toxic chemical contamination from industrial discharges. In the early to mid '70's, the Agency was charged by Congress with the protection of the country's waterways from chemical contamination. In response to this mandate, the Agency developed a list of 65 chemicals and chemical classes. This original list was subdivided into 129 specific chemicals which shortly gained the moniker of the "Priority Pollutants". USEPA Method 625 was developed as part of this effort. A large part of the list were semivolatile organic chemicals. The "Priority Pollutants" which the technique was developed, ranged from chlorinated phenols (chloro, di-, tri-, and penta- chlorinated), nitrophenols (mono and di), nitrosoamines (dimethyl, dipropyl, dibutyl, and diphenyl), and aromatics. Further, the method has been demonstrated (by the USEPA) to be appropriate for pesticides, PCBs, and aromatic amines (benzidine and dichorobenzidine).

The use of GCMS should be understood as application of state of the art technology at that junction in time. GCMS, in the late '70's and early '80's was an instrument of research typically costing in excess of $200,000; today, this is roughly equivalent to $500,000. It should then be understood that the method was not "only" a wastewater procedure, but a technique employed for general applicability to surface waters for the analysis of a broad range of toxic organic chemicals.

For application of this method to NSF/ANSI DWTU applications, it is incumbent on the laboratory to demonstrate expertise in the technique through the analysis of method validation studies demonstrating capability to generate data of known and legally defensible quality. Further, as part of the standard, maximum contaminant levels are established to ensure public safety for the chemicals of concern. The laboratory must, through its validation studies have demonstrated capability to meet this sensitivity requirement.

This technique includes that capability to perform identification of unknown compounds detected in the 625 analysis as well as an estimation of concentration. This is performed through the use of spectral identification programs versus mass spectral libraries compiled by NIST (National Institute of Science and Technology). This library exceeds 100,000 spectra of different organic chemicals. The concentration estimation is done in accordance with USEPA established protocol as part of (and not solely exclusive to) its Contract Laboratory Program. This program was initiated in 1980 for the analysis of environmental samples (soil, water, and hazardous materials). Due to the nature of this work, all data was required to be legally defensible in a court of law. Though the concentrations are estimated, this is performed following a standardized protocol allowing data users to understand the likely range of concentration of the analyte and request quantitative analysis of any particular chemical if necessary.

This standard does allow alternative analytical techniques to be developed and employed by the analytical laboratory, particularly in those cases where the formulation would indicate chemical constituents or byproducts not amenable to methods 524.2 and 625. Most notably would be HPLC, HPLC-MS, and triple quadrupole techniques.

USEPA Methods 524.2 and 625, though applicable to a wide range of chemicals, compounds that are thermally labile or highly polar may not chromatograph at all (by GC) or too poorly to be a reliable technique. When faced with this situation, alternative techniques may be utilized to generate the necessary data. HPLC and HPLC-MS (an HPLC with a mass spectrometer as the detector rather than a typical HPLC detector) compliment well the referenced GCMS techniques. Where GCMS is most applicable to relatively smaller compounds (typically below a molecular weight of 500 but may be

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extended up to around 700 to 800) of neutral to intermediate polarities, HPLC and HPLC-MS lends itself well to more polar compounds and those of greater molecular weight. Also, generally speaking, GCMS systems are capable of greater resolution than HPLC and HPLC-MS (though recent advances in HPLC column technology have diminished this differential). This is particularly important for samples with more complex chromatograms (more individual chemicals leached). Examples of chemicals particularly suited to HPLC and HPLC-MS would be carbamic acids, organic diacids, and compounds with mixed, opposing functional groups such as amino carboxylic acids (such as aminodecanoic acid).

When a reference is made to GC-MS and HPLC-MS it does not specify the type of mass-spectrometer coupled with the GC or HPLC. However, there can be significant advantages analytically to be gained here also. Typically, these instruments are single quadrupole "low-resolution" instruments. For instance, regardless if the system is a GC-MS or HPLC-MS, when the mass-spectrometer measures the mass of the ions from a compound, with a "low-resolution" instrument, they are typically capable of mass accuracy to $1/10^{th}$ of an AMU. When the atomic weight of an isotope of an element is obtained, it is discovered that rather than being whole numbers (except for carbon, whose primary isotope at "12" is used as the reference for the other elements) they all have some fractional component. For instance, chlorine whose primary isotope is typically considered to have a mass of 35AMU (or Daltons) is actually 34.96885AMU. Now if the mass spectrometer is capable of greater mass resolution (a high resolution mass spectrometer) advantage can be taken of these small differences in mass of the elements. With this approach, if an unknown peak is present in the GCMS or HPLC-MS analysis, if the molecular ion (the ion representing the intact molecule versus the fragment ions) can be identified, then the chemical formula of the peak of interest (or at minimum a fairly short list of possibilities) can be calculated. This information can then be used to add certainty to a library search match, or give the toxicologist at least chemical formula information when a peak does not give good library search information.

A final technique which has seen application in the screening of foods, particularly fruits and vegetables, for pesticides, is directly aspirating an aqueous sample into a triple quadrupole system. This approach utilizes the initial quadrupole to control which molecular ions are transmitted through to the rest of the instrument, where it is fragmented and identified. Though this technique cannot distinguish isomers, it has the advantage of avoiding the problem of potential chromatography issues.

Annex F
(normative)

Test method for evaluating mouth drawn water treatment units

F.1 Scope and Purpose

It is the purpose of this protocol to evaluate mouth drawn drinking water treatment devices for elective performance claims. The product must be designed that the only method of generating treated water for consumption is by drawing from the unit by the users mouth (by creation of a vacuum). If the product can be squeezed to dispense water (squeeze bottle as defined by NSF 330) as well as mouth drawn, the squeeze bottle protocol shall be used.

F.2 Method

F.2.1 Set-up

An example of the test setup is presented in Figure 3.

Peristaltic pumps shall be plumbed into the outlet of the test units and shall be capable of achieving at least 800 ml/min at 20.5 kPa vacuum (6 inches of Hg, 3 psig). The volume of the plumbing downstream of the test unit shall be ≥ 10 ml and be measured to determine wait time and a port installed between the test unit and peristaltic pump with a pressure gauge to monitor draw vacuum. The test units shall be configured so that test water can be continually introduced.

For a bottle, a single 18mm (3/4") hole shall be drilled in the side of the bottle as close to the bottom as possible. The bottle shall be placed upright in a vessel with the bottle submerged adequately to cover the hole and prevent air from entering the bottle, but not far enough to cover any closures. The hole in the bottle shall remain covered with influent at all times. Each bottle shall have the influent tube (Fig. 3c) positioned into or immediately adjacent to the hole (Fig. 3e) placed in the bottle.

F.2.2 Flow Rate

The flow rate shall be maintained at 800 +/- 80 ml/min up to a maximum of 20.5 kPa (3 psig) average vacuum. If the average vacuum exceeds 20.5 kPa, the flow rate shall be reduced to maintain the average vacuum at 20.5 ± 3 kPa.

F.2.3 Operational Cycle

The on cycle time shall be 3.0 seconds or up to 30 seconds as requested by the manufacturer during normal operation. The cycle ratio shall be between 50/50 and 10/90 on/off with a minimum of 8 hours of test operation within a 24 hour period, followed by a minimum 8 hour rest.

F.3 Sampling

Due to the nature of overflow influent feeding to bottled devices, no effluent samples shall be collected after a 2 hour period of no flow through the test units until a minimum of a unit void volume (of the entire device) has passed through the test unit.

F.3.1 Influent Sampling

Influent samples shall be collected after all effluent samples have been collected. The samples shall be taken directly from the influent fill tube.

F.3.2 Effluent Sampling

Due to the small volume of each cycle, multiple cycles or an extended on time shall be used at each sample point as specified below.

F.3.2.1 Chemical Reduction Effluent Samples (chemical and low pH metal reductions testing)

Collection of effluent shall commence after the down stream plumbing from the test unit has been purged (time to wait = volume of downstream plumbing/flow rate). The extended on period shall be only as long as needed to collect the required sample. The minimum sample volume collected shall be 50 ml and the maximum sample volume shall be the minimum required for analysis.

F.3.2.2 Mechanical Reduction Effluent Samples (asbestos, cyst, turbidity, and high pH metals reduction testing)

The sample shall be collected from sequential on/off cycles for as long as required to collect the entire sample volume. All samples shall be collected as the first water out of the unit for the multiple cycles. The minimum sample volume collected shall be 50 ml and the maximum sample volume shall be the minimum required for analysis.

F.3.3 Active Agent Sampling (when active agent is present)

All performance sample points shall include an active agent sample. Influent and effluent samples are collected for active agents for all samples. All active agent samples shall be collected with an extended on time. Active agent samples will be collected after the performance sample has been collected, with the exception of the Active Agent Stagnation Sample (see below).

F.3.3.1 Active Agent Stagnation Sample

During a performance test that includes active agent sampling, a minimum of one sample shall be an Active Agent Stagnation Sample. Typically this sample is scheduled for the morning of the second day of testing. Stagnation samples shall be collected after a minimum 8 hour rest with no flow through the test units. Stagnation samples shall be collected from the first water through the device after the stagnation period, immediately after the downstream plumbing has been purged (time to wait = volume of downstream plumbing/flow rate). The test unit shall be operated continuously until the required sample volume is collected. This volume shall be the minimum volume required for analysis or 50 ml, whichever is greater.

If a performance sample coincides with the Active Agent Stagnation sample, the system will be returned to cycling operation after the Active Agent Stagnation sample is collected until the required volume has passed through the test unit (1 unit volume of entire device) to allow the performance sample to be collected as required in the sampling procedures section of Annex F.

F.3.4 Back Pressure Test

A back pressure test shall be performed immediately prior to the 50% sample point. The peristalic pump shall be reversed for 30 sec. without changing the pump speed. The pump shall then return to a forward flow under normal operation. An effluent sample shall be collected after the downstream plumbing of the device has cleared and analyzed for the presence of contaminants as specified in F.3.2.

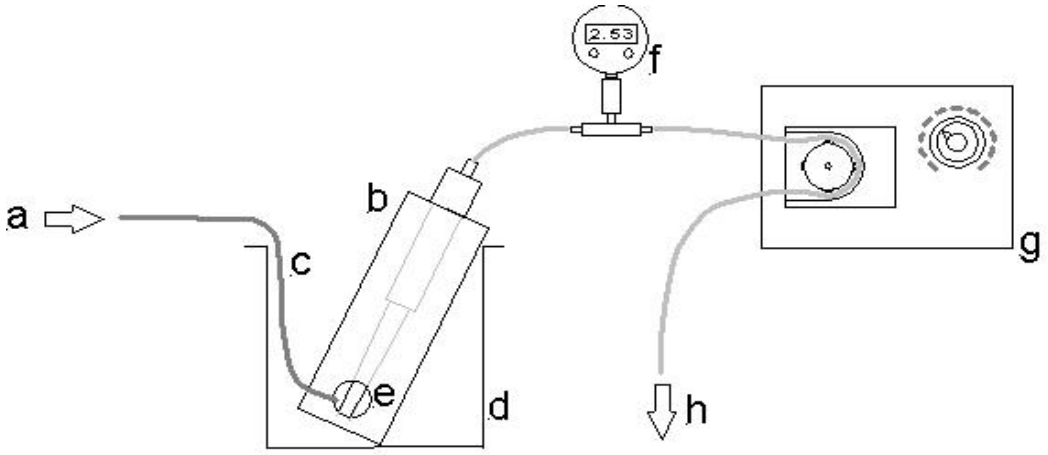

Figure 3 – Diagram of Test Configuration

a. influent test water
b. test unit
c. influent fill tube
d. influent containment vessel
e. 18mm (3/4”) hole in bottom of test unit
f. pressure gauge (recommend digital gauge set to read average vacuum values, 0.5% accuracy)
g. variable speed peristaltic pump (may be multiple pumps in parallel)
h. test unit effluent (sampling location)

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Annex G
(normative)

Test method for evaluating squeeze bottle drinking water treatment units

G.1 Scope and Purpose

It is the purpose of this protocol to evaluate squeeze bottle drinking water treatment devices for elective performance claims. The squeeze bottle shall maintain its structural integrity during performance testing. If the closure of the bottle develops a leak, it shall be corrected according to manufacturer's instructions and it shall not be considered a failure of structural integrity during performance claim testing unless the leak reoccurs within the unit void volume of the bottle.

Two methods are described for evaluating squeeze bottles, the mechanical gripper apparatus may be used for all performance claims, the alternate pressurized bottle method shall not be used for mechanical reduction or metals reduction testing if the system has any type of back-draw through the filter during normal use.

G.2 Method – Mechanical Gripper Apparatus

G.2.1 Set-up

An example of the test apparatus is provided in figure 4. The geometric arrangement and dimensions of the gripper including the size and orientation of the fingers and palm, the stroke length and pivot point are critical to generating reproducible test results and shall meet the specifications provided in figure 5. The control system should be capable of applying a consistent and specified pressure on the bottle for the specified time. The bottle shall be tilted at a minimum of 135 degrees from vertical when dispensing and no more than 50 degrees from the vertical when refilling.

The test bottle shall be attached to the test apparatus so the bottle shall remain in position, but not be under pressure when at rest. The gripper shall be positioned around the center of the test bottle to maximize the volume dispensed during each squeeze of the gripper unless a specific location to grip the bottle is specified in the manufacturer's literature.

G.2.2 Automatic Bottle Refilling

The squeeze bottle shall be refilled with the test water when the volume remaining in the bottle is no greater than 25% of the total unit void volume. The squeeze bottle shall be considered full when the test water volume has achieved greater than 75% of the total unit void volume.

G.2.3 Operational Cycle

The systems shall be operated with a 3 second on/ 5 second off cycle time (cycle time up to 3 second on/30 second off may be requested by the manufacturer). The systems shall be operated up to 16 hours per 24 hour period, followed by a minimum 8 hour rest. The on cycle time shall consist of a force rise at the initiation of each cycle of 1.5 ± .5 seconds to 20 ± 1 kg of force applied by the gripper for the remainder of the on cycle time. Each squeeze shall be followed by a minimum 5 second rest period in the vertical (or nearly vertical) position with <0.5 kg of force applied to the bottle. Total cycle time shall exceed 10 seconds due to the time required to tilt the bottle. The off cycle during refilling of the bottle may be extended as needed to complete the refilling operation.

G.3 Alternate Method – Pressurized Bottle

G.3.1 Set-up

The systems shall be plumbed onto a pressurized test rig in the same manner as an open discharge DWTU. If required to pressurize the device and generate flow, a port shall be installed in the influent reservoir of the test unit of adequate size so flow is not restricted (< 1 Cv). The bottle shall be oriented to reflect normal usage (typically outlet downward). Air space in the bottle shall be minimized. The inlet pressure to the bottle shall be 52 ± 3.5 kPa (7.5 ± 0.5 psi) at startup and is not readjusted, although the system may experience some change during testing.

G.3.2 Operational Cycle

The systems shall be operated with a 3 second on/ 5 second off cycle time (cycle time up to 3 second on/30 second off may be requested by the manufacturer). The systems shall be operated up to 16 hours per 24 hour period, followed by a minimum 8 hour rest.

G.4 Sampling

For systems that include a performance indication device samples shall be collected from the first fill of the bottle, and at 25, 50, 75, 100, and 120% of claimed capacity. For systems that do not include a performance indication device samples shall be collected from the first fill of the bottle, and at 50, 100, 150, 180, and 200% of capacity. Effluent samples shall be collected from the entire volume dispensed during multiple sequential on/off cycles until the required volume for analysis is collected. Influent samples shall be collected from a sampling port located immediately prior to the test units connection.

G.4.1 Active Agent Sampling (when active agent is present)

All performance sample points shall include an active agent sample. Influent and effluent samples are collected for active agents for all samples. Active agent samples will be collected after the performance sample has been collected, with the exception of the Active Agent Stagnation Sample (see below).

G.4.2 Active Agent Stagnation Sample

During a performance test that includes active agent sampling, a minimum of one sample shall be an Active Agent Stagnation Sample. Typically this sample is scheduled for the morning of the second day of testing. Stagnation samples shall be collected after a minimum 8 hour rest with no flow through the test units. Stagnation samples shall be collected from the first water through the device after the stagnation period, immediately after the downstream plumbing has been purged (if any). The test unit shall be operated for multiple sequential on/off cycles, if required to collect the required sample volume. This required sample volume shall be the minimum volume required for analysis or 50 ml, whichever is greater.

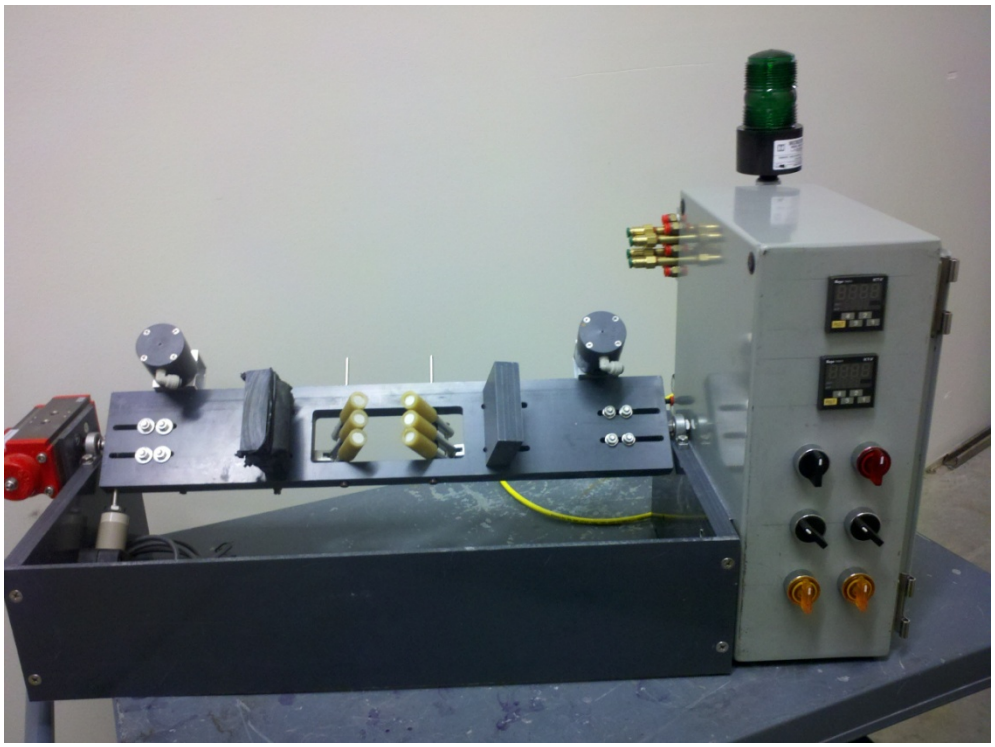

Figure 4. Photo of Example Test Apparatus using gripper

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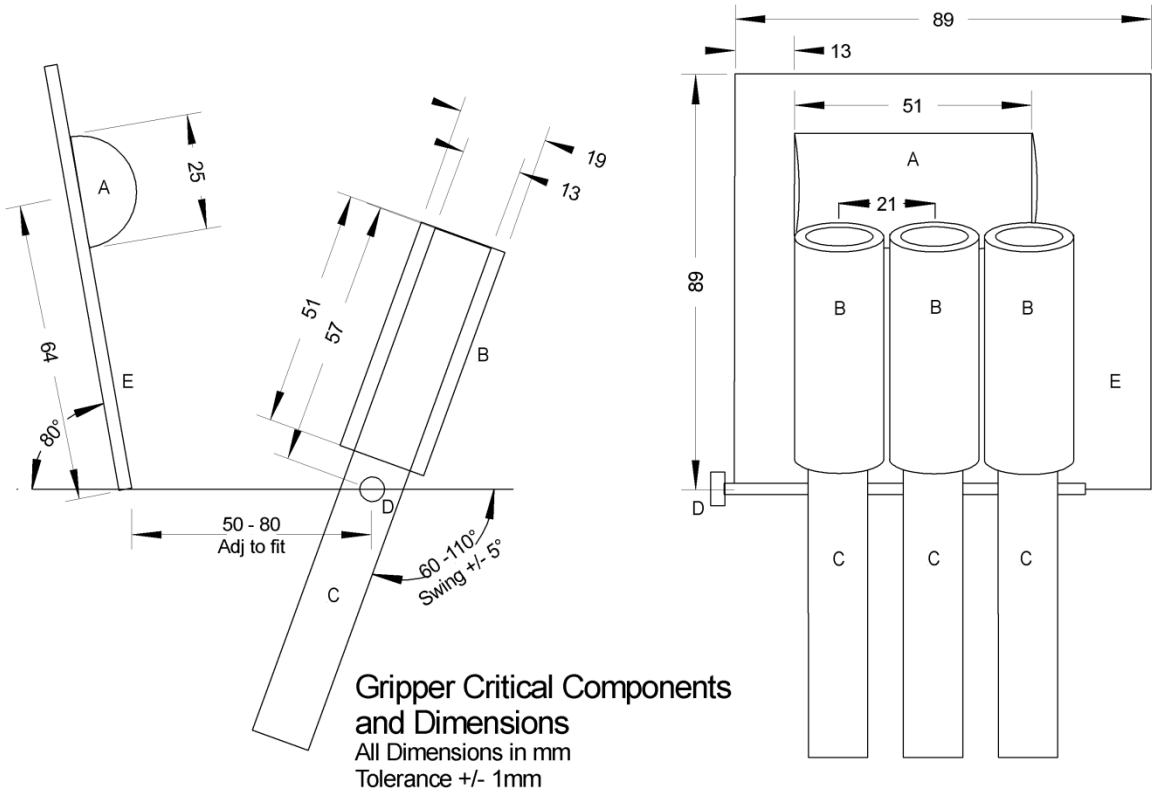

Figure 5. Critical design elements of gripper apparatus.

A. Palm Pad constructed of flexible material with a hardness of Shore A30 to A40.
B. Finger grip material constructed of 13mm ID X 19mm OD (½" x ¾") tubing with hardness of Shore A30 to A40.
C. Finger "bone" of adequate strength to support pivot and pressure on bottle without deflection.
D. Pivot point constructed of suitable material to ensure unhindered pivot of finger assembly.
E. Palm Pad support contructed to allow adjustment of distance between finger assembly and pivot and of adequate strength to withstand pressure on bottle without deflection.

Annex H
(normative)

Methods and procedures to minimize premature filter plugging

The methods and procedures within this annex shall be performed as required and referenced in the test methods. The intent is to allow the performance test to reach the desired test volume so performance claims are able to be substantiated and not prematurely plug due to common laboratory conditions. The test shall not be modified, however, in its nature by improving the performance of the test system. Influent samples and challenge levels shall be measured immediately prior to the system inlet and after any anti-plugging treatment to confirm that the actions performed to minimize premature filter plugging do not interfere with the influent challenge characteristics.

If a product prematurely plugs prior to the completion of the required test volume, the volume of the final sample point collected prior to plugging becomes the final test volume to determine capacity.

Example: A manufacturer desires to substantiate an 100 gallon alachlor claim for a point of use system that does not contain a performance indication device under NSF/ANSI Standard 53. This shall require the test to be performed to 200 gallons. The system flow rate for one of the systems falls to less than 25% of the initial clean system flow rate after the 180 gallon sample point but prior to the 200% sample point. The test is terminated and the total test volume for this test becomes 180 gallons instead of the originally desired 200 gallons which changes the maximum potential capacity claim to 90 gallons.

H.1 Mechanical filtration component of tested system

If a test system contains a separate mechanical filtration component that is not required for the successful reduction of the test contaminant and this mechanical filtration component causes premature clogging, this mechanical filtration component shall be replaced or excluded from the system to improve the flow rate.

H.2 Mechanical filtration of waters

The water source used to create test waters shall be filtered with mechanical filtration that meets or exceeds NSF/ANSI Standard 42 nominal particulate reduction class I performance. Carbon or other absorptive/adsorptive media shall not be used for source waters that require total organic carbon (TOC) unless an explicit addition of TOC is specified in the test method.

When the evaluation of the system is at an extended on/off cycle (10%-on/90%-off), extended test period (> 2 weeks) or the systems are known to plug, test waters shall be filtered with a non-absorptive/adsorptive media with a rating of 0.45 um or smaller. The filtration shall be performed prior to the addition of the contaminant and shall not alter or enhance the performance of the systems under test (with the exception of preventing premature plugging).

H.3 Disinfection and cleaning of test apparatus

Test equipment shall be cleaned and disinfected to minimize the presence of bacteria and particulate matter when the evaluation of the system is at an extended on/off cycle (10%-on/90%-off), extended test period (> 2 weeks) or the systems are known to plug. The testing laboratory shall evaluate the test equipment used to determine best practices for the equipment in use. The test systems shall not be exposed to the cleaning or disinfecting procedure and all disinfectants, cleaners, and rinse waters shall be purged from the test apparatus prior to connecting the test systems.

An example of a disinfection and cleaning procedure is as follows:

Procedure

1. Remove all test systems from the test rig.
2. Remove any test rig prefilters.
3. Plumb in any inline components that shall be used to test the systems (flow meters, UV disinfection units, etc).
4. Add the recommended concentration of quaternary ammonia disinfectant cleaner to the test apparatus and ensure all interior surfaces are exposed to the cleaner.
5. Flush and circulate (if applicable) the disinfectant for the time recommended by the cleaner manufacturer or longer.
6. Drain the test rig and install any prefilters and activate the UV disinfection units (if applicable).
7. Thoroughly rinse the test rig until all of the cleaner is removed from the apparatus.

H.4 Anti-microbial treatment

Anti-microbial procedures shall be performed when the evaluation of the system is at an extended on/off cycle (10%-on/90%-off), extended test period (> 2 weeks) or the systems are known to plug. One or more of the following procedures shall be performed. Additional or alternate procedures are acceptable to be used if they provide equivalent or improved microbial control.

1. Residual free available chlorine
   The use of free available chlorine up to 3 mg/L is acceptable to limit the growth of microorganisms within a test apparatus if it does not interfere with the challenge contaminant or improve the performance of the system under test (with the exception of limiting microbial growth).

   Exceptions: Free available chlorine shall not be used for carbofuran, nitrate/nitrite, arsenic(III), chromium, hydrogen sulfide, chloramines, iron, manganese or any microbiological testing unless required in the test method.

2. Ultraviolet treatment
   The use of UV is acceptable to limit the growth of microorganisms if it does not interfere with the challenge contaminant or improve the performance of the system under test. It is recommended that the UV treatment device be placed immediately prior to the injection of the contaminant (if applicable) and after any test water filtration. UV shall not be used for testing which requires free available chlorine, chloramines, or microbiological testing unless required in the test method.

H.5 Methanol used as carrier solvent

If methanol is used as a carrier solvent for introducing a challenge contaminant, the amount of methanol added to the test water shall be minimized if the evaluation of the system is at an extended on/off cycle (10%-on/90%-off), extended test period (> 2 weeks) or the systems are known to plug. The amount of methanol required to achieve proper dispersal and solvation of the challenge contaminant shall be maintained, but when practical, the concentration of methanol in the test water shall be minimized.

H.6 Operational cycle

If a test system has demonstrated clogging when an extended operational cycle is used (other than 50%-on/50%-off), the system shall be operated at an 50%-on/50%-off cycle if a retest is performed due to plugging. Adjusting to a longer off cycle is acceptable during the test (ex. 10%-on/90%-off) after the test system has reached the test volume where the previous test had plugged, if requested by the manufacturer.

Standards[19]

The following standards established and adopted by NSF as minimum voluntary consensus standards are used internationally:

2 Food equipment
3 Commercial warewashing equipment
4 Commercial cooking, rethermalization, and powered hot food holding and transport equipment
5 Water heaters, hot water supply boilers, and heat recovery equipment
6 Dispensing freezers
7 Commercial refrigerators and freezers
8 Commercial powered food preparation equipment
12 Automatic ice making equipment
13 Refuse processors and processing systems
14 Plastics piping system components and related materials
18 Manual food and beverage dispensing equipment
20 Commercial bulk milk dispensing equipment
21 Thermoplastic refuse containers
24 Plumbing system components for recreational vehicles
25 Vending machines for food and beverages
29 Detergent and chemical feeders for commercial spray-type dishwashing machines
35 High pressure decorative laminates (HPDL) for surfacing food service equipment
36 Dinnerware
37 Air curtains for entranceways in food and food service establishments
40 Residential wastewater treatment systems
41 Non-liquid saturated treatment systems
42 Drinking water treatment units – Aesthetic effects
44 Residential cation exchange water softeners
46 Evaluation of components and devices used in wastewater treatment systems
49 Biosafety cabinetry: Design, construction, performance, and field certification
50 Equipment for swimming pools, spas, hot tubs, and other recreational water facilities
51 Food equipment materials
52 Supplemental flooring
53 Drinking water treatment units – Health effects
55 Ultraviolet microbiological water treatment systems
58 Reverse osmosis drinking water treatment systems
59 Mobile food carts
60 Drinking water treatment chemicals – Health effects
61 Drinking water system components – Health effects
62 Drinking water distillation systems
140 Sustainable carpet assessment
169 Special purpose food equipment and devices
170 Glossary of food equipment terminology
173 Dietary supplements
177 Shower filtration systems – Aesthetic effects
184 Residential dishwashers
222 Ozone generators
223 Conformity assessment requirements for certification bodies that certify products pursuant to NSF/ANSI 60: Drinking water treatment chemicals – health effects
240 Drainfield trench product sizing for gravity dispersal onsite wastewater treatment and dispersal systems
245 Wastewater treatment systems - nitrogen reduction
305 Personal care products containing organic ingredients
321 Goldenseal root (Hydrasitis canadensis)
330 Glossary of drinking water treatment unit terminology
332 Sustainability assessment for resilient floor coverings
336 Sustainability assessment for commercial furnishings fabric
341 Health/fitness facilities
342 Sustainability assessment for wallcovering products
347 Sustainability assessment for single ply roofing membranes
350 Onsite residential and commercial water reuse treatment systems
350-1 Onsite residential and commercial graywater treatment systems for subsurface discharge
355 Greener chemicals and processes information
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***THE HOPE OF MANKIND** rests in the ability of man to define and seek out the environment which will permit him to live with fellow creatures of the earth, in health, in peace, and in mutual respect.*

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