



NSF Standard
American National Standard

NSF/ANSI 58-2024

Reverse Osmosis Drinking Water Treatment Systems



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NSF/ANSI 58-2024

NSF Standard
American National Standard
for Water –

Reverse Osmosis Drinking Water Treatment Systems

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Abbreviations

The following table is provided as a reference for unit abbreviations for common forms of measurement used within NSF documents.

Time	second	s
	minute	min
	hour	h
	day	d
	week	wk
	month	mo
	year	yr
Length	inch	in.
	foot	ft
	yard	yd
	micrometer	μm
	nanometer	nm
	millimeter	mm
	centimeter	cm
	meter	m
	kilometer	km
Liquid measure	milliliter	mL
	liter	L
	liters per day	LPD
	liters per minute	LPM
	ounce	oz
	pint	pt
	quart	qt
	gallon	gal
	gallons per minute	GPM
	gallons per day	GPD
Weight	microgram	μg
	picogram	pg
	nanogram	ng
	milligram	mg
	centigram	cg
	gram	g
	kilogram	kg
	pound	lb
	ton	t
	metric ton	mt

Miscellaneous	atomic mass unit	amu
	daltons	Da
	kilopascal	kPa
	mass-to-charge ratio	m/z
	nephelometric turbidity unit	NTU
	picocurie	pCi
	parts per million	ppm
	parts per billion	ppb
	parts per trillion	ppt
	pounds per square inch	psi
	pounds per square inch gauge	psig
	microsecond	μs

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Foreword²

The purpose of this standard is to establish minimum requirements for materials, design and construction, and performance of point-of-use (POU) reverse osmosis (RO) drinking water treatment systems. NSF/ANSI 58 also specifies minimum product literature requirements that manufacturers must provide to authorized representatives and owners. Minimum service-related obligations for manufacturers to extend to system owners are also specified in this standard.

Water contact materials in drinking water treatment units listed under NSF/ANSI 42, 44, 53, 55, 58, and 62 are tested and evaluated under a separate protocol from NSF/ANSI/CAN 61 with criteria that were developed specifically for the intended end-use. NSF/ANSI/CAN 61 listing should not be additionally required for acceptance of these listed units for water contact application.

This edition of the standard contains the following revisions:

- **Issue 111**

This revision changes the influent challenge for asbestos to solely chrysotile fibers in Section [7.2.1.4](#).

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.

This standard and the accompanying text are intended for voluntary use by certifying organizations, utilities, regulatory agencies, and/or manufacturers as a basis of providing assurances that adequate health protection exists for covered products. Product certification issues, including frequency of testing and requirements for follow-up testing, evaluation, enforcement, and other policy issues, are not addressed by this standard.

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, Standards Department, PO Box 130140, Ann Arbor, Michigan 48113-0140, USA.

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

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NSF/ANSI Standard for Water –

Reverse Osmosis Drinking Water Treatment Units

1 General

1.1 Purpose

The purpose of this standard is to establish minimum requirements for materials, design and construction, and performance of reverse osmosis (RO) drinking water treatment systems. This standard also specifies the minimum product literature that manufacturers shall supply to authorized representatives and owners, as well as the minimum service-related obligations that manufacturers shall extend to system owners.

1.2 Scope

The point-of-use (POU) RO drinking water treatment 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) considered to be microbiologically safe and of known quality. Systems covered by this standard are intended for reduction of total dissolved solids (TDS) and other contaminants specified herein. They may be 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, however, TDS testing is required. Systems with manufacturer claims that include components or functions covered under other NSF or NSF/ANSI standards or criteria shall conform to the applicable requirements therein. Systems covered by this standard are not intended to be used with drinking water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.

Note. Systems that are compliant with NSF/ANSI 55 Class A or other standards that cover technologies to treat microbiologically unsafe water (e.g. US EPA Guide *Standard and Protocol for Testing Microbiological Water Purifiers* or NSF P231) are examples of demonstrating adequate disinfection before or after the system.

1.3 Chemical and mechanical reduction performance claims

1.3.1 All NSF/ANSI 58 performance claims shall be verified and substantiated by test data generated under the requirements of NSF/ANSI 58.

1.3.2 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 58, claims not specifically addressed in the standard shall be so identified.

1.4 Treatment train

A system that contains multiple, sequential treatment technologies for a performance claim under this standard shall meet the applicable requirements as described in Annex [N-2](#).

2 Normative references

The following documents contain requirements, which by reference in this text, constitute requirements of this standard. At the time this standard was balloted, the editions listed below were valid. All documents are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the documents indicated below. The most recent published edition of the document shall be used for undated references.

21 CFR, *Food and Drugs, Subchapter B, Food for Human Consumption, Parts 170-199*³

40 CFR Part 141, *National Primary Drinking Water Regulations*³

40 CFR Part 143, *Other Safe Drinking Water Act Regulations, Subpart A, National Secondary Drinking Water Regulations*³

APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater* (hereinafter referred to as *Standard Methods*)⁴

EPA-600/4-79-020, *Methods for the Chemical Analysis of Water and Wastes*, March 1983⁵

EPA-600/4-82-057, *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater*, May 2002⁵

EPA-600/4-90-020, *Methods for the Determination of Organic Compounds in Drinking Water, Supplement 1*, July 1990⁵

EPA-600/R-05-054, *Method 521: Determination of Nitrosamines in Drinking Water by Solid Phase Extraction and Capillary Column Gas Chromatography With Large Volume Injection and Chemical Ionization Tandem Mass Spectrometry (MS/MS)*, September 2004⁵

EPA-600/R-93-100, *Methods for the Determination of Inorganic Substances in Environmental Samples*, August 1993⁵

EPA-600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*, May 1994⁵

NSF/ANSI 53, *Drinking Water Treatment Units – Health Effects*

NSF/ANSI 61, *Drinking Water System Components – Health Effects*

NSF/ANSI/CAN 372, *Drinking Water System Components – Lead Content*

NSF/ANSI/CAN 600, *Health Effects and Evaluation Criteria for Chemicals in Drinking Water*

Ontario Ministry of the Environment, Conservation and Parks, *An Interim Method for Determination of Asbestos Fibre Concentration in Water by Transmission Electron Microscopy*, 1977⁶

³ Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration. 7 G Street NW, Suite A-734, Washington, DC 20401. <[ecfr.gov](https://www.ecfr.gov)>

⁴ American Public Health Association, American Water Works Association, and Water Environment Federation. <www.standardmethods.org>

⁵ US Environmental Protection Agency. 1200 Pennsylvania Avenue NW, Washington, DC 20004. <[epa.gov](https://www.epa.gov)>

⁶ Ontario Ministry of the Environment, Conservation and Parks, Drinking Water Division. 135 St. Clair Avenue W, 8th floor, Toronto, Canada M4V 1P5. <ontario.ca/page/drinking-water>

SAE J726, *Air Cleaner Test Code*, June 1993 ⁷

3 Definitions

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

4 Materials

4.1 Materials in contact with drinking water

4.1.1 Acceptance criteria

4.1.1.1 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 NSF/ANSI/CAN 600, Table 4.1: *Drinking water criteria*. Any extractable contaminants not listed in the referenced tables shall be reviewed and shall not exceed criteria developed in accordance with NSF/ANSI/CAN 600, Section 3: *Toxicology review and evaluation procedures*.

4.1.1.2 TIC identification and quantitation shall be conducted in accordance with Section [4.5.1.2](#). 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 [4.5.1.2](#) 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 [4.5.1.2](#).

Note. Manufacturers may not be privy to formulation information, so they may not be able to assist a testing laboratory to identify a standard for the compound that extracted. Refer to Section [4.5.1.2](#) when the manufacturer does not have material formulation information.

4.1.1.3 Unknown contaminants detected by GC/MS analysis for which identification is unable to be made after performing the steps in Section [4.5.1](#) shall be reported in accordance with Section [4.1.2.2](#).

4.1.1.4 Whole-system or component assembly extraction testing may be waived if components, when separately tested, meet the requirements of this standard and are assembled in a manner that does not introduce any new components or materials, increase the surface area-to-volume ratio of previously evaluated components, or present potential concern based on cumulative factors. The reported extractable concentrations for components shall be arithmetically added to ensure that the whole-system or component assembly meets the allowable levels in accordance with Tables [4.1](#), [4.2](#), and [4.3](#), NSF/ANSI/CAN 61, and NSF/ANSI/CAN 600.

4.1.1.5 POU drinking water treatment units shall conform to the requirements of this section and be evaluated for weighted average lead content in accordance with NSF/ANSI/CAN 372. The weighted average lead content of the contact materials and coated substrates shall be less than or equal to 0.25%.

⁷ SAE International. 400 Commonwealth Drive, Warrendale, PA 15096. <sae.org>

4.1.2 Data reporting

4.1.2.1 All contaminants identified and detected at or above the reporting limit (RL) shall be reported with the identification of the contaminant, the concentration, and whether it exceeds the acceptance criteria as required in Section [4.1.1](#). Contaminants detected below the reporting limit shall be reported to the manufacturer as less than the RL's value.

Example: If the lab's RL 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).

4.1.2.2 If the extractable contaminant cannot be identified following the procedures in Section [4.5.1](#), the laboratory shall supply the manufacturer with the approximate molecular weight along with any additional information about the compound.

4.2 Membrane preservatives

After system installation and flushing in accordance with the manufacturer's instructions, membrane preservatives shall not be present in the product water at a level of toxicological significance when the system is evaluated and tested in accordance with Section [4.4.3](#).

4.3 Temperature resistance

4.3.1 Materials shall be tested in accordance with Section [4.4.3](#) to verify suitable temperature resistance.

4.3.2 Components of systems designed for exclusive application on cold water lines shall be constructed of materials suitable for a maximum operating temperature of 38 °C (100 °F).

4.4 Materials evaluation

Complete formulation information on any material not certified as specifically compliant with the sections of the US Code of Federal Regulations, Title 21, listed in Table [4.4](#), 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
- a list of toxicological studies relevant to the chemicals and impurities present in the product, component, or material.

4.4.1 Analytical methods

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

4.4.1.1 The laboratory shall validate the analytical method to the 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 greater than or equal to the MDL. When preparing its calibration standards, the lowest calibration point shall be at or less than the RL.

4.4.1.2 For extracted techniques (e.g. US EPA 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 1 L extracted, and the extract concentrated to 1.0 mL, for a factor of 1,000, if the RL is set to 0.2 µg/L, then the lowest calibration point would be less than or equal to 0.2 mg/L.

Note. See Annex [I-3](#) for additional information on GC/MS and other alternative methods.

4.4.2 Exposure water

4.4.2.1 Systems and components shall be exposed to locally available tap water that has been adjusted to contain 50 ± 5 mg/L TDS 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 [4.1](#), [4.2](#), and [4.3](#) found to be present in the exposure water shall be subtracted from the values obtained in the analysis of the extractant water.

4.4.2.2 Components designed to be installed downstream from the membrane shall be exposed to a 1:20 dilution of the exposure water listed in Section [4.4.2.1](#). Deionized water shall be used as the diluent.

4.4.3 Exposure

4.4.3.1 The system or component(s) of a system shall be installed, flushed, and conditioned in accordance with the manufacturer's instructions. If instructions are not provided, systems shall be operated with the outlet closed until the storage tank is full, or component(s) shall be flushed with one unit volume using the exposure water (see Section [4.4.2](#)) at an initial inlet static pressure of 340 kPa (50 psig).

4.4.3.2 After flushing and conditioning in accordance with Section [4.4.3.1](#), systems shall be refilled with exposure water as specified in Section [4.4.2](#) and maintained for 24 h at an ambient temperature of 23 ± 2 °C (73 ± 3 °F). A water sample shall be collected for analysis by emptying the storage tank completely and then sub-sampling. If the water holding volume of the storage tank is less than 2 L, sufficient samples shall be exposed to provide the required volume of extractant water. The system outlet shall then be closed, and the system shall be maintained for another 24 h at an ambient temperature of 23 ± 2 °C (73 ± 3 °F). A water sample shall again be collected for analysis by emptying the storage tank completely and then sub-sampling. This process shall be repeated to give a total of three 24-h exposures. Systems without storage tanks shall be exposed as membrane elements, except that the recovery shall be dictated by the system. Samples collected shall be composited and analyzed in accordance with Section [4.4.1](#).

This sequence is summarized as follows:

- a) Install the test system(s) on the test stand.
- b) Flush and condition with exposure water.
- c) Close the system outlet and maintain for 24 h.
- d) Empty the storage tank(s), if applicable, and sample.
- e) Repeat steps c and d for a total of three sampling events.
- f) Composite the three samples and analyze.

Components other than membrane elements shall follow the same process but shall be flushed according to the manufacturer's instructions prior to each 24-h exposure. A daily 2-L collection volume is recommended to

ensure there is sufficient volume in the composite sample to conduct the requested analyses. 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 at least one-third of the volume required for analysis of extractant water at each sample point. Samples collected shall be composited and analyzed in accordance with Section [4.4.1](#).

Membrane elements shall follow the same process, with the recovery set at the manufacturer's specification through the use of reject flow control. One membrane element shall be exposed in a suitable housing, with a 2-L sample drawn as product water after each 24-h exposure. The initial exposure shall involve flushing and conditioning in accordance with the manufacturer's instructions. Subsequent exposure shall involve no additional flushing and conditioning after the 2-L sample is drawn. Samples collected shall be composited and analyzed in accordance with Section [4.4.1](#).

4.4.3.3 A daily 2-L collection volume is recommended to ensure there is sufficient volume in the composite sample to conduct the requested analyses. If the water holding volume of the product is more 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 at least $\frac{1}{3}$ of the volume required for analysis of extractant water at each sample point. The maximum number of samples exposed shall not exceed 16 with 125 mL of extractant water drawn from each sample. If the components with a water holding volume that is less than 250 mL and is able to be identified as one that will only occur once in the flow path of dispensed treated water (such as diverters, faucets, RO shutoff valves, or specialty components) then a volume of 250 mL shall be drawn from each sample using a maximum number of eight samples.

4.4.3.4 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.

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

4.5.1 General requirements for GC/MS analysis

When determined to be required following a product-specific formulation review, US EPA 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. US EPA Method 625, 528, or 525.2) and volatiles (e.g. US EPA Method 524.2 or 524.3) shall be conducted using the required target compounds in Tables [4.2](#) and [4.3](#), and the laboratory's RL shall be no greater than the RL's listed in Tables [4.2](#) and [4.3](#).

4.5.1.1 Target compounds shall be validated in accordance with the requirements of the referenced method. US EPA 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 US EPA 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 more than 50% and not more than 200% of that average

- due to the number of characteristics of the analytes associated with US EPA 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. 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 US EPA Method 625 shall be achieved.

4.5.1.2 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:

- Due to the complex nature of GC/MS 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.
- 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."
- The laboratory may utilize manual spectral interpretation to identify the peak in question.
- 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 TICs, 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 US EPA 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.

4.5.1.3 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 $MW \geq 143$).
- 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.
- 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 Sections [4.1.1.2](#) and [4.1.1.3](#). 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 Section [4.4](#).

Note. Items b and c above may be automated utilizing software available from NIST with their mass-spectral database.

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

Table 4.1

Extraction testing parameters (metals)

Analyte	CAS number	Maximum reporting limit (RL) (mg/L)	US EPA Method(s)
aluminum	7429-90-5	0.1	200.7, 200.8
antimony	7440-36-0	0.001	200.8, 200.9
arsenic	7440-38-2	0.001	200.8, 200.9
barium	7440-39-3	0.2	200.7, 200.8
beryllium	7440-41-7	0.001	200.7, 200.8, 200.9
cadmium	7440-43-9	0.001	200.8, 200.9
chromium	7440-47-3	0.01	200.7, 200.8, 200.9
copper	7440-50-8	0.1	200.7, 200.8
lead	7439-92-1	0.001	200.8, 200.9
manganese	7439-96-5	0.01	200.7, 200.8
mercury	7439-97-6	0.001	200.8, 245.1
nickel	7440-02-0	0.01	200.7, 200.8
selenium	7782-49-2	0.005	200.8, 200.9
thallium	7440-28-0	0.001	200.8, 200.9

Table 4.2
Extraction testing parameters (semi-volatiles)

Analyte	CAS number	Maximum reporting limit (RL) (mg/L)	US EPA Method(s)
2,4,6-trichlorophenol	88-06-2	0.001	525.2, 528, 625
2,4-dichlorophenol	120-83-2	0.001	525.2, 528, 625
2,4-dimethylphenol	105-67-9	0.01	525.2, 528, 625
2,6-di-tert-butyl-4-methoxyphenol	489-01-0	0.003	525.2, 528, 625
2-methylnaphthalene	91-57-6	0.003	525.2, 528, 625
2-nitrophenol	88-75-5	0.001	525.2, 528, 625
2-phenyl-2-propanol	617-94-7	0.005	525.2, 528, 625
3,3-dichlorobenzidine	91-94-1	0.001	525.2, 528, 625
3- and 4-methylphenol m- & p-cresol	106-44-5 108-39-4	0.001	525.2, 528, 625
4-chloro-3-methylphenol	59-50-7	0.07	525.2, 528, 625
4-tert-butylphenol or p-tert-butylphenol	98-54-4	0.05	525.2, 528, 625
acenaphthene	83-32-9	0.004	525.2, 528, 625
acenaphthylene	208-96-8	0.0004	525.2, 528, 625
acetophenone	98-86-2	0.02	525.2, 528, 625
anthracene	120-12-7	0.0003	525.2, 528, 625
benzo(a)pyrene	50-32-8	0.0002	525.2, 528, 625
benzothiazole	95-16-9	0.003	525.2, 528, 625
bis(2-ethylhexyl)adipate	103-23-1	0.04	525.2, 528, 625
bis(2-ethylhexyl)phthalate	117-81-7	0.001	525.2, 528, 625
bButyl benzyl phthalate	85-68-7	0.1	525.2, 528, 625
chrysene	218-01-9	0.003	525.2, 528, 625
diethyl phthalate	84-66-2	0.6	525.2, 528, 625
dimethyl phthalate	131-11-3	0.001	525.2, 528, 625
di-n-butyl phthalate	84-74-2	0.07	525.2, 528, 625
fluoranthene	206-44-0	0.0003	525.2, 528, 625
isophorone	78-59-1	0.04	525.2, 528, 625
naphthalene	91-20-3	0.04	525.2, 528, 625
n-nitroso-di-n-butylamine	924-16-3	0.0006	521, 525.2, 528, 625
n-nitroso-di-n-propylamine	621-64-7	0.0005	521, 525.2, 528, 625
n-nitrosodimethylamine	62-75-9	0.000002 mg/L (2 ng/L)	521 ^a
n-nitrosodiphenylamine	86-30-6	0.007	521, 525.2, 528, 625
o-cresol or 2-methylphenol	95-48-7	0.001	525.2, 528, 625
pentachlorophenol	87-86-5	0.0005	525.2, 528, 625
phenanthrene	85-01-8	0.0003	525.2, 528, 625

Table 4.2**Extraction testing parameters (semi-volatiles)**

Analyte	CAS number	Maximum reporting limit (RL) (mg/L)	US EPA Method(s)
phenol	108-95-2	0.2	525.2, 528, 625
phenyl sulfone	127-63-9	0.002	525.2, 528, 625
pyrene	129-00-0	0.0006	525.2, 528, 625

^a An alternate validated method of equivalent sensitivity to Method 521 is permissible.

Table 4.3**Extraction testing parameters (volatiles)**

Analyte	CAS number	Maximum reporting limit (RL) mg/L	US EPA Method(s)
1,1,1,2-tetrachloroethane	630-20-6	0.001	524.2, 524.3
1,1,1-trichloroethane	71-55-6	0.02	524.2, 524.3
1,1,2,2-tetrachloroethane	79-34-5	0.0005	524.2, 524.3
1,1,2-trichloroethane	79-00-5	0.0005	524.2, 524.3
1,1-dichloroethene	75-35-4	0.0007	524.2, 524.3
1,1-dichloropropene	563-58-6	0.0005	524.2, 524.3
1,2,3-trichlorobenzene	87-61-6	0.0005	524.2, 524.3
1,2,3-trichloropropane	96-18-4	0.004	524.2, 524.3
1,2,4-trichlorobenzene	120-82-1	0.007	524.2, 524.3
1,2-dibromo-3-chloropropane	96-12-8	0.0002	524.2, 524.3
1,2-dibromoethane	106-93-4	0.0002	524.2, 524.3
1,2-dichlorobenzene	95-50-1	0.06	524.2, 524.3
1,2-dichloroethane	107-06-2	0.0005	524.2, 524.3
1,2-dichloropropane	78-87-5	0.0005	524.2, 524.3
1,3,5-trimethylbenzene	108-67-8	0.0005	524.2, 524.3
1,3-dichlorobenzene	541-73-1	0.06	524.2, 524.3
1,4-dichlorobenzene	106-46-7	0.007	524.2, 524.3
2-butanone	78-93-3	0.4	524.2, 524.3
2-chlorotoluene	95-49-8	0.01	524.2, 524.3
2-ethyl-1-hexanol	104-76-7	0.005	524.2, 524.3
4-chlorotoluene	106-43-4	0.0005	524.2, 524.3
4-isopropyltoluene	99-87-6	0.0005	524.2, 524.3
4-methyl-2-pentanone	108-10-1	0.7	524.2, 524.3
acetone	67-64-1	0.6	524.2, 524.3
acetophenone	98-86-2	0.02	524.2, 524.3
acrylonitrile	107-13-1	0.0006	524.2 SIM

Table 4.3**Extraction testing parameters (volatiles)**

Analyte	CAS number	Maximum reporting limit (RL) mg/L	US EPA Method(s)
benzene	71-43-2	0.0005	524.2, 524.3
bis(2-chloroethyl)ether or di-(2-chloroethyl) ether	111-44-4	0.0003	524.2, 524.3
bromobenzene	108-86-1	0.0005	524.2, 524.3
bromochloromethane	74-97-5	0.009	524.2, 524.3
bromodichloromethane	75-27-4	0.001	524.2, 524.3
bromoform	75-25-2	0.001	524.2, 524.3
bromomethane	74-83-9	0.001	524.2, 524.3
carbon disulfide	75-15-0	0.7	524.2, 524.3
carbon tetrachloride	56-23-5	0.0005	524.2, 524.3
chlorobenzene	108-90-7	0.01	524.2, 524.3
chloroform	67-66-3	0.001	524.2, 524.3
chloromethane	74-87-3	0.003	524.2, 524.3
cis-1,2-dichloroethene	156-59-2	0.007	524.2, 524.3
cyclohexanone	108-94-1	1.0	524.2, 524.3
dibromochloromethane	124-48-1	0.001	524.2, 524.3
dichlorodifluoromethane	75-71-8	0.0005	524.2, 524.3
ethyl acrylate	140-88-5	0.001	524.2, 524.3
ethylbenzene	100-41-4	0.014	524.2, 524.3
methyl acrylate	96-33-3	0.001	524.2, 524.3
methyl methacrylate	80-62-6	0.1	524.2, 524.3
methyl tert-butyl ether	1634-04-4	0.0005	524.2, 524.3
methylene chloride	75-09-2	0.0005	524.2, 524.3
n-butyl acrylate	141-32-2	1.0	524.2, 524.3
n-butylbenzene	104-51-8	0.0005	524.2, 524.3
sec-butylbenzene	135-98-8	0.0005	524.2, 524.3
styrene	100-42-5	0.01	524.2, 524.3
t-butyl alcohol or t-butanol or tert-butanol	75-65-0	0.1	524.2, 524.3
tetrachloroethene	127-18-4	0.0005	524.2, 524.3
tetrahydrofuran	109-99-9	5.0	524.2, 524.3
toluene	108-88-3	0.006	524.2, 524.3
xylenes (total)			
o-xylene	95-47-6	0.009	524.2, 524.3
p-xylene	108-38-3		
m-xylene	106-42-3		
trans-1,2-dichloroethene	156-60-5	0.01	524.2, 524.3
dichloropropene (total)			
cis-1,3-	542-75-6	0.0005	524.2, 524.3
trans-1,3	10061-01-5		
	10061-02-6		

Table 4.3**Extraction testing parameters (volatiles)**

Analyte	CAS number	Maximum reporting limit (RL) mg/L	US EPA Method(s)
trichloroethene or trichloroethylene	79-01-6	0.0005	524.2, 524.3
trichlorofluoromethane	75-69-4	0.2	524.2, 524.3
total trihalomethanes (TTHMs) bromodichloromethane bromoform chloroform dichlorobromomethane	—	0.001	524.2, 524.3
vinyl chloride	75-01-4	0.0002	524.2, 524.3

Table 4.4**Materials listed in US 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/CAN 61 or shall be subject to formulation review. Solvents that have been reprocessed or recycled shall not be used. <i>Note.</i> 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.

5 Structural performance

5.1 Structural integrity

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.

5.1.1 General

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

5.1.2 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 Section [5.1](#) at the pressures specified in Table [5.1](#). When more than one pressure is specified in Table [5.1](#), testing shall be done at the higher pressure.

Complete systems, pressure vessels, and components shall be watertight when tested for structural integrity under Section [5.1](#). Weepage shall be considered acceptable at the beginning of a test, but weepage shall not begin in the middle of a test.

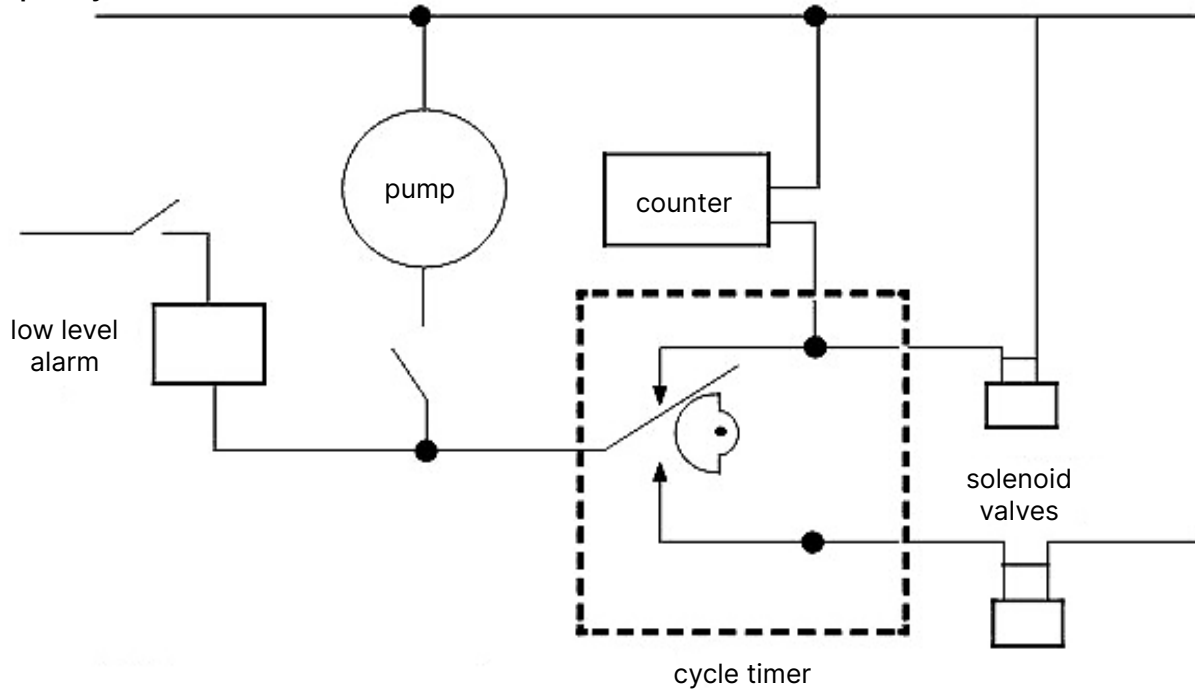
5.1.3 Structural integrity test methods

5.1.3.1 Apparatus

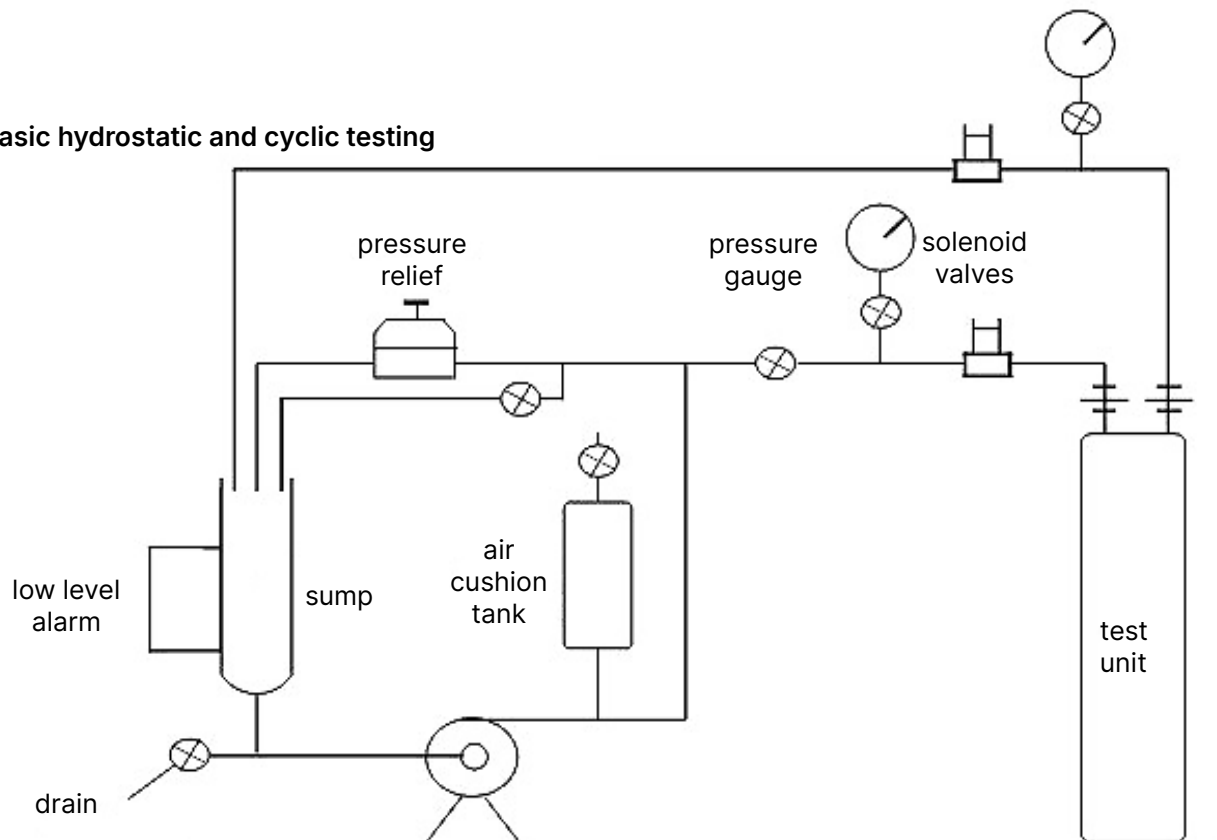
An enclosure shall be provided for each system tested to prevent injury to personnel or property damage if the system fails. An apparatus that may be used for the cyclic and hydrostatic test is shown schematically in Figure [1](#). Pressure-measuring instruments shall have a precision and accuracy of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

Figure 1
Structural testing apparatus

Close up of cyclic controllers



Basic hydrostatic and cyclic testing



5.1.3.2 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. The following procedure shall be used for the hydrostatic pressure testing of other complete systems:

- a) A water temperature of 18.5 ± 5.5 °C (65 ± 10 °F) shall be used. The test water shall be adjusted to a temperature at which condensation will not form on the surface of the test unit.
- b) The inlet of the test system shall be connected 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.
- c) The test system shall be filled with water and flushed to purge air from the system. The system outlet shall be closed, and the control valve placed in the service position. All parts of the unit, including inlet and outlet fittings that may be subject to line pressure in normal operation shall be pressurized.
- d) The hydrostatic pressure shall be raised at a constant rate so that the test pressure specified in Table 5.1 is reached within 5 min. The rate of pressure increase shall not be greater than 690 kPa/s (100 psi/s).
- e) The test pressure shall be maintained for 15 min. The system shall be inspected periodically through the end of the test period to check whether the system is watertight.

5.1.3.3 Hydrostatic pressure test – Metallic pressure vessels

The permanent increase in the circumference of the pressure vessel shall not be greater 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 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:

- a) The unit shall be installed on the elevated rack or stand. The test unit shall be prepared and filled as specified in Section 5.1.3.2, steps a, b, and c.
- b) An appropriate measuring device, such as an extensometer or dial micrometer, shall be installed vertically against the tank bottom head and either the tank top head, top mounted control valve, or another component solidly mounted to the tank top.
- c) An appropriate measuring device, such as an extensometer or periphery tape, shall be installed around the tank perpendicular to its axis and 15 cm (6 in.) above its bottom. Additional measurement devices shall be placed, vertically spaced not more than 30 cm (12 in.) apart, up the side sheet of the tank. The upper most device shall be 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 extensometers are used, the flexible wire shall be wrapped once around the tank perpendicular to its axis and 15 cm (6 in.) above its bottom. One end of the wire shall be fastened to a solid post at the same elevation. The other end shall be fastened to a second post at the same elevation by means of a spring so as to maintain the wire taut. The blocks shall be fastened 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. Blocks shall be attached to each wire wrap as previously specified.

- d) Initial readings shall be taken from the measurement devices before pressurizing the test unit. When extensometers are used, the distance between the blocks on each wire shall be measured with a micrometer caliper.
- e) The test unit shall be pressurized as specified in Section [5.1.3.2](#), steps [d](#) and [e](#).
- f) Final readings shall be taken from the extensometers or measurement devices with no pressure on the unit.
- g) 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.

5.1.4 Cycle test

The following procedure shall be used for the cyclic testing:

- a) A water temperature of 20 ± 3 °C (68 ± 5 °F) shall be used throughout the test. The test water shall be adjusted to a temperature at which condensation will not form on the surface of the test unit.
- b) The inlet of the test system shall be connected 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.
- c) The test system shall be filled with water and flushed to purge air from the system. The system outlet shall be closed, and the control valve placed in the service position. All parts of the unit, including inlet and outlet fittings, that may be subject to line pressure in normal operation shall be pressurized.
- d) The counter shall be set to zero, or its initial reading recorded, and pressure cycling shall be initiated. The pressure rise shall be greater than or equal to 1 s and the pressure in the test unit shall return to less than 14 kPa (2 psig) before the initiation of another cycle.
- e) The pressure shall be cycled as specified in Table [5.1](#). The system shall be inspected periodically through the end of the test period to check whether the system is watertight.

Table 5.1
Structural integrity testing requirements

	Hydrostatic pressure test ^a	Cyclic pressure test ^a
Complete systems		
complete systems	3 × 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
pumped systems with components subject to pump pressure	1.5 × maximum working pressure	—
faucet attached systems	1.5 × maximum working pressure or 1,040 kPa (150 psig)	10,000 cycles at 0 to 690 kPa (0 to 100 psig)
Components		
metallic ^b pressure vessels	3 × 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
non-metallic pressure vessels	3 × 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
disposable pressure vessels and components	3 × 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
low pressure storage tanks (690 kPa (100 psig) or less)	4 × maximum working pressure	—

^a When a choice is given in the table, testing shall be done at the greater pressure.

^b Metallic pressure vessels require measurement of circumference and head deflection. The pressure vessel circumference shall not exhibit a permanent increase of greater 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.

6 Minimum performance requirements

6.1 General

A system evaluated under this standard shall be designed and constructed so that its intended purpose will be accomplished when the system is installed and operated in accordance with the manufacturer's instructions.

6.2 Flow control

If the performance of a system or component is dependent on a specified flow rate, an automatic fixed flow control shall be provided as an integral part of the system to regulate the flow.

6.3 Reject water connections

If provided, reject water connections shall be designed to comply with applicable plumbing codes, and shall be designed and constructed for connection to the drain system through a vertical air gap, as defined in NSF/ANSI 330, of two pipe diameters or 25 mm (1 in.), whichever is larger. If an alternate drain system air gap device, such as an air-gap-type faucet, is supplied with the system, the alternate system air gap device shall

be tested in accordance with Section [6.9](#). The critical level of the alternate air gap device shall be clearly marked on the faucet.

6.4 Storage tank capacity

Storage tank capacity shall be within $\pm 10\%$ of the manufacturer's claimed volume when the tank is pre-charged with the manufacturer's recommended air charge pressure in the tank and tested at a static water pressure of 350 kPa (50 psig).

6.4.1 Storage tank capacity test

6.4.1.1 Apparatus

A test apparatus capable of supplying the manufacturer's recommended air charge and a static water pressure of 350 kPa (50 psig) shall be used.

6.4.1.2 Test procedure

- a) Condition the test samples at room temperature for 24 h prior to test.
- b) Verify that the air charge in the test sample is at the manufacturer's specification and adjust if necessary.
- c) Fill the test sample with test water to an initial dynamic pressure of 350 ± 18 kPa (50 ± 3 psig).
- d) Measure the amount of water in the test sample.

6.5 Product water dispensing outlets

Product water dispensing outlets other than drinking fountain outlets, if provided, shall be designed, constructed, and located so that the discharge orifice is directed downward. 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 guard shall be readily accessible for cleaning.

6.5.1.2 The outlet and guard shall be designed to discourage hose connections and 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 25 mm (1 in.) above the flood rim of the waste receptacle.

6.6 Performance indication

6.6.1 TDS reduction claims

The system shall be provided with a TDS monitor to measure product water quality, or the following statement shall appear in the performance data sheet and installation and operating instructions:

"This reverse osmosis system contains a replaceable treatment component critical for effective reduction of TDS. The product water shall be tested periodically to verify that the system is performing satisfactorily."

6.6.2 Chemical reduction and mechanical filtration claims

In addition to the requirements of Section [6.6.1](#), a system making claims for the reduction of health-related inorganic, organic, or particulate contaminants shall be provided with an effective means to warn the user when the system is not performing its functions. This may be accomplished by one of the following:

- terminating discharge of product water
- sounding an alarm connected to an acceptable power source
- flashing a light connected to an acceptable power source
- providing the user with an obvious, readily interpretable indication of the system's failure to perform, such as decreasing the flow of water by 50% or more for systems making mechanical filtration claims
- providing a sampling service by the manufacturer, either directly or through an authorized dealer, at least once every 6 mo
- providing a sampling kit for analysis of TDS or other appropriate contaminants
- providing a TDS monitor to measure the product water quality.

If an activated carbon disposable component is provided for organic reduction claims, simple explicit instructions for determining the need for servicing of the component shall be provided. If the RO system has a volatile organic chemical (VOC) reduction claim in accordance with Section [7.1.1](#), any performance indication device for the VOC reduction component in the system shall meet the requirements of NSF/ANSI 53.

6.6.3 Nitrate/nitrite reduction claims

Systems making nitrate/nitrite reduction claims shall be provided with one of the following to warn the user when the system is not performing its function:

- a nitrate/nitrite monitor on the product water stream, or
- a sampling and analysis kit for nitrate/nitrite with explicit instructions of recommended frequency of analysis.

6.7 Hazards

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

6.8 TDS reduction, recovery rating, and efficiency rating claims

6.8.1 TDS reduction claims

RO drinking water treatment systems shall reduce the influent challenge level of 750 ± 40 mg/L TDS by at least 75.0% when tested in accordance with Section [6.8](#).

Table 6.1
Contaminant reduction requirements

Contaminant	Individual influent sample point limits ^a (mg/L)	Average influent challenge level (mg/L)	Minimum allowable reduction (%)	US EPA Method(s)	Compound
TDS	750 ± 20%	750 ± 40	75.0	160.1	NaCl

^a 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 US EPA Method.
2. Acceptable spike recoveries as stated in the appropriate US EPA Method.
3. Opinion of laboratory professionals – no guidance available in US EPA Method.

6.8.1.1 Recovery rating and efficiency rating claims

Claims of recovery rating and efficiency rating made in advertising literature; in the installation, operation and maintenance instructions; on the data plate; or in the performance data sheet shall be less than or equal to the specific rating determined when the system is tested in accordance with Section [6.8](#).

Systems equipped with both an automatic shutoff device and either a pressurized or a non-pressurized storage tank shall report an efficiency rating and may report a recovery rating as an option. All other systems may report a recovery rating, but no efficiency rating shall be determined or reported.

6.8.2 Recovery rating, and efficiency rating testing

The system shall be tested for TDS reduction claims prior to or during any other chemical contaminant reduction testing. Tests for recovery rating and efficiency rating shall only be conducted in conjunction with a TDS reduction test. While a recovery rating may be determined for all types of systems, an efficiency rating shall only be determined for systems equipped with an automatic shutoff device.

6.8.3 Apparatus

A test apparatus capable of providing specified flow rates and pressures shall be used. An example of an appropriate test apparatus appears in Figure [2](#).