



*NSF International Standard /
American National Standard*

NSF/ANSI 58 - 2017

Reverse Osmosis Drinking Water Treatment Systems



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Reverse osmosis drinking water treatment systems

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

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

**Reverse osmosis
drinking water
treatment systems**

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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 reverse osmosis 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 61 with criteria that were developed specifically for the intended end-use. NSF/ANSI 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 74

Sampling procedures for the evaluations of the minimum performance and elective performance claims were revised to ensure consistency among labs.

Issue 78

Normative references were updated.

Issue 79

Evaluation criteria columns from tables 4.1, 4.2, and 4.3 were removed and now reference the evaluation criteria in Annex D, Table D.1 in NSF/ANSI 61.

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 —

Reverse osmosis drinking water treatment systems

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 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 reverse osmosis 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 supplies (public or private) considered to be microbiologically safe and of known quality (except that claims for the reduction of filterable cysts may be permitted). Systems covered by this Standard are intended for reduction of total dissolved solids (TDS) and other contaminants specified herein. Systems with components or functions covered under other NSF or NSF/ANSI Standards or Criteria shall conform to the applicable requirements therein.

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 E.

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 most recent editions of the standards indicated below. The most recent published edition of the document shall be used for undated references.

21 CFR §. Parts 170-199. Food and Drugs³

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

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

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

Ontario Ministry of the Environment 1977. *An Interim Method for Determination of Asbestos Fibre Concentration in Water by Transmission Electron Microscopy*⁵

SAE J726 *Air Cleaner Test Code*, June 1993⁶

USEPA-600/4-84-053. *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater*, June 1984⁷

USEPA-600/4B79/020. *Methods for the Chemical Analysis of Water and Wastes*, March 1983⁷

USEPA-600/RB93/100. *Methods for the Determination of Inorganic Substances in Environmental Samples*, August 1993⁷

USEPA-600/R-94/111. *Methods for the Determination of Metals in Environmental Samples*, Supplement 1, May 1994⁷

USEPA-600/4-90/020. *Methods for the Determination of Organic Compounds in Drinking Water*, Supplement 1, July 1990⁷

USEPA *National Primary Drinking Water Regulations*, 40 CFR Part 141⁸

USEPA *National Secondary Drinking Water Regulations*, 40 CFR Part 143⁸

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 61 Annex D,

³ USFDA –CFR Code of Federal Regulations Title 21
<<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcr/cfrsearch.cfm>>.

⁴ American Public Health Association (APHA), 1015 Fifteenth Street, NW, Washington, DC 20005 <www.apha.org>.

⁵ Ontario Ministry of the Environment, Toronto, Canada M4V 1P5 <www.ene.gov.on.ca>.

⁶ Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA 15096 <www.sae.org>.

⁷ U. S. Environmental Protection Agency (USEPA), Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268 <www.epa.gov>.

⁸ Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402 <www.gpo.gov>.

Table D.1. 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.

4.1.1.2 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 4.5.1 shall be reported in accordance to 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 and Annex A, D, and E of NSF/ANSI 61.

4.1.2 Data reporting

4.1.2.1 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 4.1.1. 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.

4.1.2.2 If the extractable contaminant cannot be identified following the procedures in 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 4.4.3.

4.3 Temperature resistance

4.3.1 Materials shall be tested in accordance with 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 U. S. Code of Federal Regulations, Title 21, listed in table 4.1, 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.

4.4.1 Analytical methods

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

4.4.1.1 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.

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

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

4.4.2 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 total dissolved solids 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 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 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 4.4.3.1, systems shall be refilled with exposure water as specified in 4.4.2 and maintained for 24 h at an ambient temperature of $23 \pm 2^\circ\text{C}$ ($73 \pm 3^\circ\text{F}$). A 2-L water sample shall be collected for analysis by emptying the storage tank completely and then sub-sampling a 2 L volume. 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 $23 \pm 2^\circ\text{C}$ ($73 \pm 3^\circ\text{F}$). A 2-L water sample shall again be collected for analysis by emptying the storage tank completely and then sub-sampling a 2 L volume. This process shall be repeated to give a total of three 24-h exposures and 2-L samples. 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 4.4.1.

This sequence is summarized as follows:

- 1) Install the test system/s on the test stand.
- 2) Flush and condition with exposure water.
- 3) Close the system outlet and maintain for 24 h.
- 4) Empty the storage tank/s, if applicable, and sample.
- 5) Repeat steps 3 and 4 for a total of three sampling events.
- 6) 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 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. Samples collected shall be composited and analyzed in accordance with 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 4.4.1.

4.4.3.3 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. The maximum number of samples exposed shall not exceed 16 with 125 mL of extractant water drawn from each sample. If the components with a water-holding volume that is less than 250 mL and is able to be identified as one that will only occur once in the flow path of dispensed treated water (such as diverters, faucets, RO shutoff valves, or specialty components) then a volume of 250 mL shall be drawn from each sample using a maximum number of 8 samples.

4.4.3.4 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, 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 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. USEPA Methods 524.2 and 625 have specific validation requirements including precision and accuracy requirements as well as demonstration of sensitivity (Method Detection Limit Study or MDL).

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

— To guard against significant drift from an initial instrument calibration to subsequent instrument batches, the average chromatographic peak area of each internal standard in the calibration curve shall be determined. The chromatographic peak area of each internal standard in the continuing calibration shall be greater than 50% and not more than 200% of that average;

— Due to the number of characteristics of the analytes associated with method 625, while a continuing calibration check (CCC) is performed, concentrations of 10% of the target compounds for each analysis (e. g., base/neutral, base/neutral/acid, acid) shall be allowed to fall outside the range of 70% to 130% (outlier) of the true value. None of the concentrations shall be allowed to fall below 50% or above 200% of the true value. If a positive sample analyte result is identified for any outlier, a second CCC shall be performed. If the second CCC determines the sample analyte result no longer to be an outlier, the sample shall be reanalyzed. However, if the second CCC also determines the analyte to be an outlier, a new calibration curve shall be determined and the sample shall be reanalyzed;

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

4.5.1.2 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:

- 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 a "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.

4.5.1.3 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; 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 4.1.1.2 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 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	USEPA 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	Reference 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
Butyl 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	525.2, 528, 625
N-Nitroso-di-n-propylamine	621-64-7	0.0005	525.2, 528, 625
N-Nitrosodiphenylamine	86-30-6	0.007	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
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

Table 4.3 – Extraction testing parameters (volatiles)

Analyte	CAS number	Maximum reporting limit (RL) mg/L	Reference 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
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

Table 4.3 – Extraction testing parameters (volatiles)

Analyte	CAS number	Maximum reporting limit (RL) mg/L	Reference method(s)
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	0.07	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	0.1	524.2, 524.3
Xylenes (Total)	95-47-6	0.1	524.2, 524.3
o-Xylene ² or 1,2-Xylene, m-xylene, p-xylene	106-42-3		
	108-38-3		
trans-1,2-Dichloroethene	156-60-5	0.01	524.2, 524.3
Dichloropropene (Total)	542-75-6	0.0005	524.2, 524.3
Cis-1,3-	10061-01-5		
Trans-1,3	10061-02-6		
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)		0.001	524.2, 524.3
Bromodichloromethane			
Bromoform			
Chloroform			
Dichlorobromomethane			
Vinyl chloride	75-01-4	0.0002	524.2, 524.3

Table 4.4 – 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 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 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 5.1.

NOTE — 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.

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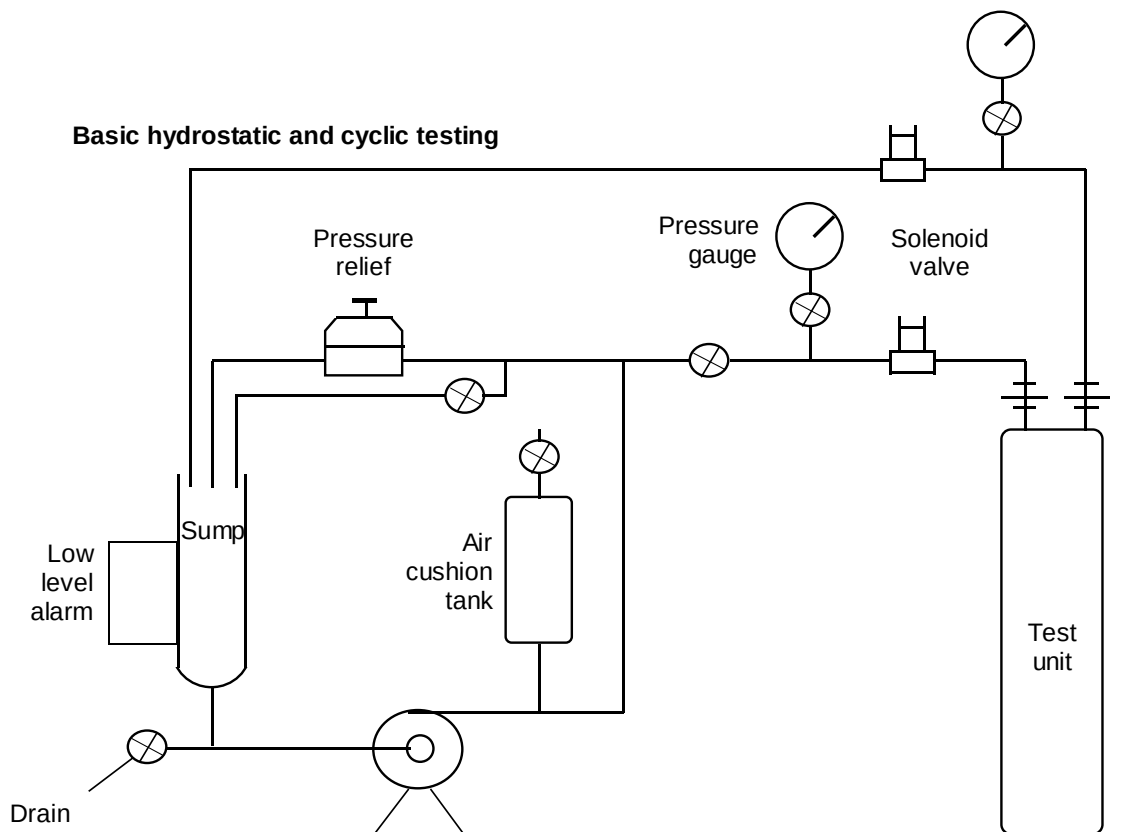
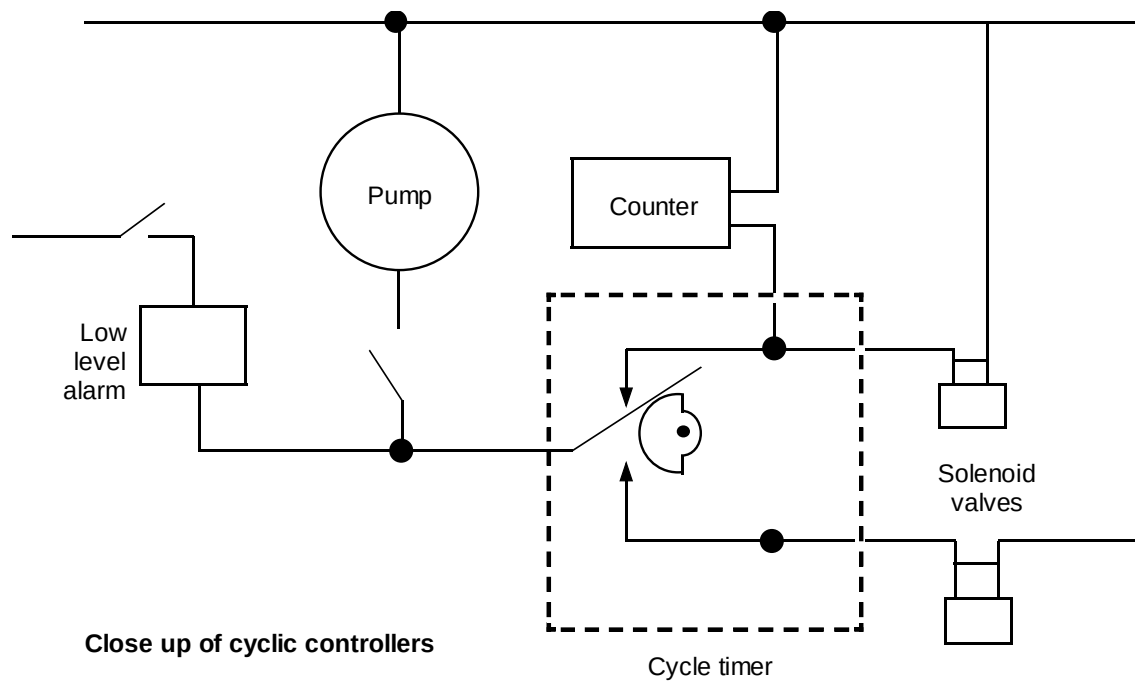


Figure 1 – Structural testing apparatus

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 13 to 24 °C (55 to 75 °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 more than 690 kPa (100 psi) per second.
- 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 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 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 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.