



# Standard Specification for Reagent Water<sup>1</sup>

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*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This specification covers requirements for water suitable for use in methods of chemical analysis and physical testing. Four grades are specified:

|                                                                                                                                         | Type I       | Type II      | Type III     | Type IV        |
|-----------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|--------------|----------------|
| Electrical conductivity, max, $\mu\text{S}/\text{cm}$ at 298 K (25°C)                                                                   | 0.056        | 1.0          | 0.25         | 5.0            |
| Electrical resistivity, min, $\text{M}\Omega\cdot\text{cm}$ at 298 K (25°C)                                                             | 18           | 1.0          | 4.0          | 0.2            |
| pH at 298 K (25°C)                                                                                                                      | <sup>A</sup> | <sup>A</sup> | <sup>A</sup> | 5.0 to 8.0     |
| Total organic carbon (TOC), max, $\mu\text{g}/\text{L}$                                                                                 | 100          | 50           | 200          | no limit       |
| Sodium, max, $\mu\text{g}/\text{L}$                                                                                                     | 1            | 5            | 10           | 50             |
| Chlorides, max, $\mu\text{g}/\text{L}$                                                                                                  | 1            | 5            | 10           | 50             |
| Total silica, max, $\mu\text{g}/\text{L}$                                                                                               | 3            | 3            | 500          | no limit       |
| Microbiological contamination—When bacterial levels need to be controlled, reagent grade types should be further classified as follows: |              |              |              |                |
|                                                                                                                                         |              | Type A       | Type B       | Type C         |
| Maximum heterotrophic bacteria count                                                                                                    |              | 10/1000 mL   | 10/100 mL    | 100/10 mL      |
| Endotoxin, EU/ml <sup>B</sup>                                                                                                           |              | <0.03        | 0.25         | not applicable |

<sup>A</sup> The measurement of pH in Type I, II, and III reagent waters has been eliminated from this specification because these grades of water do not contain constituents in sufficient quantity to significantly alter the pH.

<sup>B</sup> EU = Endotoxin Units.

1.2 The method of preparation of the various grades of reagent water determines the limits of impurities and shall be as follows:

1.2.1 Type I grade of reagent water shall be prepared by distillation or other equal process, followed by polishing with a mixed bed of ion exchange materials and a 0.2- $\mu\text{m}$  membrane filter. Feedwater to the final polishing step must have a maximum conductivity of 20  $\mu\text{S}/\text{cm}$  at 298K (25°C).

1.2.2 Type II grade of reagent water shall be prepared by distillation using a still designed to produce a distillate having a conductivity of less than 1.0  $\mu\text{S}/\text{cm}$  at 298 K (25°C). Ion exchange, distillation, or reverse osmosis and organic adsorption may be required prior to distillation if the purity cannot be attained by single distillation.

NOTE 1—Because distillation is a process commonly relied upon to produce high purity water, the levels specified for Type II reagent water

were selected to represent the minimum quality of water that a distillation process should produce.

1.2.3 Type III grade of reagent water shall be prepared by distillation, ion exchange, continuous electrodeionization reverse osmosis, or a combination thereof, followed by polishing with a 0.45- $\mu\text{m}$  membrane filter.

1.2.4 Type IV grade of reagent water may be prepared by distillation, ion exchange, continuous electrodeionization reverse osmosis, electrodialysis, or a combination thereof.

1.3 The choice of one of the various grades may be designated by the method or by the investigator.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 1125 Test Methods for Electrical Conductivity and Resistivity of Water<sup>2</sup>

D 1129 Terminology Relating to Water<sup>2</sup>

D 1293 Test Methods for pH of Water<sup>2</sup>

D 4453 Practice for Handling of Ultra-Pure Water Samples<sup>2</sup>

D 4517 Test Method for Low-Level Total Silica in High-Purity Water by Flameless Atomic Absorption Spectroscopy<sup>3, 4</sup>

D 4779 Test Method for Total, Organic, and Inorganic Carbon in High Purity Water by Ultraviolet (UV) or Persulfate Oxidation, or Both, and Infrared Detection<sup>4</sup>

D 5391 Test Method for Electrical Conductivity and Resistivity of a Flowing High Purity Water Sample<sup>2</sup>

D 5542 Test Method for Trace Anions in High Purity Water by Ion Chromatography<sup>2</sup>

D 5997 Test Method for On-Line Monitoring of Total Carbon, Inorganic Carbon in Water by Ultraviolet, Persulfate Oxidation and Membrane Conductivity Detection<sup>2</sup>

D 6071 Test Method for Low Level Sodium in High Purity

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 11.01.

<sup>3</sup> Determination of Trace Silica in Industrial Process Waters by Flameless Atomic Absorption Spectrometry, Judith Rawa and Earl Henn, Analytical Chemistry, Vol 51, No 3, March 1979.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 11.02.

Water by Graphite Furnace Atom Absorption Spectroscopy<sup>2</sup>

F 1094 Test Methods for Microbiological Monitoring of Water Used for Processing Electron and Microelectronic Devices by Direct Pressure Tap Sampling Valve and by the Presterilized Plastic Bag Method<sup>5</sup>

### 3. Terminology

3.1 *Definitions*— For definitions used in this specification refer to Terminology D 1129.

### 4. Significance and Use

4.1 Different analytical methods and industrial processes require water of different purities. Also, different types of contaminants affect these methods and processes differently. This specification is intended to provide the user with a choice of different grades of water having different purities as described in Section 1. It is intended to satisfy the requirements for normal laboratory procedures, but does not necessarily apply to the large-scale production of pure water or for specific applications. Different grades of water may be covered by other ASTM specifications or guides, or by the requirements of other standards organizations.

### 5. Use and Application

5.1 The method of preparing Type I reagent water may add organic contaminants to the water by contact with the ion-exchange materials. It should be noted also that the method may or may not remove non-ionized dissolved gases.

5.1.1 The dissolved or particulate organic contamination would normally range from 30 to 50 µg/L. The concentration of nonionized dissolved gases may exceed 5 mg/L.

5.2 The quality of the effluent water depends upon the type, age, and method of regeneration of the ion exchange materials. Likewise, the flow rate through the ion exchange resin bed will change the conductivity of the effluent water. The instructions of the manufacturer of the resins or the resin cartridge bed should be followed.

5.3 The use of the membrane filter in the preparation of Type I and Type III water may add a small amount of organic components to the water first produced.

5.3.1 Some membrane filters contain as much as 8 mass % of soluble components resulting from the manufacturing process.

5.3.2 If the contamination of the water by the organic component is of significance to the test, Type II water should be used or the membrane should be rinsed by discarding the first 10 mL of water produced per square centimetre of filter area, and until a test for the organic components shows them to have been reduced to less than the specified level.

5.4 Type II grade of reagent water should be sterile and pyrogen-free as produced and generally may be used whenever freedom from organic or biological contaminants is desirable. However, the method of storage and handling of the water may itself result in contamination.

5.4.1 Type II water should be pyrogen-free, but must be tested in conformance with the requirements of the current

edition of U.S.P. if proof is needed.

5.4.2 The description of Type II reagent water is intended to characterize the product of distillation.

5.4.3 Distilled water is often specified when freedom from moles and silica is required, or when surface-active organics are proven to be a problem, and when alternative processes have been found to be inadequate.

5.5 Types I, II, and III reagent water should be protected from atmospheric contamination and from solution of container and tubing materials.

5.5.1 Extreme care must be exercised in handling samples when making an analysis. Sample containers and tubing should be made of fluorocarbon, titanium, tantalum, block tin, quartz, 18-8 stainless steel, polyethylene, or other material proven to be sufficiently resistant to chemical attack so as not to cause contamination in the intended use. Practice D 4453 should be consulted.

5.6 Because atmospheric gases and impurities rapidly recontaminate exposed water, in-line electrodes should be employed for determining the electrical conductivity of reagent water Types I, II, and III. The measurement of pH in Type I, II, and III reagent waters has been eliminated from this specification because the values would be a function of the instrumentation.

5.7 Since freedom from biological contaminants may be important in the test procedure using any of the reagent waters specified, a classification of bacterial levels is included and should be specified if it is of significance to the test being performed.

5.7.1 To obtain sterile water, any of the types of reagent water listed in this section may be produced, bottled, and heated to 394 K (121°C) for 20 min. This procedure is most easily carried out by autoclaving at 103 kPa (15 psi) for 20 min.

5.8 *The following requirement is beyond the requirements of the general specifications:* The use of reagent grade water should recognize that analytes may exist in water that meets the criteria listed in Section 1, but these analytes may interfere with the use of the water. If levels of other analytes are important, it is the user's responsibility to specify their limits.

### 6. Requirements

6.1 Reagent water shall conform to the requirements specified in Section 1.

6.2 Additional requirements concerning specific contaminants or methods of preparation may be included in this specification by mutual agreement between the parties concerned.

### 7. Test Methods

7.1 *Electrical Conductivity and Resistivity*—Refer to Test Methods D 1125 and D 5391.

7.2 *pH*—Refer to Test Methods D 1293.

7.3 *Silica*—Refer to Test Method D 4517.

7.4 *Sodium*—Refer to Test Methods D 6071.

7.5 *Chlorides*<sup>6</sup>. Refer to Test Method D 5542.

<sup>5</sup> Annual Book of ASTM Standards, Vol 10.04.

<sup>6</sup> Published in U.S. Pharmacopeia by The U.S. Pharmacopeial Convention, Inc.

7.6 *TOC*—Refer to Test Method D 4779 and D 5997.

7.7 *Endotoxins*—Refer to LAL Test Method.<sup>6</sup>

7.8 *Microbiological Contamination*—Refer to Test Methods F 1094.

## **8. Keywords**

8.1 laboratory analysis; reagent; water

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