ANSI/AWWA **B116-19**
(Revision of ANSI/AWWA B116-15)

American Water Works Association
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AWWA Standard

Electrodialysis and Ion-Exchange Membrane Systems

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AWWA Standard

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Contents

All AWWA standards follow the general format indicated subsequently. Some variations from this format may be found in a particular standard.

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA B116.*

I. Introduction.

I.A. *Background.* The purpose of ANSI/AWWA B116 is to provide purchasers with a standard for the purchase and installation of ion-exchange membrane treatment systems such as electrodialysis (ED), electrodialysis reversal (EDR), electrodialysis metathesis (EDM), and electrodeionization (EDI). Please note that the terms *ion exchange* and *ion-exchange* are used interchangeably with the terms *ion transfer* and *ion-transfer* in this document.

A wealth of information about ion-exchange membrane (IEM)† systems and their design is available from various sources, including AWWA Manual M38;‡ *Ion-Exchange Membrane Separation Processes;*§ *Demineralization by Electrodialysis;*¶ and other references listed in Appendix A.

I.B. *History.* IEMs are made from a variety of materials, and new membrane materials, structures, and surface treatments are being developed. Measurements of membrane performance, including separation and output, are not universally standardized by regulatory agencies. However, some standards groups have published standardized measurement methods and the industry has developed approaches. This is one of the purposes of the testing requirements outlined in the US Environmental Protection Agency (USEPA) *Membrane Filtration Guidance Manual* (USEPA 2005) associated with the Long Term 2 Enhanced Surface Water Treatment Rule (USEPA 2006) as well as in NSF/ANSI 419, Public Drinking Water Equipment Performance—Filtration. However, while ED, EDR, EDM, and EDI are generically classified as membrane processes, these treatment technologies do not specifically constitute "membrane filtration" as defined by the LT2ESWTR (40 Code of Federal Regulations [CFR] 141.2). Unlike nanofiltration (NF) and reverse osmosis (RO), which use pressure to force water through membranes while rejecting dissolved solids, the driving force for separation in IEM processes is electric potential, and an applied electrical current is utilized to transport ionic species across selectively permeable IEMs. Because

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.

† The term *IEM* is used here and throughout this document to generally refer to all ED/EDR/EDM/EDI separation processes that incorporate ion-exchange membranes and electrically driven ionic transport.

‡ AWWA Manual M38, *Electrodialysis and Electrodialysis Reversal*, AWWA (1995).

§ *Ion-Exchange Membrane Separation Processes*, Heiner Strathmann, Elsevier (2004).

¶ *Demineralization by Electrodialysis,* J.R. Wilson. Butterworths Scientific Publications (1960).

the water is not "filtered" through the membrane in ion-exchange processes, particulate matter is not removed. Thus, ion-exchange (ion-transfer) membranes are specifically applied for the removal of dissolved ionic constituents but are not considered filters. Consequently, ion-exchange (ion-transfer) membrane processes are not addressed in the USEPA *Membrane Filtration Guidance Manual*.

Regulatory concerns may or may not be the primary drivers for the use of membranes by a municipality, but in all cases the regulations must be assessed for applicability. At present, US federal drinking water standards covering membrane treatment deal mainly with how much removal credit can be received from membrane treatment's use as a microbial barrier. Other issues, such as acceptable water contact materials and meeting the primary and secondary contaminant levels in the finished water, may also apply.

This standard should be considered as a list of minimum requirements for planning, procurement, selection, construction, and commissioning of microfiltration- and ultrafiltration-based treatment systems. However, its proper application requires this standard to be coupled with a thorough professional review of site-specific water treatment conditions. The AWWA Standards Council authorized a new AWWA standard for membrane systems on Sept. 10, 2004, and assigned the task of development to the AWWA Standards Committee on Membranes.

The first edition of this standard, ANSI/AWWA B116-15 Electrodialysis and Ion-Exchange Membrane Systems, was approved by the AWWA Board of Directors on Jan. 24, 2015. The standard was approved and promulgated in the course of the activities of the AWWA Standards Committee on Membranes. A previous standard, B110 Membrane Systems, had been divided into three separate standards, each focused on a specific category of membrane technology: (1) microfiltration and ultrafiltration, (2) nanofiltration and reverse osmosis, and (3) electrodialysis/ion-exchange/ion-transfer membrane systems (this standard). A standard on membrane bioreactors, B130, was also approved. Guidance to the applicable AWWA membrane standards is presented in Table 1.

I.C. *Acceptance*. In May 1985, the USEPA entered into a cooperative agreement with a consortium led by NSF International* (NSF) to develop voluntary third-party consensus standards and a certification program for direct and indirect drinking water additives. Other members of the original consortium included the Water Research Foundation (formerly AwwaRF) and the Conference of State Health

* NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

Table 1 Guide to AWWA membrane standards and typical membrane characteristics

Membrane Type	Applicable AWWA Standard	Nominal Pore Size (*μm*)	≥3-μm Particle or Surrogate Organism Removal	Virus (MS2 Phage) Removal	Typical Molecular Weight Cutoff *(daltons)*	Salt (NaCl) Rejection *(%)**
Microfiltration (MF)	B112	0.1 to 0.5	≥99.9% (≥3 log)	<90% (<1 log)	≥200,000	None
Ultrafiltration (UF)	B112	0.005 to 0.1	≥99.9% (≥3 log)	≥90% (≥1 log)	10,000 to 200,000	None
Nanofiltration (NF)*,†	B114	0.001 (approximate conceptual value)	Same as UF, but typically not designed for verifiable removal	Same as UF, but typically not designed for verifiable removal	~ 200 to > 500	0% to 95%
Reverse osmosis (RO)†	B114	0.001 (approximate conceptual value)	Same as UF, but typically not designed for verifiable removal	Same as UF, but typically not designed for verifiable removal	<200 to 500	>95%
Electrodialysis (ED)/ion-exchange membranes (IEMs)	B116	Not applicable	Not applicable: demineralized product does not pass through a membrane barrier	Not applicable: demineralized product does not pass through a membrane barrier	Not applicable	>45%
Membrane bioreactors (MBRs)	B130	‡	‡	‡	‡	‡

* NF is similar to RO with the key difference being that NF has lower sodium chloride rejection than RO, and NF exhibits greater selectivity in the types of ions that are removed such that NF allows a comparatively higher percentage of monovalent ions to pass to the permeate than multivalent ions.

† For NF and RO, rejection is generally based on test conditions for a single element, but there is some variation among membrane manufacturers and membrane models. In general, test conditions tend to vary as follows: (1) feed solutions: 500 to 700 mg/L sodium chloride, magnesium chloride, calcium chloride, or mixed solute solutions for NF; 1,500 to 2,000 mg/L sodium chloride for brackish water RO membranes; 32,000 to 38,000 mg/L sodium chloride for seawater RO membranes; (2) 25°C (77°F) temperature or corrected to that temperature; (3) 6 to 8 pH; (4) 8 to 20 percent recovery per element.

‡ For a description of typical MBR characteristics, refer to AWWA Standard B130.

and Environmental Managers (COSHEM). AWWA and the Association of State Drinking Water Administrators (ASDWA) joined later.

In the United States, authority to regulate products for use in, or in contact with, drinking water rests with individual states.* Local agencies may choose to impose requirements more stringent than those required by the state. To evaluate the health effects of products and drinking water additives from such products, state and local agencies may use various references, including:

* Persons outside the United States should contact the appropriate authority having jurisdiction.

1. Specific policies of the state or local agency.

2. Two standards developed under the direction of NSF: NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 61, Drinking Water System Components—Health Effects.

3. Other references, including AWWA standards, *Food Chemicals Codex, Water Chemicals Codex*,* and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI 60 and 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdictions. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, "Toxicology Review and Evaluation Procedures," to NSF/ANSI 61 does not stipulate a maximum allowable level (MAL) of a contaminant for substances not regulated by a USEPA final maximum contaminant level (MCL). The MALs of an unspecified list of "unregulated contaminants" are based on toxicity testing guidelines (noncarcinogens) and risk characterization methodology (carcinogens). Use of Annex A procedures may not always be identical, depending on the certifier.

In an alternative approach to inadvertent drinking water additives, some jurisdictions (including California, Louisiana, Maryland, and Vermont) are calling for reduced lead limits for materials in contact with potable water. Various third-party certifiers have been assessing products against these lead content criteria and a new ANSI-approved national standard, NSF/ANSI 372, Drinking Water System Components—Lead Contents.

On Jan. 4, 2011, legislation was signed revising the definition for "lead free" within the Safe Drinking Water Act (SDWA) as it pertains to "pipe, pipe fittings, plumbing fittings, and fixtures." The changes went into effect on Jan. 4, 2014. In brief, the new provisions to the SDWA required that these products meet a weighted average lead content of not more than 0.25 percent.

ANSI/AWWA B116 does not address additives requirements. Users of that standard should consult the appropriate state or local agency having jurisdiction in order to

1. Determine additives requirements, including applicable standards.

2. Determine the status of certifications by parties offering to certify products for contact with, or treatment of, drinking water.

3. Determine current information on product certification.

* Both publications available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20001.

II. Special Issues. There is no consensus of opinion on the precise definitions of various types of membranes, such as reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), and microfiltration (MF). The definitions and typical membrane characteristics of the membrane types shown in this standard are considered applicable to this standard and its use.

III. Use of This Standard. It is the responsibility of the user of an AWWA standard to determine that the products described in that standard are suitable for use in the particular application being considered.

III.A. *Purchaser Options and Alternatives.* The following items should be covered by the purchaser:

1. Standard used—that is, ANSI/AWWA B116, Electrodialysis and Ion-Exchange Membrane Systems, of latest revision.
2. Details of other federal, state, local, and provincial requirements (Sec. 4.1).
3. Required net production rate (Sec. 4.3.1.b).
4. Whether plans, procedures, and required testing for permitting membrane systems shall not be required in the purchase documents (Sec. 4.3.1.q and 4.3.2.n).
5. Required format of record drawings.
6. Whether compliance with other standards, rules, or regulations in addition to the requirements of the SDWA is required (Sec. 4.6.4, 4.6.4.1, and 4.6.4.2).
7. Spare part requirements (Sec. 4.6.7.1).
8. Project drawing requirements (Sec. 4.6.8.2, 4.6.8.3, 4.6.8.4, 4.6.8.5, and 4.6.8.6).
9. Installation requirements (Sec. 5.1.2).
10. Operation requirements during start-up (Sec. 5.2.1).
11. Required number of training material packages (Sec. 5.3.1).
12. Demonstration testing requirements (Sec. 5.4.3).
13. Performance testing and report requirements (Sec. 5.4.4 and 5.4.5).
14. Basis for rejection requirements (Sec. 5.5).
15. Affidavit of compliance (Sec. 6.3).

III.B. *Modification to Standard.* Any modification to the provisions, definitions, or terminology in this standard must be provided by the purchaser.

IV. Major Revisions.

1. Section I.B. History was revised.
2. Section 4.1 Materials. Mandatory requirement that materials meet the requirement of the SDWA has been removed.
3. System Description Table in Appendix B was updated.

V. Comments. If you have any comments or questions about this standard, please contact AWWA Engineering and Technical Services at 303.794.7711; FAX at 303.795.7603; write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098; or email at standards@awwa.org.

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AWWA Standard

Electrodialysis and Ion-Exchange Membrane Systems

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard sets minimum requirements for ion-exchange membrane (IEM) systems such as electrodialysis (ED), electrodialysis reversal (EDR), electrodialysis metathesis (EDM), and electrodeionization (EDI) used for water and reclaimed water treatment systems. Please note that the terms *ion exchange* and *ion-exchange* are used interchangeably with the terms *ion transfer* and *ion-transfer* in this document. Characteristics of ED and ion-exchange membranes are compared to other types of membranes in Table 1.

Sec. 1.2 Purpose

The purpose of this standard is to provide a minimum set of requirements for IEM systems used for water and reclaimed water treatment systems. This standard is intended to assist with the design, procurement, installation, and commissioning of IEM systems.

Sec. 1.3 Application

This standard can be referenced for design, procurement, installation, and commissioning of IEM systems used for water and reclaimed water treatment systems.