



**American Water Works  
Association**

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**ANSI/AWWA B304-18**  
(Revision of ANSI/AWWA B304-13)

**AWWA Standard**

# Liquid Oxygen for Ozone Generation for Water, Wastewater, and Reclaimed Water Systems

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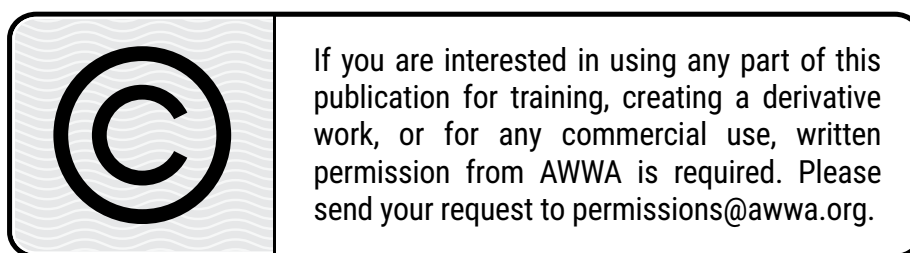
## AWWA Standard

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# Foreword

*This foreword is for information only and is not a part of ANSI\*/AWWA B304.*

## **I. Introduction.**

I.A. *Background.* Oxygen ( $O_2$ ) is commonly used as a feed gas for generating ozone ( $O_3$ ) gas, which is subsequently used for disinfection or oxidation of water supplies. Oxygen may be generated onsite as a gas or liquid or purchased in bulk as liquid oxygen (LOX). Hundreds of water plants in North America are using ozone for water treatment, with a majority generating ozone from purchased oxygen.

Gaseous oxygen is colorless and odorless while LOX is pale blue and odorless. Oxygen itself is not combustible, but it accelerates combustion to the point where materials, such as some types of clothing that are normally considered nonhazardous, become very flammable. Liquid oxygen may react spontaneously with petroleum products (such as gasoline, kerosene, oils, and greases) and other fuels (such as hydrogen and ethanol). Oxygen is nontoxic under most conditions of use, but LOX or cold gas will freeze tissues and can cause severe cryogenic burns. Breathing high-purity oxygen (greater than 60 percent) may produce a cough and chest pains.

LOX is normally produced through a cryogenic air separation process. This process involves compressing ambient air; cooling the air with a refrigeration unit; and removing residual water, carbon dioxide, and hydrocarbons with a molecular sieve adsorption unit. The clean, cold air is then liquefied and separated into its components, mainly oxygen and nitrogen, by distillation. Final oxygen purity can be controlled by further separating and removing trace components such as argon and krypton.

Ozone can be produced from oxygen in the air or from high-purity gaseous oxygen. This can be achieved by several methods, although the silent electrical discharge process is the most common method. Ozone is produced when a dry oxygen or air gas stream is subjected to a high-voltage/high-density electrical current, which provides the energy to drive the reaction. The oxygen-to-ozone reaction takes place between two electrodes separated by a dielectric, forming a gap across which the energy discharge occurs. Oxygen-fed ozone generators will produce more ozone for a given power input and produce higher ozone concentrations in the product gas compared to ozone generators fed with an air gas stream.

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\* American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036.

I.B. *History.* The first edition of ANSI/AWWA B304 was approved June 12, 2005. Subsequent editions were approved by the AWWA Board of Directors on June 8, 2008, and June 9, 2013. This edition was approved on Oct. 24, 2018.

I.C. *Purpose of Standard.* Because of the varied nature of oxygen production and feed equipment in use in the water industry today, it was the consensus of the AWWA Standards Committee on Oxygen that this standard should address only the recommendations for procurement of commercial LOX to be used for ozone generation and not for other potential uses. This does not preclude any user of oxygen who produces it onsite for use in ozone production from using the analytical techniques described in this standard to determine the purity of the product produced. It was not the intention of the committee to recommend any particular means of oxygen generation or use, or to recommend an approach to design of facilities, but merely to provide a standard for the purchaser of commercially produced oxygen on the industrial market.

One of the purposes of this oxygen standard is to describe the level of quality for the oxygen source used in ozone generation systems. As such, in the event that the level of quality is outside the recommended quality standards of this document, the purchaser may advise the supplier of the ozone generation equipment of the potential nonconformance.

I.D. *Acceptance.* In May 1985, the US Environmental Protection Agency (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 and Environmental Managers (COSHEM). The American Water Works Association 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 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.

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

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

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

Annex A, “Toxicology Review and Evaluation Procedures,” to NSF/ANSI 60 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.

ANSI/AWWA B304 addresses additives requirements in Sec. 4.3 of the standard. The transfer of contaminants from chemicals to processed water or to residual solids is becoming a problem of greater concern. The language in Sec. 4.3.5 is a recommendation only for direct additives used in the treatment of potable water to be certified by an accredited certification organization in accordance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects. However, users of the standard may opt to make this certification a requirement for the product. Users of this standard should also 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.

## **II. Special Issues.**

II.A. *Storage and Handling Precautions.* The storage and handling of LOX is widespread in many industries besides the water industry. Because of this, there are many codes and design standards associated with the storage and handling of LOX. Some of these codes and standards include the following:

1. *International Fire Code*, latest edition, International Code Council.\* The 2018 edition of this code includes requirements applicable to LOX in chapter 50, Hazardous Materials—General Provisions; chapter 53, Compressed Gases; chapter 55, Cryogenic Fluids; chapter 63, Oxidizers, Oxidizing Gases and Oxidizing Cryogenic Fluids; and appendix G, Cryogenic Fluids—Weight and Volume Equivalents.

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\* International Code Council, 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001.