



**American Water Works  
Association**

The Authoritative Resource on Safe Water<sup>SM</sup>

ANSI/AWWA B304-05  
(First Edition)

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*AWWA Standard*

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# Liquid Oxygen for Ozone Generation



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\*Liaison, nonvoting

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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 on-site as a gas or liquid or purchased in bulk as liquid oxygen (LOX). As of 2003, hundreds of water treatment plants in the United States were 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. 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 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 adsorber 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 the trace components, such as argon and krypton.

Ozone can be produced from oxygen in the air or from high-purity gaseous oxygen. This is achieved by several methods, although the silent electrical discharge process is the most common. 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 field acts 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 operating on air.

I.B. *History.* This first edition of ANSI/AWWA B304 was approved by the AWWA Board of Directors on June 12, 2005.

I.C. *Purpose of Standard.* Because of the varied nature of oxygen production and feed equipment in use in the water supply industry today, it was the AWWA Standards Committee on Oxygen consensus that this standard 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 on-site 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 the design of facilities, but merely to provide a standard for the purchaser of commercially produced oxygen on the industrial market.

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 American Water Works Association Research Foundation (AwwaRF) and the Conference of State Health and Environmental Managers (COSHEM). The American Water Works Association (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 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.

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

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

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

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