ANSI/AWWA B304-08
(Revision of ANSI/AWWA B304-05)

American Water Works Association

The Authoritative Resource on Safe Water®

AWWA Standard

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

STANDARD
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ANSI

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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 on-site as a gas or liquid or purchased in bulk as liquid oxygen (LOX). Hundreds of water plants in the United States 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. 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 removal of 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 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 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, as compared to operating on air.

I.B. *History.* The first edition of ANSI/AWWA B304 was approved June 12, 2005. This second edition was approved by the AWWA Board of Directors on June 8, 2008.

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 consensus of the AWWA Standards Committee on Oxygen 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 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.

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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.

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 the 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 2000 edition of this code included requirements applicable to LOX in Chapter 27, Hazardous Materials—General Provisions; Chapter 30, Compressed Gases; and Chapter 40, Oxidizers.

2. National Fire Protection Association (NFPA)† 50: Standard for Bulk Oxygen Systems at Consumer Sites.

3. OSHA‡ General Industry Occupational Safety and Health Standards, 29CFR1910.104—Oxygen.

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*International Code Council, 500 New Jersey Avenue, N.W., Sixth Floor, Washington, DC 20001.

†National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169.

These codes include requirements pertaining to the use of noncombustible materials and to the separation between LOX facilities and other facilities, such as public right-of-way. State and local agencies may have specific requirements in regard to oxygen systems also.

These codes and standards emphasize the need to prevent combustible or flammable materials from coming in contact with LOX or air enriched with oxygen as the result of a leak in the storage and conveyance facilities. There are many opportunities for ignition of mixtures of oxygen and combustible or flammable materials from personnel or trucks unloading LOX into the bulk storage tanks. It is important, therefore, to isolate these materials from areas where excessive oxygen can be present because of unanticipated circumstances. Examples of materials that could pose a problem in oxygen-enriched environments include rags, paper towels, any wood materials, asphaltic pavement, and any oils or hydrocarbon materials in solid, liquid, or gaseous forms. Smoking must be prohibited from the general area of the LOX storage area. Finally, it is important to apply good housekeeping practices to areas where oxygen can be present in enriched quantities.

II.B. *Gas Pretreatment.* LOX must first be vaporized to a gaseous form prior to use for ozone generation. The vaporization step can be accomplished through the heating of LOX by ambient temperature air, ambient temperature water, or electrical energy. Once vaporized, the gaseous oxygen should be pretreated prior to introduction to the ozone generators. This pretreatment typically involves the addition of nitrogen to improve ozone generation efficiency and filtering to remove particulate matter. Gaseous oxygen is typically monitored for excessive moisture content downstream of nitrogen addition to prevent problems in the ozone generator equipment.

As discussed above, it has been found that small concentrations (at least 1 percent, by weight) of nitrogen in the gaseous oxygen stream fed to ozone generators improve generator efficiency significantly. It has become common practice to introduce a small stream of compressed, dry air into the gaseous oxygen to achieve this efficiency benefit. The air must be compressed by an oil-free compressor to prevent the introduction of hydrocarbons into the oxygen stream, and the air must be dried by a desiccant dryer or similar means.

‡Occupational Safety and Health Administration, 200 Constitution Avenue NW, Washington, DC 20210.

Particulate matter could enter the ozone generators from the piping or storage tank if not properly cleaned prior to startup or following maintenance of the system. A filtration system is necessary to remove this particulate prior to the ozone generators.

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 provided by the purchaser:

1. Standard used—that is, ANSI/AWWA B304, Liquid Oxygen for Ozone Generation, of latest revision.
2. Whether the recommended compliance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, is required.
3. Details of other federal, state or provincial, and local requirements (Sec. 4.1).
4. Purity requirement if other than 99 percent (Sec. 4.3).
5. Certified analysis report delivery requirements (Sec. 5.1).
6. Preferred sampling method (Sec. 5.2).
7. Whether the purchaser will reject product from containers or packaging with missing or damaged seals. The purchaser may reject product from bulk containers or packages with missing or damaged seals unless the purchaser's tests of representative samples, conducted in accordance with Sec. 5.2 and 5.3, demonstrate that the product meets specifications. Failure to meet specifications or the absence of, or irregularities in, seals may be sufficient cause to reject the shipment.
8. Preferred analytical method (Sec. 5.3.3).
9. Preferred method for determination of water content (Sec. 5.3.4).
10. Preferred method for determination of hydrocarbon content (Sec. 5.3.5).
11. Notice of Nonconformance (Sec. 5.4).
12. Delivery method (Sec. 6.2).
13. Types of containers to be used (Sec. 6.2).
14. Whether alternative security measures have been adopted to replace or augment the security measures set out in Sec. 6.2.1.2 and 6.2.2.2.
15. If bulk shipments are specified, whether a weight certificate from a certified weigher is required in lieu of a certified liquid meter ticket (Sec. 6.2.2.1).
16. An affidavit of compliance (Sec. 6.3), if required.
17. A certified analysis (Sec. 6.3), if required.

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

IV. Major Revisions. Major revisions made to the standard in this edition include the following:

1. Wastewater and reclaimed water systems were added to the scope and application.
2. Additional references were added to the Purchaser's Options Section of the foreword.
3. Total hydrocarbon content (as methane) shall not exceed 40 ppm (v/v) at delivery.
4. Particulate level determination no longer required, replaced by inline filtration.
5. Tamper-evident packaging requirements were added.

V. Comments. If you have any comments or questions about this standard, please call the AWWA Volunteer and Technical Support Group at 303.794.7711, FAX at 303.795.7603, write to the group at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.

American Water Works Association

ANSI/AWWA B304-08
(Revision of ANSI/AWWA B304-05)

AWWA Standard

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

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes liquid oxygen (LOX) for use in water, wastewater, and reclaimed water systems.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for LOX intended for water, wastewater, and reclaimed water systems. This standard includes physical, chemical, packaging, shipping, sampling, and testing requirements.

Sec. 1.3 Application

This standard can be referenced in contract documents for purchasing and receiving LOX and can be used as a guide for sampling and testing the physical and chemical properties of LOX samples. The stipulations of this standard apply when this document has been referenced and only for LOX used for generation of ozone for water supply applications.