American Water Works Association

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ANSI/AWWA F120-18
(First Edition)

AWWA Standard

Ozone Systems for Water

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AWWA Standard

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The AWWA Standards Committee on Oxygen for Ozone Generation, which reviewed and approved this standard, had the following personnel at the time:

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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 F120.*

I. Introduction.

I.A. *Background.* Ozone treatment is accepted for oxidation of organic compounds, taste and odor control, disinfection, pathogen inactivation, enhanced particulate removal, and other potable water, wastewater, or reclaimed water treatment uses. Ozonation is used with other treatment processes to achieve regulatory and aesthetic water quality goals. Ozone processes and equipment are often used with other equipment and chemicals including coagulation, filtration, and biofiltration that are covered by AWWA standards.

I.B. *History.* The need for a standard addressing ozone disinfection systems was recognized by the American Water Works Association (AWWA) in 2004. The new standard was originally assigned to the UV Disinfection Committee. The Standards Council reassigned the development of the new standard to the Oxygen for Ozone Generation Committee in March 2009. This first edition of ANSI/AWWA F120 was approved by the AWWA Board of Directors on Jan. 20, 2018.

I.C. *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

1. Specific policies of the state or local agency.

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

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

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 appropriate to the state or local agency.

Various certification organizations may be certifying products in accordance with NSF/ANSI 61. 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 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.

ANSI/AWWA F120 does not address additives requirements. Therefore, users of this 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 certification by all 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. *Safety*. The National Fire Protection Association (NFPA) rating for oxygen and ozone indicates that there are potentially serious health hazards and flammability and reactivity hazards associated with this product. These chemicals are oxidizers and affect the skin, eyes, lungs, and other body tissues. Oxygen and ozone present unusual fire and explosion hazards. For information on the health hazards, fire and explosion hazards, and reactivity hazards with oxygen, consult the Safety Data Sheet (SDS).

It is important for operations and maintenance personnel at potable water, wastewater, and reclaimed water facilities with ozone generation equipment to understand the safety risks of both oxygen and ozone. Proper safety training for both of these gases is required for all personnel before beginning any operational

[*] NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.

[†] Both publications available from The National Academies Press, 500 Fifth Street NW, Keck 360, Washington, DC 20001.

or maintenance task involving oxygen storage/generation, ozone generation, or ozone contacting equipment.

Vaporized liquid oxygen is typically used as a feed gas in the production of ozone. Liquid and gaseous oxygen present several unique safety aspects to personnel at potable water, wastewater, and reclaimed water facilities. Oxygen is nonflammable but readily supports combustion. All materials that are flammable in air burn much more vigorously in oxygen. Some combustibles, such as oil and grease, burn with nearly explosive violence in oxygen if ignited. Safety precautions and procedures for potential exposure to oxygen should be understood and followed including cryogenic safety for liquid oxygen and fire hazards for gaseous oxygen.

Since ozone cannot be stored prior to use, it must be generated onsite. Ozone as a concentrated gas is classified as a highly toxic material that presents potential risks where ozone is generated and used. Ozone odor is very distinctive, and even minor ozone leaks are readily detected by smell. Unlike chlorine, ozone does not produce a flee response at low concentrations and may actually smell sweet or be easily tolerated. However, even at low concentrations ozone may be a health hazard. At a concentration of 10 ppm, death can occur in exposures as short as one hour. High concentration ozone exposure is very unpleasant. All ozone leaks should be identified and corrected immediately to reduce risk associated with exposure.

Ozone systems have typical safety considerations for chemical feed systems including electrical hazards and confined space entry that require specific training and awareness that is typically outlined in general plant hazard and risk management training.

There are many important safety considerations when working with oxygen and ozone including handling, storage, leak detection, and exposure limits. A detailed discussion on safety considerations is provided in Appendix A.

II.B. *Adherence to Codes and Regulations*. Due to the nature of oxygen and ozone, there are a number of regulations and codes that must be followed. Please refer to Sec. 2 and the codes summary in Appendix B.

II.C. *Assumed Ozone System Configuration.* This standard is intended to address a particular type of ozone treatment system with an assumed basis of configuration with liquid oxygen (LOX) as the source for ozone production. A typical process flow diagram is shown in Figure F.1 at the end of this section.

The ozone treatment system configuration generally includes the following equipment:

- LOX storage, LOX vaporization, and feed gas preparation equipment.
- Ozone generator and power supply unit.

- Ozone dissolution system.
- Ozone destruct system.
- Control system.
- Cooling loop for ozone generator and power supply unit.

LOX is vaporized to gaseous oxygen (GOX) before use for ozone generation. The GOX is passed through a filter to remove any particulate before the ozone generators. Nitrogen may be added to improve ozone generation efficiency. As an alternative to using vaporized LOX as a feed gas, oxygen can be concentrated onsite using air separation technology.

GOX enters the ozone generator where electricity is applied through a discharge within the generator's interior elements to create ozone gas. A mixture of oxygen gas and ozone gas, typically 4 to 15 percent ozone based on weight, along with trace levels of other atmospheric gases such as nitrogen and argon, leaves the ozone generator at the concentration of ozone required for treatment and within the constraints of the generator. The power to create the ozone formation reaction within the ozone generator is provided by the power supply unit. There is typically one power supply unit connected to each ozone generator. The power supply unit provides the electrical current to the elements within the ozone generator.

The electrical energy required to create ozone causes the ozone generator elements and the power supply unit to heat up. Therefore, the ozone generator and power supply unit are equipped with cooling water connections that allow cooled water to flow around the internals of these pieces of equipment to remove heat. The cooling water system typically includes an open-loop system and a closed-loop system. Flows from both systems are connected to a heat exchange unit to remove heat from the closed-loop water system. The temperature of the ozone generator has an impact on the efficiency with which the ozone generator can produce ozone gas; keeping the system cooler improves generator efficiency.

When ozone gas leaves the ozone generator, it is conveyed to the ozone dissolution system where ozone gas is transferred into the liquid phase. Obtaining dissolution of ozone gas within the process water is typically done by one of the two following methods:

- Contact basin with fine bubble diffusers.
- Side stream injection with a gas/water mixing device.

Ozone dissolution systems will place the ozone gas into solution within the process water. Based on the limited solubility and mixing constraints of the dissolution system, there will be a certain amount of ozone that does not dissolve into solution. This undissolved ozone is referred to as ozone vent gas. The ozone that is not dissolved can create safety, hydraulic, and treatment issues by building up a gas bubble within the contacting system; therefore, the undissolved ozone gas needs to be removed from the process water stream. Since ozone gas is a chemical that poses a health hazard to humans (see Part II.A), the ozone vent gas that is undissolved must be treated. Treatment of ozone vent gas involves an ozone destruct unit.

See Figure F.1 for a typical process flow diagram of the ozone treatment system discussed previously.

II.D. *Power Supply Unit*. This standard does not address issues associated with the ozone generator power supply units (PSUs) or the safety concerns related to the supply of power to the PSUs. Recommendations regarding supply of power, operations, maintenance, and safeguards for the PSUs should be obtained from the ozone generator manufacturer.

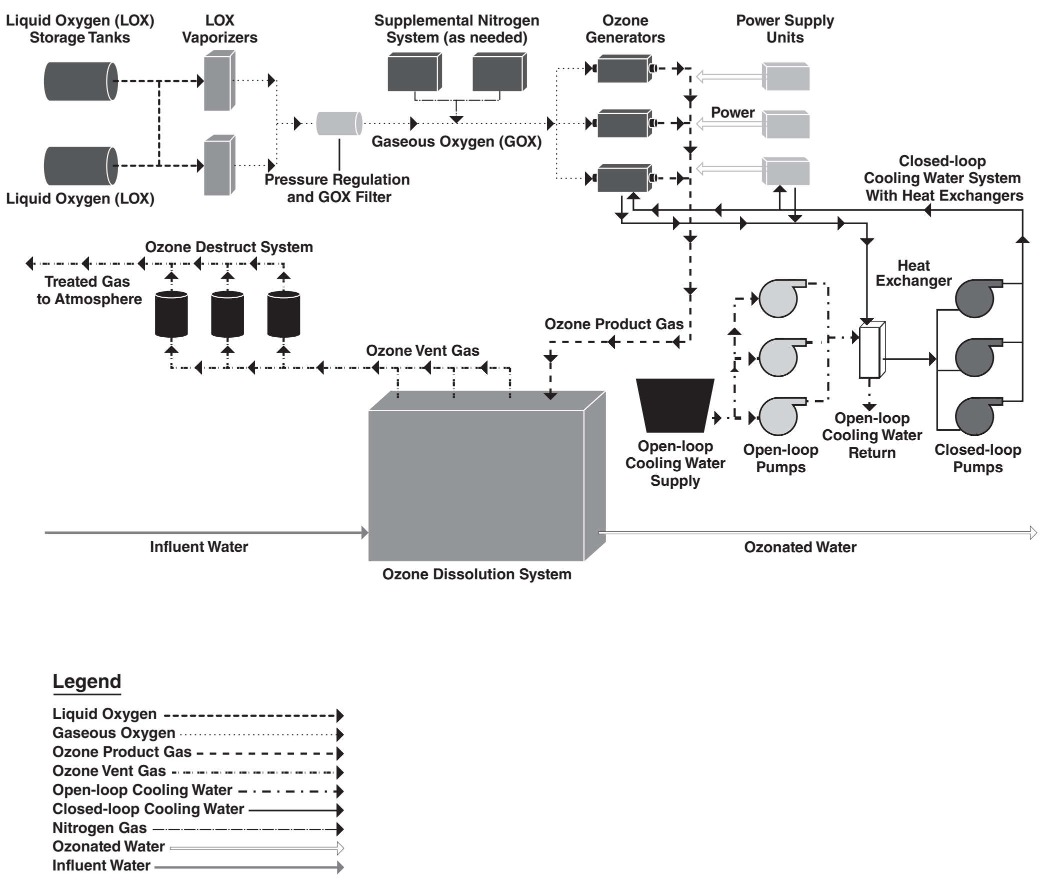

Figure F.1 Process flow diagram

Note: Number of units and piping configuration can vary based on project needs.

II.E. *Other Considerations.* The user of the standard may want to consider additional requirements for ozone systems that are not addressed in the standard as follows: buildings housing the ozone system, contactor structures, ozone system power distribution equipment, emergency ventilation, and regulatory permits. The user may want to refer to other appropriate standards and consult with an ozone system professional for further technical details on these items if they are required.

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 information should be provided by the purchaser:

1. Standard used—that is, ANSI/AWWA F120, Ozone Systems for Water, of latest revision.
2. Ozone system configuration requirements (Sec. 4.2.2).
3. Request for a required number of training materials (Sec. 4.3.8).
4. Performance test report (Sec. 4.3.12).
5. Details of federal, state, and local requirements (Sec. 4.4).
6. For applications other than potable water, whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects, is required (Sec. 4.4.1.1).
7. Ozone generator and power supply monitoring options (Sec. 4.5.5.3.3).
8. Request pre-installation equipment storage requirements (Sec. 5.2.3).
9. Certificate of proper installation (Sec. 5.3.8).
10. Training of operation and maintenance personnel (Sec. 5.4).
11. Number of printed or electronic operation and maintenance (O&M) manuals (Sec. 5.5.1.3).
12. Request for factory test results (Sec. 6.1).
13. Request for functional test results (Sec. 6.2).
14. Notice of nonconformance if applicable (Sec. 6.4).

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

IV. Major Revisions. This is the first edition of this standard.

V. Comments. If you have any comments or questions about this standard, please call 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

Ozone Systems for Water

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes the minimum requirements for ozone systems and equipment used to treat potable water, wastewater, reclaimed water, and storm water. This standard covers high concentration ozone generation equipment using discharge dielectrics and modular-type ozone generators fed from oxygen gas vaporized from a liquid oxygen (LOX) storage system. Equipment under this standard includes ozone generators with associated ancillary equipment, design considerations, and testing requirements. Both fine bubble diffusion and sidestream ozone dissolution systems are described in the standard. For ozone destruct systems, both thermal-catalytic and thermal systems are described.

1.1.1 *Systems and facilities not included in this standard.* Ozone systems provided by the ozone system supplier per this standard do not include the following systems or facilities:

1. Interconnecting piping, electrical and control wiring, and conduits.
2. Structure or housing for the ozone system including normal and emergency HVAC systems.
3. Quenching agent storage and feed facilities.
4. Regulatory agency permits.