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(Revision of ANSI/AWWA B510-00)

American Water Works Association

The Authoritative Resource on Safe Water®

AWWA Standard

Carbon Dioxide

ANSI American National Standards Institute

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AWWA Standard

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AWWA unites the entire water community by developing and distributing authoritative scientific and technological knowledge. Through its members, AWWA develops industry standards for products and processes that advance public health and safety. AWWA also provides quality improvement programs for water and wastewater utilities.

Committee Personnel

The AWWA Standards Committee on Carbon Dioxide, which developed this standard, had the following personnel at the time of approval:

Franklyn W. Pogge, *Chair*

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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 B510.

I. Introduction.

I.A. *Background.* Carbon dioxide (CO_2) is a colorless, odorless, and tasteless gas that forms a very weak acid known as carbonic acid when dissolved in water. The reaction of carbon dioxide in water to be treated forms bicarbonates with calcium carbonate or calcium hydroxide when used to neutralize excess lime following lime softening. Originally, carbon dioxide gas was added to the water to convert normal carbonates, which are slightly soluble, to bicarbonates, which are more soluble, to prevent the precipitation of encrusting scale from the water. This practice, however, led to the formation of an aggressive water, and the addition of carbon dioxide is now used primarily for pH adjustment following excess lime softening or lime treatment. Additional information on carbon dioxide is contained in CGA* G-6, Carbon Dioxide.

Carbon dioxide gas for recarbonation may be obtained in several ways. In older water plants, the gas is made by burning a hydrocarbon fuel, such as coke, oil, or gas (or a combination of these), with an excess of air, scrubbing the stack gases if necessary, and conveying the gas to the point of application, using a compressor or blower. There may be a wide variation in the percentage of carbon dioxide in the gases, so that very frequent attention and adjustment of the regulating valves is necessary. Underwater burners, in which a mixture of air and gas such as propane is ignited and burned near the bottom of the recarbonation basin, are free from many of these difficulties.

Production problems in on-site generation of carbon dioxide and low-absorption efficiency led to the use of commercially manufactured carbon dioxide in the 1960s. A vaporizer is used to change the liquid carbon dioxide to a gas, which passes through a pressure-regulating valve to the diffusers. The amount of gas used can be controlled very accurately by flow measurement. Because the gas is pure carbon dioxide, much smaller pipe and diffusing equipment is needed than for carbon dioxide generated from fuels, and the danger from carbon monoxide is virtually eliminated.

*Compressed Gas Association Inc., 1235 Jefferson Davis Highway, Room 501, Arlington, VA 22202.

Commercial carbon dioxide is generally obtained in bulk as a liquid under pressure from industrial gas companies and certain chemical suppliers. It must be vaporized and dissolved in the water at the point of application. Commercial production of carbon dioxide is generally by one of the following methods:

- recovery of carbon dioxide gas as a by-product from ammonia plants
- recovery and purification of by-product carbon dioxide from steam reforming of methane followed by the shift reaction
- recovery and purification of gas produced as a by-product of alcohol plants
- natural carbon dioxide gas wells
- recovery and purification of by-product gas from the calcining of limestone
- acid neutralization
- combustion of carbonaceous materials (such as fuel oil and natural gas) and purification of the resulting flue gas

Carbon dioxide obtained from any of these sources is processed to a purity of 99 percent or better, and contains no odor or taste contaminants. By compressing and cooling, carbon dioxide gas is condensed into its liquid form, which is the state most commonly used for transfer and storage in water treatment plants.

Because of the varied nature of carbon dioxide production and feed equipment in use in the water supply industry today, it was the consensus of the AWWA Standards Committee on Carbon Dioxide that this standard address only the recommendations for procurement of commercial carbon dioxide. This does not preclude any user of carbon dioxide 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 carbon dioxide generation or use, but merely to provide a standard for the purchaser of commercially produced carbon dioxide on the industrial market.

I.B. *History.* The first edition of the AWWA standard for carbon dioxide was approved by the AWWA Board of Directors on June 18, 1989. The standard was approved in the course of the activities of the AWWA Standards Committee on Carbon Dioxide. The purpose of ANSI/AWWA B510 is to cover carbon dioxide and not the design of carbon dioxide handling facilities or methods of transfer of carbon dioxide to the water being treated. Design information may be found in *Journal AWWA* and in other publications, some of which are listed in Appendix A. Subsequent editions of this standard were approved by the AWWA Board of

Directors on Jan. 22, 1995, and June 11, 2000. This fourth edition was approved on Feb. 12, 2006.

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 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 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 B510 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. 4.3.4 is a recommendation only for direct additives used in the treatment of potable water to

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

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

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

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 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. *Storage and Handling Precautions.* Carbon dioxide is a colorless, odorless gas of high specific gravity. It is hazardous because it is an asphyxiant and can replace the ambient air, causing an oxygen deficiency. Carbon dioxide gas is physiologically active and is ingested and exhaled by humans in low concentrations. Increasing exposure to elevated concentrations of carbon dioxide in air breathed results in an increased respiration rate. Carbon dioxide gas has been given an 8-hr, time-weighted average (TWA) by the Occupational Safety and Health Administration (OSHA) of 5,000 ppm (1/2 percent).* The immediately dangerous to life or health level (IDLH) recommended by the National Institute for Occupational Safety and Health (NIOSH)† has been set at 40,000 ppm (4 percent). Further details on physiological effects of carbon dioxide can be found in specific texts, such as *Carbon Dioxide Tolerance and Toxicity.*‡

Because carbon dioxide is denser than air, it tends to accumulate in low and confined areas. Therefore, precautions, such as the careful location of storage facilities and ventilation of enclosed areas where carbon dioxide can accumulate should be incorporated in the design of carbon dioxide systems to minimize the hazard. Filtering-type gas masks are not to be used where there is a possibility of a high concentration of carbon dioxide. Self-contained breathing apparatus and hose masks are required. Contact of skin with the cold gas and solid (dry ice) formed by

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* *Code of Federal Regulations*, Title 29, CFR Part 1910 (Labor). US Department of Labor, Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

† National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45226.

‡ Lambertson, C.J. 1974. *Carbon Dioxide Tolerance and Toxicity.* Institute for Environmental Medicine, University of Pennsylvania, Philadelphia, PA 19104.

expanding liquid carbon dioxide should be avoided, as it can cause severe freeze burns on the skin. Consult appropriate OSHA, NIOSH, and Compressed Gas Association (CGA) reference materials for additional safety information.

All lines or piping from a bulk carbon dioxide storage tank must be protected by adequate pressure-relief devices when there is any possibility of pressure buildup from entrapped liquid carbon dioxide. A pressure-relief device should be provided between the tank shutoff valve and the first pressure regulator, between the first and second pressure regulators, and between any other two points where liquid carbon dioxide might be entrapped. Because of the possibility that a buildup of static electricity could result from the flow of liquid carbon dioxide in a pipeline, liquid carbon dioxide pipelines should be electrically grounded.

Appropriate signs should be posted near areas where carbon dioxide is stored or fed to warn of the possibility of high carbon dioxide concentrations. Tunnels or other poorly ventilated areas where carbon dioxide lines are placed should be monitored with a continuous carbon dioxide analyzer. The analyzer should indicate carbon dioxide levels at the entrances to tunnels or poorly ventilated areas, and should be capable of activating high-level alarms.

For additional safety information, refer to material safety data sheets (MSDS) available from the supplier or manufacturer.

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. Whether compliance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, is required.
2. Standard used—that is, ANSI/AWWA B510, Carbon Dioxide, of latest revision.
3. Delivery method.
4. Size and specific type of storage container to be used.
5. If the carbon dioxide supplied should exceed the 99.5 percent purity level or be less than 99.5 percent pure (Sec. 4.2), in accordance with Table 1 of this standard.
6. If cylinder shipments are specified and, if required, the number of cylinders to be sampled (Sec. 5.1.1).

7. In the event that an analysis by a referee laboratory is required, the assignment of testing costs (Sec. 5.2.16.4).

8. If bulk shipments are specified and, if required, a weight certificate from a certified weigher supplied by the supplier or manufacturer. In lieu of weight certificates, certified liquid meter tickets may be accepted by the purchaser (Sec. 6.2.2.2).

9. If an affidavit of compliance or certified analysis, or both, are required (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. Major changes to the standard made in this revision include the following:

1. Table 1 has been updated to match the most recent information from the CGA. Changes include removal of Quality Verification Level (QVL) F, and updated values for QVLs G, H, and I.

2. A section has been added describing bulk storage equipment (Sec. 6.2.2.1).

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

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AWWA Standard

Carbon Dioxide

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes carbon dioxide (CO_2) for use in recarbonation and pH adjustment in water supply service.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for carbon dioxide, including physical, chemical, packaging, shipping, and testing requirements.

Sec. 1.3 Application

This standard can be referenced in specifications for purchasing and receiving carbon dioxide and can be used as a guide for testing the physical and chemical properties of carbon dioxide samples. The stipulations of this standard apply when this document has been referenced and only to carbon dioxide used in water supply service applications.