ANSI/AWWA B301-10
(Revision of ANSI/AWWA B301-04)

American Water Works Association

The Authoritative Resource on Safe Water®

AWWA Standard

Liquid Chlorine

Effective date: April 1, 2010.
First edition approved by AWWA Board of Directors Jan. 26, 1992.
This edition approved Jan. 17, 2010.
Approved by American National Standards Institute Jan. 14, 2010.

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AWWA Standard

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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 B301-10.

I. Introduction.

I.A. *Background.* Chlorine is an oxidizing agent commonly used for disinfection of water supplies. The first full-scale use of liquid chlorine for water disinfection was in 1912 at Niagara Falls, N.Y., where it helped to eliminate recurring typhoid outbreaks. Advocates of chlorination soon began to recognize the usefulness of prechlorination for reduction of color, tastes, and odors in water. It is also used for the oxidation of metallic substances in water to facilitate their removal during filtration. About 4.5 percent of the annual chlorine produced in the United States is used for municipal water supply treatment and wastewater treatment.

I.B. *History.* ANSI/AWWA B301 was first approved as tentative on Oct. 17, 1957. It was made a standard by the AWWA Board of Directors on January 26, 1959. Subsequent editions were approved June 7, 1981, January 25, 1987, January 26, 1992, June 20, 1999, and January 18, 2004. This edition of ANSI/AWWA B301 was approved on January 17, 2010.

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, now Water Research Foundation) 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

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

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 B301 addresses additives requirements in Sec. 4.4 of the standard. The transfer of contaminants from chemicals to processed water or the residual solids is becoming a problem of great concern. The language in Sec. 4.4.2 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 Standard 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. *Safety and Security Precautions.* Chlorine is a greenish-yellow gas that normally is packaged as a liquid under pressure in containers fabricated in accordance with specifications of the US Department of Transportation (DOT). Chlorine should be stored in a secured location. Chlorine-handling facilities should take appropriate precautions to minimize the possibility that an individual or group might be successful in intentionally rupturing or stealing a chlorine container.

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* NSF International, 789 N. Dixboro Rd., Ann Arbor, MI 48105

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

Chlorine is fed into the water being treated using special feeders designed for that purpose. Because of the extreme corrosiveness of moist chlorine gas and the health hazards for operators handling chlorine, the feeding equipment must be fabricated of corrosion-resistant materials. Safety devices must be provided to protect operators in the event of chlorine leaks or exposure to chlorine during maintenance work on the feeders.

Chlorine gas is a respiratory irritant. Moderate concentrations (in the low ppm range) in air cause coughing, labored breathing, and irritation of the eyes. In extreme cases, the difficulty in breathing may cause death by suffocation. Liquid chlorine will burn skin and eyes on contact. Details on safety precautions that should be followed in handling chlorine are beyond the scope of this discussion, but excellent safety guidelines are detailed in the Chlorine Manual.* Federal safety regulations promulgated by the US Occupational Safety and Health Administration (OSHA) and the Clean Air Act (Risk Management Program) should also be implemented in both existing and new chlorination facilities.

Several chlorine emergency kits are available, including the following (contact the Chlorine Institute for suppliers):

Kit A—for 100-lb (45-kg) and 150-lb (68-kg) cylinders

Kit B—for ton containers

Kit C—for tank cars and tank trucks

These kits are designed to stop most common leaks that may occur in the container for which they are designed. There are also cylinder containment vessels for 100-lb and 150-lb cylinders designed to encapsulate the entire cylinder.

Leak detectors, automatic shutoff, and containment devices are also available from several suppliers. The OSHA permissible exposure limit (PEL) is 1.0 ppm as a "ceiling" concentration (15 min) (29 CFR† 1910.1000 [Table 21]).

Current editions of manuals published by the Chlorine Institute and the Compressed Gas Association, which are useful to purchasers of liquid chlorine as described in this standard, are listed in appendix A.

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:

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* Available from the Chlorine Institute Inc., 1300 Wilson Blvd., Arlington, VA 22209.

† Code of Federal Regulations, Government Printing Office, 720 N. Main, Pueblo, CO 81003.

1. Standard used—that is, ANSI/AWWA B301, Standard for Liquid Chlorine, of latest revision.

2. Details of other federal, state or provincial, and local requirements (Sec. 4.1).

3. Type and grade of material wanted or required (Sec. 4.2 and 4.3).

4. Testing (Sec. 5.3), if required.

5. Containers to be used.

6. Whether compliance with NSF/ANSI Standard 60, Drinking Water Treatment Chemicals—Health Effects, is required.

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. 5.3, demonstrate that the product meets the standard. Failure to meet the standard or the absence of, or irregularities in, seals may be sufficient cause to reject the shipment.

8. Whether alternative security measures have been adopted to replace or augment the security measures out in Sec. 6.2.3 and 6.2.4.

9. Affidavit of compliance or certified analyses (Sec. 6.3), if required.

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 revisions made to the standard in this edition include the following:

1. Inclusion of a requirement for compliance with the Safe Drinking Water Act and other federal regulations (Sec. 4.1).

2. Inclusion of a requirement for tamper-evident packaging (Sec. 6.2.3 and 6.2.4).

3. A revision to the Chemical Requirements (Sec. 4.3) calling for the liquid chlorine to be not less than 99.5 percent pure rather than 99.5 percent pure.

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 303.795.7603, write to the group at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.

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American Water Works Association

AWWA Standard

Liquid Chlorine

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes liquid chlorine for use in water, wastewater, and reclaimed water treatment.

Sec. 1.2 Purpose

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

Sec. 1.3 Application

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

SECTION 2: REFERENCES

This standard references the following documents. In their latest editions, these documents form a part of this standard to the extent specified within this standard. In any case of conflict, the requirements of this standard shall prevail.

ANSI*/AWWA B300—Hypochlorites.

ASTM† E410—Standard Test Method for Moisture and Residue in Liquid Chlorine.

ASTM E412—Standard Test Method for Assay of Liquid Chlorine (Zinc Amalgam Method).

ASTM E506—Standard Test Method for Mercury in Liquid Chlorine.

ASTM E806—Standard Test Method for Carbon Tetrachloride and Chloroform in Liquid Chlorine by Direct Injection (Gas Chromatographic Procedure).

Food Chemicals Codex (4th ed., 1996). National Academy of Sciences.‡

Packaging Plant Safety and Operational Guidelines. Chlorine Institute§ Pamphlet 17. Chlorine Institute Inc.

NSF¶/ANSI 60—Drinking Water System Chemicals—Health Effects.

Safe Sampling of Liquid Chlorine. Chlorine Institute Pamphlet 77. Chlorine Institute Inc.

Standard Methods for the Examination of Water and Wastewater. APHA,** AWWA, and WEF.††

Standards for Visual Inspection of Steel Compressed Gas Cylinders. Compressed Gas Association‡‡ Pamphlet C6. Compressed Gas Association.

US Department of Transportation, Hazardous Materials Regulations, 49 CFR§§ 100–177 (Chapter 1, Subchapter C).

US Environmental Protection Agency, 40 CFR 162.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

1. *Day:* A day is defined as a 24-hr period.

2. *Liquid chlorine:* The commercially available form of liquefied elemental chlorine gas. (The term *liquid chlorine* is sometimes used to describe a hypo-

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.
† ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.
‡ Water Environment Foundation, 601 Wythe St., Alexandria, VA 22314.
§ Compressed Gas Association, 1235 Jefferson Davis Hwy., Arlington, VA 22202.
¶ National Academy of Sciences, 2101 Constitution Avenue, Washington, DC 20418.
** Available from the Chlorine Institute Inc., 1300 Wilson Blvd., Arlington, VA 22209.
†† NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.
‡‡ Code of Federal Regulations, Government Printing Office, 720 N. Main, Pueblo, CO 81003.
§§ American Public Health Association, 800 I St. N.W., Washington, DC 20001.

chlorite solution. This use of the term is discouraged. See ANSI/AWWA B300, Hypochlorites.)

3. *Manufacturer:* The party that manufactures, fabricates, or produces materials or products.

4. *Packager:* A company or organization that generally does not manufacture or produce liquid chlorine. The packager normally purchases liquid chlorine in bulk containers (tank car or tank truck) or pipeline and transfers the material to cylinders, 1-ton (900-kg) containers, or tank trucks for delivery to the purchaser. Some packagers also supply customers with chlorine tank car or tank truck shipments. In these cases, the chlorine is loaded into the shipping container directly by a chlorine manufacturer. The packager may or may not be the supplier.

5. *Potable water:* Water that is safe and satisfactory for drinking and cooking.

6. *Purchaser:* The person, company, or organization that purchases any materials or work to be performed.

7. *Reclaimed water:* Wastewater that becomes suitable for beneficial use as a result of treatment.

8. *Supplier:* The party that supplies materials or services. A supplier may or may not be the manufacturer.

9. *Tamper-evident packaging:* Packaging having one or more indicators or barriers to entry which, if breached or missing, can reasonably be expected to provide visible evidence to the purchaser that tampering has occurred. The tamper-evident features of the packaging shall be designed to, and shall, remain intact when handled in a reasonable manner during manufacture, storage, shipment, and delivery to the purchaser. Properly constructed, labeled, and sealed cylinders and tanks constitute two forms of tamper-evident packaging.

10. *Wastewater:* A combination of the liquid and water-carried waste from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and stormwater that may be present.

SECTION 4: REQUIREMENTS

Sec. 4.1 Materials

Materials shall comply with the requirements of the Safe Drinking Water Act and other federal regulations for potable water, wastewater systems, and reclaimed water as applicable.

Sec. 4.2 Physical Characteristics

Characteristics of liquid chlorine are as follows:

4.2.1 *General.* In its liquid state, chlorine is amber colored and about 1.5 times as dense as water. It exerts a vapor pressure that varies with its temperature. At atmospheric pressure, liquid chlorine boils at approximately –30°F (–35°C) and freezes at approximately –150°F (–100°C). At normal room temperature, liquid chlorine exerts a pressure of about 90 psig (600 kPa [gauge]); but at 100°F (37.8°C), the chlorine vapor pressure increases to about 140 psig (1,000 kPa [gauge]). When the pressure is released, liquid chlorine vaporizes into a greenish-yellow gas about 2.5 times as dense as air. One volume of liquid chlorine, when vaporized, will yield about 460 volumes of gas. At 60°F (15.6°C) under atmospheric pressure, about 0.8 lb of chlorine is soluble in 100 lb of water (equivalent to about 8 kg of chlorine in 1,000 kg [1 m^3] of water).*

4.2.2 *Reactivity.* Neither gaseous nor liquid chlorine is explosive or flammable, but both can react violently with many organic materials and chemicals. Although dry chlorine does not react with (corrode) many metals, it is very reactive (strongly corrosive) when moisture also is present. It will react spontaneously with iron or steel at 483°F (251°C), and a similar reaction has been reported with copper at elevated temperatures. Dry chlorine will react spontaneously with titanium metal.

Sec. 4.3 Chemical Requirements

The liquid chlorine supplied according to this standard shall be not less than 99.5 percent pure by volume as determined by analyzing the chlorine by the method described in Sec. 5.3.2.1.

Sec. 4.4 Impurities†

4.4.1 *General.* The liquid chlorine supplied according to this standard shall contain no soluble mineral or organic substances in quantities capable of producing deleterious or injurious effects on the health of persons consuming water that has been treated properly with the liquid chlorine.

4.4.2 *Product certifications.* Liquid chlorine is a direct additive used in the treatment of potable water and wastewater. This material should be certified

* For additional information on physical and thermodynamic properties, see the Chlorine Institute manuals referenced in appendix A of this standard or R.M. Kapoar and J.J. Martini, *Thermodynamic Properties of Chlorine*, University of Michigan Press (1957).

† See Sec. I.C of the foreword.

as suitable for contact with or treatment of drinking water by an accredited certification organization in accordance with NSF/ANSI Standard 60, Drinking Water Treatment Chemicals—Health Effects. Evaluation shall be accomplished in accordance with requirements that are no less restrictive than those listed in NSF/ANSI Standard 60. Certification shall be performed by a certification organization accredited by the American National Standards Institute.

All chlorine used in water disinfection is required to be registered with USEPA under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).*

4.4.3 *Moisture.* The liquid chlorine supplied shall be dry chlorine. Moisture shall not exceed 150 ppm (0.015 percent) by weight.

4.4.4 *Heavy metals.* The sum of all heavy metals shall not exceed 30 ppm (0.003 percent) expressed as lead.

4.4.4.1 Lead shall not exceed 10 ppm (0.001 percent) reported as lead.

4.4.4.2 Mercury shall not exceed 1 ppm (0.0001 percent) reported as mercury.

4.4.4.3 Arsenic shall not exceed 3 ppm (0.0003 percent) reported as metallic arsenic.

4.4.5 *Nonvolatile residue.* The total residue shall not exceed (1) 50 ppm (0.005 percent), by weight, in liquid chlorine, as loaded by the manufacturer in tank cars and chlorine tank trucks, or (2) 150 ppm (0.015 percent), by weight, in liquid chlorine, as packaged in cylinders or ton containers.

4.4.6 *Carbon tetrachloride.* Carbon tetrachloride shall not exceed 100 ppm (0.010 percent). Testing for carbon tetrachloride is not required unless a carbon tetrachloride tail-gas scrubbing system is used in the chlorine production unit or if it is used as a diluent for nitrogen trichloride. Consult with your manufacturer, packager, or supplier.

4.4.7 *Trihalomethanes.* Trihalomethanes shall not exceed 300 ppm (0.030 percent).

* Users of ANSI/AWWA B301 outside the United States should verify applicable local, provincial, and national regulatory requirements. Because of frequent changes in these regulations, all parties should remain informed of possible revisions. Provisions of the purchaser's documents should not preclude compliance with applicable regulations.

SECTION 5: VERIFICATION

Sec. 5.1 Inspection

All containers shall be carefully examined by the supplier as discussed in Chlorine Institute Pamphlet 17 and in Compressed Gas Association Pamphlet C6, including proper holding of filled containers to check for leaks before filling. Any containers that show evidence of leakage, damage, or corrosion shall be rejected. Chlorine cylinders and ton containers, valves, valve threads, and valve packings shall be in good mechanical order and shall operate normally with a wrench that is no longer than 8 in. (0.2 m). If the condition of the container and valves does not conform to any recommended practice in the above pamphlets in all applicable respects, the manufacturer or packager supplying the chlorine shall be notified immediately and shall take immediate action to ensure compliance.

Routine inspection and cleaning of the interiors of chlorine cylinders and ton containers shall be performed by the supplier because of the potential buildup of contaminants when chlorine is removed as a gas.

Sec. 5.2 Sampling

If the purchaser specifies that the chlorine shall be tested, the samples shall be taken at the point of shipment according to ASTM E410, ASTM E412, and ASTM E806.

Also see Chlorine Institute Pamphlet 77 on sampling chlorine. This system must be followed for carbon tetrachloride and trihalomethane analyses.

Sec. 5.3 Test Procedures

5.3.1 *General.* Most purchasers will depend on the manufacturer or supplier to provide a certified analysis detailing the desired items; therefore, testing methods are listed by reference to the applicable ASTM and *Food Chemicals Codex* methods.

5.3.2 *Referenced test methods.*

5.3.2.1 Assay. Assay shall be as determined by ASTM E412 or by a gas chromatographic method.

5.3.2.2 Moisture and residue. Moisture and residue shall be as determined by ASTM E410.

5.3.2.3 Carbon tetrachloride and trihalomethanes. Carbon tetrachloride and trihalomethanes shall be determined by the test method described in ASTM E806.

5.3.3 *Sample solution for the determination of arsenic, heavy metals, lead, and mercury.*

To prepare the sample solution, dissolve the residue (obtained in the test for residue) in 2.5 mL of freshly prepared aqua regia. Dilute with water to a volume in milliliters equivalent to the weight in grams of the initial chlorine sample, so that 1 mL of the final dilution is equivalent to 1 g of chlorine.

5.3.3.1 Arsenic.* A 1-mL portion of the sample solution diluted with water to 35 mL shall meet the requirements of the arsenic test of the *Food Chemicals Codex* (6th ed., 2008).

5.3.3.2 Heavy metals. A 0.67-mL portion of the sample solution diluted with water to 25 mL shall meet the requirements of the heavy metals test of the *Food Chemicals Codex* (6th ed., 2008), using 20 µg of lead ion (Pb) in the control (solution A).

5.3.3.3 Lead.* A 1-mL portion of the sample solution mixed with 5 mL of water and 11 mL of diluted hydrochloric acid test solution† shall meet the requirements of the lead limit test of the *Food Chemicals Codex* (6th ed., 2008), using 10 µg of lead ion (Pb) in the control.

5.3.3.4 Mercury. Mercury shall be determined by the test method described in ASTM E506.

Sec. 5.4 Notice of Nonconformance

If the material or its container delivered to the purchaser does not meet the chemical, physical, safety, or security requirements of this standard, the purchaser shall provide a notice of nonconformance to the supplier within 5 days after receipt of shipment at the point of destination. In this event, the supplier shall remove the unsuitable product or container from the premises of the purchaser at the purchaser's request and replace it with a like amount of satisfactory liquid chlorine in an acceptable container.

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* Atomic absorption spectrometric methods as described in *Standard Methods for the Examination of Water and Wastewater* (latest edition) may be used for these tests.

† A solution containing 10 percent (weight/volume) of hydrochloric acid (HCl). Prepare by diluting 236 mL of hydrochloric acid (36 percent) with sufficient water to make 1,000 mL.

SECTION 6: DELIVERY

Sec. 6.1 Marking*

Each container shall be marked to clearly indicate the contents and shall bear the current precautionary information required by the US Department of Transportation (DOT), US Environmental Protection Agency (USEPA), and other regulatory agencies concerned with the hazardous nature of chlorine. Liquid chlorine is classified by DOT as a 2.3 toxic gas.

Sec. 6.2 Packaging

The manufacturer or packager shall pack the liquid chlorine in containers that comply in every respect with the current Hazardous Materials Regulations of the DOT (49 CFR 100-177 [Chapter 1, Subchapter C]) for shipment of chlorine. The containers shall be inspected, reconditioned, cleaned, maintained, and loaded in strict accordance with the latest edition of Chlorine Institute Pamphlet 17. (Because of frequent changes in the regulations, the purchaser should not restate the actual regulations in their documents.)

6.2.1 *Packaging precautions.* Packagers receiving liquid chlorine from a manufacturer shall be extremely cautious during packaging operations to prevent the addition of moisture or other contaminants that would increase the formation of ferric chloride or the introduction of any other deleterious material that could clog valves, evaporators, or chlorinators.

6.2.2 *Filling density.*

Filling density shall not exceed 125 percent. The filling density is defined as the percent ratio of the weight of chlorine in the container to the weight of water that the container will hold at 60°F (15.6°C).

6.2.3 *Security requirements for nonbulk shipments.* Packaged product shall be stored, shipped, and delivered in tamper-evident packaging as defined in Section 3, item 9, or an alternative method or methods may be agreed on by the manufacturer and purchaser that provide a reasonable assurance of protection against tampering.

* Governmental packaging and marking references reflect US requirements. Users of ANSI/AWWA B301 outside the United States should verify applicable local and national regulatory requirements. Because of frequent changes in these regulations, all parties should remain informed of possible revisions. Provisions of the purchaser's documents should not preclude compliance with applicable regulations.

6.2.4 *Security requirements for bulk shipments.* Bulk quantities of product shall be secured employing one of the following security measures (or a combination of measures):

6.2.4.1 Seals. Bulk quantities of product may be sealed with a uniquely numbered, tamper-evident seal(s). The seal numbers shall be recorded and disclosed on shipping documents, such as the Bill of Lading. Seals shall be inspected upon receipt of product by the purchaser, and evidence of tampering or removal should be reported to the carrier and supplier.

6.2.4.2 Chain of custody. A continuous chain of custody may be maintained between the manufacturer and the purchaser during storage and shipment if so specified by the purchaser.

6.2.4.3 Alternative method. An alternative method or methods may be agreed on by the manufacturer and purchaser that provide reasonable assurance of protection against tampering.

Sec. 6.3 Affidavit of Compliance

The purchaser may require either (1) an affidavit from the manufacturer or supplier stating that the liquid chlorine provided according to the purchaser's order complies with all applicable requirements of this standard or (2) provide certified analyses of the liquid chlorine, at the time of container loading, detailing the desired items.

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APPENDIX A

Bibliography

This appendix is for information only and is not a part of ANSI/AWWA B301-10.

The following references are available from AWWA:

Safety Practice for Water Utilities. AWWA Manual M3.

The following references are available from the Chlorine Institute Inc.:*

Atmospheric Monitoring Equipment for Chlorine. Pamphlet 73.

Chlorine Manual. Pamphlet 1.

Chlorine Pipelines. Pamphlet 60.

Chlorine Safety for Water and Wastewater Operators. DVD.

Chlorine Scrubbing Systems. Pamphlet 89.

Recommended Practices for Handling Chlorine Tank Cars. Pamphlet 66.

Cylinder and Ton Container Procedure for Chlorine Packaging. Pamphlet 17.

Emergency Response Plans for Chlorine Facilities. Pamphlet 64.

Emergency Shutoff Facilities for Tank Car and Tank Truck Transfer of Chlorine. Pamphlet 57.

Estimating the Area Affected by Chlorine Releases. Pamphlet 74.

Gaskets for Dry Chlorine Service. Pamphlet 95.

Recommended Practices for Handling Chlorine Bulk Highway Transport. Pamphlet 49.

Nonrefrigerated Liquid Chlorine Storage. Pamphlet 5.

Chlorine Vaporizing Equipment. Pamphlet 9.

Personal Protective Equipment for Chlor-Alkali Chemicals. Pamphlet 65.

Piping Systems for Dry Chlorine. Pamphlet 6.

Safe Sampling of Liquid Chlorine. Pamphlet 77.

Water and Wastewater Operators Chlorine Handbook. Pamphlet 155.

The following reference is available from the Compressed Gas Association:†

Standards for Visual Inspection of Compressed Steel Gas Cylinders.

The following reference is available from ASTM International:

ASTM E1754—Standard Test Method for Determination of Low Levels of Water in Liquid Chlorine CIR—Grab Sample Method.

* Chlorine Institute Inc., 1300 Wilson Blvd., Arlington, VA 22209.

† Compressed Gas Association, 1235 Jefferson Davis Hwy., Arlington, VA 22202.

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AWWA is the authoritative resource for knowledge, information, and advocacy to improve the quality and supply of water in North America and beyond. AWWA is the largest organization of water professionals in the world. AWWA advances public health, safety, and welfare by uniting the efforts of the full spectrum of the entire water community. Through our collective strength, we become better stewards of water for the greatest good of people and the environment.

1P-2.6M-42301-03/10-PP

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