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American Water Works Association

The Authoritative Resource on Safe Water®

AWWA Standard

Permanganates

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA B603.*

I. Introduction.

I.A. *Background.* Potassium and sodium permanganate are strong oxidizing agents. They oxidize organic matter responsible for many types of tastes, odors, and colors. Potassium and sodium permanganate oxidize dissolved iron, manganese, and arsenic to produce oxides, which can then be settled or filtered out. They also oxidize hydrogen sulfide, thereby eliminating the rotten-egg odor. Potassium permanganate is listed by the US Environmental Protection Agency (USEPA) as a substitute preoxidant for chlorine to control total trihalomethanes (TTHMs).

Potassium permanganate ($KMnO_4$) is a manufactured product. The manufacturer should comply with the regulations stated in parts 210 through 226 of 21 CFR, as applicable, which contain minimum current good manufacturing practices as defined by the Food and Drug Administration (FDA). Potassium permanganate crystals are rhombic or needle-like in shape and are purple or bronze in color. They are manufactured in several different grades, including USP. Any grade of potassium permanganate that meets quality and feed requirements may be used in water treatment. The two most widely used grades are technical grade, designed for solution feed, and free-flowing grade, suitable for either solid or solution feed. The free-flowing grade contains an additive to minimize caking and lumping caused by moisture and compaction. It may be gray because of the additive.

Liquid sodium permanganate ($NaMnO_4$) solution is an alternative to dry potassium permanganate crystals. This product was developed in response to requests by users for a liquid permanganate solution. Because of the limited solubility of potassium permanganate (6 percent at room temperature) the cation was exchanged to increase the solubility. Sodium permanganate is commercially available in concentrations up to 40 percent by weight and is manufactured according to the same manufacturing practices described above that are used in the manufacture of potassium permanganate.

I.B. *History.* AWWA B603 was initially approved as a standard by the AWWA Board of Directors on Jan. 28, 1968. Revisions were approved on May 8, 1977; June 5, 1983; June 19, 1988; June 6, 1993; June 21, 1998; and June 15, 2003. This edition was approved on Jan. 17, 2010.

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

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 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 B603 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 60, Drinking Water Treatment Chemicals—Health Effects. However, users of the standard may opt

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

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

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.* Permanganates are strong oxidizing agents and should be treated as such. The products themselves are noncombustible but will accelerate the burning of combustible materials. They react with many materials, and care should be exercised in their handling, storage, and use. Therefore, contact with all combustible materials or chemicals must be avoided. These include but are not limited to wood, cloth, organic materials, and charcoal. Avoid contact with acids, peroxides, sulfites, oxalates, and other oxidizable inorganic chemicals. Permanganates should be segregated from ammonium compounds, metallic powders, phosphorus, hydrogen peroxide, carbon, metal hydrides, hydrazine, hydroxylamines, antifreeze, hydraulic oils, and formaldehyde.

The products should be stored in a cool, dry area in closed containers and should be protected from physical damage. Concrete floors are preferred. Avoid wooden decks. Protect the liquid sodium permanganate solution from freezing.

Spills of dry potassium permanganate should be swept up and transferred to clean metal drums and disposed of according to federal, state or provincial, and local regulations. Spilled dry potassium permanganate should not be returned to the original drums that contain uncontaminated product. After the permanganate has been cleaned up, the residual permanganate on the floor should be flushed with water into a sanitary sewer, complying with federal, state or provincial, and local regulations.

Spills of liquid sodium permanganate solution should be collected and disposed of properly. Contain and dilute spillage to approximately 6 percent with water and reduce the permanganate with sodium thiosulfate, sodium bisulfite, or sodium metabisulfite. Deposit sludge in an approved landfill or, where permitted, flush into a sanitary sewer with large quantities of water.

When handling either potassium or sodium permanganate, good safety procedures must be observed. These include the use of safety goggles, safety glasses with side shields, or face shield; impervious rubber or PVC gloves, and apron. A NIOSH–MSHA-approved respirator meeting general industry standards as described in ANSI Z88.2, Practices for Respiratory Protection, latest revision, is recommended when

handling dry potassium permanganate crystals and where significant exposure to the liquid sodium permanganate solution exists.

If clothing becomes spotted when handling the liquid sodium permanganate, wash off immediately with large quantities of water.

Permanganates are corrosive to the eyes and can cause severe burns. If exposed to permanganate, immediately flush the affected eye with water for 15 min while holding the eyelid open. Consult a physician immediately.

For additional safety aspects, refer to material safety data sheets (MSDS) available from the chemical 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 information should be provided by the purchaser.

1. Standard used—that is, ANSI/AWWA B603, Standard for Permanganates, of latest revision.
2. Whether compliance with NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, is required.
3. Quantity required.
4. Details of other federal, state or provincial, and local requirements (Sec. 4.1).
5. Grade desired—technical, free-flowing, USP, or other dry crystals, or liquid solution. Physical and chemical requirements are provided in the standard for both the dry technical and free-flowing grades (Sec. 4.2.1) and the liquid products (Sec. 4.2.2). Chemical requirements for dry potassium permanganate are provided for technical, free-flowing, and the USP grade (Sec. 4.3). Dry USP-grade physical requirements shall be as specified by the purchaser. If a grade other than technical, free-flowing, USP, or liquid product is desired, the purchaser must specify the requirements of the grade desired.
6. Form of shipment—bulk, container size (weight), and type of package (Sec. 6.2).
7. Affidavit of compliance, if required (Sec. 6.3).
8. 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, 5.4, and 5.5, 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.

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

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).

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 the group at standards@awwa.org.

American Water Works Association

AWWA Standard

Permanganates

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes both dry potassium permanganate ($KMnO_4$) crystals, CAS* No. 7722-64-7, as well as liquid sodium permanganate ($NaMnO_4$) solutions, CAS* No. 10101-50-5, for use in the treatment of potable and reuse or reclaimed water and wastewater.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for dry potassium permanganate crystals and liquid sodium permanganate solutions, including physical, chemical, sampling, testing, packaging, and shipping requirements.

Sec. 1.3 Application

This standard can be referenced in documents for purchasing and receiving permanganates and can be used as a guide for testing the physical and chemical properties of permanganate samples. The stipulations of this standard apply when this document has been referenced and then only to permanganates used in potable, wastewater, and reuse or reclaimed water.

* Chemical Abstract Service, P.O. Box 3012, Columbus, Ohio 43210.

SECTION 2: REFERENCES

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

ASTM* E11—Standard Specification for Wire-Cloth Sieves for Testing Purposes.

NSF†/ANSI‡ 60—Drinking Water Treatment Chemicals—Health Effects.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

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

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

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

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

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

6. *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 closed steel drums and pails constitute two forms of tamper-evident packaging.

7. *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 storm water that may be present.

* ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.
† NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.
‡ American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.

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 and wastewater systems as applicable.

Sec. 4.2 Physical Requirements

4.2.1 *Dry potassium permanganate crystals.*

4.2.1.1 Description. Potassium permanganate has a bulk density of 90 lb/ft^3 to 100 lb/ft^3 (1,450 kg/m^3 to 1,600 kg/m^3) at 22°C/72°F.* Its solubility in distilled water is shown in the following table:

Temperature		Solubility	
°F	°C	*g/L*	*lb/gal*
32	0	27.8	0.23
68	20	65.0	0.54
140	60	230.0	1.92

4.2.1.2 Particle size. The technical and free-flowing grades shall be of similar particle size. No more than 7 percent by weight of the material shall pass through a US Standard Sieve Series No. 200 (International Standard No. 75) sieve, and no more than 20 percent by weight shall be retained on a US Standard Sieve Series No. 40 (International Standard No. 425) sieve.†

Particle size for USP‡ grade shall be as specified in the purchaser's documents.

4.2.1.3 Water tolerance. This applies to the free-flowing grade only. The free-flowing grade shall not form lumps that cannot be broken up easily with minimal pressure and shall have no other characteristics that could prevent its use in dry-type chemical feeders. The water tolerance shall be 0.7 or greater, as measured by the test method in Sec. 5.5.

4.2.2 *Liquid sodium permanganate solutions.*

* Metric conversions given in this standard are direct conversions of US customary units and are not those specified in International Organization of Standardization.

†ASTM E11.

‡ *United States Pharmacopoeia.*

4.2.2.1 Description. Aqueous sodium permanganate solutions are dark purple and odorless. Permanganate solutions are miscible with water in all proportions.

The specific gravity of the solutions will vary with the concentration of sodium permanganate as shown in the following table:

% Sodium Permanganate by Weight	Specific Gravity at 22° C
10	1.06
15	1.11
20	1.16
30	1.26
40	1.36

Sec. 4.3 Chemical Requirements

4.3.1 *Dry potassium permanganate crystals.* The potassium permanganate content (percent $KMnO_4$) shall not be less than 98 percent by weight for the technical grade, 97 percent by weight for the free-flowing grade, and 99 percent by weight for USP grade.

4.3.2 *Liquid sodium permanganate solutions.* The sodium permanganate content (percent $NaMnO_4$) of the delivered solution shall be as specified by the purchaser and may vary up to commercially available 40 percent $NaMnO_4$ by weight.

Sec. 4.4 Impurities*

4.4.1 *General.* The dry or liquid permanganate supplied in accordance with this standard shall contain no substances in quantities capable of producing deleterious or injurious effects to the health of those consuming water that has been treated properly with either the dry or liquid permanganate.

4.4.2 *Product certifications.* Both dry potassium permanganate crystals and liquid sodium permanganate solutions are direct additives used in the treatment of potable water. This material should be certified as suitable for contact with, or treatment of, drinking water by an accredited certification organization in accordance with NSF/ANSI 60. Evaluation shall be accomplished in accordance with requirements that are no less restrictive than those listed in NSF/ANSI 60. Certification shall be accomplished by a certification organization accredited by the American National Standards Institute.

* See Sec. I.C of the foreword.

SECTION 5: VERIFICATION

Sec. 5.1 Sampling

5.1.1 *Sampling point.* Samples shall be taken at the point of destination.

5.1.1.1 Dry potassium permanganate crystals. Individual samples shall be combined into a gross or composite 3-lb (1.35-kg) minimum sample, mixed, and properly divided to produce three final samples. A 1-lb (0.45-kg) final sample shall be reserved for tests, and two 1-lb (0.45-kg) samples shall be sealed and retained for possible retesting.

5.1.1.2 Liquid sodium permanganate solutions. Samples of the liquid sodium permanganate shall be combined to make up three 500-mL (0.5-L) composite samples. One sample shall be reserved for tests, and two samples shall be sealed and retained for possible retesting.

5.1.2 *Packaged material.* A composite sample of the shipment shall be collected from manufacturer-sealed containers only, according to the following table. For lots of less than 10 containers, each container shall be sampled.

Composite Sampling for Quality Inspection

Potassium Permanganate Container Size	Sodium Permanganate Container Size	Number of Containers Sampled
55 lb (25 kg)	5 gal (19 L)	1%, no fewer than 10
110 lb (50 kg)	—	30%, no fewer than 10
330 lb (150 kg)	55 gal (208 L)	50%, no fewer than 10
3,300 lb (1,500 kg)	250 gal (946 L)	75%, no fewer than 10

5.1.2.1 Dry potassium permanganate crystals. Using a sampling thief, sufficient sample quantity shall be taken from each container to yield a minimum 3-lb (1.35-kg) composite sample. The composite sample shall be divided into three (3) 1-lb (0.45-kg) individual samples. The 1-lb (0.45-kg) composite samples shall be placed in separate, clean, dry, glass, or polypropylene containers, which are to be sealed and marked appropriately. See Sec. 5.1.1.1 regarding samples for testing and retesting. A chain-of-custody form shall accompany all samples and shall be properly completed by the individuals collecting samples.

5.1.2.2 Liquid sodium permanganate solution. Collect sufficient samples from the appropriate number of containers to make up 1.5 L of composite sample. Divide the composite sample into three 0.5-L samples. The solution samples should

be placed in clean, dark-brown glass or HDPE bottles with PTFE seals or other compatible material, taped securely, marked appropriately, and stored in a cool, dark place. See Sec. 5.1.1.2 regarding samples for testing and retesting. A chain-of-custody form shall accompany all samples and shall be properly completed by individuals collecting the samples.

5.1.3 *Bulk material.* If the material is shipped or stored in bulk, a mechanical sampling arrangement may be used. Random, incremental sampling shall be performed during unloading to collect a minimum 3-lb (1.35-kg) sample of dry potassium permanganate crystals or 1.5 L of liquid sodium permanganate solution. See Sec. 5.1.1 and 5.1.2 for sample preparation, handling, and storage.

Sec. 5.2 Test Procedures

When performing tests, observe all safety precautions. Use good laboratory practices. Before handling chemicals, refer to the respective material safety data sheets (MSDS).

Sec. 5.3 $KMnO_4$ and $NaMnO_4$ Assay

5.3.1 *Procedure.*

1. Tare a plastic weigh boat or weigh paper.
2. Accurately weigh 1.00 g sample potassium permanganate or 1.00 g sodium permanganate. Record the exact sample weight.
3. Transfer the weighed sample into a 500-mL Erlenmeyer flask containing approximately 100 mL distilled or deionized water. Rinse weighing boat or paper into the flask with distilled or deionized water.
4. Add the correct amount of sodium oxalate into the flask. Refer to Table 1, Potassium Permanganate, or Table 2, Sodium Permanganate, below, for the correct amount according to the grade of permanganate being assayed.
5. Add 25 mL analytical grade (1 + 4 v/v) sulfuric acid solution to the flask and rinse the sides with distilled or deionized water.
6. Add a magnetic stir bar to the flask and transfer the flask to a magnetic stirrer/ hot plate. Heat the flask to clearness. The sample must be 80°–90°C during the titration.
7. Using a fine-tipped water bottle, carefully rinse the sides of the flask with distilled or deionized water to wash down any condensation that has accumulated during heating.
8. Titrate the heated sample using a buret apparatus containing 0.0316*N* $KMnO_4$ solution. Titrate to a pale (faint) pink end-point. The end-point must

Table 1 Potassium permanganate

Product	$KMnO_4$ Sample Weight *g*	Sodium Oxalate Target Weight *g*
Technical grade	1.00	≅ 2.12
Free-flowing grade	1.00	≅ 2.12
USP grade	1.00	≅ 2.13

Table 2 Sodium permanganate

Product	$NaMnO_4$ Sample Weight *g*	Sodium Oxalate Target Weight *g*	Specific Gravity Range
20% grade	1.00	≅ 0.53	1.159–1.169
40% grade	1.00	≅ 1.00	1.365–1.375

remain for at least 30 seconds. Record the volume of the 0.0316*N* $KMnO_4$ titrant added.

5.3.2 *Assay Calculation.*

5.3.2.1 Potassium Permanganate.

$$\% KMnO_4 = \frac{[(0.4718 \times S) - (31.606 \times T \times N)] \times 100}{W_s}$$

5.3.2.2 Sodium Permanganate.

$$\% NaMnO_4 = \frac{[(0.4718 \times S) - (31.606 \times T \times N)] \times 89.8}{W_s}$$

Where:

S = sodium oxalate weight, mg

T = titration volume, mL 0.0316*N* $KMnO_4$ solution

N = normality of $KMnO_4$ solution

W_s = weight of permanganate sample, mg

Sec. 5.4 Particle Size

Particle size applies to dry potassium permanganate crystals only and does not apply to liquid sodium permanganate solution.

1. Using US Standard sieves with 8-in. (200-mm) diameter screens, stack a No. 40 (International Standard No. 425) sieve above a No. 200 (International Standard No. 75) sieve with a pan on the bottom and a lid on top.

2. Weigh out a 100 g ± 0.1 g sample of the potassium permanganate to be tested.

3. Place the sample on the upper, or coarser, screen and mount in a mechanical shaker. Shake for 3 min.

4. Disassemble the screens and weigh the product retained on the No. 40 sieve and also the product that passed through the No. 200 sieve and was collected in the pan.

5. The percentage retained on the No. 40 sieve and the percentage that passed through the No. 200 sieve collected in the pan are equal to the respective weights obtained in Sec. 5.4(3).

Sec. 5.5 Water Tolerance

Water tolerance applies to dry potassium permanganate crystals only and does not apply to liquid sodium permanganate solution.

The capacity of free-flowing grade potassium permanganate to adsorb moisture and remain flowable shall be determined by the following procedure:

1. Weigh out 100 g ± 1 g of the sample to be tested.

2. Add the weighed material to a suitable container (about 500 mL in volume) that has a tight-fitting lid.

3. Using distilled water and a buret or pipette calibrated in 0.1-mL increments, add 0.7 mL to the preweighed sample in the container, distributed evenly over the surface of the sample.

4. Cover and shake vigorously by hand for 20 to 30 sec so that the water and sample are mixed thoroughly.

5. Remove the lid and pour the potassium permanganate sample into a funnel mounted on a ring stand.

6. If the material mixed with the water flows freely through the funnel, the sample meets the water-tolerance test. If the material mixed with water does not flow freely through the funnel, the sample does not meet the standard.

Sec. 5.6 Notice of Nonconformance

If the permanganates delivered to the purchaser do not meet the chemical, physical, safety, or security requirements of this standard, the purchaser shall provide a notice of nonconformance to the supplier within 10 days after receipt of the shipment at the point of destination. The results of the purchaser's test shall prevail unless the supplier notifies the purchaser within 5 days after receipt of the notice of nonconformance that a retest is desired. On receipt of the request for a retest, the

purchaser shall forward to the supplier one of the sealed samples taken according to Sec. 5.1. If the results obtained by the supplier do not agree with the test results obtained by the purchaser, the other sealed sample shall be forwarded, unopened, for analysis to a referee laboratory agreed on by both parties. The results of the referee analysis shall be accepted as final.

The supplier shall provide to the purchaser an adjustment that is agreed on between the supplier and purchaser reflecting the diminished quality of the product.

SECTION 6: DELIVERY*

Sec. 6.1 Marking

6.1.1 *Required.* Each shipment shall be identified as to product, grade, net weight, name, and address of manufacturer, and brand name. Packages or containers shall show a lot number and identification of manufacturer. All markings on packaged, containerized, or bulk shipments shall conform to applicable laws and regulations, including requirements established by the US Occupational Safety and Health Administration (OSHA) and US Department of Transportation (DOT).

6.1.2 *Optional.* Each package, drum, or other container of material may also bear the statement "Guaranteed by (name of manufacturer) to meet American Water Works Association Standard B603 for Permanganates," provided that the requirements of this standard are met.

Sec. 6.2 Packaging and Shipping

Packaging and shipping of permanganates shall conform to all applicable federal regulations.

6.2.1 *Containers.* Dry potassium permanganate crystals shall be shipped in DOT-authorized bulk trailers, returnable semibulk bins, single-trip steel drums, and pails or other DOT-approved containers. Current package sizes include 3,300 lb (1,500 kg), 330 lb (150 kg), 110 lb (50 kg), or 55 lb (25 kg) net weight. Purchaser's specifications must meet the DOT regulations.

* Governmental packaging and marking references reflect US requirements. Users of this standard 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.

Liquid sodium permanganate solution shall be shipped in 5 gal, 55 gal, 250 gal, bulk tanker trailers (approximately 3,000 gal), or other DOT-approved packages. Purchaser's specifications must meet DOT regulations.

6.2.2 *Net weight.* The net weight of the package or container shall not deviate from the recorded weight by more than ± 2.0 percent. If a dispute arises concerning the weight of packaged or containerized material, acceptance or rejection shall be based on the weight of not less than 10 percent of the packages received, selected at random from the shipment.

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, or an alternative method or methods may be agreed on by the manufacturer and purchaser that provide a reasonable assurance of protection against tampering.

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 the 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 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 an affidavit from the manufacturer or supplier that the permanganate provided complies with applicable requirements of this standard.

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.

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