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NSF/ANSI/CAN 60 - 2020

Drinking Water Treatment Chemicals - Health Effects

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NSF International Standard /
American National Standard /
National Standard of Canada
for Drinking Water Additives –

Drinking Water Treatment Chemicals – Health Effects

Standard Developer
NSF International

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At the time of this publication, examples of programs and processes were provided for general guidance. This information is given for the convenience of users of this standard and does not constitute an endorsement by NSF International. Equivalent programs and processes may be used.

Unless otherwise referenced, the annexes are not considered an integral part of NSF Standards. The annexes are provided as general guidelines to the manufacturer, regulatory agency, user, or certifying organization.

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Contents

Foreword[2]

In response to a competitive request for proposals from the US Environmental Protection Agency (US EPA), a Consortium led by NSF International (NSF) agreed to develop voluntary third-party consensus standards and a certification program for all direct and indirect drinking water additives. Other members of the Consortium include the American Water Works Association Research Foundation (WRF), the Association of State Drinking Water Administrators (ASDWA), the Conference of State Health and Environmental Managers (COSHEM), and the American Water Works Association (AWWA). (COSHEM has since become inactive as an organization.) Each organization was represented on a steering committee with oversight responsibility for the administration of the cooperative agreement. The Steering Committee provides guidance on overall administration and management of the cooperative agreement. Currently, the member organizations remain active in an oversight role.

Two standards for additives products have been adopted. NSF/ANSI/CAN 61: *Drinking Water System Components – Health Effects* currently covers indirect additives products and materials. This Standard, NSF/ANSI/CAN 60, and subsequent product certification against it, will replace the US EPA Additives Advisory Program for drinking water treatment chemicals. For more information with regard to US EPA's actions, refer to the July 7, 1988 *Federal Register* (53FR25586).

NSF/ANSI/CAN 60 has been developed to establish minimum requirements for the control of potential adverse human health effects from products added to water for its treatment. It does not attempt to include product performance requirements, which are currently addressed in standards established by such organizations as AWWA, ASTM International, and the American National Standards Institute (ANSI). Because this Standard complements the performance standards of these organizations, it is recommended that products also meet the appropriate performance requirements specified in the standards of such organizations.

The Standard and the accompanying text are intended for voluntary use by certifying organizations, utilities, regulatory agencies, and/or manufacturers as a basis of providing assurances that adequate health protection exists for covered products.

All references to gallons (gal) are in US gallons.

This Standard was developed by the NSF Joint Committee on Drinking Water Additives – Treatment Chemicals using the consensus process described by the Standards Council of Canada's *Requirements and Guidance*. At the time of approval, the Joint Committees consisted of 9 public health / regulatory, 10 industry, 4 product certifier / testing lab, and 7 user representatives.

This Standard is designated as a National Standard of Canada (NSC) in compliance with requirements and guidance set out by the Standards Council of Canada (SCC).

This edition of the Standard contains the following revisions:

Issue 85

This revision updated the tamper evidence requirements for packaged products under Section 3.9.2.

Issue 86

This revision added language to clarify requirements for the application of tamper-evident seals in Section 3.9.3.1.

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Issue 87

3-chloro-1,2-propanediol was added to the minimum test battery for epichlorohydrin, a polyamine-based coagulant, under Table 4.1.

Issue 88

This revision updated the labeling requirements for sodium hypochlorite products under Section 6.3.3.

Issue 89

Chlorine dioxide was added to the list of disinfection and oxidation products in Table 6.2.

Issue 90

Bromochlorodimethylhydantoin (BCDMH) was added to the list of disinfection and oxidation products in Table 6.2.

Issue 91

This revision defines the term *biological substrate* under Section 7.2 and added acetic acid to the miscellaneous treatment applications under Table 7.1.

Issue 92

This revision will clarify the appropriate use of citric acid with its addition under Table 7.1 (use with copper-based algicides), and Table 8.1 (use in well development / rehabilitation, and as an offline separation process cleaner).

Suggestions for improvement of this Standard are welcome. This Standard is maintained on a Continuous Maintenance schedule and can be opened for comment at any time. Comments should be sent to: Chair, Joint Committee on Drinking Water Additives – Treatment Chemicals at standards@nsf.org, or c/o NSF International, Standards Department, PO Box 130140, Ann Arbor, Michigan 48113-0140, USA.

SCC Foreword[3]

A National Standard of Canada is a standard developed by a Standards Council of Canada (SCC) accredited standards development organization, in compliance with requirements and guidance set out by the SCC. More information on National Standards of Canada can be found at <www.scc.ca>.

SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) Canada. With the goal of enhancing Canada's economic competitiveness and social well-being, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts.

Accreditation services are provided by SCC to various customers, including product certifiers, testing laboratories, and standards development organizations. A list of SCC programs and accredited bodies is publicly available at <www.scc.ca>.

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Consortium Organizations

NSF International

Popularly referred to as NSF, NSF International is a noncommercial agency. It is incorporated under the laws of Michigan as a not-for-profit organization devoted to research, education, and service. It seeks to solve problems involving man and his environment. It wishes to promote health and enrich the quality of life through conserving and improving that environment. Its fundamental principle of operation is to serve as a neutral medium in which business and industry, official regulatory agencies, and the public come together to deal with problems involving products, equipment, procedures, and services related to health and the environment. It is conceived and administered as a public service organization.

NSF is perhaps best known for its role in developing Standards and Criteria for equipment, products, and services that bear upon health. NSF was the lead organization in the Consortium responsible for developing this Standard. NSF conducts research; tests and evaluates equipment, products, and services for compliance with standards and criteria; and grants and controls the use of NSF registered Marks.

NSF offers product certification (listing services) for all products covered by its Standards. Each program has established policies governing the associated product evaluation, Listing Services, follow-up, and enforcement activities. The NSF Listing Mark is widely recognized as a sign that the product or service to which it relates complies with the applicable NSF Standard(s).

Water Research Foundation

The mission of the American Water Works Association Research Foundation (now the Water Research Foundation), is to sponsor practical, applied research on behalf of the drinking water industry of North America. The scope of the research program embraces all aspects of water supply operation, from development and maintenance of water resources to treatment technologies and water quality issues, from storage and distribution system operations to health effects studies and utility planning and management activities. Water Research Foundation (WRF) serves as the centralized industry institution for planning, managing, and funding cooperative research and development in drinking water, including the subsequent transfer of technology and results for practical application by the water utility community.

WRF's purpose in this cooperative program is to provide a communication link with the water utilities throughout North America and serve as the focal point for identification of research needs of the water supply industry with respect to the additives program.

The Association of State Drinking Water Administrators

The Association of State Drinking Water Administrators (ASDWA) is a nonprofit organization whose eligible membership is comprised of drinking water program administrators in each of the 50 states and seven US territories. Through the organization, representatives speak with a collective voice to Congressional committees, the United States Environmental Protection Agency (EPA), professional and trade associations, water utilities, and the general public on issues related to state drinking water programs. With its mission of protecting the public health through assurance of high-quality drinking water, and promoting responsible, reasonable, and feasible drinking water programs at the state and federal levels, the Association is a valued contributor to the consortium, and to the program. It provides the link between the additives program and the state drinking water programs.

The Conference of State Health and Environmental Managers

The Conference of State Health and Environmental Managers (COSHEM), known formerly as the Conference of State Sanitary Engineers (CSSE), is currently inactive as an organization. It brought to the consortium expertise and involvement of state health and environmental program managers. The Conference was the focal point for health concerns of all state environmental programs, including drinking water, wastewater, air, solid and hazardous wastes, radiology, occupational health, and food. A standing committee on water supply focused on drinking water issues and kept the membership informed. The Conference played an important role early in the program through two-way communication with state health and environmental program decision makers.

American Water Works Association

The purpose of the American Water Works Association (AWWA) is to promote public health, safety, and welfare by improving the quality and increasing the quantity of water delivered to the public, and to developing and furthering an understanding of the problems relating thereto by:

- advancing the knowledge of the design, construction, operation, water treatment, and management of water utilities;
- developing standards for procedures, equipment, and materials used by public water supply systems;
- advancing the knowledge of problems involved in the development of resources, production, and distribution of safe and adequate water supplies;
- educating the public on the problems of water supply and promoting a spirit of cooperation between consumers and suppliers in solving these problems; and
- conducting research to determine the causes of problems with providing a safe and adequate water supply, and proposing solutions thereto in an effort to improve the quality and quantity of the water supply provided to the public.

AWWA brings to the Consortium its established position as the largest public drinking water association in North America, with a broad membership that includes utilities, consultants, manufacturers / distributors / agents, contractors, and other organizations with a direct interest in drinking water.

NSF/ANSI/CAN Standard
for Drinking Water Additives –

Drinking Water Treatment Chemicals –
Health Effects

1 General

1.1 Purpose

This Standard establishes minimum health effects requirements for the chemicals, the chemical contaminants, and the impurities that are directly added to drinking water from drinking water treatment chemicals. This Standard does not establish performance or taste and odor requirements for drinking water treatment chemicals.

1.2 Scope

This Standard contains health effects requirements for drinking water treatment chemicals that are directly added to water and are intended to be present in the finished water. This Standard also contains health effects requirements for other chemical products that are directly added to water but are not intended to be present in the finished water. Chemicals covered by this Standard include, but are not limited to, coagulation and flocculation chemicals, softening, precipitation, sequestering, pH adjustment, and corrosion / scale control chemicals, disinfection and oxidation chemicals, miscellaneous treatment chemicals, and miscellaneous water supply chemicals.

Contaminants produced as by-products through reaction of the treatment chemical with a constituent of the treated water are not covered by this Standard.

Acknowledging the fact that indigenous microorganisms may be present in drinking water, products resulting in the intentional introduction of microorganisms for the treatment of drinking water are excluded from the scope of the Standard.

1.3 Normative references

The following documents contain requirements, which by reference in this text, constitute requirements of this Standard. At the time this Standard was balloted, the editions listed below were valid. All documents are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the documents indicated below. The most recent published edition of the document shall be used for undated references.

21 CFR Part 58, *Good Laboratory Practice for Non-Clinical Laboratory Studies*[4]

40 CFR Part 160, *Good Laboratory Practice Standards*[5]

40 CFR Part 798, *Health Effects Testing Guidelines*[5]

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[4] US Food and Drug Administration. 5600 Fishers Lane, Rockville, MD 20857. <www.fda.gov>

[5] US Government Publishing Office. 732 N Capitol Street NW, Washington, DC 20401. <www.gpo.gov>

APHA/AWWA/WEF, *Standard Methods for the Examination of Water and Wastewater*, twenty-second edition[6]

ASTM E29-02, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*[7]

ASTM G22-76 (1996), *Standard Practice for Determining Resistance of Plastics to Bacteria*[7]

CGA, G-6.2-1994, *Commodity Specification for Carbon Dioxide*[8]

NSF/ANSI/CAN 600, *Health Effects Evaluation and Criteria for Chemicals in Drinking Water*

OECD, *Guidelines for the Testing of Chemicals*, May 1996[9]

US EPA-600/4-79-020, *Methods for the Chemical Analysis of Water and Wastes*, March 1983[10]

US EPA-600/4-80-032, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*[10]

US FDA, *Toxicological Principles for the Safety Assessment of Direct Food Additives and Color Additives in Food*[4]

1.4 Alternate chemicals

Chemicals or mixtures of chemicals used for the various purposes discussed in this Standard, but not specifically referenced, shall be acceptable provided they meet the requirements of this Standard.

1.5 Significant figures and rounding

When determining conformance with the specifications in this Standard, the Absolute Method in ASTM E29 *Standard Practice for Using Significant Digits in Test Data to Determine Conformance With Specifications* shall be used. When rounding data, the Rounding Procedure in Section 6.4 of ASTM E29 shall be used.

2 Definitions

2.1 analytical summary: A list of the analytical procedures, both chemical and microbiological, which are selected to determine whether a product is compliant to the requirements of the Standard.

2.2 at-the-tap: Referring to the point of delivery of potable water.

2.3 blend: A treatment product composed of two or more individual chemicals that do not react with one another.

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[6] American Public Health Association, American Water Works Association, and Water Environment Federation. <www.standardmethods.org>

[7] ASTM International. 100 Barr Harbor Drive, West Conshohocken, PA 19428-2859. <www.astm.org>

[8] Compressed Gas Association. 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. <www.cganet.com>

[9] Organization for Economic Cooperation and Development. 2 Rue Andre-Pascal, 75775 Paris Cedex 16, France. <www.oecd.org>

[10] US Environmental Protection Agency. 1200 Pennsylvania Avenue NW, Washington, DC 20004. <www.epa.gov>

2.4 blender: A manufacturer who produces a physical mixture of two or more ingredients. The mixture may be further diluted with potable water.

NOTE — The definition of blender pertains to physical mixtures of ingredients, and not to chemical products that are produced by a chemical reaction in blended processes.

2.5 bonded individual: A bond is a promise that a contractor, or driver, will fulfill his obligations. If a driver is bonded, a third-party company or his trucking company backs his performance and promises he will complete the task as agreed upon. Therefore, a bond provides assurance that the contracted work will be satisfactorily completed. If a loss occurs, however, a separate insurance policy may be required to cover the property, not the bond.

2.6 bulk transfer facilities: A facility / location where a source product is transferred from one bulk vessel to another, with or without intermediate product storage.

2.7 by-product: A contaminant produced secondarily to the production of a principal compound.

2.8 certified product: A single product or trade designation that appears in the public listings of a NSF/ANSI/CAN 60 certification agency.

2.9 chain of custody (COC): A record documenting the existence of positive control and security over an item with counter signatures or other acknowledgements (receiver / deliverer) at each stage of transition of control / security responsibility.

2.10 chemical stock: a store or supply accumulated or available for product manufacture.

2.11 contaminant: Any physical, chemical, biological, or radiological substance or matter in water.

NOTE — Consistent with the definition in the federal Safe Drinking Water Act, a contaminant can have either a beneficial or detrimental effect on the potability of water.

2.12 diluter: A manufacturer that produces a product composed of a single source product, diluted with water to a specific concentration.

2.13 direct additive: A drinking water treatment chemical and any of its contaminants added directly to water during the production of drinking water.

2.14 drinking water: Water intended for human consumption.

2.15 evaluation dose: The concentration of a direct additive used to evaluate the impurities imparted to drinking water.

2.16 facility: a building, special room, etc., that facilitates or makes possible some activity.

2.17 good manufacturing practice: The practice of maximizing the purity of the product by maintaining and practicing appropriate quality control and quality assurance procedures.

2.18 indirect additive: A contaminant that is extracted into drinking water through contact with surfaces of materials or products used for drinking water treatment, storage, transmission, or distribution.

2.19 manufacturer: The original chemical manufacturer, in which some process is used to produce a drinking water treatment chemical.

2.20 maximum contaminant level (MCL): The maximum concentration of a contaminant permitted in a public drinking water supply as defined by the federal Safe Drinking Water Act.

> NOTE — If the manufacturer requests review relevant to alternate regulatory requirements, the certifying agency can consider alternative regulatory levels, e.g., Canadian maximum acceptable concentrations (MACs).

2.21 maximum use level (MUL): The maximum concentration of a direct additive that has been found to be acceptable under this Standard. This refers to the total quantity used in the process train, regardless of the number of application points.

2.22 normalization: The process of adjusting laboratory results to account for differences between laboratory and at-the-tap exposures.

2.23 normalized concentration: A value for a contaminant concentration from a laboratory evaluation that has been adjusted to reflect the contaminant concentration at-the-tap.

2.24 product family: A group of products, under the same chemical category, under which a NSF/ANSI/CAN 60 certification agency has bracketed a single designated test product (one of the products in the group) for testing purposes.

2.25 repackager: A company, other than the original product manufacturer or the same production facility, that opens the packaging of a product, places it into another container, seals, and labels the product.

2.26 relabeller: A company that places a new product label on a source product without opening the original packaging.

2.27 single product allowable concentration (SPAC): The maximum concentration of a contaminant in drinking water that a single product is allowed to contribute under NSF/ANSI/CAN 600 (previously Annex A).

2.28 source product: The original product that is repackaged, relabeled, or diluted by a chemical distributor to produce a new finished product.

2.29 storage: space or a place for storing.

2.30 total allowable concentration (TAC): The maximum concentration of a nonregulated contaminant permitted in a public drinking water supply as defined by NSF/ANSI/CAN 600 (previously Annex A).

2.31 typical use level: An application level that has been used historically in water treatment. The typical use level is not the maximum use level for the product except where specifically stated.

2.32 unannounced facility inspection: An audit of a chemical supplier's facility, without prior notice, that includes compliance checks to the NSF/ANSI/CAN 60 standard and product certification agency's program policies.

> NOTE — A delay of 1 to 2 hr between arrival time of the inspector and before the onset of the inspection due to security, safety and personnel availability issues is acceptable.

3 General requirements

3.1 General

Direct additives shall be tested and evaluated in accordance with Annex N-1 and NSF/ANSI/CAN 600 (previously Annex A). The single product allowable concentration (SPAC) of a contaminant shall be calculated as outlined in NSF/ANSI/CAN 600 (previously Annex A). Under the provisions of this Standard, a product shall not contribute any contaminant to drinking water in excess of the contaminant's SPAC.

Direct additives under this Standard shall be:

- the treatment or water supply product itself;
- the product-specific contaminants listed in each of the product sections of this Standard; and
- other constituents as identified in the formulation review.

Figure 1 provides an overview of the evaluation process.

3.2 Formulation submission and review

3.2.1 The manufacturer shall submit, at a minimum, the following information for each product:

- a proposed maximum use level (MUL) for the product, which is consistent with the requirements of NSF/ANSI/CAN 600 (previously Annex A);

- complete formulation information, which includes the following:

  - the composition of the formulation (in percent or parts by weight for each chemical in the formulation);

  - the reaction mixture used to manufacture the chemical, if applicable;

  - chemical abstract number (CAS number), chemical name, and supplier for each chemical present in the formulation;

  - a list of known or suspected impurities within the treatment chemical formulation and the maximum percent or parts by weight of each impurity; and

  - the source and type of water used in the manufacture of the treatment chemical as well as any available documentation regarding quality monitoring of such water source, if applicable.

- a description or classification of the process in which the treatment chemical is manufactured, handled, and packaged;

- selected spectra (e.g., UV / visible, infrared) shall be required for some additive products or their principle constituents; and

- when required by NSF/ANSI/CAN 600 (previously Annex A) a list of published and unpublished toxicological studies relevant to the treatment chemical and the chemicals and impurities present in the treatment chemical.

3.2.2 The formulation information provided by the manufacturer shall be reviewed, and this review shall determine any formulation-dependent contaminants to be evaluated in addition to the product-specific analytes identified in each product section (see Sections 4 through 8).

3.2.3 If the finished product contains water, the formulation information provided by the manufacturer shall be reviewed to determine if the water source used in the manufacturing of the finished product requires testing.

3.2.3.1 Water sources that require testing include, but are not limited to, the following: nontreated surface water; nontreated ground water; nontreated rain water; and water collected from other nontreated sources. Testing of water sources shall include the following analyses; metals, VOCs, base / neutral / acid scan, radionuclides, herbicides / pesticides, and dioxin / furan scan.

> NOTE 1 — Testing related to water sources may be performed on the finished product or on a separate water sample; however, any test conducted on the finished product itself, as part of such product's certification testing battery, may be omitted from testing performed on a separate water sample.
>
> NOTE 2 — Metals analysis shall include antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, and thallium.

3.2.3.2 Water sources that do not require testing include the following: treated or nontreated water sources that comply with state or national drinking water standards, deionized water, distilled water, demineralized water, water treated on-site to drinking water quality with the exception of disinfection, drinking water treated with a reverse osmosis system, and ground water treated on-site to drinking water quality or a higher purity grade.

3.3 Sampling, preparation, and analysis of samples

Sample collection, preparation, and analysis shall be done in accordance with methods outlined in Annex N-1.

3.4 Contaminant concentrations

3.4.1 Individual treatment chemicals

Contaminant concentrations for individual treatment chemicals shall be no greater than the limits established in accordance with NSF/ANSI/CAN 600 (previously Annex A).

3.4.2 Blends of treatment chemicals

For products which are blended entirely of treatment chemicals which have met the requirements of this Standard as individual treatment chemicals, contaminant concentrations from the individual treatment chemicals shall be no greater than the limits established in accordance with NSF/ANSI/CAN 600 (previously Annex A).

For products which are blended using one or more treatment chemical(s) which have not met the requirements of this Standard, contaminant concentrations of the blended product shall be no greater than the limits established in accordance with NSF/ANSI/CAN 600 (previously Annex A).

Evaluation of products that are blends shall also consider whether contaminant concentrations from the individual chemicals are changed by the use of the chemicals in combination.

3.5 Product labeling

The product container or documentation shipped with the product, such as a product technical data sheet or MSDS, shall be clearly identified with the manufacturer's name and address, product identification, net weight, lot number, MUL, and certification markings of applicable certification organizations. When applicable, the manufacturer shall specify any special precautions for handling, storage and use.

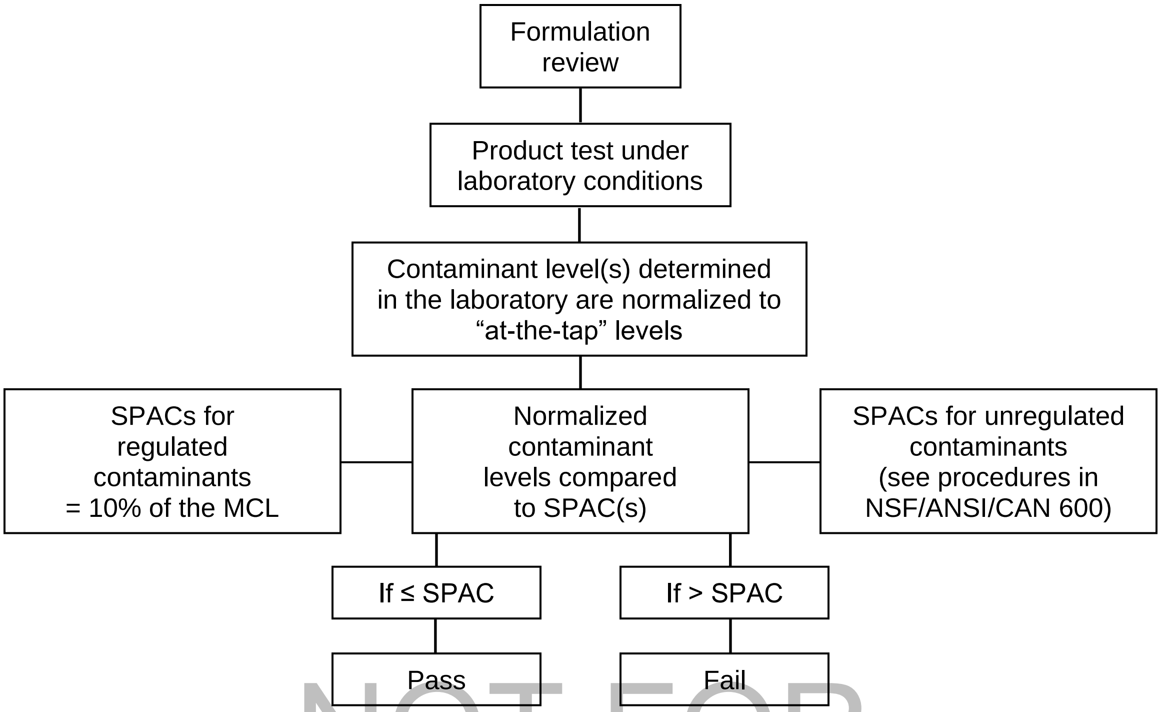

Figure 1
Product evaluation overview

3.6 Formulation control

The manufacturer shall have practices in place to ensure that the product is manufactured according to the approved formulation, and to ensure that no changes in manufacturing processes, product composition, or raw materials, can occur without prior authorization by the certification body. The practices shall ensure that no contamination is introduced by product packaging, transfer and storage equipment, or dilution water. Containers shall either be dedicated to one category of chemical, or written records of cleaning (e.g., wash tickets) must be available for review. Documentation of these practices shall be available for review.

3.6.1 Hazard assessment procedures for process water

3.6.1.1 If the finished product contains water supplied by a public water system, the manufacturer shall have procedures in place that identify steps to be taken when utilities issue warnings, such as a boil water alert, do not drink, or do not use order.

3.6.1.2 If the finished product contains water sourced through other than a public water system, the manufacturer shall have procedures that periodically monitor the water for chemicals of concern. The procedure shall also specify treatment of the source water, or preclude its use, when significant quality changes may introduce unacceptable levels of contaminants to the product.

> NOTE — Significant water quality changes can occur seasonally, after heavy rains or droughts, or other events, such as chemical spills. Manufacturers need processes in place that identify steps to be taken when utilities issue warnings such as a boil water alert, do not drink, or do not use order. Similar hazards can occur with nonutility waters. Steps need to be taken to reduce the potential contamination of treatment chemicals during these periods of varying water quality.

3.7 Product traceability

The manufacturer shall establish and maintain practices that ensure all products and product blends are uniquely labeled according to the requirements of Section 3.5. These practices shall provide for traceability from raw materials to finished products.

3.8 Conformity assessment requirements

This section applies to certification organizations only. All products certified under this Standard shall conform to the following requirements:

3.8.1 Product testing

Except as noted, a product shall be sampled and tested at least once per calendar year for the chemistry-specific analytes (Tables 4.1, 5.1, 6.1 & 7.1) and other parameters identified in the product analytical summary from the formulation review. The product with the highest concentration may be tested as the representative of a series of analogous lower concentration products. For a diluted, blended, or repackaged certified product, a minimum of one product per facility shall be tested annually. Products that are unavailable for testing by the certification agency for more than three years from the last test date cannot be considered compliant with this Standard.

3.8.2 Facility inspections

Except as noted, facilities producing certified products shall receive an unannounced inspection at least once per calendar year. The inspection frequency may be increased in cases of noncompliance. Such inspections shall include (but not be limited to):

- visual inspection of production;
- sample collection pursuant to Section 3.6.1;
- formulation validation;
- analytical procedures and methods review;
- records review related to formulation control; and
- records review of chemical stock control.

Announced inspections can be authorized in lieu of unannounced inspections for the initial inspection, security concerns, intermittently staffed facilities, and during accreditation reviews.

3.9 Product security

Products to be sold for drinking water treatment applications shall be protected to maintain the quality required by this Standard. Appropriate, effective measures shall be made to control access to products at all points of manufacturing, blending, diluting, packaging, repackaging, storage, shipping and handling, and to provide the manufacturer and the purchasing user of product with the ability to detect tampering (see Annex I-5).

3.9.1 Definition of tamper-evident (T/E) packaging

Packaging having one or more indicators or barriers to entry which, if breached or missing, can reasonably be expected to provide visible evidence that tampering has occurred.

3.9.2 Security requirements for packaged products

Packaged product shall be stored, shipped, and delivered in T/E packaging as defined in Section 3.9.1. Properly constructed, labeled, and sealed multi-wall containers such as bags, fiber drums, and multi-layer stretch-wrap / shrink-wrap / pallet sleeves with T/E labeling, T/E tape, or unique features constitute three forms of acceptable T/E packaging.

Smaller containers do not require individual T/E seals when shipped in a larger container from the manufacturer with acceptable seals or closures on the larger container, as noted in the prior paragraph, provided the smaller containers are not intended to be sold individually as certified product (i.e., not labeled for individual sale / use for drinking water applications). Valve bags are an exception and it is permissible to label them for individual sale as described in Section 3.9.2.1.

3.9.2.1 Bags and super sacks

Packages for product shipped without reusable openings shall be constructed and properly sealed to make opening or substitution obvious to the purchaser. The packages shall display the company's name, and employ seals that are destroyed upon opening, or that make resealing unlikely (e.g., serialized tags), or other equivalent T/E measures so that once opened, the T/E feature of the seal on the packaging is unable to be restored or readily duplicated.

3.9.2.1.1 Individual bags with valve closures

Individual bags that utilize valve closures do not require T/E seals when shipped in a larger container from the manufacturer with acceptable seals or closures on the larger container as noted in Section 3.9.2. (See Annex I-5 for photo example.) It is permissible to label individual valve bags for sale, including labeling according to Section 3.5.

3.9.2.2 Drums and small containers

Drums and small containers used for product shall be constructed and properly sealed to make opening or substitution obvious to the purchaser. Openings in the containers shall be sealed with T/E seals and the packages shall display the company's name. Packages shall employ seals that are destroyed upon opening, or that make resealing unlikely (e.g., ultrasonic seals), or other equivalent T/E measures so that once opened, the T/E feature of the seal is unable to be restored or readily duplicated.

3.9.3 Security requirements for bulk shipments and large reusable containers (totes)

Drinking water treatment chemicals shipped in bulk[11] shall be secured during storage and distribution by employing one or more of the following security measures (see Sections 3.9.3.1, 3.9.3.2, and 3.9.3.3). These requirements are applicable to a single load delivered to one or to multiple locations.[12] This requirement applies to railcar chemical deliveries that are direct to drinking water utilities, or to other end users involved in the addition of the delivered chemical to drinking water, and to truck deliveries whether to a single destination or by milk run deliveries.

3.9.3.1 Tamper-evident (T/E) seals

Containers used for bulk shipments shall have tamper protection provided at all openings capable of loading or unloading chemicals. Vents shall have tamper protection provided, unless they are protected by construction that makes them incapable of receiving chemicals. Bulk containers may be sealed with a uniquely numbered, nonreusable T/E seal**,** or a T/E seal which contains a unique company identifier or logo**,** on each opening in the container. If T/E seals are used, the seals shall remain in place until removed at the point of delivery. Seal numbers, or the unique company identifier or logo**,** shall be recorded and disclosed on shipping documents provided to the purchaser at the time of delivery and kept available for review by the certification body. If T/E seals are used in milk run deliveries, a new seal shall be applied after each partial off-loading and noted in the consignment records after each partial delivery.

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[11] The term "bulk" is used for shipments being transported in a container having a volume of more than 1,000 L and applies to containers holding solid, liquid, and gaseous products. Such containers can be multi-modal containers, tank trucks, or tank cars appropriate to the physical characteristics of the product being transported.

[12] Multiple destination shipments are referred to as "milk run deliveries".

3.9.3.2 Chain of custody (COC)

An auditable continuous COC protocol may be used to record secure distribution of product. Maintaining a continuous COC requires that the product is under the continuous control of bonded and designated individuals, that direct access to the product is restricted to those individuals, and that the container is sealed or secured at all times during transport from the place of shipment to the place of delivery. If COC is used, a completed COC record showing continuous and secure custody between the certification holder to the purchaser shall be provided by the transporter to the certification holder and to the purchaser at the time of delivery. The completed COC record returned to the certification holder shall be kept available for review by the certification body.

> NOTE — For the custody procedure during transport by road of certain drinking water treatment chemicals, there may be a requirement for two persons to be assigned to the distribution activity, with the vehicle being under the direct supervision of at least one person at all times.

Where a paper-based COC procedure is used for milk run deliveries, the documentation shall have sufficient copies so that a copy of the documentation shall be signed and provided to each consignee noting the quantity delivered at that destination, and the balance remaining in the shipment. A copy of the complete series of deliveries shall be provided by the transporter to the certification holder.

Where an electronically-based COC procedure is used for milk run deliveries, the record of the custody and deliveries shall be provided by the transporter to the certification holder.

> NOTE — It is normal transport procedure for the transporter to retain duplicate records of all cargo acceptances and deliveries, including COC documents or records. These may be accessed if necessary to verify COC.

3.9.3.3 Alternative method

An alternative method or methods[13] agreed upon by the certification holder and the purchaser may be used for bulk shipments if the alternative method provides protection against tampering that is equivalent to this Standard. If alternative methods are used, the agreement with the purchaser and description of the alternative methods shall be in written form and kept available for review by the certification body.

3.9.4 Tamper-evident (T/E) integrity

The T/E features employed on all final product packaging, seals, and containers used for bulk shipments shall be designed to remain intact when handled in a reasonable manner during manufacture, storage, shipment and delivery to the purchaser.

4 Coagulation and flocculation chemicals

4.1 Coverage

This section covers products used as coagulants, flocculants, and filtration aids in treating drinking water. Products include individual treatment chemicals, blends of treatment chemicals, and dilutions of these products. Uses include removal of suspended solids, color, dissolved components, and sludge dewatering (where recycle flows exist).

4.2 Definitions

4.2.1 bentonite: An adsorptive and colloidal native hydrated aluminum silicate clay consisting principally of montmorillonite.

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[13] Alternative methods may include secured electronic tracking and communication methods.

4.2.2 clay: Soil consisting of inorganic materials, which are primarily minerals, the grains of which have diameters less than 0.002 mm.

4.2.3 coagulant: A direct additive used in water treatment to induce coagulation.

4.2.4 coagulation: The destabilization of colloidal and dispersed particles, inducing growth to larger particle sizes.

4.2.5 copolymer: A polymer consisting of two or more monomers as repeating units.

4.2.6 DADMAC: Diallyldimethylammonium chloride monomer.

4.2.7 EPI/DMA: Epichlorohydrin / dimethyla-mine copolymer.

4.2.8 filtration aid: A direct additive used in water treatment to enhance the filterability of water.

4.2.9 flocculant: A direct additive used in water treatment to induce flocculation.

4.2.10 flocculation: The agglomeration of coagulated and finely divided suspended matter into aggregates or complexes.

4.2.11 hectorite: A swelling and gelling clay of the montmorillonite group.

4.2.12 metal salt coagulant: An inorganic salt used in water treatment for coagulation, usually contains a multivalent cation of iron or aluminum.

4.2.13 monomer: Basic reactive unit(s) from which higher molecular weight molecules (polymers) are formed.

4.2.14 polyacrylamide: A class of polymers produced from acrylamide monomer. These polymers can be anionic, cationic, or nonionic in charge.

4.2.15 polyDADMAC: A polymer produced from DADMAC monomer.

4.2.16 polyelectrolyte: A polymer with multiple charged functional groups.

4.2.17 polymer: A high molecular weight molecule made from lower molecular weight basic reactive units (monomers).

4.2.18 sludge conditioner: A chemical added to sludge to improve its dewatering ability.

4.2.19 suspended solids: Solid organic or inorganic particles physically held in suspension by agitation or flow.

4.3 General requirements

4.3.1 General information about the products covered in this section is summarized in Table 4.1.

4.3.2 Metal salt coagulants

Metal salt coagulant products shall not be evaluated for residual levels of the parent metal (e.g., aluminum or iron) after flocculation of the product.

4.4 Sample requirements

Samples of product obtained for testing and evaluation shall have been manufactured from a formulation identical to that of the commercially available product.

4.5 Sample preparation

4.5.1 Analytical summary

An analytical summary shall be prepared for each product. The analytical summary shall consist of the minimum test batteries of chemistry-specific analytes identified in Table 4.1 and any formulation-dependent analytes identified during the formulation review (see Section 3.2).

4.5.2 Selection of preparation method

4.5.2.1 Individual treatment chemicals

The test sample shall be prepared for analysis per the appropriate preparation method indicated in Table 4.1, if applicable.

4.5.2.2 Blends of treatment chemicals

Preparation method(s) for blends of treatment chemicals (e.g., a blend of a metal salt coagulant and a polymer) shall be selected according to the individual treatment chemicals in the blended product.

> NOTE — For example, a blend of a metal salt coagulant and a polymer is prepped using Method K (see Annex N-1, Section N-1.3.12) for analysis of the metal salt contaminants, and the product is not prepped for analysis of the polymer contaminants. Separate aliquots of the sample are used for analysis of each component of the blend.

4.6 Analysis

Following preparation (see Section 4.5.2), the sample shall be analyzed for the contaminants identified on the analytical summary per the methods outlined in Annex N-1, Section N-1.4.

4.7 Normalization

4.7.1 Nonpolymer chemicals

The concentration of contaminants detected in the analysis solution shall be adjusted to reflect the contaminant concentration in the finished drinking water according to the following equation:

$$\begin{array}{ccccccc}
\dfrac{\text{contaminant (mg)}}{\text{analysis solution (L)}} & \times & \dfrac{\text{analysis solution (L)}}{\text{product (mg)}} & \times & \dfrac{\text{product (mg)}}{\text{drinking water (L)}} & = & \dfrac{\text{contaminant (µg)}}{\text{drinking water (L)}} \\
\text{[analysis solution]} & & \text{[lab prep solution]} & & \text{[MUL]} & & \begin{array}{c}\text{[at-the-tap}\\ \text{exposure]}\end{array}
\end{array}$$

4.7.2 Polymer chemicals

The concentration of contaminants detected in the analysis solution shall be adjusted to reflect the contaminant concentration in the finished drinking water according to the following equation:

$$\underset{\text{[analysis solution]}}{\frac{\text{contaminant (µg)}}{\text{product (g)}}} \times \underset{\text{[lab prep solution]}}{\frac{\text{1 g}}{\text{1,000 mg}}} \times \underset{\text{[MUL]}}{\frac{\text{product (mg)}}{\text{drinking water (L)}}} = \underset{\text{[at-the-tap exposure]}}{\frac{\text{contaminant (µg)}}{\text{drinking water (L)}}}$$

4.8 Evaluation of contaminant concentrations

4.8.1 General

The normalized concentration of each contaminant shall be no greater than the SPAC determined in accordance with the requirements of NSF/ANSI/CAN 600 (previously Annex A).

4.8.2 Blends

The MUL of each treatment chemical in a blended product shall not exceed its MUL when evaluated as an individual treatment chemical.

The following table is a generic listing of the types of products covered in this section. This table is not intended to be a complete list of all products used for coagulation and flocculation applications. Inclusion of a product does not indicate either a use endorsement of the product or an automatic acceptance under the provisions of this Standard. Annex I-3, Table I-3.1, includes a cross-reference index of the various chemicals(and the more common synonyms) contained in this table.

Table 4.1
Coagulation and flocculation products – Product identification and evaluation

Chemical type (description)	Synonyms	Formula (CAS number)	Approximate molecular weight	Preparation Method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
acrylamide / acrylic acid copolymer[3] (polyelectrolytes)	—	(31212-13-2)	4 to 30 million	—	1.0[4]	acrylamide, acrylic acid, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile
activated silica (coagulant)	silicic acid	$SiO_2 \cdot nH_2O$ (1343-98-2)	78 @ n = 1	Method A, Annex N-1, Section N-1.3.2	5.0	metals,[5] radionuclides, base / neutral scan[6]
aluminum chloride (metal salt coagulant)	aluminum trichloride	$AlCl_3$ (41630-01-7) (7446-70-0)	133.34	Method K, Annex N-1, Section N-1.3.12	70.0 / 26.8[7]	metals,[5] base / neutral scan[6]
aluminum chlorohydrate (metal salt coagulant)	aluminum chloride hydroxide, basic aluminum hydroxide, alum	$Al_2Cl(OH)_5$ (12042-91-0)	variable	Method K, Annex N-1, Section N-1.3.12	—	metals,[5] base / neutral scan[6]
aluminum sulfate (metal salt coagulant)	aluminum alum, cake alum, aluminum trisulfate	$Al_2(S0_4)_3 \cdot nH_20$ (10043-01-3)	594.4 (n = 14)	Method K, Annex N-1, Section N-1.3.12	156 / 26.8[7]	metals,[5] base / neutral scan[6]
anionic polyacrylamide (dry)[3] (polyelectrolytes)	—	(31212-13-2)	4 to 30 million	—	1.0[4]	acrylamide, acrylic acid, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile
anionic polyacrylamide (emulsion)[3] (polyelectrolytes)	—	(31212-13-2)	4 to 30 million	—	4.0[4]	acrylamide, acrylic acid, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile

Table 4.1
Coagulation and flocculation products – Product identification and evaluation

Chemical type (description)	Synonyms	Formula (CAS number)	Approximate molecular weight	Preparation Method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
bentonite / montmorillonite (clays)	wilkinite, montmorillonite, volclay	$RO.33(Al, Mg)_2$ $Si_40_{10}(0H)_2 \odot nH_2O$ (R = Na, K, Mg or Ca) (1302-78-9)	Unknown	Method F, Annex N-1, Section N-1.3.7	200	metals,[5] radionuclides, base / neutral / acid scan
cationic polyacrylamide (dry)[3] (polyelectrolytes)	acrylamide / acryl-oxy-ethyltrimethyl ammonium chloride (dry)	(9003-05-8)	4 to 20 million	—	1.0[4]	acrylamide, cationic monomer, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile
cationic polyacrylamide (emulsified)[3] (polyelectrolytes)	acrylamide / acryl-oxy-ethyltrimethyl ammonium chloride (emulsified)	(9003-05-8)	4 to 20 million	—	4.0[4]	acrylamide, cationic monomer, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile
ferric chloride (metal salt coagulant)	iron (III) chloride, iron trichloride	$FeCl_3 \odot nH_20$ (7705-08-0)	162.22 (n = 0) 270.30 (n = 6)	Method K, Annex N-1, Section N-1.3.12	60.0 / 20.7[8] 100.0 / 20.7[8]	metals,[5] VOCs, base / neutral / acid scan[6]
ferric sulfate (metal salt coagulant)	ferric persulfate ferric tersulfate iron (III) sulfate	$Fe_2(S0_4)_3 \odot nH_20$ (10028-22-5)	399.88 (n = 0)	Method K, Annex N-1, Section N-1.3.12	100.0 / 28[8]	metals,[5] base / neutral / acid scan[6]
ferrous chloride (metal salt coagulant)	iron (II) chloride, iron dichloride	$FeCl_2$ (7758-94-3)	126.75	Method K, Annex N-1, Section N-1.3.12	—	metals,[5] VOCs, base / neutral / acid scan[6]
ferrous sulfate (metal salt coagulant)	iron (II) sulfate	$FeS0_4 \odot nH_20$ (7720-78-7)	151.91 (n = 0) 278.0 (n = 7)	Method K, Annex N-1, Section N-1.3.12	43.7 / 16.1[8] 80.0 / 16.1[8]	metals,[5] base / neutral / acid scan[6]
hectorite (clay)	—	—	—	Method F, Annex N-1, Section N-1.3.7	200	metals,[5] radionuclides, base / neutral scan

Table 4.1
Coagulation and flocculation products – Product identification and evaluation

Chemical type (description)	Synonyms	Formula (CAS number)	Approximate molecular weight	Preparation Method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
hydrolyzed polyacrylamide (polyelectrolytes)	HPAM	ammonium salt (26100-47-0) sodium salt (25085-02-3)	4 to 30 million	—	1.0[4]	acrylamide, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile
nonionic polyacrylamide (dry)[3] (polyelectrolytes)	PAM, PAMD	(9003-05-8)	4 to 20 million	—	1.0[4]	acrylamide, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile
nonionic polyacrylamide (emulsion)[3] (polyelectrolytes)	PAM, PAMD	(9003-05-8)	4 to 20 million	—	4.0[4]	acrylamide, acrylonitrile, 3-hydroxypropane nitrile, isobutane nitrile
poly (diallyldimethyl-ammonium chloride) (polyelectrolytes)	polyDADMAC	(26062-79-3)	10 thousand to 3 million	—	25.0[9]	DADMAC monomer, dimethylamine
polyaluminum chloride (metal salt coagulant)	polybasic aluminum chloride, aluminum chlorhydroxide	$Al_2(OH)_xCl_y$◌ nH_20 (1327-41-9) (12042-91-0)	248.2 (n = 0) variable	Method K, Annex N-1, Section N-1.3.12	— / 26.8[7]	metals,[5] base / neutral scan[6]
polyaluminum chlorosulfate (metal salt coagulant)	PACS	—	variable	Method K, Annex N-1, Section N-1.3.12	— / 26.8[7]	metals,[5] base / neutral scan[6]
polyaluminum silicate sulfate (metal salt coagulant)	PASS, aluminum hydroxide sulfate	(53810-32-5)	variable	Method K, Annex N-1, Section N-1.3.12	— / 26.8[7]	metals,[5] base / neutral scan[6]
poly (epichlorohydrin / dimethylamine) (polyamines) (polyelectrolytes)	EPI/DMA, polyamine	(25988-97-0) or (42751-79-1)	30 thousand to 3 million	—	10.0[10]	epichlorohydrin, 1,3-dichloro-2-propanol, 1,2-dichloro-3-propanol, 3-chloro-1,2-propanediol, glycidol, dimethylamine, ethylenediamine (if used as a branching agent)

Table 4.1
Coagulation and flocculation products – Product identification and evaluation

Chemical type (description)	Synonyms	Formula (CAS number)	Approximate molecular weight	Preparation Method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
polyethyleneamines (polyelectrolytes)	—	(26913-06-4)	25 thousand to 1 million	—	10.0[11]	ethylene dichloride, ethylene diamine, epichlorohydrin, glycidol, 1,3-dichloro-2-propanol, 1,2-dichloro-3-propanol
resin amines (polyelectrolytes)	melamine / formaldehyde polymer	(9003-08-1)	10 thousand minimum	—	10.0[11]	melamine, formaldehyde
sodium aluminate (metal salt coagulant)	aluminum sodium oxide	$Na_2Al_20_4$ (1302-42-7)	163.94	Method K, Annex N-1, Section N-1.3.12	43 / 26.8[7]	metals,[5] base / neutral scan[6]
sodium silicate[12] (coagulant)	activated silica	$Na_2O(SiO_2)_n$ typically n = 3 (1344-09-8)	122 @ n = 1	Method A, Annex N-1, Section N-1.3.2	7.8	metals[5]
starch, anionic (coagulant)	starch, base-hydrolyzed	(68412-33-9)	—	—	10	metals[5]

[1] The typical use level is an application level which has been used historically in water treatment. The typical use level is not the maximum use level (MUL) for the product unless specifically stated.

[2] Analysis for all chemistry-specific analytes in these minimum test batteries shall be performed each time the product is evaluated. Analysis shall also include formulation-dependent analytes as identified during formulation review. Testing for specific repackages, blends, or dilutions of previously certified products may be waived.

[3] If nitrogen-containing initiators are used in these chemical types, evaluation shall include analysis for the initiator and any initiator by-products.

[4] The typical use level for this product is based on an acrylamide polymer application of 1 mg/L and an acrylamide monomer level of 0.05% in the polymer, or equivalent (40 CFR § 141.111) for a carryover of not more than 0.5 ppb of acrylamide monomer into the finished water.

[5] Metals = antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, thallium

[6] A GC/MS analysis shall also be performed on this chemical type when recycled materials are used in the manufacturing process.

[7] The first value is the typical use level as indicated by the chemical formula. The second value is the typical use level as aluminum oxide for the aluminum salts (aluminum chloride, aluminum sulfate, polyaluminum chloride, and sodium aluminate).

[8] The first value is the typical use level as indicated by the chemical formula. The second value is the typical use level as Fe for the iron salts (ferric chloride, ferric sulfate, ferrous chloride, and ferrous sulfate).

Table 4.1
Coagulation and flocculation products – Product identification and evaluation

Chemical type (description)	Synonyms	Formula (CAS number)	Approximate molecular weight	Preparation Method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
[9] The typical use level for this product is based on a polyDADMAC polymer application of 25 mg/L and a carryover of not more than 50 ppb of DADMAC into the finished water. [10] The typical use level for this product is based on a EPI/DMA polymer application of 10 mg/L and a epichlorohydrin monomer level of 0.01% in the polymer, or equivalent (40 CFR § 141.111) for a carryover of not more than 1 ppb of epichlorohydrin monomer into the finished water. [11] The typical use level of this product is expressed as mg/L of active polymer in the product as sold. [12] Sodium silicate may be used in conjunction with an acid-forming substance to produce activated silica. The net concentrations of sodium silicate and acid-forming substance are not to exceed the MULs for these chemicals individually.						

5 Chemicals for corrosion and scale control, softening, precipitation, sequestering, and pH adjustment

5.1 Coverage

This section covers chemicals and chemical blends used in drinking water treatment for softening, remineralization, precipitation, and pH adjustment, and to control corrosion, scale, and metallic color problems.

5.2 Definitions

5.2.1 blended phosphate: A product containing at least two active and distinct phosphate species, one of which is a polymeric phosphate, each at 5% or greater of the total dry weight. A blended phosphate can contain other intentional ingredients (acids, bases, silicates, etc.) up to 5% individually, and up to 10% of the total dry weight of the product.

5.2.2 corrosion and scale control chemicals: Chemicals that either alter the treated water chemistry or interact with the surface of metallic materials in the water distribution system to inhibit corrosion or to prevent the formation of scale deposits.

5.2.3 dry weight: The weight of all ingredients except water and waters-of-hydration.

5.2.4 pH adjustment chemical: A chemical that either increases or decreases the pH of the treated water.

5.2.5 precipitation chemical: A chemical that causes a component of a solution to form an insoluble matter.

5.2.6 remineralization chemical: A chemical used to increase dissolved mineral content in water following treatment processes (e.g., reverse osmosis, distillation) for purposes of reducing corrosion of metallic and cementitious materials, stabilizing water chemistry, providing essential minerals, and for aesthetic effects.

5.2.7 sequestering chemical: Any compound that in aqueous solution binds with a metal or metallic ion to form a water soluble complex or chelate.

5.2.8 softening chemical: A chemical that either decreases or masks the presence of the dissolved concentration of calcium ion, magnesium ion, or both, in the treated water.

5.2.9 zinc orthophosphate: A product manufactured from orthophosphate and zinc salts. The proportion (ratio) of zinc to phosphate is variable.

5.3 General requirements

General information and evaluation requirements for the products covered in this section are summarized in Table 5.1.

5.3.1 Minimizing risk for pathogen transmittal in chemicals

To minimize the risk for pathogen transmittal in chemicals evaluated under this section, those that contain water in the finished product shall only be produced using waters meeting the criteria of Section 3.2.3.2.

> NOTE — The chemicals in Section 5 may be added to drinking water post disinfection or in drinking water systems not adding disinfectant to the treated water. As such, this section is intended to minimize the potential for pathogen introduction from treatment chemicals where other measures are not in place to prevent it.

The following water treatment chemicals are exempted from this restriction.

— those with a pH less than or equal to 2 or greater than or equal to a pH of 11; or

— those where the product literature limits the use of the treatment chemical to applications where the water is disinfected post addition of the chemical.

5.4 Sample requirements

Samples of product obtained for evaluation shall have been manufactured from a formulation identical to that of the commercially available product.

5.5 Sample preparation

5.5.1 Analytical summary

An analytical summary shall be prepared for each product. The analytical summary shall consist of the minimum test batteries of chemistry-specific analytes identified in Table 5.1 and any formulation-dependent analytes identified during the formulation review (see Section 3.2).

5.5.2 Selection of preparation method

5.5.2.1 Sample preparation for individual treatment chemicals

The test sample shall be prepared for analysis per the appropriate method indicated in Table 5.1, if applicable.

5.5.2.2 Sample preparation for blends of treatment chemicals

Preparation method(s) for blends of treatment chemicals (e.g., a blend of different phosphate species) shall be selected according to the individual treatment chemicals in the blended product.

NOTE — For example, a blend of phosphoric acid and another phosphate species is prepped using Annex N-1, Method D for analysis of the phosphoric acid contaminants, and Annex N-1, Method B for analysis of the phosphate species contaminants. Separate aliquots of the sample are used for analysis of each component of the blend.

5.6 Analysis

Following preparation (see Section 5.5.2), the sample solution shall be analyzed for the contaminants identified on the analytical summary per the methods referenced in Annex N-1, Section N-1.4.

5.7 Normalization

The concentration of contaminants detected in the analysis solution shall be adjusted to reflect the contaminant concentration in the finished drinking water according to the following equation:

$$\underset{\text{[analysis solution]}}{\frac{\text{contaminant (mg)}}{\text{solution (L)}}} \times \underset{\text{[lab prep solution]}}{\frac{\text{analysis solution (L)}}{\text{product (g)}}} \times \frac{1\text{ g}}{1{,}000\text{ mg}} \times \underset{\text{[MUL]}}{\frac{1{,}000\ \mu\text{g}}{1\text{ mg}}} = \underset{\text{[at-the-tap exposure]}}{\frac{\text{contaminant }(\mu\text{g})}{\text{drinking water (L)}}}$$

5.8 Evaluation of contaminant concentrations

5.8.1 General

The normalized concentration of each contaminant shall be no greater than its SPAC determined in accordance with the requirements of NSF/ANSI/CAN 600 (previously Annex A).

5.8.2 Blends

The MUL of each treatment chemical in a blended product shall not exceed its MUL when evaluated as an individual treatment chemical.

The following table is a generic listing of the types of products covered in this section of the standard. This table is not intended to be a complete list of all products used for corrosion and scale control, softening, precipitation, sequestering, and pH adjustment. Inclusion of a product does not indicate either a use endorsement of the product or an automatic acceptance under the provisions of this Standard. Annex I-3, Table I-3.1 includes a cross-reference index of the various chemicals (and the more common synonyms) contained in this table.

Table 5.1
Chemicals for corrosion and scale control, softening, sequestering, precipitation, and pH adjustment – Product identification and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level[1] (mg/L)	Minimum test batteries of chemistry-specific analyses[2]
calcium carbonate[3] (pH adjustment)	limestone	$CaCO_3$ (471-34-1)	100.9	Method C, Annex N-1, Section N-1.3.4	650	metals,[4] radionuclides, base / neutral / acid scan[5]
calcium hydroxide (pH adjustment)	slaked or hydrated lime	$Ca(OH)_2$ (1305-62-0)	74.10	Method C, Annex N-1, Section N-1.3.4	650	metals,[4] radionuclides,[6] fluoride[6]
calcium oxide[7] (pH adjustment)	lime, quicklime	CaO (1305-78-8)	56.0	Method C, Annex N-1, Section N-1.3.4	500	metals,[4] radionuclides,[8] fluoride[8]
carbon dioxide (pH adjustment)	—	CO_2 (124-38-9)	44	Method E, Annex N-1, Section N-1.3.6	600	VOCs
dipotassium orthophosphate (corrosion control)	potassium phosphate, dibasic	K_2HPO_4 (7758-11-4)	174.2	Method B, Annex N-1, Section N-1.3.3	18.4[9]	metals,[4] radionuclides,[8] fluoride[8]
disodium orthophosphate (corrosion control)	sodium phosphate, dibasic	Na_2HPO_4 (7758-79-4)	142.0	Method B, Annex N-1, Section N-1.3.3	14.9[9]	metals,[4] radionuclides,[8] fluoride[8]
ethylenediamine tetraacetic acid (sequestering)	EDTA	$C_{10}H_{16}N_2O_8$ (60-00-4)	292.3	Method A, Annex N-1, Section N-1.3.2	1.0	metals[4]

Table 5.1
Chemicals for corrosion and scale control, softening, sequestering, precipitation, and pH adjustment – Product identification and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level[1] (mg/L)	Minimum test batteries of chemistry-specific analyses[2]
hydrochloric acid[10] (pH adjustment)	muriatic acid	HCl (7647-01-0)	36.5	Method D, Annex N-1, Section N-1.3.5	40	metals,[4] VOCs
magnesium carbonate hydroxide (pH adjustment)	magnesium carbonate pentahydrate	$(MgCO_3)_4\ Mg(OH)_2\ 5H_2O$ (39409-82-0)	232.57	Method C, Annex N-1, Section N-1.3.4	115	metals[4]
magnesium hydroxide (pH adjustment)	magnesium hydrate, magnesia	$Mg(OH)_2$ (1309-42-8)	58.3	Method C, Annex N-1, Section N-1.3.4	150	metals[4]
magnesium oxide (pH adjustment)	magnesium monoxide, maglite	MgO (1309-48-4)	40.32	Method C, Annex N-1, Section N-1.3.4	100	metals[4]
monopotassium orthophosphate (corrosion control)	potassium phosphate, monobasic	KH_2PO_4 (7778-77-0)	136.1	Method B, Annex N-1, Section N-1.3.3	14.3[9]	metals,[4] radionuclides,[8] fluoride[8]
monosodium orthophosphate (corrosion control)	sodium phosphate, monobasic	NaH_2PO_4 (7558-80-7)	120.0	Method B, Annex N-1, Section N-1.3.3	12.6[9]	metals,[4] radionuclides,[8] fluoride[8]
phosphoric acid (corrosion control)	orthophosphoric acid	H_3PO_4 (7664-38-2)	97.9	Method D, Annex N-1, Section N-1.3.5	13.8[9]	metals,[4] radionuclides,[8] fluoride[8]
polyphosphoric acid (corrosion control)	—	— (8017-16-1)	variable	Method D, Annex N-1, Section N-1.3.5	9.0[9]	metals,[4] radionuclides,[8] fluoride[8]

Table 5.1
Chemicals for corrosion and scale control, softening, sequestering, precipitation, and pH adjustment – Product identification and evaluation

Chemical type (primary use)	**Synonyms**	**Formula (CAS number)**	**Molecular weight (g)**	**Preparation method**	**Typical use level[1] (mg/L)**	**Minimum test batteries of chemistry-specific analyses[2]**
potassium hydroxide (pH adjustment)	caustic potash	KOH (1310-58-3)	56.10	Method B, Annex N-1, Section N-1.3.3	100	metals[4]
potassium tetrametaphosphate (corrosion control)	KTMP	$(KPO_3)_4$	472.3	—	—	metals,[4] radionuclides,[8] fluoride[8]
potassium tripolyphosphate (corrosion control)	KTPP	$K_5P_3O_{10}$ (13845-36-8)	448.4	Method A, Annex N-1, Section N-1.3.2	15.7[9]	metals,[4] radionuclides,[8] fluoride[8]
sodium acid pyrophosphate[10] (corrosion control)	SAPP	$Na_2H_2P_2O_7$ (7758-16-9)	222.0	Method A, Annex N-1, Section N-1.3.2	11.7[9]	metals,[4] radionuclides,[8] fluoride[8]
sodium bicarbonate (pH adjustment)	baking soda	$NaHCO_3$ (144-55-8)	84.0	Method B, Annex N-1, Section N-1.3.3	100	metals[4]
sodium bisulfate (pH adjustment)	sodium pyrosulfate, sodium hydrogen sulfate	$NaHSO_4$ (7681-38-1)	120.1	Method B, Annex N-1, Section N-1.3.3	2.4	metals[4]
sodium calcium magnesium polyphosphate, glassy (corrosion control)	—	$(MPO_3)_n \cdot M_2O$ M=Na, .5 Ca, .5 Mg; n = 5 (65997-17-3)	variable	Method A, Annex N-1, Section N-1.3.2	15.0[9]	metals,[4] radionuclides,[8] fluoride[8]
sodium carbonate (pH adjustment)	soda ash	Na_2CO_3 (497-19-8)	105.0	Method B, Annex N-1, Section N-1.3.3	100	metals[4]

Table 5.1
Chemicals for corrosion and scale control, softening, sequestering, precipitation, and pH adjustment – Product identification and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level[1] (mg/L)	Minimum test batteries of chemistry-specific analyses[2]
sodium hydroxide (pH adjustment)	caustic soda	NaOH (1310-73-2)	40.1	Method B, Annex N-1, Section N-1.3.3	100	metals[4]
sodium polyphosphate, glassy[10] (corrosion control)	SHMP, sodium hexametaphosphate	$(NaPO_3)_n \cdot Na_2O$ typically n = 14 (68915-31-1)	variable	Method A, Annex N-1, Section N-1.3.2	10.7 to 11.9[9]	metals,[4] radionuclides,[8] fluoride[8]
sodium sesquicarbonate (pH adjustment)	carbonic acid, sodium salt	$Na_2CO_3 \cdot NaHCO_3 \cdot 2H_20$ (533-96-0)	226.0	Method B, Annex N-1, Section N-1.3.3	100	metals[4]
sodium silicate (corrosion inhibitor)	water glass, silicic acid, sodium salt	$Na_2O(SiO_2)_n$ typically n = 3 (1344-09-8)	242 @ n = 3	Method A, Annex N-1, Section N-1.3.2	100	metals[4]
sodium trimetaphosphate (corrosion control)	metaphosphoric acid, trisodium salt	$Na_3P_3O_9$ (7785-84-4)	306	Method A, Annex N-1, Section N-1.3.2	10.7[9]	metals,[4] radionuclides,[8] fluoride[8]
sodium tripolyphosphate (corrosion control)	STPP, pentasodium tripolyphosphate	$Na_5P_3O_{10}$ (7758-29-4)	368	Method A, Annex N-1, Section N-1.3.2	12.9[9]	metals,[4] radionuclides,[8] fluoride[8]
sodium zinc polyphosphate, glassy (corrosion control)	—	$(MPO_3)_n \cdot M_2O$ M = Na and/or 2n at 1 : 0.5	variable	Method A, Annex N-1, Section N-1.3.2	12.3 to 13.6[9]	metals,[4] radionuclides,[8] fluoride[8]
sulfuric acid[10] (pH adjustment)	oil of vitriol	H_2SO_4 (7664-93-9)	98.0	Method D, Annex N-1, Section N-1.3.5	50	metals,[4] VOCs

Table 5.1
Chemicals for corrosion and scale control, softening, sequestering, precipitation, and pH adjustment – Product identification and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level[1] (mg/L)	Minimum test batteries of chemistry-specific analyses[2]
tetrapotassium pyrophosphate[11] (corrosion control, sequestering)	TKPP diphosphoric acid tetrapotassium salt	$K_4P_2O_7$ (7320-34-5)	330.34	Method A, Annex N-1, Section N-1.3.2	17.4[9]	metals,[4] radionuclides,[8] fluoride[8]
tetrasodium ethylenediaminetetra-acetic acid (sequestering)	EDTA, sodium salt	$Na_4C_{10}H_{12}N_2O_8$	360.2	Method A, Annex N-1, Section N-1.3.2	1.0	metals[4]
tetrasodium pyrophosphate (corrosion control, sequestering)	TSPP, sodium pyrophosphate, sodium diphosphate	$Na_4P_2O_7$ (7722-88-5)	266	Method A, Annex N-1, Section N-1.3.2	14.05[9]	metals,[4] radionuclides,[8] fluoride[8]
tripotassium orthophosphate (corrosion control)	potassium phosphate, tribasic	K_3PO_4 (7778-53-2)	212.27	Method A, Annex N-1, Section N-1.3.2	22.4[9]	metals,[4] radionuclides,[8] fluoride[8]
trisodium orthophosphate (corrosion control)	sodium phosphate, tribasic	Na_3PO_4 (7601-54-9)	163.94	Method A, Annex N-1, Section N-1.3.2	17.3[9]	metals,[4] radionuclides,[8] fluoride[8]
zinc chloride (corrosion control)	zinc dichloride, zinc chloride fume	$ZnCl_2$ (7646-85-7)	135.4	Method B, Annex N-1, Section N-1.3.3	4.0[11]	metals[4]
zinc orthophosphate (corrosion control)	—	$Zn_3(PO_4)_2$ (7779-90-1)	386.04	Method A, Annex N-1, Section N-1.3.2	4.0[11]	metals,[4] radionuclides,[8] fluoride[8]
zinc sulfate (corrosion control)	zinc vitriol, sulfuric acid, zinc salt	$ZnSO_4 \cdot H_2O$ (7733-02-0)	179.6	Method B, Annex N-1, Section N-1.3.3	5.0[11]	metals[4]

Table 5.1
Chemicals for corrosion and scale control, softening, sequestering, precipitation, and pH adjustment – Product identification and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level[1] (mg/L)	Minimum test batteries of chemistry-specific analyses[2]

[1] The typical use level is an application level that has been used historically in water treatment. The typical use level is not the maximum use level (MUL) for the product, except where specifically stated.

[2] Analysis for all chemistry-specific analytes in these minimum test batteries shall be performed each time the product is evaluated. Analysis shall also include formulation-dependent analytes as identified during formulation review. Testing for specific repackages, blends, or dilutions of previously certified products may be waived.

[3] This product differs from other products covered in this section because it dissolves slowly over time. Calcium carbonate is exposed using the following ratio: 156 g product / 250 mL deionized water, in accordance with Annex N-1, Section 3.4 (Method C).

[4] Metals = antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, thallium

[5] BNA scan not run if no waste fuels used in the manufacturing process.

[6] Radionuclides and fluoride not run when CaO is sampled from the same location.

[7] Calcium oxide products may be bracketed by the testing of calcium hydroxide products, produced at the same location and from the same source of calcium oxide.

[8] Radionuclides and fluoride not run if product is a blend or repackage of certified materials.

[9] Equivalent to 10 mg/L of PO_4, on a dry basis. This typical use level is based on potential ecological effects of phosphates at levels exceeding 10 mg/L of PO_4.

[10] The potential impurities for these products may vary considerably depending on source.

[11] The potential impurities for these products may vary considerably depending on source.

6 Disinfection and oxidation chemicals

6.1 Coverage

This section covers products used in drinking water disinfection and oxidation processes. It is not intended to include ambient air.

6.2 Definitions

6.2.1 disinfection: The process of destruction, inactivation, or rendering harmless of certain microorganisms, usually vegetative forms of pathogenic bacteria, viruses and protozoa.

6.2.2 oxidation: The process through which a substance combines with oxygen. The conversion of organic or inorganic materials by loss of electrons.

6.3 General requirements

6.3.1 General information about the products covered in this section is summarized in Table 6.2.

6.3.2 Hypochlorite treatment chemicals

Bromate is a known contaminant of the hypochlorite chemical production process. Based on the limited number of sources of bromate in drinking water (ozonation is another known source), the SPAC for bromate has been determined to be 0.0033 mg/L, 30% of the US EPA maximum contaminant level (MCL) of 0.010 mg/L. All hypochlorite treatment chemicals shall meet the bromate SPAC of 0.0033 mg/L.

6.3.2.1 Bromate is a known impurity of the hypochlorite chemical production process. Because of the potential cancer risk associated with human exposure to bromate, it is recommended that production or introduction of bromate into drinking water be limited. The two major sources of bromate in drinking water are ozonation of water containing bromide and use of hypochlorite treatment chemicals containing bromate (sodium and calcium hypochlorites). All hypochlorite treatment chemicals shall meet the bromate SPAC of 0.0033 mg/L.

Although the MUL may be less than 10 mg/L of Cl_2, it shall not be less than 2 mg/L of Cl_2.

6.3.3 Required labeling for sodium hypochlorite products (production dates and repackage dates)

Because aged solutions of sodium hypochlorite may contain elevated levels of chlorate and perchlorate, certification listings shall reference the recommended handling and storage practices contained in AWWA B300 – Hypochlorites.

For sodium hypochlorite products, the manufacturing date, and if applicable the repackaging date, for the product shall be included on the documentation supplied with any shipment. This alerts the end user of the bleach product age, as aged solutions of sodium hypochlorite may contain elevated levels of chlorate and perchlorate. Reference the AWWA B300 Standard Appendix: *Recommendations for the Handling and Storage of Hypochlorite Solutions* for additional information.

6.4 Sample requirements

Samples of product obtained for evaluation shall have been manufactured from a formulation identical to that of the commercially available product.

6.4.1 Hypochlorite for oxyhalide analysis

As samples of liquid hypochlorite decompose overtime, producing additional chlorate and perchlorate, those collected for oxyhalide analysis shall be quenched upon collection if the analysis is not to be performed immediately. Details on the quenching agent used and the date and time of addition shall be recorded with the sample.

A suitable quenching agent shall be used that will not interfere with the analytical method. Quenching agents that may be used include, but are not limited to, those in Table 6.1.

Table 6.1
Quenching agent guide

Quenching agent[1]	Guidance on rate of use[2]
malonic acid	0.75:1 mol ratio, or approximately 11 g malonic acid for every 10 g free available chlorine expected
hydrogen peroxide	1.1:1 mol ratio, or approximately 5.3 g hydrogen peroxide (i.e., 18 g of a 30% hydrogen peroxide solution) for every 10 g free available chlorine expected

[1] Each quenching chemical bears potential hazards and appropriate safety precautions need to be followed when used.

[2] Source: *Hypochlorite – An Assessment of Factors That Influence the Formation of Perchlorate and Other Contaminants,* AWWA-WRF, 2009.

6.5 Sample preparation

6.5.1 Analytical summary

An analytical summary shall be prepared for each product. The analytical summary shall consist of the minimum test batteries of chemistry specific analytes identified in Table 6.1 and any formulation-dependent analytes identified during the formulation review (see Section 3.2).

6.5.2 Selection of preparation method

The test sample shall be prepared for analysis per the appropriate preparation method indicated in Table 6.2.

6.6 Analysis

Following preparation (see Section 6.5.2), the sample solution shall be analyzed for the contaminants identified on the analytical summary per the methods referenced in Annex N-1, Section N-1.4.

6.7 Normalization

The concentration of contaminants detected in the analysis solution shall be adjusted to reflect the contaminant concentration in the finished drinking water according to the following equation:

$$\underset{\text{[analysis solution]}}{\frac{\text{contaminant (mg)}}{\text{solution (L)}}} \times \underset{\text{[lab prep solution]}}{\frac{\text{analysis solution (L)}}{\text{product (g)}}} \times \frac{1\ \text{g}}{1{,}000\ \text{mg}} \times \underset{\text{[MUL]}}{\frac{\text{product (mg)}}{\text{drinking water (L)}}} \times \frac{1{,}000\ \mu\text{g}}{1\ \text{mg}} = \underset{\text{[at-the-tap exposure]}}{\frac{\text{contaminant }(\mu\text{g})}{\text{drinking water (L)}}}$$

6.8 Evaluation of contaminant concentrations

The normalized concentration of each contaminant shall be no greater than the SPAC determined in accordance with the requirements of NSF/ANSI/CAN 600 (previously Annex A).

The following table is a generic listing of the types of products covered in this section of the standard. This table is not intended to be a complete list of all products used for disinfection and oxidation applications. Inclusion of a product does not indicate either a use endorsement of the product or an automatic acceptance under the provisions of this Standard. Annex I-3 includes a cross-reference index of the various chemicals (and the more common synonyms) contained in this table.

Table 6.2
Disinfection and oxidation products – Product identification, and evaluation

Chemical type (primary use)	**Synonyms**	**Formula (CAS number)**	**Molecular weight (g)**	**Preparation method**	**Typical use level (mg/L)[1]**	**Minimum test batteries of chemistry-specific analyses[2]**
ammonia, anhydrous[3] (disinfection & oxidation)	ammonia gas	NH_3 (7664-41-7)	17.0	Method E, Annex N-1, Section N-1.3.6	5	metals,[4] VOCs
ammonium hydroxide (disinfection & oxidation)	liquid ammonia	NH_4OH (1336-21-6)	35.0	Method B, Annex N-1, Section N-1.3.3	10	metals[4]
ammonium sulfate (disinfection & oxidation)	dry ammonia	$(NH_4)_2SO_4$ (7783-20-2)	132.0	Method A, Annex N-1, Section N-1.3.2	25	metals[4]
bromochlorodimethylhydantoin (disinfection & oxidation)	BCDMH	$C_5H_6BrClN_2O_2$ (16079-88-2 & 126-06-7)	241.5	Method A, Annex N-1, Section N-1.3.2	9[5]	VOCs
calcium hypochlorite[6] (disinfection & oxidation)	—	$Ca(OCl)_2$ (7778-54-3)	143.1	Method A; Annex N-1, Section N-1.3.2	10[13]	metals,[4] VOCs, bromate, chlorate, perchlorate
chlorine[7] (disinfection & oxidation)	chlorine gas	Cl_2 (7782-50-5)	71.0	Method E, Annex N-1, Section N-1.3.6	10[8]	VOCs
chlorine dioxide (disinfection & oxidation)	—	ClO_2 (10049-04-4)	67.45	Method A, Annex N-1, Section N-1.3.2	1.4	metals,[4] VOCs

Table 6.2
Disinfection and oxidation products – Product identification, and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
hydrogen peroxide (disinfection & oxidation)	—	H_2O_2 (7722-84-1)	34.0	Method A, Annex N-1, Section N-1.3.2	23[9]	metals,[4] VOCs
iodine[10] (disinfection & oxidation)	—	I_2 (7553-56-2)	254.0	Method A, Annex N-1, Section N-1.3.2	1	metals[4]
potassium permanganate (oxidation)	permanganate	$KMnO_4$ (7722-64-7)	158.0	Method B, Annex N-1, Section N-1.3.3	15	metals[4]
sodium chlorate[11] (chlorine dioxide production)	—	$NaClO_3$ (7775-09-9)	106.5	Method A, Annex N-1, Section N-1.3.2	8	metals,[4] VOCs, perchlorate
sodium chlorite[11] (chlorine dioxide production)	—	$NaClO_2$ (7758-19-2)	90.5	Method A, Annex N-1, Section N-1.3.2	7	metals,[4] VOCs
sodium hypochlorite[6,12] (disinfection & oxidation)	liquid bleach	NaOCl (7681-52-9)	74.5	Method B, Annex N-1, Section N-1.3.3	10[13]	metals,[4] VOCs, bromate, chlorate, perchlorate

[1] The typical use level is an application level that has been used historically in water treatment. The typical use level is not the maximum use level (MUL) for the product, except where specifically stated.

[2] Analysis for all chemistry-specific analytes in these minimum test batteries shall be performed each time the product is evaluated. Analysis shall also include formulation-dependent analytes as identified during formulation review. Testing for specific repackages, blends, or dilutions of previously certified products may be waived.

[3] Testing on anhydrous ammonia products may be bracketed based on the testing of ammonium hydroxide (aqua ammonia), if the aqua ammonia solution is prepared with the same respective anhydrous ammonia product.

[4] Metals = antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, and thallium.

[5] Based on mg of dry chemical and a bromochlorodimethylhydantoin SPAC of 9 mg/L.

Table 6.2
Disinfection and oxidation products – Product identification, and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]

[6] Hypochlorite products shall include the appropriate statement in product literature, per the requirements of Sections 6.3.2, and 6.3.3

[7] Chlorine products may be bracketed based on testing of sodium hypochlorite bleach, prepared from the same chlorine source, or annual analysis may alternate between the chlorine and sodium hypochlorite product.

[8] Equivalent to 10 mg/L of Cl_2, on a dry basis. Use levels up to 30 mg/L of Cl_2 may be acceptable for short-term applications such as shock chlorination and disinfection of new installations. The residual level of chlorine in the treated water is to be compliant with the applicable state or federal requirement.

[9] The 23 mg/L value in the typical use level column represents the MUL based on a 35% hydrogen peroxide solution and a hydrogen peroxide SPAC of 8 mg/L. The MUL for other concentrations of hydrogen peroxide can be derived in the same manner.

[10] Iodine disinfection is acceptable for short-term or emergency use, but it is not recommended for long-term or routine community water supply application.

[11] Sodium chlorate and sodium chlorite are used for on-site production of chlorine dioxide in drinking water disinfection. These chemicals are reactants and require mixing with a second chemical to produce chlorine dioxide. These chemicals are generally not approved for unaltered addition to drinking water. Use for other applications will require additional analyses for testing.

[12] When all certified ingredients are used, testing for this chemical may be alternated every other year.

[13] Equivalent to 10 mg/L of Cl_2, on a dry basis. The residual level of chlorine in the treated water is to be compliant with the applicable state or federal requirement.

7 Miscellaneous treatment applications

7.1 Coverage

This section covers those chemicals, chemical compounds, blends, and mixtures intended for use in a variety of drinking water applications. These uses include fluoridation, defluoridation, algae control, dechlorination, antioxidants, dyes, biological substrate, and tracers. These products are generally applied directly to the water supply. Residuals of chemicals used for fluoridation, algae control, dyes, and tracers are likely to persist in the finished drinking water. Chemicals used for dechlorination, defluoridation, and antioxidation, and biological substrate are intended to be consumed by reaction, and residuals of these products are not likely to be found in the finished drinking water.

7.2 Definitions

7.2.1 algicide: A product added to the water in order to control or eliminate the growth of algae.

7.2.2 antioxidant: A product added to the water to retard or prevent the oxidation of other constituents in the water.

7.2.3 biological substrate: a product added to the water treatment process to serve as an electron donor for reduction reactions in biological treatment systems.

7.2.4 dechlorination: The process of removing or reducing the amount of chlorine in the drinking water.

7.2.5 defluoridation: The process of removing or reducing the amount of fluoride in the drinking water.

7.2.6 dyes / tracers: Products that are visually or analytically detectable, and are added to the water for the purpose of modeling water flow or for the detection of leaks and cross-connections, etc.

7.2.7 fluoridation: The process of adding fluoride to drinking water at a beneficial concentration as a means of reducing the incidence of dental caries in the population consuming the water.

7.3 General requirements

7.3.1 General information about the products covered in this section is summarized in Table 7.1.

7.3.2 Special labeling requirements

A product, which qualifies under this section for a specific and limited use, shall be clearly labeled to reflect this specific use and limitation.

7.3.3 Minimizing risk for pathogen transmittal in chemicals

To minimize the risk for pathogen transmittal in chemicals evaluated under this section, those that contain water in the finished product shall only be produced using waters meeting the criteria of Section 3.2.3.2.

> NOTE — The chemicals in Section 7 may be added to drinking water post disinfection or in drinking water systems not adding disinfectant to the treated water. As such, this section is intended to minimize the potential for pathogen introduction from treatment chemicals where other measures are not in place to prevent it.

The following water treatment chemicals are exempted from this restriction.

- those with a pH less than or equal to 2 or greater than or equal to a pH of 11; or
- those where the product literature limits the use of the treatment chemical to applications where the water is disinfected post addition of the chemical.

7.4 Sample requirements

Samples of product obtained for evaluation shall have been manufactured from a formulation identical to that of the commercially available product.

7.5 Sample preparation

7.5.1 Analytical summary

An analytical summary shall be prepared for each product. The analytical summary shall consist of the minimum test battery of chemistry specific analytes identified in Table 7.1 and any formulation-dependent analytes identified during the formulation review (see Section 3.2).

7.5.2 Selection of preparation method

The test sample shall be prepared for analysis per the appropriate preparation method indicated in Table 7.1.

7.6 Analysis

Following preparation (see Section 7.5.2), the sample solution shall be analyzed for the contaminants identified on the analytical summary per the methods referenced in Annex N-1, Section N-1.4.

7.7 Normalization

The concentration of contaminants detected in the analysis solution shall be adjusted to reflect the contaminant concentration of the finished drinking water according to the following equation ([analysis solution] × [lab prep solution] × [(MUL) × (MUL) × (MUL)] = [at-the-tap exposure]):

$$\frac{\text{contaminant (mg)}}{\text{solution (L)}} \times \frac{\text{analysis solution (L)}}{\text{product (g)}} \times \frac{\text{1 g}}{\text{1,000 mg}} \times \frac{\text{product (mg)}}{\text{drinking water (L)}} \times \frac{\text{1,000 µg}}{\text{1 mg}} = \frac{\text{contaminant (µg)}}{\text{drinking water (L)}}$$

[analysis solution] [lab prep solution] [MUL] [at-the-tap exposure]

7.8 Evaluation of contaminant concentrations

The normalized concentration of each contaminant shall be no greater than the SPAC determined in accordance with the requirements of NSF/ANSI/CAN 600 (previously Annex A).

7.9 Sodium chloride evaluated for use in electrolytic sodium hypochlorite generators

In addition to meeting the requirements of Sections 7.1 to 7.8, sodium chlorides evaluated for use in electrolytic sodium hypochlorite generators shall meet the requirements of this section.

7.9.1 Bromide concentration

The manufacturer shall submit a specification declaring the maximum bromide concentration for the product. Verification that the bromide concentration is less than or equal to the manufacturer's specification shall be performed on product in accordance with the analytical requirements of Annex N-1, Section N-1.4.2.2.1.

The bromide specification shall not exceed 59 mg/kg in NaCl for electrolytic sodium hypochlorite generators at a 10 mg/L of Cl_2 chlorine maximum feed concentration. A higher concentration of bromide is permitted in NaCl used in generators delivering lower maximum feed concentrations of chlorine so that the total concentration of bromate does not exceed 0.0033 mg/L. Although a maximum feed concentration may be less than 10 mg/L of Cl_2, it shall not be less than 2 mg/L of Cl_2. Sodium chlorides evaluated as "low-bromide" salts shall not have a bromide specification in excess of 59 mg/kg.

NOTE — The 59 mg/kg limit is based on a use assumption that 0.0033 mg/L bromate will be produced from 3.5 lbs of NaCl containing 59 mg/kg bromide with 56.8 liters (15.0 gal) of water to produce via electrolysis 1 lb of free available chlorine (FAC) equivalent disinfectant and dosed to effect a 10 mg/L FAC in the finished drinking water.

7.9.2 Denotion of bromide content specification

In all instances where compliance with this Standard is indicated for a product use in electrolytic sodium hypochlorite generators (e.g., product packaging, product literature, certification listings), an indication of the maximum bromide concentration specification and associated maximum feed concentration of chlorine attested by this Standard shall also be indicated.

The following table is a generic listing of the types of products covered in this section of the standard. This table is not intended to be a complete list of all products used for miscellaneous treatment applications. Inclusion of a product does not indicate either a use endorsement of the product or an automatic acceptance under the provisions of this Standard. Annex I-3, Table I-3.1, includes a cross-reference index of the various chemicals (and the more common synonyms) contained in this table.

Table 7.1
Miscellaneous treatment application products – Product identification, and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
acetic acid (biological substrate)	vinegar	$C_2H_4O_2$ (64-19-7)	60.0	Method A, Annex N-1, Section N-1.3.2	200	acetone, metals[3]
ammonium hexafluorosilicate (fluoridation)	ammonium silico-fluoride, ammonium fluosilicate	$(NH_4)_2SiF_6$ (16919-19-0)	178.14	Method B, Annex N-1, Section N-1.3.3	1.0[4]	metals,[3] radionuclides
calcium fluoride (fluoridation)	fluorspar, fluorite	CaF_2 (7789-75-5)	78.08	Method B, Annex N-1, Section N-1.3.3	1.0[4]	metals,[3] radionuclides
citric acid (copper chelator)	citric acid monohydrate	$C_6H_8O_7 \bullet H_2O$ (77-92-9)	210	Method A, Annex N-1, Section N-1.3.2	3.3[5]	metals[3]
copper ethanolamine complexes (algicide)	—	$Cu(NH_2C_2H_4OH)_4^{++}$	variable	Method A, Annex N-1, Section N-1.3.2	1.0[6]	metals,[3] formulation dependent organics
copper sulfate (algicide)	cupric sulfate	CuSO4 (7758-98-7)	159.61	Method A, Annex N-1, Section N-1.3.2	1.0[6]	metals[3]
copper triethanolamine complexes (algicide)	—	$Cu(N(C_2H_4OH)_3)^{++}$	variable	Method A, Annex N-1, Section N-1.3.2	1.0[6]	metals,[3] formulation dependent organics

Table 7.1
Miscellaneous treatment application products – Product identification, and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]
ferrous chloride (chlorite reduction)	iron (II) chloride, iron dichloride	$FeCl_2$ (7758-94-3)	126.75	Method K, Annex N-1, Section N-1.3.12	—	metals,[3] VOCs
fluorosilicic acid (fluoridation)	fluosilicic acid, hydrofluosilicic acid	H_2SiF_6 (16961-83-4)	144.11	Method B, Annex N-1, Section N-1.3.3	1.0[4]	metals,[3] radionuclides
magnesium fluorosilicate (fluoridation)	magnesium silicofluoride, magnesium hexafluorosilicate	$MgSiF_6$ (16949-65-8)	166.40	Method B, Annex N-1, Section N-1.3.3	1.0[4]	metals[3]
potassium chloride (softening)	potassium salt	KCl (7447-40-7)	74.55	Method A, Annex N-1, Section N-1.3.2	1,000[7]	metals,[3] radionuclides
potassium fluoride (fluoridation)	—	KF (7789-23-3)	58.10	Method B, Annex N-1, Section N-1.3.3	1.0[4]	metals[3]
sodium bisulfite (dechlorinator & antioxidant)	sodium acid sulfite	$NaHSO_3$ (7631-90-5)	104.07	Method A, Annex N-1, Section N-1.3.2	18[8]	metals[3]
sodium chloride (softening or electrolytic chlorination)	sodium salt	NaCl (7647-14-5)	58.44	Method A, Annex N-1, Section N-1.3.2	800[7]	metals,[3] radionuclides, bromide[9]
sodium fluoride (fluoridation)	florocid	NaF (7681-49-4)	42.0	Method B, Annex N-1, Section N-1.3.3	1.0[4]	metals,[3] radionuclides

Table 7.1
Miscellaneous treatment application products – Product identification, and evaluation

Chemical type (primary use)	**Synonyms**	**Formula (CAS number)**	**Molecular weight (g)**	**Preparation method**	**Typical use level (mg/L)**[1]	**Minimum test batteries of chemistry-specific analyses**[2]
sodium metabisulfite (dechlorinator & antioxidant)	sodium pyrosulfite	$Na_2S_2O_5$ (7681-57-4)	190.13	Method A, Annex N-1, Section N-1.3.2	15	metals[3]
sodium fluorosilicate (fluoridation)	sodium silicofluoride, sodium fluosilicate	Na_2SiF_6 (16893-85-9)	132.0	Method B, Annex N-1, Section N-1.3.3	1.0[4]	metals[3]
sodium sulfite (dechlorinator & antioxidant)	—	Na_2SO_3 (7757-83-7)	126.06	Method A, Annex N-1, Section N-1.3.2	22[8]	metals[3]
sulfur dioxide (dechlorinator & antioxidant)	sulfurous oxide	SO_2 (7446-09-5)	64.07	Method F, Annex N-1, Section N-1.3.7	10	metals[3]
tricalcium phosphate (defluoridation)	hydroxyapatite	$Ca_5(PO_4)_3OH$ (12167-4-7)	502	Method B, Annex N-1, Section N-1.3.3	120[10]	metals,[3] radionuclides, fluoride

Table 7.1
Miscellaneous treatment application products – Product identification, and evaluation

Chemical type (primary use)	Synonyms	Formula (CAS number)	Molecular weight (g)	Preparation method	Typical use level (mg/L)[1]	Minimum test batteries of chemistry-specific analyses[2]

[1] The typical use level is an application level that has been used historically in water treatment. The typical use level is not the maximum use level (MUL) for the product, except where specifically stated.

[2] Analysis for all chemistry-specific analytes in these minimum test batteries shall be performed each time the product is evaluated. Analysis shall also include formulation-dependent analytes as identified during formulation review. Testing for specific repackages, blends, or dilutions of previously certified products may be waived.

[3] Metals = antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, selenium, and thallium.

[4] Based on mg fluoride ion per L water. Total concentration of fluoride ion in finished water may include fluoride which occurs naturally in the source water. US Centers for Disease Control and Prevention recommends an optimal concentration of 0.7 mg/L fluoride ion in drinking water.

[5] Based on a weight to weight ratio of 1:1 between copper sulfate pentahydrate and citric acid monohydrate.

[6] Based on mg copper per L water.

[7] Based on treating up to 40 grains of hardness.

[8] Based on chlorine level of 12 mg/L prior to treatment.

[9] Bromide analysis required for NaCl for use in electrolytic chlorination only.

[10] Based on fluoride level of 15 mg/L prior to treatment.

8 Miscellaneous water supply products

8.1 Coverage

This section covers products used in a variety of drinking water supply applications. These products are not routinely used to produce a treatment effect in the water they may contact. The products can be fed continuously, applied intermittently, or flushed from the water supply system prior to its return to use. These products include, but are not limited to, antifoamers, separation process scale inhibitors and cleaners, separation process tracers, water well-drilling aids, water well rehabilitation aids, well pump lubricating oils, backfill materials for cathodic protection or electrical installations, and distribution system cleaning aids.

8.2 Definitions

8.2.1 backfill materials for cathodic protection or electrical installations: Conductive materials that surround cathodic protection electrodes or electrical grounding electrodes in order to enhance their electrical contact to earth.

8.2.2 bore hole sealants: Products used in sealing and grouting wells used as drinking water sources.

8.2.3 distribution system rehabilitation aids: Products used in the rehabilitation and cleaning of the distribution system used to convey potable water.

8.2.4 regenerants: Products used to restore ion exchange resins and water softeners to a state suitable for further service.

8.2.5 separation process cleaners: Products used in reverse osmosis and distillation units to remove built-up scale.

8.2.6 separation process scale inhibitors: A sequestering agent specifically used to prevent the build-up of scale during a separation process such as reverse osmosis or evaporative desalinization. This use of the scale inhibitor is designed to have low carryover into the finished water.

8.2.7 separation process tracers: Chemical products used in reverse osmosis and nanofiltration systems to verify the integrity of the seals, membranes, etc. These products are dosed into the feed water and their absence verified via an analytical method in the permeate water to show that the membrane and seals are intact.

8.2.8 well-drilling aids: Products used in drilling and development of wells used as drinking water sources.

8.2.9 well rehabilitation aids: Products used in the rehabilitation and the cleaning of wells used as drinking water sources.

8.3 General requirements

General information about the products covered in this section is summarized in Table 8.1.

8.3.1 Natural polymers

Selected natural polymers and physically modified natural polymers are not approved for use in water well construction or remediation under this Standard (examples of natural polymers are guar gum, welan gum, potato starch, and corn starch, whether modified by pregelatinization, clarification or other physical processes that do not affect the CAS number of the resolution polymer). Highly derivatized (i.e., by degrees of substitution greater than 0.4) carboxymethyl starches and celluloses are approved for these uses under the Standard.

8.3.2 Published instructions

For products designed to be flushed out prior to using the system for drinking water, the manufacturer's product data sheet shall contain instructions for proper flushing and draining before placing a system back into service. A product that qualifies under this section for a specific and limited use shall be clearly identified in the manufacturer's product data sheet. Polyacrylamide-containing well-drilling additives shall be identified in the manufacturer's product data sheet to indicate that these products are not acceptable for use in constructing wells in highly porous formations such as cavernous limestone.

8.4 Sample requirements

When required for evaluation, a sample of the product equivalent to that used in field applications shall be obtained.

8.5 Sample preparation

8.5.1 Analytical summary

An analytical summary shall be prepared for each product to be tested. The analytical summary shall consist of the product-specific analytes identified in Table 8.1 and any formulation-dependent analytes identified during the formulation review (see Section 3.2).

8.5.2 Selection of preparation method

When applicable, the test sample shall be prepared for analysis per the appropriate preparation method indicated in Table 8.1. For sealants / grouts that can be exposed as a solid mass, the manufacturer shall provide instructions for sample preparation.

8.6 Analysis

Following preparation (see Section 8.5.2), the sample solution shall be analyzed for the contaminants identified on the analytical summary per the methods referenced in Annex N-1, Section N-1.4.

8.7 Normalization of contaminant concentrations

8.7.1 General

The concentration of the product's active ingredient(s) and any contaminants detected in the analysis solution shall be adjusted to reflect the concentration in the finished drinking water when the product is used in accordance with the manufacturer's use instructions. When appropriate, the applicant shall provide data, which define the decay curve for removal of the product from the water supply system when the manufacturer's recommended flushing procedures are utilized.

The following equation shall be used to calculate contaminant concentrations for products other than those specified in Sections 8.7.2, 8.7.3, 8.7.4, and 8.7.5:

$$\begin{matrix}\text{laboratory}\\ \text{contaminant}\\ \text{concentration}\end{matrix} \times \frac{\text{analysis solution (L)}}{\text{product (g)}} \times \frac{1\ \text{g}}{1{,}000\ \text{mg}} \times \begin{matrix}\text{product dosage}\\ \text{(mg/L)}\end{matrix} = \begin{matrix}\text{normalized}\\ \text{contaminant}\\ \text{concentration}\end{matrix}$$

8.7.2 Well-drilling additives

8.7.2.1 Turbid well-drilling additives

Ingredient and contaminant concentrations for turbid well-drilling additives shall be multiplied by the dilution factor required to reduce the analysis solution to a turbidity of 1 NTU.

8.7.2.2 Nonturbid well-drilling additives

Residual levels of ingredients or contaminants present in nonturbid well-drilling additives shall be calculated on the basis of the following assumptions:

— the aquifer contains 3.1×10^6 L (815,500 gal) of water, based on a 0.5 acre aquifer of 6.1 m depth (20 ft) and 25% porosity;

— the amount of well-drilling fluid used is 3780 L (1,000 gal), to which the drilling fluid additive has been added at the manufacturer's maximum recommended level;

— the bore hole is 61 m (200 ft) in total depth, the screen is 6.1 m (20 ft) in length, and the bore hole is 25.4 cm (10 in) in diameter; and

— the amount of well-drilling fluid removed from the well during construction is equal to the combined volumes of the casing, the screen, and the bore hole annulus around the casing and the screen, plus an additional amount removed through well disinfection and development (90% removed).

NOTE — Example calculation of a residual level is provided in Table 8.2.

8.7.3 Well-drilling foamers

8.7.3.1 Assumptions

Residual levels of ingredients or contaminants from well-drilling foamers shall be calculated based on the following assumptions:

— the aquifer contains 3.1×10^6 L (815,500 gal) of water, based on a 0.5 acre aquifer of 6.1 m (20 ft) depth and 25% porosity;

— the bore hole is 61 m (200 ft) in total depth and 25.4 cm (10 in) in diameter;

— after the bore hole has been blown free of foam, a foam layer of 6.40 mm (0.25 in) remains on the bore hole wall;

— all foamer ingredients and contaminants in the foam layer enter the aquifer; and

— the foamer addition rate percentage is calculated as the manufacturer's maximum recommended use rate of the foamer per unit volume of water (e.g., 0.946 L [0.25 gal] foamer per 158.987 L [42 gal] water equals 0.6%).

NOTE — The volume of the foam layer on the bore hole wall is determined by subtracting the volume of a cylinder with a diameter equal to the inside diameter of the foam layer (2787 L [736 gal]) from the volume of a cylinder with a diameter equal to the bore hole diameter (3088 L [816 gal]). For the well specified, the foam layer volume is 301 L (66 gal).

8.7.3.2 Foam factor

The following test shall be used to determine the foam factor for the well-drilling foamer:

a) Prepare 100 mL of foamer solution at the manufacturer's recommended foamer usage rate using tap water.

b) Carefully decant the foamer solution in a graduated Waring[14] blender jar or equivalent. Cover and blend at high speed for 60 s.

c) Turn blender off and immediately measure and record the foam volume in mL.

d) Calculate the foam factor by dividing the foam volume by 100 mL.

8.7.3.3 Normalization equation

The following equation shall be used to calculate the normalized ingredient and contaminant exposure(s) from well-drilling foamers:

$$\begin{array}{c}\text{laboratory concentration of}\\ \text{ingredient or contaminant}\end{array} \times \frac{\begin{array}{c}\text{foam volume}\\ \text{(301 L)}\end{array}}{\text{foam factor}} \times \frac{\begin{array}{c}\text{\% foamer}\\ \text{addition rate}\end{array}}{3.1 \times 10^{6}\ \text{L}} = \begin{array}{c}\text{normalized}\\ \text{concentration}\end{array}$$

8.7.4 Bore hole sealants

8.7.4.1 Assumptions

Residual levels of ingredients and contaminants from bore hole sealants shall be based on the following assumptions:

— the aquifer contains 3.1×10^6 L (815,500 gal) of water, based on a 0.5 acre aquifer of 6.1 m (20 ft) depth and 25% porosity;

— the bore hole is 61 m (200 ft) in total depth, the screen is 6.1 m (20 ft) in length, and the bore hole diameter is 25.4 cm (10 in);

— a 10.2 cm (4 in) diameter casing is used;

— the surface area of the sealant / grout exposed to the aquifer is 11 m^2 (118 ft^2), based on 25% of the sealant / grout column being in direct contact with water from the aquifer; and

— the volume of sealant / grout exposed to the aquifer is 583 L (154 US gal), based on 25% of the sealant / grout column being in direct contact with water from the aquifer.

NOTE — The surface area and volume exposure assumptions are based on a worst-case that 25% of the sealant / grout column is in direct contact with the aquifer. The surface area of 11 m^2 (118 ft^2) is 25% of the surface area of a cylinder 25.4 cm (10 in) in diameter and 54.9 m (180 ft) in length. The volume of 583 L (154 gal) is 25% of the volume of the annular space formed by a bore hole 25.4 cm (10 in) in diameter and 54.9 m (180 ft) in length that contains a well casing of 10.2 cm (4 in) diameter.

8.7.4.2 Normalization options for sealants / grouts

The following options shall be selected based on the sample preparation and exposure method used.

8.7.4.2.1 For sealants or grouts, which have been exposed as a solid mass, the following equation shall be used to calculate the normalized ingredient and contaminant concentrations:

$$\begin{array}{c}\text{laboratory concentration of}\\ \text{ingredient or contaminant}\end{array} \times \frac{SA_F}{SA_L} \times \frac{\text{V}_\text{L}}{3.1 \times 10^{6}\ \text{L}} = \begin{array}{c}\text{normalized concentration of}\\ \text{ingredient of contaminant}\end{array}$$

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[14] Waring Products, Division of Conair Corp. 1 Crystal Dr, McConnellsburg, PA 17233. <www.waringproducts.com>

Where:

SA_F = surface area of sealant / grout exposed in the field (assumed to be 11 m^2 [118 ft^2])
SA_L = surface area of sealant / grout exposed in the laboratory
V_L = volume of extraction water used in the laboratory

8.7.4.2.2 Ingredient and contaminant concentrations for solid swelling well sealants which have been prepared using Method G (see Annex N-1, Section N-1.3.8) shall be multiplied by the dilution factor required to reduce the analysis solution to a turbidity of 1 NTU.

8.7.4.2.3 For sealants / grouts that cannot be exposed in the laboratory as a solid mass, or for ingredients or contaminants for which an adequately sensitive analytical method is not available, the following alternate calculation procedure shall be used:

a) Calculate the mass (in mg) of the ingredient or contaminant in 583 L (154 gal) of sealant / grout based on the manufacturer's preparation instructions.

b) Divide this mass by the aquifer volume (3.1×10^6 L) to calculate the normalized exposure to the ingredient or contaminant.

8.7.5 Separation process chemicals

8.7.5.1 Reverse osmosis chemicals

For chemicals of greater than 500 molecular weight, normalized concentrations of ingredients and contaminants shall be calculated based on a carryover of 0.5 weight percent of the concentration in the feedwater when the product is dosed at the manufacturer's recommended use level:

$$\text{feedwater concentration of the active ingredient or contaminant} \times 0.5\% = \text{normalized concentration of the active ingredient or contaminant}$$

For chemicals of less than 500 molecular weight, the manufacturer shall provide data to justify the use of the 0.5 weight percent feedwater concentration normalization factor or to establish an alternate normalization factor. In the absence of data to justify otherwise, a 100% carryover shall be assumed for ingredients and contaminants of less than 500 molecular weight.

8.7.5.2 Other membrane separation process chemicals

For other chemicals used in other membrane separation processes (e.g., microfiltration, nanofiltration, ultrafiltration, and electrodialysis / electrodialysis reversal), the manufacturer shall provide data regarding the anticipated carryover of product ingredients and contaminants. These data shall be specific for use of the chemical in the separation process(es) for which evaluation has been requested. These data shall be used to calculate an appropriate carryover factor to estimate the normalized concentration(s) of the product ingredients and contaminants. In the absence of data to justify otherwise, a 100% carryover shall be assumed for ingredients and contaminants from these membrane separation process chemicals.

8.7.5.3 Evaporation process chemicals

Normalized concentrations of nonvolatile, high boiling point ingredients and contaminants shall be calculated based on a carryover of 0.1 weight percent of the concentration in the feedwater when the product is dosed at the manufacturer's recommended use level.

$$\text{feedwater concentration of the active ingredient or contaminant} \times 0.1\% = \text{normalized concentration of the active ingredient or contaminant}$$

In the absence of data to justify otherwise, a 100% carryover shall be assumed for ingredients and contaminants which are volatile or which have boiling points close to that of water.

8.7.6 Backfill materials for cathodic protection or electrical installations

The following equation shall be used to calculate the normalized contaminant exposure(s) from backfill materials for cathodic protection or electrical installations:

$$\begin{array}{c}\text{laboratory concentration of}\\\text{ingredient or contaminants}\end{array} \times \frac{M_F}{M_L} \times \frac{V_L}{V_F} = \begin{array}{c}\text{normalized concentration of}\\\text{ingredient or contaminant}\end{array}$$

Where:

M_F = mass (g) of the backfill material required for an installation of the maximum recommended diameter and for an aquifer of 6.1 m (20 ft) depth

M_L = mass (g) of the backfill material exposed during the laboratory test

V_L = volume of water used for laboratory exposure

V_F = volume of water in the aquifer assumed to be in contact with contaminants from the backfill material 1.1×10^6 L (293,760 gal)

NOTE — The assumed volume of water is based on a 0.5 acre aquifer of 25% porosity and 6.1 m (20 ft) depth. The well and the backfill installation are located a minimum of 30.5 m (100 ft) apart within the defined aquifer. The extractants from the backfill material are assumed to be within the volume of water defined by a circle of 30.5 m (100 ft) diameter of the same depth and porosity as the aquifer.

8.8 Evaluation of contaminant concentrations

The normalized concentration of each ingredient or contaminant shall be no greater than the SPAC determined in accordance with the requirements of NSF/ANSI/CAN 600 (previously Annex A). For residential well application products, calculation of the SPAC for a specific contaminant under Section 8 shall consider such factors as the more limited number of materials in contact with the drinking water distribution system in a well installation.

The short term exposure limit (STEL) shall be used to evaluate the normalized concentration of ingredients and contaminants for well development / rehabilitation materials.

NOTE — These applications typically occur at a frequency less than every 12 months, warranting the use of a Short Term Evaluation Level. Additionally, these products are used within the bore hole and flushed from the well screen pack

The following table is a generic listing of some of the types of products covered in this section of the standard. The chemicals described in this table can be fed continuously, applied intermittently, or flushed from the water supply system prior to its return to use. Products incorporated in this table include regenerants and well-drilling aids. This table is not intended to be a complete list of all products used for miscellaneous water supply applications. Inclusion of a product does not indicate either a use endorsement of the product or an automatic acceptance under the provisions of this Standard. Annex I-3, Table I-3.1 includes a cross-reference index of the various chemicals (and the more common synonyms) contained in this table.

Table 8.1
Miscellaneous water supply products – Product identification and evaluation (limited contact)

Product	Product –Specific analyses	Preparation method
antifoamers	formulation dependent	Method I, Annex N-1, Section N-1.3.10
distribution system rehabilitation materials	formulation dependent	—
backfill materials for cathodic protection or electrical installations	formulation dependent	Method G, Annex N-1, Section N-1.3.8
scale inhibitors	formulation dependent	Method H, Annex N-1, Section N-1.3.9
Well development / rehabilitation materials		
acids	formulation dependent	Method D, Annex N-1, Section N-1.3.5
bases (caustics)	formulation dependent	Method B, Annex N-1, Section N-1.3.3
disinfectants	formulation dependent	see Section 6
flocculants	formulation dependent	see Section 4
frac sand	formulation dependent	Method G, Annex N-1, Section N-1.3.8
organic acid (citric acid)	regulated metals	Method A, Annex N-1, Section N-1.3.2
scale removers	formulation dependent	Method H, Annex N-1, Section N-1.3.9
Separation process cleaners		
organic acid (citric acid)	regulated metals	Method A, Annex N-1, Section N-1.3.2
Drilling additives		
bentonite-based drilling additives	regulated metals, radionuclides, pesticides / herbicides, and other formulation dependent impurities	Method F, Annex N-1, Section N-1.3.7
biocides	formulation dependent	—
clay thinners	formulation dependent	—
defoamers	formulation dependent	—
filtration control	formulation dependent	—
foamers	formulation dependent	Method I; Annex N-1, Section N-1.3.10
loss circulation materials	formulation dependent	—
lubricants (e.g., grease)	formulation dependent	—
oxygen scavengers	formulation dependent	—
polymer-based drilling additives	formulation dependent	Method J, Annex N-1, Section N-1.3.11
regenerants	formulation dependent	—
viscosifiers	formulation dependent	—
weighting agents	formulation dependent	—

Table 8.1
Miscellaneous water supply products – Product identification and evaluation (limited contact)

Product	**Product –Specific analyses**	**Preparation method**
well pump lubricating oils	formulation dependent	Method I, Annex N-1, Section N-1.3.10
Bore hole sealants		
bentonite-based grouts	regulated metals, radionuclides, herbicides / pesticides, and other formulation dependent impurities	Method F, Annex N-1, Section N-1.3.7 or per manufacturer’s instructions
cements	regulated metals, radionuclides, and other formulation dependent impurities	per manufacturer’s instructions

Table 8.2
Example calculation of a residual contaminant level from a well-drilling additive

residual contaminant	monomer from an organic polymer (0.05% monomer in polymer)
assumed well casing diameter	4 in
weight of monomer in 14.2 L (3.75 gal) of polymer – manufacturer’s recommended use level	14.2 L of polymer × 0.0005 = 7.1 × 10^{-3} L of monomer = 7.1 mL of monomer 7.1 mL of monomer = 8.0 g monomer (density of monomer is 1.122 g/mL)
percent removal of the drilling fluid	90%
weight of monomer remaining in aquifer after installation	8.0 g × 10% = 0.8 g monomer remaining in the aquifer (90% removed during construction)
concentration of monomer remaining in aquifer	$\frac{0.8 \text{ g monomer}}{3.1 \times 10^{6} \text{ L water}} = \frac{0.25 \text{ µg monomer}}{\text{L water}}$ 0.25 ppb is concentration of monomer remaining in the aquifer

Normative Annex 1

(previously Annex B)

Sampling, preparation, and analysis of samples

N-1.1 General

Samples of products to be analyzed for impurities shall be prepared and analyzed as detailed in this section:

— coagulation and flocculation chemicals (also see Section 4, Table 4.1);

— corrosion and scale control, softening, precipitation, sequestering, and pH adjustment chemicals (also see Section 5, Table 5.1);

— disinfection and oxidation chemicals (also see Section 6, Table 6.1);

— miscellaneous treatment applications (also see Section 7, Table 7.1); and

— miscellaneous water supply products (also see Section 8, Table 8.1).

The analysis methods listed for a product are based on detecting impurities that may be present when established methods of production are used and the materials are derived from known sources. If the products are produced using alternate methods or originate from alternate sources, the analytical procedures may require modification. Alternate analytical procedures shall be described in detail, by the manufacturer, with appropriate literature references.

N-1.2 Sampling

A representative sample of the product / material shall be obtained in accordance with requirements outlined below at a point prior to shipment. No sample shall be taken from a broken or leaky container.

N-1.2.1 Liquid samples

N-1.2.1.1 Sampling from bulk

A specified quantity of sample shall be obtained from a bulk storage tank, or bulk shipping vessel, through normal connections. Where available on site, sampling from bulk shipping vessels is preferred, as it is representative of the final container of product being shipped to the customer. For hypochlorite, samples shall be taken from the oldest production lot that is on-site at the time.

N-1.2.1.2 Sampling from packages

Sufficient sample shall be collected from packaged inventory to fulfill the sample quantity requirements specified in the relevant subsection of Section N-1.3. For hypochlorite, samples shall be taken from the oldest production lot that is on-site at the time.

N-1.2.1.3 Sampling from production

Sufficient sample shall be collected from production to fulfill the requirements of the quantity needed for the product sample according to the relevant subsection of Section N-1.3.

N-1.2.1.4 Sampling from retains

Up to ten samples shall be collected, covering the length of the specified retain period or 6 mo, whichever is greater, but not to exceed 12 mo in the age of material sampled. A portion shall be collected from each retain, and the samples shall be mixed thoroughly to form a composite.

N-1.2.1.5 Sample for analysis

The sample obtained according to Sections N-1.2.1.1, N-1.2.1.2, N-1.2.1.3, or N-1.2.1.4, shall be mixed thoroughly. This sample shall be poured into two approximately 250 mL, airtight, moisture-proof glass containers, and sealed. If a glass container is not appropriate, the manufacturer shall recommend a type of sample container. Each sample container shall be clearly labeled with the product name, manufacturer’s name, sampling date, production location, and lot number, and shall be signed by the person responsible for sampling.

One sample shall be used for analysis as described in Sections N-1.3 and N-1.4. The remaining sample shall be retained for reevaluation purposes (if necessary) for at least one year or until results are received by the certification agency.

N-1.2.2 Solid samples

N-1.2.2.1 Sampling from bulk

Specified amount of sample shall be obtained from storage tank or bulk shipping vessel through normal connections. Where available on site, sampling from bulk shipping vessels is preferred, as it is representative of the final container of product being shipped to the customer.

N-1.2.2.2 Sampling from packages

Sufficient sample shall be collected from packaged inventory to fulfill the sample quantity requirements specified in the relevant subsection of Section N-1.3.

N-1.2.2.3 Sampling from production

Sufficient sample shall be collected from production to fulfill the sample quantity requirements specified in the relevant subsection of Section N-1.3.

N-1.2.2.4 Sampling from retains

Up to ten samples shall be collected, covering the length of the specified retain period or six months, whichever is greater, but not to exceed 12 mo in the age of material sampled. A portion shall be collected from each retain, and the samples shall be mixed thoroughly to form a composite.

N-1.2.2.5 Sample for analysis

The sample obtained per Sections N-1.2.2.1, N-1.2.2.2, N-1.2.2.3, or N-1.2.2.4, shall be mixed thoroughly. This sample shall be poured into two approximately 200 g, airtight, moisture-proof glass containers, and sealed. If a glass container is not appropriate, the manufacturer shall recommend a type of sample container. Each sample container shall be clearly labeled with the product name, manufacturer’s name, sampling date, production location, and lot number, and shall be signed by the person responsible for sampling.

N-1.2.3 Gas samples

A representative sample shall be obtained using an appropriate gas-sampling cylinder. The sample shall be acquired in accordance with the manufacturer's specifications and precautions.

N-1.2.4 Blends and mixtures

Samples collected for analysis shall be verified as being identical to the product initially submitted.

N-1.3 Preparation of samples

The methods included in this section have been written for trained chemical laboratory personnel. Appropriate quality assurance procedures and safety precautions shall be followed.

N-1.3.1 General

Acid-washed glassware and equipment, organic-free deionized water for dilutions, trace metals grade acids, and reagent blanks, shall be used in all preparation methods referenced in this section.

N-1.3.1.1 Reagent blank

A reagent blank shall be prepared using the same reagents and in the same manner as a product sample, but no product sample shall be added.

N-1.3.1.2 Reagent water

All test samples shall be prepared using a reagent water produced through one or more of the following treatment processes: distillation, reverse osmosis, ion exchange, or other equivalent treatment processes. The reagent water shall have the following general water characteristics:

- — electrical resistivity, minimum 18 MΩ-cm at 25 °C (77 °F); and
- — total organic carbon (TOC) maximum 100 µg/L.

For each specific analyte of interest, the reagent water shall not contain the target analyte at a concentration greater than one-half the designated analytical report limit of that analyte.

N-1.3.2 Method A

This method shall be used for ammonium sulfate, calcium hypochlorite, copper ethanolamine, copper sulfate, copper triethanolamine, ethylenediaminetetraacetic acid, iodine, potassium tripolyphosphate, sodium acid pyrophosphate, sodium bisulfite, sodium calcium magnesium polyphosphate, sodium chlorate, sodium chlorite, sodium metabisulfite, sodium polyphosphate, sodium silicate, sodium sulfite, sodium trimetaphosphate, sodium tripolyphosphate, sodium zinc polyphosphate, sodium zinc potassium polyphosphate, tetrapotassium pyrophosphate, tetrasodium ethylenediaminetetraacetic acid, tetrasodium pyrophosphate, tripotassium orthophosphate, trisodium orthophosphate, and zinc orthophosphate.

> NOTE — For bromate, chlorate, and perchlorate analysis of calcium hypochlorite, no preparation of the quenched sample is required. Bromate analysis can be performed on the sample as received.

The following procedure shall be followed for sample preparation to this method:

a) Dilute the sample to a strength equivalent to 10× the maximum use dose of the chemical using organic-free deionized water[15,16] and the following formula:

$$\underset{\text{[maximum use dose]}}{\text{mg/L}} \times \underset{\text{[multiple factor]}}{10} \times \text{required volume of sample solution (L)} = \underset{\text{[amount sample to be weighed]}}{\text{mg}}$$

b) Preserve the sample according to the requirements of Table N-1.1[17].

N-1.3.3 Method B

This method shall be used for ammonium hexafluorosilicate, ammonium hydroxide, blended phosphates, calcium fluoride, dipotassium orthophosphate, disodium orthophosphate, fluosilicic acid, magnesium silicofluoride, monopotassium orthophosphate, monosodium orthophosphate, potassium fluoride, potassium hydroxide, potassium permanganate, sodium bicarbonate, sodium bisulfate, sodium carbonate, sodium fluoride, sodium hydroxide, sodium hypochlorite, sodium sesquicarbonate, sodium silicofluoride, tricalcium phosphate, zinc chloride, and zinc sulfate.

> NOTE — For bromate, chlorate and perchlorate analysis of sodium hypochlorite, no preparation of the quenched sample is required. Bromate, chlorate and perchlorate analysis can be performed on the sample as received.

The following procedure shall be followed for sample preparation to this method:

a) Dilute the sample to a strength equivalent to 10× the maximum use dose of the chemical using organic-free deionized water[14,15,18] and the following formula:

$$\underset{\text{[maximum use dose]}}{\text{mg/L}} \times \underset{\text{[multiple factor]}}{10} \times \text{required volume of sample solution (L)} = \underset{\text{[amount sample to be weighed]}}{\text{mg}}$$

b) Acidify with concentrated hydrochloric acid (HCl) to pH < 2.[16]

c) Quantitatively transfer to a volumetric flask of a size corresponding with the required volume of sample solution determined above and dilute to volume with organic-free deionized water.

d) Preserve the sample according to the requirements of Table N-1.1.

N-1.3.4 Method C

This method shall be used for calcium carbonate, calcium hydroxide, calcium oxide, magnesium carbonate hydroxide, and magnesium oxide.

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[15] All sample weights are on a dry product mass basis.

[16] Use polyethylene or PTFE beakers for fluoride chemicals.

[17] If the sample does not dissolve completely into solution, heat gently until all sample is in solution (do not boil).

[18] Tricalcium phosphate and other compounds will not dissolve until the addition of hydrochloric acid.

The following procedure shall be followed for sample preparation to this method:

a) Sample pulverization shall be performed as follows:

   1) Crush approximately 125 g of sample to pass a No. 100 US Standard Sieve, using a nonmetallic crusher such as an acid-washed glass mortar and pestle.

   2) Mix thoroughly and store in an airtight, moisture-proof container.

b) Pipette 20 mL of organic-free deionized water into 500 mL beaker.

c) Place the beaker on 60 °C (140 °F) hot plate and add stir bar.

d) Slowly add 10× the maximum use dose of the test sample using the following formula:

$$\underset{\text{[maximum use dose]}}{\text{mg/L}} \times \underset{\text{[multiple factor]}}{10} \times \begin{matrix}\text{required volume of}\\ \text{sample solution (L)}\end{matrix} = \underset{\text{[amount sample to be weighed]}}{\text{mg}}$$

e) Mix thoroughly to include all of pulverized sample, making a paste. If the sample spatters, remove from hot plate.

f) When paste has a smooth, homogeneous consistency, remove from hot plate.

g) While stirring, slowly add 325 mL of 82 °C (180 °F) organic-free deionized water.

h) Cool to room temperature.

i) Filter through GF/C filter under vacuum into 500 mL beaker.

j) Add 10 mL of 1 M sodium carbonate solution and stir for 5 min. Quantitatively transfer this solution into a second filter apparatus and filter again through a GF/C filter.

k) Using a 3 mL plastic, disposable, pipette, adjust the pH with 1:4 nitric acid (HNO_3) until it remains between 1.8 and 2.0 for 5 min.

l) Quantitatively transfer to 1,000 mL (1 L) volumetric flask and dilute to volume with dilute nitric acid (1:20, HNO_3:water) solution.

N-1.3.5 Method D

This method shall be used for hydrochloric acid, phosphoric acid, polyphosphoric acid, and sulfuric acid.

The following procedure shall be followed for sample preparation to this method:

a) Into a 500 mL volumetric flask, add approximately 250 mL of organic-free water.
b) Slowly, and with agitation, add 5 mL of sample (for liquids) or 5 g of sample (for solids).
c) Dilute to volume with organic-free deionized water.
d) Preserve the sample according to the requirements Table N-1.1.

N-1.3.6 Method E

This method shall be used for ammonia, carbon dioxide, chlorine, oxygen, and sulfur dioxide.

The following procedure shall be followed for sample preparation to this method:

a) Calculate the amount of sample needed to prepare a dissolved gas sample that has a concentration equivalent to 10× the MUL, or the maximum amount which can be dissolved in water (whichever is smaller), and the following formula:

mg/L	×	10	×	required volume of sample solution (L)	=	mg
[maximum use dose]		[multiple factor]				[amount sample to be weighed]

b) Fill a 1,000 mL (1 L) gas sampling flask with approximately 1,000 mL (1 L) of 4 °C (39 °F) organic-free water.

c) Weigh the flask, air stone cap assembly, and contents to the nearest 0.01 g. Record weight and tare. If preparing oxygen gas, record the weight of the gas cylinder and contents instead of the flask assembly.

d) Bubble the product through the air stone cap assembly until the desired weight is obtained. (Caution: perform procedure in a well-ventilated hood.) For oxygen, bubble the gas through the air stone cap assembly for 10 min.

e) Record the final weight of the flask, assembly and contents to the nearest 0.01g; the increase in weight is equal to the product weight. For oxygen, weigh the final weight of the cylinder; the decrease in weight is equal to the oxygen product weight.

f) Preserve and store sample in accordance with the analysis test method requirements.[19]

N-1.3.7 Method F

This method is applicable to well-drilling muds and solid swelling well sealants.

a) Moisten 25 g of sample using 100 mL reagent water in an appropriately sized beaker.
b) Cover with a watch glass and allow to stand 24 h.
c) After 24 h, make a solution of 1 g moistened sample per 1 L reagent water.
d) Place on a stirring plate until sample is fully dispersed.
e) Collect a sample for turbidity analysis prior to addition of Superfloc.[20]
f) Add 1.5 mL of 1% SuperFloc for each liter of sample solution prepared.
g) Remove from stirring plate and let stand for a minimum of 1 h.
h) Filter sample under vacuum.
i) Preserve the filtrate according to the requirements of Table N-1.1.

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[19] The method detailed is applicable to analysis of water samples. In some cases, the gas can be analyzed directly as follows:

— chlorine for carbon tetrachloride – ASTM E806
— carbon dioxide – CGA G-6.2-1985

[20] Kemira Oyj, Energiakatu 4, PO Box 330, 00101 Helsinki, Finland. <www.kemira.com>

N-1.3.8 Method G

This method is applicable to the following products: frac sands and backfill materials for cathodic protection or electrical installations.

N-1.3.8.1 Conditioning

The analysis sample obtained shall be initially prepared according to the manufacturer's written specifications. The product sample shall be allowed to air dry prior to exposure, if needed.

N-1.3.8.2 Preparation

Samples shall be prepared according to the following procedure:

a) Following conditioning as described in Section N-1.3.8.1, combine the manufacturer’s recommended amount or 1250 ± 50 g of sample with 2 L reagent water in a 4 L Erlenmeyer flask.

b) Seal with PTFE film and agitate for 1 min.

c) Expose sample for 24 h.

d) Decant, discard, and replace extractant water.

e) Expose extractant water 24 h.

f) Immediately filter and collect analysis samples.

g) Preserve according to the requirements of Table N-1.1.

N-1.3.9 Method H

This method shall be used for reverse osmosis and distillation process chemicals.

Dry products shall be prepared according to the manufacturer's instructions. No preparation shall be required for liquid products, which shall be analyzed as received.

N-1.3.10 Method I

This method shall be used for well-drilling foams.

Chemical analyses for contaminants shall be conducted on the liquid product, as received.

N-1.3.11 Method J

This method shall be used for polymers used as well-drilling aids and in reverse osmosis or distillation processes.

Polymers shall be analyzed according to the methods described in Sections N-1.4.3.1 through N-1.4.3.3, as applicable.

N-1.3.12 Method K

This method shall be used for metal salt coagulants such as alum, ferric chloride, ferrous chloride, ferric sulfate, ferrous sulfate, and polyaluminum chloride.

N-1.3.12.1 Preparation

For the preparation of coagulant solutions, the amount of product on a dry weight basis shall be determined. To calculate the weight of the material (dry basis) in a coagulant solution, the following procedure shall be followed:

a) Weigh a clean, dry 100 mL volumetric flask to the nearest 0.01g (*Wt A*).

b) Pipette a known volume (20 to 50 mL) of well-mixed coagulant solution into the flask (take care not to touch the ground glass).

c) Weigh the flask and contents to the nearest 0.01g (*Wt C*).

d) Dilute the solution to volume with DI water (take care not to wet the ground glass). Do not mix.

e) Weigh the flask and contents to the nearest 0.01g (*Wt D*).

f) After weighing, mix the contents thoroughly and transfer into a 125 mL bottle.

g) Thoroughly rinse the flask with DI water, allow the neck of the flask to dry, then fill the flask to volume with DI water (take care not to wet the ground glass).

h) Weigh the flask and water to the nearest 0.01g (*Wt B*).

i) The weight of the material (dry basis) shall be calculated as follows:

— *Wt B* - *Wt A* = weight of water = *W*;
— *Wt C* - *Wt A* = weight of sample solution = *X*;
— *Wt D* - *Wt C* = weight of water added = *Y*;
— *Wt D* - *Wt B* = weight of material (dry basis) in sample solution = *M*;
— *W* - *Y* = weight of water equivalent to sample solution = *Z* ;
— *X/Z* = SPG of sample solution; and
— *X* - *Z* = weight of material (dry basis) in sample solution = *M*.

> NOTE — If the material is alum, to account for waters of hydration:
>
> — M = Wt of $Al_2(SO_4)_3$; and
> — $M \times 1.7372$ = Wt of $(Al_2(SO_4)_3 \cdot 14\ H_2O$.

For other metal salt coagulants with waters of hydration, similar calculations shall be made. If the test material is provided as a dry product:

a) Weigh 10× the maximum use dose of the chemical in an acid-washed 1 L volumetric flask.

b) Dilute to volume with deionized distilled water, or follow manufacturer's instructions for dissolving the material and then dilute to volume.

> NOTE — Contaminants of interest can be determined on the base (unflocked) material. If the level of contaminants in the base material meets the requirements of this Standard (i.e., ≤ SPAC), then no analyses need be performed for the flocked material. If the SPAC is exceeded, then the flocked supernatant may be analyzed and the contaminant levels compared to the appropriate SPACs.

N-1.3.12.2 Analysis of chemical before flocking

For analysis of the base material, the base material shall be prepared as described below.

a) Pipette an aliquot of the solution into a 250 mL griffin beaker and add DI water to 100 mL.

b) Carefully add 2 mL of 30% H_2O_2 and 1 mL of concentrated nitric acid to the solution in the beaker.

c) Heat for 1 h at 95 °C (203 °F), or until the volume is slightly less than 50 mL.

d) Cool to ambient temperature and quantitatively transfer the solution into a 100 mL volumetric flask. Dilute the volume with DI water and mix thoroughly.

N-1.3.12.3 Analysis of solution after flocking

For analysis of the flocked material, the following preparation steps shall be followed.

a) The volume of solution to give the equivalent of 10× the evaluation dose shall be calculated by the following equation:

$$\left[\underset{\text{[evaluation dose]}}{\frac{mg}{L}} \times \underset{\text{[multiple factor]}}{10} \times 1L\right] \div \underset{\text{[dry weight sample in solution]}}{\left[\frac{mg}{100\ mL} \times \frac{1{,}000\ mg}{Lgm}\right]} = mL$$

b) Pipette the calculated aliquot into a 1 L volumetric flask and dilute to volume with DI water.

c) Transfer a 100 mL aliquot into a 200 mL beaker.

d) Add 0.1 M NaOH with constant stirring until the desired pH is reached and the pH holds for 1 min.

e) Allow the mixture to stand undisturbed for at least 1 h.

f) Filter through GF/C (or equivalent) filter with the aid of vacuum.

g) Preserve the sample according to the requirements of Annex N-1, Table N-1.1.

N-1.3.13 Method Z

This method shall be used for tracer dyes.

a) Preheat a sufficient volume of organic-free deionized water to 82 ˚C (180 ˚F).

b) Use a graduated cylinder to measure 950 mL of the hot water and transfer into a beaker with a stir bar.

c) Weigh a quantity of the tracer dye equivalent to 10× the maximum use dose when diluted to 1 L. Transfer dye to the beaker of hot water with stirring.

d) Cool to room temperature.

e) Transfer solution to a 1 L (0.26 gal) volumetric flask and dilute to volume with room temperature organic-free deionized water.

N-1.4 Analysis methods

N-1.4.1 General

This section is divided into three parts: inorganics (metals and others), organics, and radionuclides.

N-1.4.2 Inorganics

N-1.4.2.1 Metals

Analyses for metals shall be performed in accordance with currently accepted US EPA Methods (see 40 CFR Part 141), except as otherwise provided for herein. When no US EPA method is provided, analyses shall be performed in accordance with *Standard Methods for the Examination of Water and Wastewater* (most current edition).

If neither of these references includes the required method, a method from another recognized source shall be allowed, and the method cited and validated. If no recognized method is available, a method shall be developed, provided the method is fully documented and validated, including all appropriate quality assurance procedures. The method used to determine the contaminant level shall have an analytical concentration range, such that the report limit is no greater than 50% of the lowest contaminant concentration being sought. Quality control standards shall be run at concentrations of 0.5, 1.0, 2.0, 5.0, and 10.0× the target limit.

N-1.4.2.2 Nonmetallic inorganics

Analyses for inorganics (other than metals) shall be performed in accordance with currently accepted US EPA Methods (see 40 CFR Part 141), except as otherwise provided for herein. When no US EPA method is provided, analyses shall be performed in accordance with *Standard Methods for the Examination of Water and Wastewater* (most current edition).

If neither of these references includes the required method, a method from another recognized source shall be allowed, and the method cited and validated. If no recognized method is available, a method shall be developed, provided the method is fully documented and validated, including all appropriate quality assurance procedures. The method used to determine the contaminant level shall have an analytical concentration range, such that the report limit is no greater than 50% of the lowest contaminant concentration being sought. Quality control standards shall be run at concentrations of 0.5, 1.0, 2.0, 5.0, and 10.0× the target limit.

N-1.4.2.2.1 Oxyhalides in hypochlorite

The analysis of bromate, chlorate and perchlorate shall be performed in accordance with Section N-1.4.2.2. Selection of the method shall take into consideration the type of quenching agent used in order to minimize interference.

Spiked samples shall be processed with each analytical batch or every 10 samples, whichever is the greater number. A spiked sample shall be prepared for each hypochlorite type. The percent recovery of spiked samples shall be within 80% to 120%. Matrix spikes shall be performed in duplicate. The matrix spike, matrix spike duplicate shall have a calculated relative percent difference of ≤ 20%.

If the analytical methodology performed employs an internal standard or surrogate, the percent recovery criteria for either quality control compound shall be within 70% to 130%, or if outside that range, a sample spike performed and demonstrated a percent recovery of 80% to 120% obtained. For analytical methodologies not employing an internal standard or surrogate, spiked samples shall be processed with each analytical batch or every five samples, whichever is the greater number.

Blank samples shall be prepared using the same reagents and quantities used in the sample preparation, placed in vessels of the same type, and processed with the samples.

N-1.4.2.2.2 Bromide in sodium chloride

The analysis of bromide in sodium chloride shall be performed in accordance with Section N-1.4.2.2.

Spiked samples shall be processed with each analytical batch or every 10 samples, whichever is the greater number. A spiked sample shall be prepared for each batch. The percent recovery of spiked samples shall be within 80% to 120%. Matrix spikes shall be performed in duplicate. The matrix spike, matrix spike duplicate shall have a calculated relative percent difference of < 20%.

If the analytical methodology performed employs an internal standard or surrogate, the percent recovery criteria for either quality control compound shall be within 70% to 130%, or if outside that range, a sample spike performed and demonstrated a percent recovery of 80% to 120% obtained. Blank (control) samples shall be prepared using the same reagents and quantities used in the sample preparation, placed in vessels of the same type, and processed with the samples.

N-1.4.3 Organics

Analyses for organics shall be performed in accordance with currently accepted US EPA Methods (see 40 CFR Part 141), except as otherwise provided for herein. When no US EPA Method is provided, analyses shall be performed in accordance with *Standard Methods for the Examination of Water and Wastewater* (most current edition).

If neither of these references includes the required method, a method from another recognized source shall be allowed, and the method cited and validated. If no recognized method is available, a method shall be developed, provided the method is fully documented and validated, including all appropriate quality assurance procedures. The method used to determine the contaminant level shall have an analytical concentration range, such that the report limit is no greater than 50% of the lowest contaminant concentration being sought. Quality control standards shall be run at concentrations of 0.5, 1.0, 2.0, 5.0, and 10.0× the target limit.

N-1.4.3.1 Epichlorohydrin-dimethylamine copolymer (EPI-DMA)

N-1.4.3.1.1 General

Sample analysis shall be by gas chromatography with flame ionization detection (FID). An internal standard comprised of 100 µg/mL 1,3-dichloroacetone in 1:1 methylene chloride / isopropanol shall be used. Alternate methods shall be allowed to be used but shall be validated.

N-1.4.3.1.2 Apparatus

The following apparatus shall be used in this analysis:

- gas chromatograph, equipped with a split / splitless capillary injection port and a flame ionization detector;
- capillary column: 30 m × 0.53 mm DB-Wax, 1.0 µm film thickness;
- analytical balance, 0.1 mg accuracy;
- syringe, GC – 10 µL;
- Pasteur pipettes;

- 40 mL glass vials with polytetrafloroethylene (PTFE) faced septa;

- 2 mL GC glass vials with PTFE-faced septa;

- 10 mL volumetric flasks;

- 0.45 µm syringe filters; and

- 10 mL disposable syringe.

N-1.4.3.1.3 Reagents

The following reagents shall be used in this analysis:

- epichlorohydrin, 99%+ (EPI);
- 1,3-dichloro-2-propanol, 98% (DCIP);
- 1,2-dichloro-3-propanol;
- glycidol;
- 1,3-dichloroacetone (internal standard);
- 2-propanol (IPA); and
- methylene chloride.

N-1.4.3.1.4 Procedure

N-1.4.3.1.4.1 Preparation of solutions

The following standards and solutions shall be prepared.

a) Prepare a stock solution of each compound of interest by weighing approximately 0.1 g of the neat material into a 10 mL volumetric flask, and dilute to volume with methylene chloride.

b) Prepare an internal standard stock solution by weighing 0.1 g 1,3-dichloroacetone into a 10 mL volumetric flask, and dilute to volume with methylene chloride.

c) Prepare a dilution standard at 1,000 µg/mL by adding the appropriate volumes of each stock standard to a 10 mL volumetric flask containing methylene chloride / isopropanol (1:1). Add an appropriate volume of the internal standard stock solution to give a 1,3-dichloroacetone concentration of 100 µg/mL and dilute to mark.

d) Prepare an extracting solution by weighing 0.0500 g of 1,3-dichloroacetone into a 500 mL volumetric flask and add 250 mL methylene chloride to dissolve. Dilute to mark with isopropanol. The resulting solution shall be used to prepare calibration standards and as the extracting solution for the polymer products.

e) Prepare five calibration standards at concentrations of 5.0, 10, 25, 50, and 200 µg/mL by serial dilution of the 1,000 µg/mL dilution standard using the extracting solution.

N-1.4.3.1.4.2 Extraction of samples

Polymer samples shall be extracted as follows.

a) Add 5.0 mL of extracting solution to 10.0 g of polymer in a 40 mL glass vial.

b) Mix the solution on a wrist action shaker for 1 h.

c) Allow the two layers to separate.

d) Use a Pasteur pipette to transfer approximately 2 mL of extract to a syringe fitted with a filter.

e) Filter the extract prior to injection onto the instrument (extract should be free of any polymer droplets).

> NOTE — Analyze the extract within 8 h of extraction since aged extracts are unstable and will not produce accurate results.

N-1.4.3.1.4.3 Instrument conditions

The polymer extract shall be analyzed under the following conditions:

- oven temperature – multiple ramp:
  - 40 to 125 °C (104 to 257 °F) at 20 °C (36 °F)/min; initial hold – 5.0 min; final hold – 2.5 min;
  - 125 to 150 °C (257 to 302 °F) at 20 °C (36 °F)/min; final hold – 2.0 min; and
  - 150 to 175 °C (302 to 347 °F) at 20 °C (36 °F)/min; final hold – 10.0 min.
- injector temperature: 235 °C (455 °F);
- detector temperature: 300 °C (572 °F);
- injection volume: 3.0 µL;
- column head pressure: 5 psi; and
- injection port – splitless mode, purge valve on at 0.5 min.

N-1.4.3.1.5 Calculations

A linear regression of the five calibration standards shall be used to calculate the concentration of each analyte in the sample extract (in µg/mL). The following equation shall be used to calculate the concentration of the analyte in the polymer sample:

$$\text{curve concentration } (\mu\text{g/mL}) \times \frac{5.0 \text{ mL}}{10 \text{ g polymer sample}} = \frac{\mu\text{g analyte}}{\text{g polymer sample}}$$

N-1.4.3.2 Acrylamide monomer in polyacrylamide

Acrylamide monomer shall be determined using one of the following methods. Alternate methods shall be allowed to be used but shall be validated.

N-1.4.3.2.1 Method A

Sample analysis shall be by High Performance Liquid Chromatography (HPLC) with ultraviolet (UV) detection.

N-1.4.3.2.1.1 Apparatus

The following apparatus shall be used in this analysis:

- vacuum apparatus or Sonicator to degas mobile phase;
- HPLC pump;
- HPLC-UV spectrophotometric detector;
- YMC ODS-AL column, 4.6 × 150 mm, (AL12S05-1546WT); Guard Housing (XPEF43WTI); and YMC ODS-AL S-5 Guard Column (AL12S05 G 304WTA);

- Bio-Rad HPLC Fast Acid Analysis Column Cat. No. 125-0100 and Micro-Guard Refill Cartridges Cat. No. 125-0129;
- autosampler 100 µL capabilities;
- analytical data acquisition system;
- millipore 0.1 VV µm filter disc and 0.22 µm GS filter paper;
- volumetric pipettes;
- analytical balance accurate to 0.0001 g;
- multi-plate stirrer and 1 in stirring bars;
- vacuum filtration flasks;
- 100 mL volumetric flasks;
- 400 mL beakers;
- vacuum manifold for 0.1 µm Millex-VC filters; and
- for latex: cage stirrer, Jiffy mixer, Model LM, and cone-driven stirring motor.

N-1.4.3.2.1.2 Reagents

The following reagents shall be used in this analysis:

- concentrated sulfuric acid (H_2SO_4) reagent grade;
- acrylamide of 99%+; and
- Milli-Q water.

N-1.4.3.2.1.3 Procedure

N-1.4.3.2.1.3.1 Preparation of mobile phase

The mobile phase shall be prepared in the following manner:

a) Add 1.0 mL of concentrated sulfuric acid to a 2 L volumetric flask, QS with DI water and mix well. This yields a solution of sulfuric acid at approximately 0.01 M.

b) Filter through 0.22 µm GS Millipore filter paper.

c) Vacuum or ultrasonicate to degas.

N-1.4.3.2.1.3.2 Sample preparation

- dry polymer preparation:

  a) Weigh 199.5 ± 0.1 g DI water into a 400 mL tall form beaker. Record the weight as W_{wt}.

  b) Clamp beaker under the mixer with the impeller centered about 1 cm above the bottom of the beaker.

  c) Set mixer speed to 800 ± 20 rpm.

d) Place 0.5 g (to the nearest 0.1 mg) of dry polymer into the beaker. Record the weight as DP_{wt}.

e) Mix at 800 rpm for 30 min.

— chromatography sample preparation for dry polymer:

a) Weigh 1.0 g (to the nearest 0.1 mg) of the solution prepared in Section N-1..4.3.2.1.3.2.e into a glass jar. Record the weight as DP_S.

b) Add 10 mL of mobile phase weighed to the nearest (0.1 mg) into the same jar. Record the total weight as DP_T.

c) Add a stir bar and stir for 30 min at a medium speed.

d) After 30 min, filter through a 0.1 µm Millex-VC using a vacuum manifold.

e) The sample is now ready for injection.

— chromatography sample preparation for latex polymer:

a) Weigh 0.1 g (to the nearest 0.1 mg) of latex polymer into a 100 mL volumetric flask. Record the weight as LP_{wt}.

b) QS the flask with mobile phase.

c) Add a stir bar and stir for 30 min at a medium speed.

d) After 30 min, filter through a 0.1 µm Millex-VV filter unit.

e) The sample is now ready for injection.

N-1.4.3.2.1.3.3 Calibration standards

Five calibration standards shall be prepared at concentrations of 0.005, 0.05, 0.1, 1 and 5 ppm using the dilution sequence noted below:

a) Prepare a 1,000 ppm stock solution then prepare standards as listed in Table N-1.1 noted below. Dilute all standards with mobile phase.

b) Pipette volume in column A into volumetric listed in column B to yield standard concentration listed in column C. Adjust accordingly for the actual concentration of the stock solution.

Table N-1.1

Working standard	A Standard used	B Volumetric size (mL)	C Standard concentration
A	0.5 mL of 1,000 ppm stock	100	5 ppm
B	0.1 mL of 1,000 ppm stock	100	1 ppm
C	2.0 mL of 5 ppm solution	100	0.1 ppm
D	1.0 mL of 5 ppm solution	100	0.05 ppm
E	0.1 mL of 5 ppm solution	100	0.005 ppm

N-1.4.3.2.1.3.4 Instrumentation conditions

The sample solution of the polymer sample shall be analyzed using the following conditions.

- columns:

  1. YMC ODS-AL S-5 guard column
  2. YMC ODS-AL C18, 4.6 × 150 mm column
  3. Bio-Rad HPLC fast acid analysis column and guard cartridge

- the columns are connected in series, C18 guard column, C18 column, Bio-Rad guard column, Bio-Rad Fast Acid column;

- mobile phase: 0.01 M H_2SO_4;

- flow rate: 0.6 mL/min;

- detection: 210 nm UV 0.002 a.u.f.s. (adjustable);

- injection volume: 100 µL; and

- temperature: ambient.

N-1.4.3.2.1.4 Calculations

A linear regression of the five calibration standards shall be used to calculate the concentration of each analyte in the sample preparation (ppm). The following equations shall be used to calculate the concentration of the analyte in the respective polymer sample.

- dry polymer calculation:

$$\text{curve concentration (ppm)} \times \left[\left(\frac{W_{wt} + DP_{wt}}{DP_{wt}}\right)\right] \times \frac{DP_t}{DP_s} = \text{ppm of acrylamide in polymer product}$$

- latex polymer calculation:

$$\text{curve concentration (ppm)} \times \frac{100}{LP_{wt}} = \text{ppm of acrylamide in polymer product}$$

N-1.4.3.2.2 Method B[21]

Sample analysis shall be by HPLC with ultraviolet UV detection.

N-1.4.3.2.2.1 Apparatus

The following apparatus shall be used in this analysis:

- HPLC equipped with UV detector;
- column: BioRad Fast Acid 100 × 7.8 mm (Catalog # 125-0100) or equivalent;
- analytical balance, 0.1 mg accuracy;
- syringes;
- analytical shaker;
- centrifuge;

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[21] Based on method in *Analytical Chemistry* 50: 1959 (1978). *"Determination of acrylamide monomer in polyacrylamide and in environmental samples by high performance liquid chromatography."*

- volumetric flasks; and
- 0.45 µm syringe filters.

N-1.4.3.2.2.2 Reagents

The following reagents shall be used in this analysis:

- HPLC grade acetonitrile;
- HPLC grade methanol;
- HPLC deionized water; and
- 93 to 98% trace metal grade sulfuric acid.

N-1.4.3.2.2.3 Procedure

N-1.4.3.2.2.4 Preparation of mobile phase

- 5 mM sulfuric acid:

  a) Add 280 µL sulfuric acid into 1 L deionized water.

N-1.4.3.2.2.5 Preparation of standard

- acrylamide ≥ 99% Sigma (Catalog #A8887) or equivalent
- stock standard:

  a) Accurately weigh 10 mg acrylamide into 10 mL methanol.

N-1.4.3.2.2.6 Calibration standards

Five calibration standards shall be prepared at concentrations of 10, 50, 100, 500 and 1,000 µg/L by serial dilution of the acrylamide stock standard using deionized water.

N-1.4.3.2.2.7 Extraction solvent

- 70% acetonitrile / 30% deionized water:

  a) Into a 500 mL volumetric flask add 350 mL acetonitrile and 150 mL of deionized water and mix.

  b) If the sample does not disperse in the acetonitrile / water solution, an extraction solvent with higher aqueous content can be used (e.g., 50% methanol / 50% acetonitrile).

N-1.4.3.2.2.8 Analysis solution

a) Mix / shake polymer sample to insure homogeneity.

b) Add 1 g of sample into 10 mL of extraction solvent (70% acetonitrile / 30% DI water) to a 40 mL vial.

c) Cap vial and place on the shaker for at least 15 min.

d) Centrifuge at 2,000 rpm for 5 minutes.

e) Filter supernatant through 0.45 µm filter and collect into an 8 mL vial.

f) Dilute supernatant 1:100 into deionized water.

N-1.4.3.2.2.9 Instrument conditions

The analysis solution containing the polymer sample shall be analyzed under the following conditions:

- column temperature: ambient
- injection volume: 100 µL
- detector: scan 200 to 360 nm @ 2 nm intervals – quantitate @ 205nm

N-1.4.3.2.2.10 Calculations

A linear regression of the five calibration standards shall be used to calculate the concentration of acrylamide in the sample extract (in µg/L). The following equation shall be used to calculate the concentration of the analyte in the polymer sample. (Calculations assume a 100-fold dilution prior to analysis. In the event a greater dilution factor is required, that value should be used in the equations):

$$\frac{\text{curve concentration } \left(\frac{\mu\text{g}}{\text{L}}\right) \times \text{ dilution } (100) \times 1\text{L} \times \text{ extraction volume } (10\text{ mL})}{\text{sample mass (g)}} = X\frac{\mu\text{g}}{\text{g}} = \frac{\text{mg}}{\text{kg}}$$

N-1.4.3.2.3 Method C

Sample analysis shall be determined by HPLC with UV detection.

N-1.4.3.2.3.1 Apparatus and equipment

- HPLC equipped with UV detector and acquisition system;
- column: Atlantis dC18 150 × 4.6 mm – 3 µm (ref waters # 186001342);
- volumetric cylinders;
- beakers;
- glass bottles;
- pipettes;
- 30 mL vials with cap;
- mechanical stirrer;
- analytical balance (0.001 g);
- calibrated pH meter;
- volumetric flasks; and
- 0.45 µm syringe filters (compatible with solvent).

N-1.4.3.2.3.2 Reagents

The following reagents shall be used in this analysis:

- HPLC grade methanol;
- HPLC grade ethanol;
- isopropanol;
- acetone;
- HPLC deionized water;
- potassium phosphate monobasic, KH_2PO_4, 99%+;
- acrylamide of 99%+;
- phosphoric acid.

N-1.4.3.2.3.3 Procedure

N-1.4.3.2.3.3.1 Preparation of mobile phase

— 20 mM/L KH_2PO_4, pH = 3.8 solution:

a) Weigh 2.72 g of potassium phosphate monobasic and complete to 1 L with deionized water in a volumetric flask.

b) After dissolution, adjust the pH to 3.8 with phosphoric acid.

— mobile phase:

a) Take 850 mL of the previous solution and add 150 mL of methanol.
b) Filter through 0.20 µm acetate cellulose filter paper.

N-1.4.3.2.3.3.2 Preparation of standard

— prepare a 10,000 ppm stock solution:

a) Accurately weigh 1.00 g of acrylamide and dissolve it with deionized water in a 100 mL volumetric flask.

N-1.4.3.2.3.3.3 Calibration standards

Five calibration standards shall be prepared at concentrations of 10, 20, 40, 50 and 100 ppm by dilution of the acrylamide stock solution using deionized water.

For example: pipet 1 mL of stock solution and complete with deionized water to 100 mL in a volumetric flask to obtain a standard at 100 ppm.

N-1.4.3.2.3.3.4 Extraction solvent

— Solution A: 540 mL of isopropanol + 450 mL of deionized water + 10 mL ethanol

— Solution B: 740 mL of isopropanol + 250 mL of deionized water + 10 mL ethanol

— Solution C: 990 mL of isopropanol + 10 mL ethanol

— Solution D: 900 mL of acetone + 100 mL of deionized water

— Solution E: 800 mL of isopropanol + 200 mL of deionized water

N-1.4.3.2.3.3.5 Sample preparation

The extraction is made in function of the physical form of the polymer. All supernatants are filtrated through a 0.45 µm filter before injection.

1. Dry polymer

   — anionic:

   a) Weigh 1.99 to 2.01 g of polymer.
   b) Add 10 mL of Solution A – shake for 40 min.
   c) Add 10 mL of Solution B – shake for 40 min.

- low cationic:

  a) Weigh 1.99 to 2.01 g of polymer.
  b) Add 10 mL of Solution A – shake for 40 min.
  c) Add 10 mL of Solution B – shake for 40 min.

- mid to high cationic:

  a) Weigh 0.99 to 1.01 g of polymer.
  b) Add 10 mL of Solution A – shake for 40 min.
  c) Add 10 mL of Solution C – shake for 40 min.

- for all products:

  a) Weigh 1.99 to 2.01 g of polymer.
  b) Add 20 mL of Solution D – shake for 4 h.

2. Emulsion

- anionic:

  a) Place 50 mL of ethanol in 100 mL beaker and place under stirring.
  b) Add 5.00 of polymer (measured by double weighing).
  c) Let stir for 30 min.

- low to middle cationic:

  a) Place 50 mL of ethanol in 100 mL beaker and place under stirring.
  b) Add 5.00 of polymer (measured by double weighing).
  c) Let stir for 30 min.

- high cationic:

  a) Place 50 mL of isopropanol in 100 mL beaker and place under stirring.
  b) Add 5.00 of polymer (measured by double weighing).
  c) Let stir for 30 min.

- for all products:

  a) Weigh 1.99 to 2.01 g of polymer.
  b) Add 20 mL of Solution D – shake for 4 h.

3. Liquid

a) Weigh 1.99-2.01 g of polymer.
b) Add 20 mL of Solution E – shake for 2 h.

NOTE — if the obtained value after injection is higher than the standard, the sample shall be diluted and new injection made.

N-1.4.3.2.3.4 Instrument conditions

The analysis solution containing the polymer sample shall be analyzed under the following conditions:

- mobile phase: 85% 20 mM/L KH_2PO_4 pH = 3.8 / 15% methanol (v/v);
- flow rate: 1.0 mL/min;
- detection: 205 nm UV;
- injection volume: 10 µL; and
- temperature: ambient.

N-1.4.3.2.3.5 Calculations

A linear regression through zero of the five calibration standards shall be used to calculate the concentration in the sample preparation (ppm):

$$\text{area} = B \times \text{concentration (ppm)}$$

The following equations shall be used to calculate the concentration in the respective polymer sample:

$$\text{acrylamide (ppm)} = \text{concentration (ppm)} \times \frac{\text{extraction volume (mL)}}{\text{sample mass (g)}}$$

In the event a greater dilution factor is required, that value should be used in the last equation.

N-1.4.3.3 Dimethyldiallylammonium chloride monomer in polyDADMAC

N-1.4.3.3.1 General

Sample analysis shall be by HPLC with UV detection. Alternate methods shall be allowed to be used but shall be validated.

N-1.4.3.3.2 Apparatus

The following apparatus shall be used in this analysis:

- HPLC equipped with UV detector;
- column: 250 × 4.6 mm Alltima C18, 5µ (Alltech catalog #88054 or equivalent);
- analytical balance, 0.1 mg accuracy;
- syringe, HPLC – 20 µL;
- 10 mL volumetric flasks; and
- 0.45 µm syringe filters.

N-1.4.3.3.3 Reagents

The following reagents shall be used in this analysis:

- 1-octane sulfonic acid, Na salt;
- tetramethylammonium hydroxide;
- o-phosphoric acid;
- n-butanol;
- acetonitrile; and
- diallyldimethylammonium chloride monomer (mDADMAC).

N-1.4.3.3.4 Procedure

N-1.4.3.3.4.1 Preparation of mobile phase

A mobile phase solution shall be prepared by adding the following to 900 mL of HPLC grade water:

— 1.08 g of 1-octane sulfonic acid, Na salt;
— 5.0 mL of 1.0 M tetramethylammonium hydroxide;
— 100 mL acetonitrile; and
— 25 mL of n-butanol.

The pH of the solution shall be adjusted to 3.0 by adding o-phosphoric acid.

N-1.4.3.3.4.2 Analysis solution

An analysis solution shall be prepared as follows:

a) Dissolve a 2.0 g aliquot of the polyDADMAC sample in 10 mL of deionized water.
b) Filter approximately 2 mL of this solution through a 0.45 μm syringe filter.
c) Dilute 1.0 mL of the filtrate to 10 mL with mobile phase solution.

N-1.4.3.3.4.3 Calibration standards

Four calibration standards shall be prepared at concentrations of 20, 50, 200, and 500 μg/mL by serial dilution of the mDADMAC stock standard using the mobile phase solution.

N-1.4.3.3.4.4 Instrument conditions

The analysis solution containing the polymer sample shall be analyzed under the following conditions:

— column temperature: ambient;
— column flow: 2.0 mL/min;
— injection volume: 20 μL;
— detector: UV at 200 nm; and
— retention time of mDADMAC = 6.5 min.

N-1.4.3.3.5 Calculations

A linear regression of the four calibration standards shall be used to calculate the concentration of each analyte in the sample extract (in μg/mL). The following equation shall be used to calculate the concentration of the analyte in the polymer sample:

$$\text{curve concentration } (\mu\text{g/mL}) \times \frac{10.0 \text{ mL}}{2 \text{ g polymer sample}} \times 10 = \frac{\mu\text{g analyte}}{\text{g polymer sample}}$$

N-1.4.3.4 Dimethylamine in polyDADMAC and Epichlorohydrin / dimethylamine polymers

N-1.4.3.4.1 General

This procedure shall be used for the analysis of dimethylamine in polyDADMAC and epichlorohydrin / dimethylamine polymers. Alternate methods shall be allowed to be used but shall be validated.

N-1.4.3.4.2 Apparatus

The following apparatus shall be used in this analysis:

- gas chromatograph with electron capture detector and autosampler;
- 100% dimethyl siloxane .32 mm × 30 M, 1.0 u film capillary column;
- hot plate;
- disposable pipettes;
- syringes of various sizes;
- 40 mL VOA vials; and
- appropriately sized volumetric flasks

N-1.4.3.4.3 Reagents

The following reagents shall be used in this analysis:

- toluene;
- dimethylamine (40% wt);
- hexachlorobenzene (100 µg/mL);
- 2,4-dinitrofluorobenzene;
- sodium hydroxide;
- sodium tetraborate; and
- 1,4-dioxane.

N-1.4.3.4.4 Analytical procedure

N-1.4.3.4.4.1 Preparation of reagent solutions

a) Prepare a 2.0 N solution of NaOH by adding 8 g of NaoH into 100 mL of deionized water.

b) Prepare a 2.5% sodium tetraborate solution by adding 2.5 g of sodium tetraborate into 100 mL of deionized water.

c) Prepare 2,4-dinitrofluorobenzene derivatizing solution by adding .625 g of 2,4-dinitrofluorobenzene into 25 mL of 1,4-dioxane.

d) Prepare a stock standard solution at 1,000 µg/mL by weighing out approximately 25 mg of dimethylamine (40% w/w) into 10 mL of deionized water.

e) Prepare a dilution standard at 100 µg/mL by adding 1 mL of stock standard solution to 10 mL of deionized water.

f) Prepare four calibration standards at concentrations of 10, 50, 200, 500 µg/L by serial dilution of the 100 µg/mL dilution standard into deionized water.

N-1.4.3.4.4.2 Preparation of calibration standards and samples

a) Add 10 mL of each calibration standard to a 40 mL VOA vial.

b) For each sample add 0.5 g of sample to 100 mL of deionized water. Cap and shake for 30 min. Add 1 mL of sample and 9 mL of deionized water to a 40 mL VOA vial.

c) For each QC, MS (matrix spike) and MSD (matrix spike duplicate), add 0.5 g of sample to 100 mL of deionized water. Spike at 50 mg/Kg or level equivalent to that found in sample. Cap and shake for 30 min. Add 1 mL of each QC sample and 9 mL of deionized water to a 40 mL VOA vial.

N-1.4.3.4.4.3 Derivatization and extraction of standards and sample the vials

a) To each standard and sample add 5.0 mL of 2.5% sodium tetraborate and 1.0 mL of the 2,4-dinitrofluorobenzene solution.

b) Cap the vials and place them in a 60 °C water bath for 20 min.

c) Remove the vials and add 2.0 mL of 2.0 N sodium hydroxide.

d) Return the vials to the water bath for 30 min.

e) Place the vials in an ice bath until they reach room temperature.

f) To each vial add 5.0 mL of toluene.

g) Cap the vials and shake for 2 min.

h) Allow the samples to set for approximately 5 min.

i) Transfer 1.0 mL of toluene layer into 1.8 mL autosampler vial.

j) Add 10 µL of hexachlorobenzene into each vial and cap the vial.

N-1.4.3.4.4.4 Run conditions

a) Set up the GC with the GC column.
b) Set the GC with the following temperature program:

initial temperature	150 °C
final temperature	220 °C
rate	4 °C/min
initial time	1 min
final time	10 min
injector temperature	235 °C
detector temperature	300 °C
signal range	1

N-1.4.3.4.4.5 Calculations

A linear regression of the four standards is to be used to calculate the concentration in each sample extract. The following equation shall be used to calculate the concentration of dimethylamine in the polymer sample:

$$\frac{\text{curve concentration } (\mu\text{g/L}) \times (1\text{ L}/1{,}000\text{ mL}) \times 100\text{ mL} \times 10}{0.5\text{ g polymer sample}} = \frac{\text{dimethylamine } (\mu\text{g})}{\text{polymer sample (g)}}$$

N-1.4.4 Radionuclides

Analyses for radionuclides shall be performed in accordance with *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA-600/4-80-032, except as otherwise provided for herein. When no US EPA Method is provided, analyses shall be performed in accordance with *Standard Methods for the Examination of Water and Wastewater* (most current edition).

If neither of these references includes the required method, a method from another recognized source shall be allowed, and the method cited and validated. If no recognized method is available, a method shall be developed, provided the method is fully documented, including all appropriate quality assurance procedures. The method used to determine the contaminant level shall have an analytical concentration range, such that the report limit is no greater than 50% of the lowest contaminant concentration being sought. Quality control standards shall be run at concentrations of 0.5, 1.0, 2.0, 5.0, and 10.0× the target limit.

N-1.4.4.1 Potassium-40 correction for gross beta

If the normalized concentration for gross beta exceeds the health effects evaluation criteria, analysis shall be completed for the naturally occurring potassium-40 beta particle activity from the same or equivalent sample used for the gross beta particle activity. As indicated in the Code of Federal Regulations (CFR 40 §141.26 (b)(4)),[22] the potassium-40 beta particle activity (pCi/L) is calculated by multiplying elemental potassium concentrations (in mg/L) by a factor of 0.82. The gross beta particle and photon activity attributable to potassium-40 is then subtracted from the total gross beta particle activity value. The potassium-40 corrected gross beta particle and photon activity shall be compared against the health effects evaluation criteria.

N-1.4.4.2 Requirements for gross beta speciation

When the potassium-40 corrected gross beta particle and photon activity exceeds a normalized concentration of 15 pCi/L, the beta emitting radioisotopes shall be speciated. Speciation testing is required for all radioisotopes at risk of exceeding the health effects evaluation criteria. Appendix I in US EPA Implementation Guidance for Radionuclides (2002) details a list of radioisotopes and associated doses (in pCi/L) to produce a 4 mrem/y dose.[23] The US EPA Implementation Guidance for Radionuclides (2002)[24] provides example calculations to determine the fractional contribution in mrem/yr dose for each speciated radioisotope. The fractional contributions shall be summed for comparison to the health effects evaluation criteria.

N-1.5 Estimated contaminant exposure concentration

To estimate the exposure concentration of a contaminant in the finished drinking water, the following calculations shall be used. These calculations adjust the contaminant concentrations measured in the laboratory preparation solution to the evaluation or maximum dose. The resulting value is compared to the SPAC, as determined in Annex A.

$$\underbrace{\frac{\text{contaminant (mg)}}{\text{solution (L)}}}_{\text{[analysis concentration]}} \times \underbrace{\frac{\text{analysis solution (L)}}{\text{product (g)}}}_{\text{[lab prep solution]}} \times \frac{\text{g}}{\text{1,000 mg}} \times \underbrace{\frac{\text{product (mg)}}{\text{drinking water (L)}}}_{\text{[evaluation dose]}} \times \frac{\text{1,000 µg}}{\text{1 mg}} = \underbrace{\frac{\text{contaminant (µg)}}{\text{drinking water (L)}}}_{\text{[µg/L = ppb]}}$$

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[22] Code of Federal Regulations, *Monitoring Frequency and Compliance Requirements for Radionuclides in Community Water Systems*, Title 40, Sec. 141.26.

[23] US EPA *Implementation Guidance for Radionuclides*, Appendices A through J, Appendix I *Comparison of Derived Values of Beta and Photon Emitters*.

[24] US EPA *Implementation Guidance for Radionuclides*, Section II through B.2, *Violation / Compliance Determination of Gross Beta and Photon Emitters.*

Table N-1.2
Preservation of prepared sample solutions

Contaminant	Preservative	Container	Storage
herbicides / pesticides	none	amber glass with PTFE cap	4 °C (39 °F)
metals	1.25 mL HNO_3 per 125 mL of sample	HDPE plastic	room temperature
organics	none	amber glass with PTFE cap	4 °C (39 °F)
radionuclides	10 mL HNO_3 per 1 L of sample	HDPE plastic	room temperature
VOCs	4 drops 50% HCl per 160 mL of sample	glass vial with PTFE cap	4 °C (39 °F)

Informative Annex 1

(previously Annex A)

Toxicology review and evaluation procedures

The information contained in this Disclaimer is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Disclaimer may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

The toxicological review and evaluation procedures for substances imparted to drinking water through direct addition to the municipal water supply were removed from NSF/ANSI 60 Annex A and reestablished in NSF/ANSI/CAN 600. Annex A was retired from NSF/ANSI 60 in December 2018.

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Informative Annex 2

(previously Annex C)

Normative drinking water criteria

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The drinking water evaluation criteria for the determination of product compliance with the health effects requirements were removed from NSF/ANSI 60 Annex C and reestablished in NSF/ANSI/CAN 600. Annex C was retired from NSF/ANSI 60 in December 2018.

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Informative Annex 3

(previously Annex D)

Chemical product index

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Table I-3.1
Chemical product index

Chemical name / synonym	Section reference	Table reference	Name used in standard
acrylamide / acrylic acid copolymer	4	4.1	same
activated silica	4	4.1	see sodium silicate
alum	4	4.1	see aluminum sulfate
aluminum alum	4	4.1	see aluminum sulfate
aluminum chloride	4	4.1	same
aluminum chloride hydroxide	4	4.1	see polyaluminum chloride
aluminum chloride hydroxide sulfate	4	4.1	see polyaluminum chloride
aluminum sodium oxide	4	4.1	see sodium aluminate
aluminum sulfate	4	4.1	same
aluminum trichloride	4	4.1	see aluminum chloride
aluminum trisulfate	4	4.1	see aluminum sulfate
ammonia, anhydrous	6	6.2	same
ammonia gas	6	6.2	see ammonia, anhydrous
ammonium fluosilicate	7	7.1	see ammonium hexafluorosilicate
ammonium hexafluorosilicate	7	7.1	same
ammonium hydroxide	6	6.2	same
ammonium silicofluoride	7	7.1	see ammonium hexafluorosilicate
ammonium sulfate	6	6.2	same
antifoamers	8	8.1	same
baking soda	5	5.1	see sodium bicarbonate
bentonite	4	4.1	same
biocides	8	8.1	same
cake alum	4	4.1	see aluminum sulfate
calcium carbonate	5	5.1	same
calcium fluoride	7	7.1	same
calcium hydroxide	5	5.1	same
calcium hypochlorite	6	6.2	same
calcium oxide	5	5.1	same
carbon dioxide	5	5.1	same
cationic polyacrylamide	4	4.1	same
caustic potash	5	5.1	see potassium hydroxide

Table I-3.1
Chemical product index

Chemical name / synonym	Section reference	Table reference	Name used in standard
caustic soda	5	5.1	see sodium hydroxide
cements	8	8.2	same
china clay	4	4.1	see kaolinite
chlorine	6	6.2	same
chlorine gas	6	6.2	see chlorine
clay thinners	8	8.1	same
copper ethanolamine complexes	7	7.1	same
copper sulfate	7	7.1	same
copper triethanolamine complexes	7	7.1	same
cupric sulfate	7	7.1	see copper sulfate
DADMAC	4	4.1	see diallyldimethylammonium chloride acrylamide copolymer
defoamers	8	8.1	same
descalers / scale inhibitors	8	8.1	same
development / rehabilitation materials	8	8.1	same
diallyldimethylammonium chloride crylamide copolymer	4	4.1	same
diphosphoric acid, tetrapotassium salt	5	5.1	see tetrapotassium pyrophosphate
dipotassium hydrogen phosphate	5	5.1	see dipotassium orthophosphate
dipotassium monophosphate	5	5.1	see dipotassium orthophosphate
dipotassium orthophosphate	5	5.1	same
dipotassium phosphate	5	5.1	see dipotassium orthophosphate
disodium diphosphate	5	5.1	see sodium acid pyrophosphate
disodium hydrogen phosphate	5	5.1	see disodium orthophosphate
disodium monophosphate	5	5.1	see disodium orthophosphate
disodium orthophosphate	5	5.1	same
disodium phosphate	5	5.1	see disodium orthophosphate
DKP	5	5.1	see dipotassium orthophosphate
DMDAAC	4	4.1	see diallyldimethylammonium chloride acrylamide copolymer
drilling fluids	8	8.1	same
dry ammonia	6	6.2	see ammonium sulfate
DSP	5	5.1	see disodium orthophosphate
EDTA	5	5.1	see ethylenediaminetetraacetic acid
EDTA, sodium salt	5	5.1	see tetrasodium ethylenediaminetetraacetic acid
EPI–DMA	4	4.1	see polyamines
ethylenediaminetetraacetic acid	5	5.1	same
ferric chloride	4	4.1	same
ferric persulfate	4	4.1	see ferric sulfate

Table I-3.1
Chemical product index

Chemical name / synonym	Section reference	Table reference	Name used in standard
ferric sulfate	4	4.1	same
ferric tersulfate	4	4.1	see ferric sulfate
ferrous sulfate	4	4.1	same
filtration control	8	8.1	same
florocid	7	7.1	see sodium fluoride
fluorite	7	7.1	see calcium fluoride
fluorspar	7	7.1	see calcium fluoride
fluosilicic acid	7	7.1	same
foamers	8	8.1	same
frac sands	8	8.1	same
glassy sodium phosphate	5	5.1	see sodium polyphosphates, glassy
Graham’s salt	5	5.1	see sodium polyphosphates, glassy
gravel	8	8.1	same
grouts	8	8.1	same
HPAM	4	4.1	see hydrolyzed polyacrylamide
hydrated lime	5	5.1	see calcium hydroxide
hydrochloric acid	5	5.1	same
hydrofluosilicic acid	7	7.1	see fluosilicic acid
hydrolyzed polyacrylamide	4	4.1	same
hydroxyapatite	7	7.1	see tricalcium phosphate
iodine	6	6.2	same
iron (II) sulfate	4	4.1	see ferrous sulfate
iron (III) chloride	4	4.1	see ferric chloride
iron (III) sulfate	4	4.1	see ferric sulfate
iron trichloride	4	4.1	see ferric chloride
kaolinite	4	4.1	same
KTPP	5	5.1	see potassium tripolyphosphate
lime	5	5.1	see calcium oxide
limestone	5	5.1	see calcium carbonate
liquid ammonia	6	5.1	see ammonium hydroxide
liquid bleach	6	6.2	see sodium hypochlorite
loss circulation materials	8	8.1	same
lubricants	8	8.1	same
magnesia	5	5.1	see magnesium oxide
magnesium carbonate hydroxide	5	5.1	same
magnesium hexafluorosilicate	7	7.1	see magnesium silicofluoride
magnesium oxide	5	5.1	same
magnesium silicofluoride	7	7.1	same
MKP	5	5.1	see monopotassium orthophosphate

Table I-3.1
Chemical product index

Chemical name / synonym	Section reference	Table reference	Name used in standard
monophosphoric acid	5	5.1	see phosphoric acid
monopotassium dihydrogen phosphate	5	5.1	see monopotassium orthophosphate
monopotassium monophosphate	5	5.1	see monopotassium orthophosphate
monopotassium orthophosphate	5	5.1	same
monopotassium phosphate	5	5.1	see monopotassium orthophosphate
monosodium dihydrogen phosphate	5	5.1	see monopotassium orthophosphate
monosodium monophosphate	5	5.1	see monosodium orthophosphate
monosodium orthophosphate	5	5.1	same
monosodium phosphate	5	5.1	see monosodium orthophosphate
montmorillonite	4	4.1	see bentonite
MSP	5	5.1	see monosodium orthophosphate
muriatic acid	5	5.1	see hydrochloric acid
oil of vitriol	5	5.1	see sulfuric acid
orthophosphoric acid	5	5.1	see phosphoric acid
oxygen scavengers	8	8.1	same
PAM	4	4.1	see polyacrylamide
PAMD	4	4.1	see polyacrylamide
pentapotassium tripolyphosphate	5	5.1	see potassium tripolyphosphate
pentasodium tripolyphosphate	5	5.1	see sodium tripolyphosphate
permanganate	6	6.2	see potassium permanganate
phosphoric acid	5	5.1	same
polyacrylamide	4	4.1	same
polyaluminum chloride	4	4.1	same
polyamines	4	4.1	same
polybasic aluminum chloride	4	4.1	see polyaluminum chloride
poly(diallyldimethylammonium chloride)	4	4.1	same
polyDADMAC	4	4.1	see poly(diallyldimethylammonium chloride)
polyDMDAAC	4	4.1	see poly(diallyldimethylammonium chloride)
polyethyleneamines	4	4.1	same
polyphosphoric acid	5	5.1	same
porcelain clay	4	4.1	see kaolinite
potassium fluoride	7	7.1	same
potassium hydroxide	5	5.1	same
potassium permanganate	6	6.2	same
potassium phosphate, dibasic	5	5.1	see dipotassium orthophosphate
potassium phosphate, monobasic	5	5.1	see monopotassium orthophosphate
potassium phosphate, tribasic	5	5.1	see tripotassium orthophosphate

Table I-3.1
Chemical product index

Chemical name / synonym	Section reference	Table reference	Name used in standard
potassium pyrophosphate	5	5.1	see terapotassium pyrophosphate
potassium triphosphate	5	5.1	see potassium tripolyphosphate
potassium tripolyphosphate	5	5.1	see potassium tripolyphosphate
PPA	5	5.1	see polyphosphoric acid
quicklime	5	5.1	see calcium oxide
regenerants	8	8.1	same
resin amines	4	4.1	same
SAPP	5	5.1	see sodium acid pyrophosphate
SHMP	5	5.1	see sodium polyphosphates, glassy
slaked lime	5	5.1	see sodium hydroxide
soda ash	5	5.1	see sodium carbonate
sodium acid pyrophosphate	5	5.1	same
sodium aluminate	4	4.1	same
sodium acid sulfite	7	7.1	see sodium bisulfate
sodium bicarbonate	5	5.1	same
sodium bisulfate	5	5.1	same
sodium bisulfite	7	7.1	same
sodium calcium magnesium polyphosphate, glassy	5	5.1	same
sodium carbonate	5	5.1	same
sodium chlorate	6	6.2	same
sodium chlorite	6	6.2	same
sodium dihydrogen pyrophosphate	5	5.1	see sodium acid pyrophosphate
sodium fluoride	7	7.1	same
sodium fluosilicate	7	7.1	see sodium silicofluoride
sodium hexametaphosphate	5	5.1	see sodium polyphosphates, glassy
sodium hydrogen sulfate	5	5.1	see sodium bisulfate
sodium hydroxide	5	5.1	same
sodium hypochlorite	6	6.2	same
sodium metabisulfite	7	7.1	same
sodium phosphate, dibasic	5	5.1	see disodium orthophosphate
sodium phosphate, monobasic	5	5.1	see monosodium orthophosphate
sodium phosphate, tribasic	5	5.1	see trisodium orthophosphate
sodium polyphosphates, glassy	5	5.1	same
sodium pyrophosphate	5	5.1	see tetrasodium pyrophosphate
sodium pyrosulfate	5	5.1	see sodium bisulfate
sodium pyrosulfite	7	7.1	see sodium metabisulfite
sodium sesquicarbonate	5	5.1	same
sodium silicate	5	5.1	same
sodium silicofluoride	7	7.1	same

Table I-3.1
Chemical product index

Chemical name / synonym	Section reference	Table reference	Name used in standard
sodium sulfite	7	7.1	same
sodium tetrapolyphosphate	5	5.1	see sodium polyphosphates, glassy
sodium trimetaphosphate	5	5.1	same
sodium triphosphate	5	5.1	see sodium tripolyphosphate
sodium tripolyphosphate	5	5.1	same
sodium zinc phosphate, glassy	5	5.1	same
sodium zinc potassium polyphosphate, glassy	5	5.1	same
starch, anionic	4	4.1	same
starch, base hydrolyzed	4	4.1	see starch, anionic
STP	5	5.1	see sodium tripolyphosphate
STPP	5	5.1	see sodium tripolyphosphate
sulfur dioxide	7	7.1	same
sulfuric acid	5	5.1	same
sulfurous oxide	7	7.1	see sulfur dioxide
superphosphoric acid	5	5.1	see polyphosphoric acid
tetrapotassium diphosphate	5	5.1	see tetrapotassium pyrophosphate
tetrapotassium pyrophosphate	5	5.1	same
tetrasodium diphosphate	5	5.1	see tetrasodium pyrophosphate
tetrasodium ethylenediaminetetra-acetic acid	5	5.1	same
tetrasodium pyrophosphate	5	5.1	same
TKP	5	5.1	see tripotassium orthophosphate
TKPP	5	5.1	see tetrapotassium pyrophosphate
tricalcium phosphate	7	7.1	same
tripotassium monophosphate	5	5.1	see tripotassium orthophosphate
tripotassium orthophosphate	5	5.1	same
tripotassium phosphate	5	5.1	see tripotassium orthophosphate
trisodium monophosphate	5	5.1	see trisodium orthophosphate
trisodium orthophosphate	5	5.1	same
trisodium phosphate	5	5.1	see trisodium orthophosphate
TSP	5	5.1	see trisodium orthophosphate
TSPP	5	5.1	see tetrasodium pyrophosphate
viscosifiers	8	8.1	same
weighting agents	8	8.1	same
well grouting / sealing materials	8	8.1	same
wilkinite	4	4.1	see bentonite
zinc chloride	5	5.1	same
zinc orthophosphate	5	5.1	same
zinc sulfate	5	5.1	same

Informative Annex 4

(previously Annex E)

Revisions to the evaluation of bromate

The information contained in this Disclaimer is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Disclaimer may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

The revisions previously listed under Annex I-4 were incorporated into the Standard and became effective on January 1, 2013.

Informative Annex 5

(previously Annex F)

Examples of tamper evidence for bulk shipments

The information contained in this Disclaimer is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Disclaimer may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

While there is a clear need to protect all materials used in the treatment of potable water from tampering, there is also a clear understanding that tamper evidence (T/E) does not equal tamper proof. It is also understood that while a determined effort will find ways to subvert any tamper management protocol, it is the intent of this rule to make it much more difficult to do so.

With that in mind the following visual examples of typical temper evident measures are offered as a guide to future compliance with the rule. The general guide is that, if it takes less than a few minutes with simple hand tools to access the contents of a vessel, it then needs to be protected with appropriate T/E measures. Similarly if access is not logical, nonobvious or only indirect then normally T/E measures would not be appropriate for that area. On vessels with domes it is appropriate that the dome be protected with T/E measures. On vessels with dispersed fittings, then the above should be the guide.

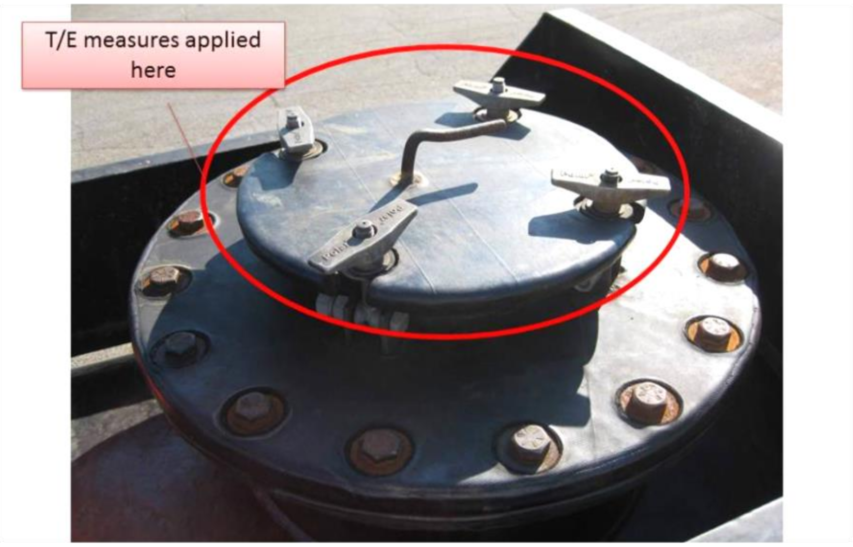
Products with the following end use functions are exempt from the product security requirements outlined in Section 3.9 of this standard as these products do not meet the definition of a drinking water additive under this Standard (see definition section of NSF/ANSI/CAN 60, 2.13 Direct additive):

— salt products (including sodium chloride, calcium chloride, and potassium chloride) used exclusively for softener resin generation;

— products used exclusively as feed stocks to chemical generators (examples: salt used in the electrochlorination process for on-site disinfectant generators, and oxygen for use in ozone generators); and

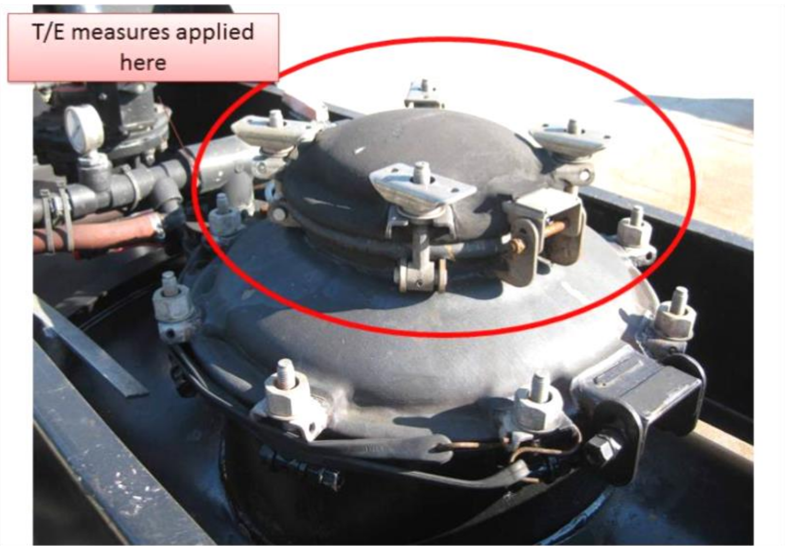
— products used exclusively in water well applications; including well cleaning aids, well-drilling aids and fluids, well pump lubricants, well rehabilitation aids, and well sealants.

I-5.1 Loading ports



Common load point protected; torqued bolts are not.

Figure 2



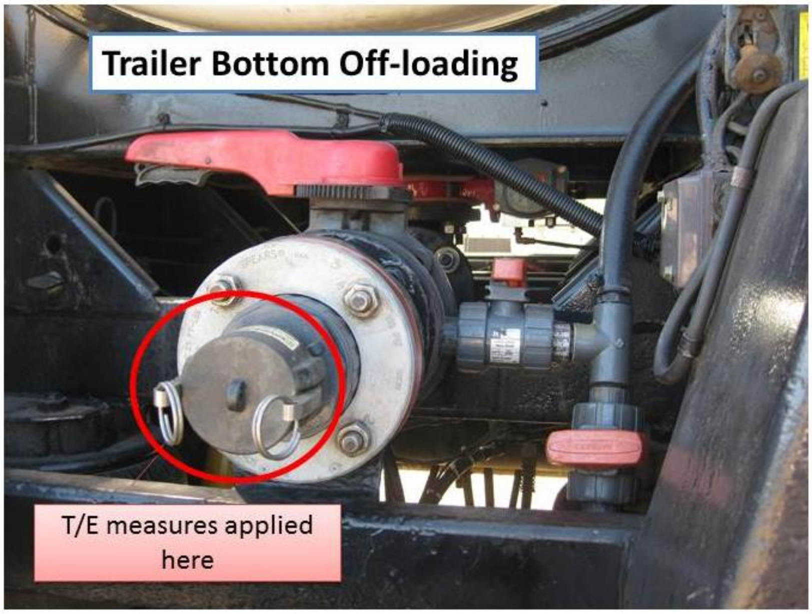
Common load point protected; torqued bolts are not.

Figure 3

I-5.2 Typical off-loading ports

Common off-load point protected; torqued bolts and miscellaneous air fittings are not.

Figure 4



Common off-load point protected; torqued bolts and miscellaneous air fittings are not.

Figure 5

I-5.3 Areas of a truck trailer not normally requiring tamper evident measures

Air fittings and offloading hoses not protected.

Figure 6

Miscellaneous in-line plumbing not protected.

Figure 7

Miscellaneous in-line plumbing not protected.

Figure 8

Miscellaneous in-line plumbing not protected.

Figure 9

Miscellaneous in-line plumbing not protected.

Figure 10

Torqued bolts not protected.

Figure 11

Off-loading hose not protected

Figure 12

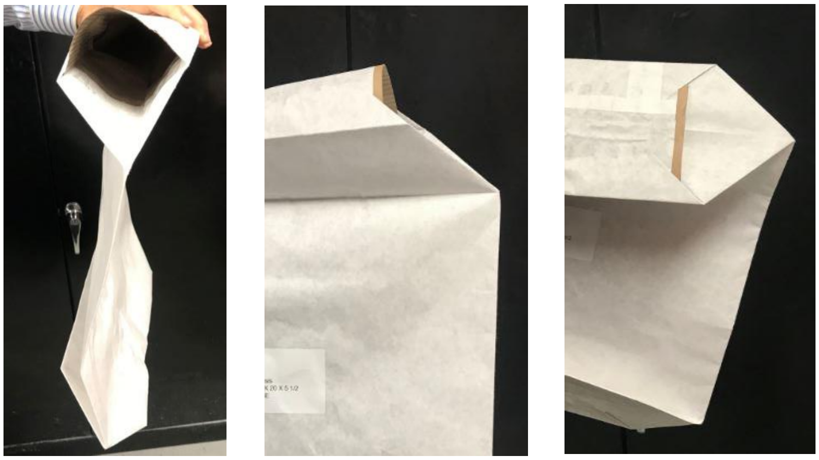
I-5.4 Examples of tamper evidence for outer packed shipments

Example of outer packaging providing tamper evidence of smaller containers.

Figure 13

Example of outer packaging providing tamper evidence for valve bags
via stretch-wrap / shrink-wrap or pallet sleeves

Figure 14



Examples of valve bag

Figure 15

Standards[25]

The following Standards established and adopted by NSF as minimum voluntary consensus Standards are used internationally:

Std. #	Standard title
2	Food Equipment
3	Commercial Warewashing Equipment
4	Commercial Cooking, Rethermalization, and Powered Hot Food Holding and Transport Equipment
5	Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
6	Dispensing Freezers
7	Commercial Refrigerators and Freezers
8	Commercial Powered Food Preparation Equipment
12	Automatic Ice Making Equipment
13	Refuse Processors and Processing Systems
14	Plastics Piping System Components and Related Materials
18	Manual Food and Beverage Dispensing Equipment
20	Commercial Bulk Milk Dispensing Equipment
21	Thermoplastic Refuse Containers
24	Plumbing System Components for Recreational Vehicles
25	Vending Machines for Food and Beverages
29	Detergent and Chemical Feeders for Commercial Spray-Type Dishwashing Machines
35	High Pressure Decorative Laminates for Surfacing Food Service Equipment
37	Air Curtains for Entranceways in Food and Food Service Establishments
40	Residential Wastewater Treatment Systems
41	Non-liquid Saturated Treatment Systems
42	Drinking Water Treatment Units – Aesthetic Effects
44	Residential Cation Exchange Water Softeners
46	Evaluation of Components and Devices Used in Wastewater Treatment Systems
49	Biosafety Cabinetry – Design, Construction, Performance, and Field Certification
50	Equipment and Chemicals for Swimming Pools, Spas, Hot Tubs, and Other Recreational Water Facilities
51	Food Equipment Materials
52	Supplemental Flooring
53	Drinking Water Treatment Units – Health Effects
55	Ultraviolet Microbiological Water Treatment Systems
58	Reverse Osmosis Drinking Water Treatment Systems
59	Mobile Food Carts
60	Drinking Water Treatment Chemicals – Health Effects
61	Drinking Water System Components – Health Effects
62	Drinking Water Distillation Systems
140	Sustainable Carpet Assessment
169	Special Purpose Food Equipment and Devices
170	Glossary of Food Equipment Terminology
173	Dietary Supplements

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[25] The information contained in this list of Standards is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Standards page may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

Std. #	Standard title
177	Shower Filtration Systems – Aesthetic Effects
184	Residential Dishwashers
223	Conformity Assessment Requirements for Certification Bodies that Certify Products Pursuant to NSF/ANSI 60 Drinking Water Treatment Chemicals – Health Effects
240	Drainfield Trench Product Sizing for Gravity Dispersal Onsite Wastewater Treatment and Dispersal Systems
244	Drinking Water Treatment Units Supplemental Microbiological Water Treatment Systems – Filtration
245	Wastewater Treatment Systems – Nitrogen Reduction
305	Personal Care Products Containing Organic Ingredients
321	Goldenseal Root (*Hydrastis canadensis*)
330	Glossary of Drinking Water Treatment Unit Terminology
332	Sustainability Assessment for Resilient Floor Coverings
336	Sustainability Assessment for Commercial Furnishings Fabric
342	Sustainability Assessment for Wallcovering Products
347	Sustainability Assessment for Single-Ply Roofing Membranes
350	Onsite Residential and Commercial Water Reuse Treatment Systems
350-1	Onsite Residential and Commercial Greywater Treatment Systems for Subsurface Discharge
358-1	Polyethylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems
358-2	Polypropylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems
358-3	Cross-linked Polyethylene (PEX) Pipe and Fittings for Water-based Ground-Source (Geothermal) Heat Pump Systems
358-4	Polyethylene of Raised Temperature (PE-RT) Tubing and Fittings for Water-based Ground-Source (Geothermal) Heat Pump Systems
359	Valves for Cross-linked Polyethylene (PEX) Water Distribution Tubing Systems
360	Wastewater Treatment Systems – Field Performance Verification
363	Good Manufacturing Practices (GMP) for Pharmaceutical Excipients
372	Drinking Water Treatment System Components – Lead Content
375	Sustainability Assessment for Water Contact Products
385	Disinfection Mechanics
401	Drinking Water Treatment Units – Emerging Compounds / Incidental Contaminants
416	Sustainability Assessment for Water Treatment Chemical Products
418	Effluent Filters – Field Longevity Testing
419	Public Drinking Water Equipment Performance – Filtration
426	Environmental Leadership and Corporate Social Responsibility Assessment of Servers
455-1	Terminology for the NSF 455 Portfolio of Standards
455-2	Good Manufacturing Practices for Dietary Supplements
455-3	Good Manufacturing Practices for Cosmetics
455-4	Good Manufacturing Practices for Over-the-Counter Drugs
457	Sustainability Leadership Standard for Photovoltaic Modules and Photovoltaic Inverters
600	Health Effects Evaluation and Criteria for Chemicals in Drinking Water
14159-1	Hygiene Requirements for the Design of Meat and Poultry Processing Equipment
14159-2	Hygiene Requirements for the Design of Hand-held Tools Used in Meat and Poultry Processing Equipment
14159-3	Hygiene Requirements for the Design of Mechanical Belt Conveyors Used in Meat and Poultry Processing Equipment

THE HOPE OF MANKIND rests in the ability of man to define and seek out the environment which will permit him to live with fellow creatures of the earth, in health, in peace, and in mutual respect.