BSR/ASHRAE Standard 514P

_____Public Review Draft

Risk Management for Building Water Systems: Physical, Chemical and Microbial Hazards

Second Public Review (February 2023)
(Draft Shows Proposed Independent Substantive Changes to Previous Public Review Draft)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at https://www.ashrae.org/technical-resources/standards-and-guidelines/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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180 Technology Parkway NW, Peachtree Corners, GA 30092

(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

The independent substantive changes to the previous public review draft shown reflect input from comments received during the first publication public review. The full text of the proposed ASHRAE Standard 514P was previously available for public comment during an Advisory Public Review (APR) and subsequent 1st full Publication Public Review (PPR).

This Independent Substantive Changes (ISC) Publication Public Review draft considers only the content which the project committee has revised since the 1st PPR draft to be open for public comment at this time. The 1st PPR draft is available to view for comparison to this ISC draft to better understand the revisions. The 1st PPR draft can be accessed by selecting the "View Related Archive Documents" button on the page where comments can be submitted on this current public review draft.

As part of the ASHRAE standards development process, the committee may elect not to consider comments that are outside of the scope of the ISC public review at this time. The committee recognizes that there may be some proposed changes submitted to content outside of the scope of this ISC draft which may be beneficial for the committee to consider. The committee will review all comments that are submitted, including those outside of the scope of the ISC draft. Comments outside of the ISC scope which the committee considers to be potential improvements to the standard may be considered for inclusion in a subsequent public review draft.

Upon publication, Standard 514 will be placed on continuous maintenance, which is a process which allows for the committee to revise sections of the standard based on based on proposals from the public or members of the committee, rather than requiring periodic revisions of the full text of the standard. While the committee may elect not to consider comments outside of the scope of the ISC draft at this time, where appropriate, the committee will defer selected comments to consider as continuous maintenance proposals after initial publication of the standard. For additional information regarding the continuous maintenance process, refer to "Standards and Guidelines Under Continuous Maintenance": https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-and-guidelines-under-continuous-maintenance.

For additional questions regarding the ASHRAE standards development process, please contact standards.section@ashrae.org.

Note to Reviewers: This public review makes proposed independent substantive changes to the previous public review draft. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions), except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the previous public review draft are open for review and comment at this time. Additional material is provided for context only and is not open for comment, except as related to the proposed substantive changes.

Modify Section 3 as shown. The remainder of Section 3 is unchanged.

3. DEFINITIONS

[…]

chemical hazard: any chemical substance associated with a *building water system* that, in the absence of *control*, has the potential to cause harm to humans.

[…]

commissioning: see *start-up*.

[…]

cross-connection: a physical connection between *potable* and *nonpotable* water systems, between treated and untreated ~~*nonpotable*~~ water systems, or between hot and cold *potable water systems*.

[…]

disinfection byproduct (DBP): a chemical byproduct that forms when *disinfectants* used for *microbial control* react with bromide and/or natural organic matter, such as decaying vegetation, already present in the water. Some *DBPs* can be metabolized by and promote the *growth* of a number of *microbial hazards* and some *DBPs* have been linked to increased health *risks*.

epidemiologically linked: a condition in which the patient or affected individual has been exposed to a *chemical* or *microbial hazard* and *transmission* of the *hazard* from a *building water system* ~~point source~~ by the usual modes is plausible. The link may be possible, likely, or confirmed.

FDA Class II: a filter that has been cleared by the U.S. Food and Drug Administration (FDA) as a Class II Medical Device pursuant to submittal of a 510(k) notification to the FDA for use as an aid in infection *control*.

~~***FIFRA:*** The Federal Insecticide Fungicide Rodenticide Act is the law that established federal regulation by the U.S. Environmental Protection Agency of pesticide distribution, sale, and use in the United States, including antimicrobial *disinfectants*.~~

[…]

~~***HVAC:*** heating, ventilating, and air conditioning.~~

[…]

microbial hazard: any *microbial* agent associated with a *building water system* that, in the absence of *control*, has the potential to cause harm to humans.

[…]

microorganisms: very small ~~single celled~~ organisms or infectious particles, including *bacteria*, protozoa, viruses, and some algae and fungi.

[…]

~~***NDMA:*** *N-Nitrosodimethylamine* is a semi-volatile organic chemical that is highly toxic and is a suspected human carcinogen, and in drinking water has been linked primarily to the use of monochloramine.~~

~~***nitrification:*** a process that can lead to depletion of the *disinfectant residual* in a *building water system* through the *microbial* oxidation of ammonia in the systems into nitrites, followed by the oxidation of the nitrites into nitrates.~~

[…]

~~***OSHA:*** the U.S. Occupational Safety and Health Administration.~~

[…]

physical hazard: any property of water associated with a *building water system* that, in the absence of *control*, has the potential to cause mechanical, thermal, or radiological harm to humans.

[…]

potable ~~water~~: water intended for human consumption, such as water intended for drinking, bathing, showering, hand washing, teeth brushing, food preparation, dishwashing, and maintaining oral hygiene.

[…]

primary disinfectant: a *disinfectant* applied to water as part of the *treatment* process in a drinking water *treatment* plant.

[…]

7-log reduction/F838: a filter performance rating demonstrating a filter has been validated for retention of at least 10^7 (>7 logs) *bacteria* per square centimeter of membrane surface from a *potable* water source when tested in accordance with ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters*

Utilized for Liquid Filtration. Also known as a 7-log (99.99999%) reduction *bacteria* filter.

[…]

start-up (starting up) (commissioning): initially placing a *building water system*(*s*) into operation and confirming that the system(s) are installed and operating as designed.

[…]

total retention/F838: a filter performance rating demonstrating that the filter has been validated for retention of all *bacteria* from a *potable* water source when tested in accordance with ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*. Also known as a "sterilizing-grade" filter.

Informative Note: A sterilizing grade filter does not provide USP sterile water.

[…]

~~***trihalomethanes:*** *disinfection byproducts* that are the result of a reaction between chlorine or monochloramine and natural organic matter in the water.~~

[…]

water processing equipment: mechanical equipment and associated components that can impact *potable* and *nonpotable* water quality and utility through actions such as conditioning, treating, screening, filtering, heating, tempering, cooling, heat exchanging, storing, controlling flow, controlling *backflow*, regulating pressure and pressure surges, and pumping.

[…]

Modify Section 4 as shown. The remainder of Section 4 is unchanged.

4. COMPLIANCE

The results of each Section 4 compliance determination and the associated new and existing building reviews in Section 4.1 and survey conducted by the *owner* in Section 4.2 *shall* be documented and *shall* be physically or electronically on-site for review by the *authority having jurisdiction* (*AHJ*).

[…]

4.1 Building Designer Requirements. The building designer *shall* review the design of *building water systems* in each new building, and in the renovation, addition, or modification of existing buildings. ~~and the associated *building water systems.*~~ If the design contains any of the following systems, devices, or factors, the design of the new building, renovation, addition, or modification *shall* comply with the applicable requirements of Section 7, "Requirements for Designing and Documenting Building Water Systems":

a. Systems and Devices
   1. …
   2. ornamental fountains or other water features~~,~~ that include misters, atomizers, air washers, *humidifiers*, or other *nonpotable* water systems or devices that release water *aerosols* in the building or on the site

b. Factors
   1. General Factors
      i. …
      ii. the building includes equipment on-site for ~~on-site~~ *supplemental disinfection* of *building water system potable* water

[…]

   2. Healthcare Factors
      i. …

ii. the building is a facility that provides long-term residential health services, including skilled nursing care, physical rehabilitation care, or both skilled nursing care and physical rehabilitation~~all of the following:~~

- ~~lodging,~~
- ~~board, and~~
- ~~nursing care, or physical care, or both nursing and physical care~~

[…]

4.2 Building Owner Requirements

[…]

4.2.5 The building *owner* of exhibition space *shall* require users of the exhibition space (including space used for temporary public display) that operate whirlpools, spas, ornamental fountains, misters, atomizers, air washers, *humidifiers*, or other *nonpotable* water systems or devices that release water *aerosols* in the space or on the site, to comply with the equipment manufacturer's operating instructions and comply with local *disinfection* codes and regulations.

4.3 Healthcare Facility Requirements

4.3.1 For buildings~~Buildings~~ containing healthcare facilities that do not contain any of the healthcare factors listed in Section 4.1(b)(2), "Healthcare Factors," the building *owner shall* comply with the requirements in Section 4.2, "Building Owner Requirements."

4.3.2 For buildings~~Buildings~~ containing one or more of the healthcare factors listed in Section 4.1(b)(2), "Healthcare Factors," the building *owner shall* comply with the requirements of Section 8, "Requirements for Healthcare Facilities," and the applicable requirements of Section 6, "Requirements for Building Water Systems."

Modify Section 5 as shown. The remainder of Section 5 is unchanged.

5. GENERAL REQUIREMENTS

[…]

5.2 Program Development

Note to Reviewers: Sections 5.2.1 and 5.2.2 are deleted in their entirety as shown. Subsequent sections and associated cross-references are revised accordingly.

5.2.1 ~~If the building has any of the devices listed in Section 4.1(a), "Systems and Devices," and none of the general factors listed in Section 4.1(b)(1), "General Factors," then a *Program shall* be implemented to manage the *risk* from physical, chemical, and *microbial hazards* associated with the *building water systems* and devices listed in Section 4.1(a), and *shall* comply with the requirements of Section 6, "Requirements for Building Water Systems."~~

5.2.2 ~~If the building has any of the general factors listed in Section 4.1(b)(1), "General Factors," then a *Program shall* be implemented to manage the *risk* from physical, chemical, and *microbial hazards* associated with all *building water systems* and all associated devices, including the *building water systems* and devices listed in Section 4.1(a), "Systems and Devices," and *shall* comply with the requirements of Section 6, "Requirements for Building Water Systems."~~

[…]

5.2.2 **Program Team.** … A member of the *Program Team shall* have building *owner* or senior organizational leadership authority and responsibility for the actions required by the *Program*, and to ~~make command decisions about~~ provide decision-making authority for *Program* activities, including, but not limited to, water-use restrictions, implementation of *remedial treatment*, and other response measures. The *Program Team shall* include, but not be limited to, one or more individuals selected from the following: the building *owner* or *designee*, employees, suppliers, contractors, consultants, or *building water systems* design

professionals.

[…]

5.2.8 Program Confirmation

[…]

b(2)(ii) There is a ~~prior~~ history of injury or illness from *microbial hazards* associated with the *building water systems*.

[…]

Modify Section 6 as shown. The remainder of Section 6 is unchanged.

6. REQUIREMENTS FOR BUILDING WATER SYSTEMS

[…]

All *building water systems* in Section 6 and all water *treatments shall* be installed, applied, and used in conformance to, and *shall* comply with, all applicable national, regional, and local regulations as determined by the *AHJ*.

[…]

6.1 Potable Water Systems…

6.1.1 System Start-up and Shutdown. The *Program documents shall* include procedures for:

a. ~~the maximum duration after shutdown~~ when *disinfection* and flushing is to be implemented before occupancy;

[…]

6.1.3 Water Treatment. The *Program documents shall* identify persons responsible for water *treatment* and *shall* provide the *owner* or *owner's designee* with ~~include~~ procedures for the application of water *treatment* products included in the *Program*, and confirmation that the products comply with applicable regulations.

[…]

6.1.4 Contingency Response Plan…

[…]

c. procedures for emergency remediation of physical, chemical, and *microbial hazards* identified by the *Program Team*. The procedures *shall*:
   1. ~~include the criteria for when and where physical, chemical, or *microbial testing shall* be performed, if the *Program Team* determines *testing* is to be performed~~
   2. comply with *AHJ* requirements
   3. include evaluation of the *water management program* by the *Program Team* to determine if changes are needed
   4. identify the person responsible for taking the *corrective action*, identify the required response time for taking the *corrective action*, and identify all persons to be notified

[…]

6.2 Open-Circuit Cooling Towers, Closed-Circuit Cooling Towers, and Evaporative Condensers. The *Program shall* comply with the requirements of Section 7.2, "Cooling Towers and Evaporative Condensers" of ANSI/ASHRAE Standard 188, *Legionellosis: Risk Management for Building Water Systems*[1].

6.3 Public Pools and Spas...

6.3.1 Microbiology…

6.3.2 Microbiological Testing…

a. a schedule for ~~minimum of monthly~~ *testing* of pool or spa water for indictor organisms and *pathogens* identified by the *Program Team* or as required by national, regional, or local regulation

[…]

6.3.3 Contingency Response Plan. The *Program documents shall* include procedures to be followed if there are *epidemiologically linked* known or suspected cases of illness, disease, or injury caused by *microbiological hazards* associated with pools or whirlpool spas.

6.4 Ornamental Fountains and Other Water Features...

6.5 Aerosol-Generating Misters, Atomizers, Air Washers, and Humidifiers…

6.5.1 Additional Chemical Water Treatment Requirements. When chemical water *treatment* is used:

a. the persons responsible for water *treatment shall* provide documentation to the *Program Team* ~~*shall*~~ of selected water *treatment* chemicals after *analysis of building water systems* as defined in Section 5.2.7, "Analysis of Building Water Systems" is completed; and

[…]

6.5.2 Physical Barriers. If filters are used to provide physical barriers to prevent *transmission* of *bacteria* in *potable* water~~are used for *microbial control*~~:

a. the filters ~~must~~ *shall* have a pore size of 0.22~~0.2~~ µm or less and ~~must~~ *shall* be *Total Retention/F838* or *7-Log Reduction/F838* filters.~~FDA cleared under 510(K) as a Class II medical device for use as an aid in infection *control*, and must comply with the requirements of ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*[3];~~

[…]

Modify Section 7 as shown. The remainder of Section 7 is unchanged.

7. REQUIREMENTS FOR DESIGNING AND DOCUMENTING BUILDING WATER SYSTEMS

7.1 Design Documents…

[…]

j. design provisions that address *hazardous conditions* for each of the following:

[…]

3. no-flow and low-flow (as defined by the *Program documents*) portions of the piping and *building water systems* for all utilization cases included in the *building water system* design;

[…]

7.2 Final As-Built Installation Documents

7.2.1 Drawings and documents of the *building water systems*' actual installation, applicable to the specific project, *shall* be provided to the building *owner* or *designee*, and *shall* include:

[…]

Modify Section 8 as shown. The remainder of Section 8 is unchanged.

8. REQUIREMENTS FOR HEALTHCARE FACILITIES

[…]

8.2.3 Designated Team. The building *owner*, senior organizational leadership, or their *designee shall* select the

members of the *Designated Team* and the *Designated Team* leader and *shall* delegate to the *Designated Team* the responsibility for developing and implementing the *Program*, the *Designated Team's* tasks, and any other activities assigned by the *owner*, senior organizational leadership, or their *designee*. The *Designated Team shall* be permitted to delegate *Program* tasks to subgroups. The *Designated Team shall* have knowledge of the *building water system* design and water management as related to physical, chemical, and *microbial hazards*, and associated *hazardous conditions*. ~~A member of the *Designated Team shall* have building *owner* or senior organizational leadership authority and responsibility for the actions required by the *Program*, and to make command decisions about water restrictions and other response measures.~~ The *Designated Team shall* include, but is not limited to:

a. one or more individuals selected from the following: the building *owner* or *designee*, employees, suppliers, contractors, consultants, or *building water systems* design professionals;
b. a building *owner* or senior organizational leader with authority to make command decisions;
c. a member of the facilities management staff with knowledge of the *building water systems*~~, if the facility has on-site facilities management staff~~;
d. an individual who has knowledge of the healthcare facility's Infection Prevention and Control program;
e. a person responsible for clinical care leadership at the healthcare facility; and
f. a member of Occupational and Environmental Safety Management (OES), if the facility has an OES program or a member of Environment of Care Management (EC), if the facility has an EC program.

8.2.4 Describe the Building Water Systems. The *Designated Team shall* identify and describe the *potable* and *nonpotable building water systems* within the building and on the building site, including:

~~a. a drinking water quality report for the water supplied to the building, if available, published by the *water utility* within eighteen months of the *risk management plan* review required by Section 8.2.11, "Existing Building Review, New Construction, and Renovation;"~~

[…]

8.2.9 Program Confirmation

[…]

b(3)(iii) There is a ~~prior~~ history of illness from *microbial hazards* associated with the *building water systems*.

[…]

Modify Informative Appendix A as shown. The remainder of Informative Appendix A is unchanged.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX A—BIBLIOGRAPHY

This informative appendix provides resources for additional information about physical, chemical, and *microbial hazards*. These resources are provided for the reader's convenience; however, the resources are provided without confirmation of suitability for any particular purpose.

[…]

ASTM. 2021. ASTM Standard D8422-21, *Standard Practice for Pre-Stressing Terminal Point-of-Use Water Filters before Testing by Test Method F838.* West Conshohocken, PA: American Society for Testing and Materials International.

[…]

CTI. 2020. CTI GDL-159, *Legionellosis Guideline: Practices to Reduce the Risk of Legionellosis from Evaporative*

Heat Rejection Equipment Systems. Houston, TX: Cooling Technology Institute.

[…]

GPO. Code of Federal Regulations, *Title 40 CFR 141-143*. Environmental Protection Agency National Primary Drinking Water Regulations. Washington, D.C.: U.S. Government Publishing Office.

GPO. Code of Federal Regulations, *Title 40 CFR 150-180*. Environmental Protection Agency Pesticide Programs Washington, D.C.: U.S. Government Publishing Office.

[…]

ISO. 2006. ISO 16266, *Water quality – Detection and enumeration of Pseudomonas aeruginosa – Method by membrane filtration.* Geneva, Switzerland: International Organization for Standardization.

ISO. 2018. ISO 16266-2, *Water quality – Detection and enumeration of Pseudomonas aeruginosa – Part 2: Most probable number method.* Geneva, Switzerland: International Organization for Standardization.

[…]

Note to Reviewers: Informative Appendix B, "Guidance if Microbial Testing is Utilized in the Absence of Suspected or Confirmed Facility-Associated Disease" of the 1st Publication Public Review draft of Standard 514P has been redesignated as Informative Appendix E herein. Informative Appendix C, "Building Water Systems Physical Hazards Guidance," Informative Appendix D, "Building Water Systems Chemical Hazards Guidance," and Informative Appendix E, "Building Water Systems Microbial Hazards Guidance," have been redesignated as Informative Appendix B, Informative Appendix C, and Informative Appendix D, respectively. All applicable section numbers and cross-references have been revised accordingly.

Modify Informative Appendix B as shown. The remainder of Informative Appendix B is unchanged.

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INFORMATIVE APPENDIX B—BUILDING WATER SYSTEMS PHYSICAL HAZARDS GUIDANCE

[…]

B2 References

[…]

5. ASSE. 2009. ANSI/ASSE Standard 1017, *Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems*. Mokena, IL: American Society of Sanitary Engineering.
6. CSA. 2022. CSA B125.3, *Plumbing Fittings*. Toronto, Canada: CSA Group.

Note to Reviewers: Informative Appendix B, "Guidance if Microbial Testing is Utilized in the Absence of Suspected or Confirmed Facility-Associated Disease" of the 1st Publication Public Review draft of Standard 514P has been redesignated as Informative Appendix E herein. Informative Appendix C, "Building Water Systems Physical Hazards Guidance," Informative Appendix D, "Building Water Systems Chemical Hazards Guidance," and Informative Appendix E, "Building Water Systems Microbial Hazards Guidance," have been redesignated as Informative Appendix B, Informative Appendix C, and Informative Appendix D, respectively. All applicable section numbers and cross-references have been revised accordingly.

Modify Informative Appendix C as shown. The remainder of Informative Appendix C is unchanged.

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necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX C—BUILDING WATER SYSTEMS CHEMICAL HAZARDS GUIDANCE

ACRONYMS AND ABBREVIATIONS

[…]

HAA	Haloacetic Acids – Disinfection byproducts that are the result of a reaction between chlorine compounds and other naturally-occurring chemicals in water.

[…]

NDMA	N-Nitrosodimethylamine – A semi-volatile organic chemical that is highly toxic and is a suspected human carcinogen.

[…]

THM	Trihalomethanes – toxic *disinfection byproducts* that are the result of a reaction between chlorine or monochloramine and natural organic matter in water.

[…]

C3 Contaminants Occurrence

~~*Contaminants*~~ The association of specific *disinfection byproducts* (*contaminants*) with specific *disinfectants* listed in Table C-1, "Antimicrobial Disinfection Chemicals Used for Supplemental Disinfection of Potable Water in Building Water Systems" is based on published information drawn from a number of sources, including laboratory studies and research on public water distribution systems. These *contaminants* may, but do not necessarily, occur when the *disinfectant* with which they are associated is used for *supplemental disinfection* of *potable* water in a *building water system*. When these *contaminants* do occur, some or all may be present and may be at concentrations of concern. Factors that may influence the occurrence of *contaminants* in *potable water systems* include:

[…]

Table C-1 Antimicrobial Disinfection Chemicals Used for Supplemental Disinfection of Potable Water in Building Water Systems

Antimicrobial Disinfection Chemicals[a]	Typical Control Range (Residual)	Associated Chemical Contaminants[b, c]	Associated Corrosion Products[b]
Chlorine	0.5 – 3.0 (MRDL: 4.0)	~~Bromate ion~~ Chlorate ion Haloacetic Acids (HAA) Trihalomethanes (THM)	Cadmium Copper Iron Lead Nickel
Chlorine Dioxide	0.1 – 0.8 (MRDL: 0.8)	~~Bromate ion~~ Chlorate ion Chlorite ion	
Monochloramine	2.0 – 3.0 (MRDL: 4.0)	Ammonia/Ammonium ion ~~Bromate ion~~ ~~Chlorine~~ Nitrate ion Nitrite ion ~~*N-Nitrosodimethylamine*~~	
Copper-Silver Ions	Copper: 0.2 – 0.8 Silver: 0.01 – 0.08 (MRDL: N/A)	Copper Silver	

Notes:

Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter in water are equivalent to parts per million (ppm).

a. Refer to Section D7, "Antimicrobial *Disinfection* Chemicals"

b. Refer to Section D8, "Chemical *Contaminants*"

c. N-Nitrosodimethylamine (NDMA) is a *disinfection byproduct* associated primarily with monochloramine and to a significantly lesser extent with chlorine and chlorine dioxide in public water systems. Research on NDMA formation in *building water systems* is limited and there are no publications showing NDMA formation in *building water systems*.

[…]

C7 Antimicrobial Disinfection Chemicals

[…]

C7.2 Chlorine Dioxide

Rules, regulations, guidance, etc.:

USEPA, MRDL = 0.8 mg/L

Analytical Method(s):

Standard Methods 4500-ClO_2-E or other USEPA approved methods

~~ChloridoX Plus (Amperometry using disposable sensors) (USEPA Approved 2013)~~

[…]

C8 Chemical Contaminants

C8.1 Ammonia/Ammonium Ion

Rules, regulations, guidance, etc.: Not Applicable

~~Health Canada, guidance: To help prevent nitrification, limit excess free ammonia entering the distribution system to below 0.1 mg/L, and preferably below 0.05 mg/L, measured as nitrogen.~~

Health Effects: …

Analytical Method(s): …

Note: Ammonia/ammonium ions are decay products of monochloramine.[9] ~~Ammonia/ammonium ions can be used as nutrients by certain *microorganisms*, including clinically significant *building water system* associated *pathogens* such as *Acinetobacter, Burkholderia, Elizabethkingia, Klebsiella,* non tuberculous~~

~~mycobacteria (NTM), *Pseudomonas*, *Sphingomonas*, and *Stenotrophomonas*.~~

~~Because ammonia/ammonium ions can be metabolized by these *pathogens*, ammonia/ammonium ions can promote their *growth*. In addition, certain *microorganisms* called nitrifying *bacteria* that are generally present in *potable water* can oxidize reduced nitrogen compounds (primarily ammonia) to form nitrite and nitrate. Nitrite and nitrate also can be metabolized by the above listed *pathogens*.[16,44,45,46] *Legionella* are not known to metabolize ammonia/ammonium ions, nitrate, or nitrite. (Refer to Informative Appendix D, "*Building Water Systems Microbial Hazards* Guidance," for information about specific *pathogens*.)~~

C8.2 Bromate Ion

[…]

Note: Bromate ion can be formed in reactions where bromide ion (in salt) is oxidized during the electrolytic production of sodium hypochlorite solution. Sodium hypochlorite solution (bleach) is the form of chlorine most often used for *supplemental disinfection*. ~~and is also used as a precursor chemical in the on site generation of chlorine dioxide and monochloramine. Bromate ion can also be formed in reactions where bromide ion (in salt) is oxidized during the electrolytic production of sodium chlorite, a precursor chemical used to generate chlorine dioxide.~~

[…]

C8.7 Haloacetic Acids

[…]

Note: The five haloacetic acids (HAA5) regulated by USEPA under SDWA are (1) monochloroacetic acid, (2) dichloroacetic acid, (3) trichloroacetic acid, (4) monobromoacetic acid, and (5) dibromoacetic acid. HAA5 are formed as *disinfection byproducts* of chlorine. Other haloacetic acids not regulated by USEPA under SDWA may also result from use of chlorine-containing *disinfectant* chemicals.

[…]

C8.11 Nitrate Ion

[…]

Note: Nitrate ions are decay products of monochloramine.[9] ~~Nitrification is a *microbial* process by which reduced nitrogen compounds (primarily ammonia) are sequentially oxidized to nitrite and nitrate. Ammonia can be present in source water used by some *utility water treatment* facilities. Nitrification in *potable* water is often associated with the use of monochloramine for *secondary disinfection*.[9] Nitrate can be used as a nutrient by certain *microorganisms*, including clinically significant *building water system*-associated *pathogens* such as *Acinetobacter*, *Burkholderia, Elizabethkingia*, *Klebsiella*, non-tuberculous mycobacteria (NTM), *Pseudomonas*, *Sphingomonas*, and *Stenotrophomonas*. Because nitrate can be metabolized by these *pathogens*, it can promote their *growth*.[16,44,45,46] *Legionella* are not known to metabolize nitrate. (Refer to Informative Appendix D, "*Building Water Systems Microbial Hazards* Guidance," for information about specific *pathogens*.)~~

C8.12 Nitrite Ion

[…]

Note: Nitrite ions are decay products of monochloramine.[9] ~~Nitrification is a *microbial* process by which reduced nitrogen compounds (primarily ammonia) are sequentially oxidized to nitrite and nitrate. Ammonia can be present in source water used by some *utility water treatment* facilities. Nitrification in *potable* water is often associated primarily with the use of monochloramine for *secondary disinfection*.[9] Nitrite can be used as a nutrient by certain *microorganisms*, including clinically significant *building water system*-associated *pathogens* such as *Acinetobacter*, *Burkholderia, Elizabethkingia*, *Klebsiella*, non-tuberculous mycobacteria (NTM), *Pseudomonas*, *Sphingomonas*, and *Stenotrophomonas*. Because nitrite can be metabolized by these *pathogens*, it can promote their *growth*.[16,44,45,46] *Legionella* are not known to~~

~~metabolize nitrite. (Refer to Informative Appendix D, "*Building Water Systems Microbial Hazards* Guidance," for information about specific *pathogens*.)~~

C8.13 N-Nitrosodimethylamine (NDMA)

[…]

Note: NDMA is a *disinfection byproduct* composed primarily of monochloramine, and to a lesser extent, of chlorine and chlorine dioxide. Other nitrosamines listed on CCL are *N*-nitrosodiethylamine (NDEA), *N*-nitroso-di-n-propylamine (NDPA), *N*-Nitrosodiphenylamine, and *N*-nitrosopyrrolidine (NPYR).

[…]

C8.15 Total Trihalomethanes (THM)

[…]

Note: The four trihalomethanes (total trihalomethanes [TTHM]) regulated under the SDWA are (1) chloroform, (2) bromodichloromethane, (3) dibromochloromethane, and (4) bromoform. Other trihalomethanes not regulated by USEPA under SDWA may also result from use of chlorine-containing *disinfectant* chemicals.

C9 References

[…]

~~16. Potgieter SC, Dai Z, Venter SN, Sigudu M, Pinto AJ. Microbial nitrogen metabolism in chloraminated drinking water reservoirs. *Sphere*. 2020;5(2). doi:10.1128/mSphere.00274-20~~

[…]

Note to Reviewers: Except as otherwise noted, subsequent reference numbers are revised accordingly.

~~44. Qin W, Li W, Zhang D, Huang X, Song Y. Ammonium reduction kinetics in drinking water by newly isolated Acinetobacter sp. HITLi 7 at low temperatures. Desalination Water Treat. 2016;57(24):11275-11282. doi:10.1080/19443994.2015.1043649~~

~~45. Van Alst NE, Sherrill LA, Iglewski BH, Haidaris CG. Compensatory periplasmic nitrate reductase activity supports anaerobic growth of Pseudomonas aeruginosa PAO1 in the absence of membrane nitrate reductase. Can J Microbiol. 2009;55(10):1133-1144. doi:10.1139/w09-065~~

~~46. Wu SQ, Chai W, Lin JT, Stewart V. General nitrogen regulation of nitrate assimilation regulatory gene nasR expression in Klebsiella oxytoca M5al. J Bacteriol. 1999;181(23):7274-7284. doi:10.1128/JB.181.23.7274-7284.1999~~

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Modify Informative Appendix D as shown. The remainder of Informative Appendix D is unchanged.

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INFORMATIVE APPENDIX D—BUILDING WATER SYSTEMS MICROBIAL HAZARDS GUIDANCE

This informative appendix provides information and guidance about *building water system microbial hazards*.

D1 What is a Microbial Hazard?

[…]

Building water system pathogens are different from fecal source *pathogens*, such as *E. coli*, *Cryptosporidium*, and *Giardia*, that inhabit the gastrointestinal tract of humans. Fecal source *pathogens* can contaminate *building water systems* due to inadequate *treatment* of water supplied to the building or *intrusion* of sewage into *potable* water. The primary path for fecal source *pathogens* to enter the body is through ingestion, not inhalation or *aspiration*. Fecal source *pathogens* are not naturally found in *building water systems*, but can infect healthy adults, generally causing gastrointestinal illnesses ~~similar to food poisoning~~, which can be severe.

While *microorganisms* can certainly lead to other water quality issues in *building water systems*, such as *microbially* induced corrosion and nitrification of the *building water system*, this appendix addresses *microbial hazards* in *building water systems* that can cause human illness. Nitrification is a process that can lead to the depletion of the *disinfectant residual* in a *building water system* through the *microbial* oxidation of ammonia in the systems into nitrites, followed by the oxidation of the nitrites into nitrates.

D2 How Do People Get Sick from Microbial Hazards?

Microbial hazards in *building water systems* can cause infection through a "chain of infection" pathway when susceptible human hosts are exposed to water containing ~~waterborne~~ *opportunistic pathogens* (Refer to Figure D1, "The Chain of Infection"). Breaking any single link in the chain of infection can stop *transmission* of the *microbial hazard* to an individual. The most effective *water management programs* interrupt the chain at multiple points and can be applied generally to prevent exposure to many *microbial hazards*, and not just one specific *pathogen*.

In order for a *microbial hazard* to cause illness or disease, a series of six conditions must be met, commonly referred to as the "chain of infection." For *building water systems*, this chain of infection consists of:

[…]

4. **Mode of Transmission.** The mode of *transmission* is the way a *pathogen* can be passed to a human host. This can be done by:
   a. inhalation of *aerosols* that can occur when water exits ~~shower heads,~~ *taps*, misters, and water features, such as fountains. Water splashing on sinks can also generate *aerosols*~~, and can occur when water splashes on a sink~~
   b. direct physical contact with (including *aspiration* of) water containing *pathogens*, such as can occur when consuming water or ice ~~drinking~~, bathing, or showering

[…]

5. **Portal of Entry.** A portal of entry is the way through which the *pathogen* enters a human host. Portals of entry associated with water from *building water systems* include, but are not limited to:

[…]

   c. getting water ~~"down the wrong pipe"~~ directly into the lungs (*aspiration*)

[…]

6. **Susceptible Host.** Presence of a susceptible human host, in which the entering *pathogen* ~~can~~ *grow* ~~and~~ cause disease. A susceptible host can be any individual, but the most vulnerable are:

[…]

   c. *at-risk individuals*, including, but not limited to, those receiving *treatment* for burns or receiving chemotherapy for cancer; those receiving *treatment* associated with solid organ or bone marrow

transplantation; those with underlying diseases, such as cancer, renal disease, diabetes, kidney failure, liver failure, and lung disease; ~~those with compromised skin integrity;~~ those with compromised skin integrity; those with weak immune systems or those taking drugs that weaken the immune system; those otherwise immunocompromised; infants; the elderly; current or former smokers. The population that may be "*at-risk*" for disease may vary depending on the *pathogen*.

[…]

D3 What Microbial Hazards Are Most Commonly Associated with Disease?

[…]

In healthcare environments, patient susceptibility to *opportunistic pathogens* commonly associated with *building water systems* is often greater than in the general population. Because patients are more susceptible, there are more *pathogens*, including *bacteria* and fungi, that can cause infections and disease in patients than in the general population. Patients are often more susceptible due to conditions such as non-intact skin, open wounds, immune suppressing drugs or diseases, or the presence of invasive devices.[1] Examples of *pathogens* commonly associated with ~~healthcare~~ *building water systems* that are commonly identified in cases of healthcare-acquired infections include: certain NTM species (*Mycobacterium abscessus* clade, *Mycobacterium avium* complex, *Mycobacterium mucogenicum*, *Mycobacterium phocaicum*, *Mycobacterium gordonae*, *Mycobacterium kansasii*, and *Mycobacterium xenopi*) and other *bacteria*, including *Legionella*, *P. aeruginosa*, *Stenotrophomonas maltophilia*, *Elizabethkingia*, *Burkholderia cepacia* complex, *Sphingomonas*, *Acinetobacter*, and fungi (*Aspergillus* and *Fusarium*).

[…]

D4 What Types of Infections Do These Microbial Hazards Cause?

[…]

D4.3 ***Legionella*.** The majority of known *Legionella* infections are caused by one species, *L. pneumophila*. However, of the about sixty recognized species in this genus, approximately half have been associated with human disease. *Biofilm*-associated protozoa, including those described below, can serve as a reservoir for *Legionella bacteria*. After *Legionella* multiplies in a *building water system*, exposure typically occurs when people inhale droplets of water in the air that contain *bacteria*. People can also get infected through *aspiration* of drinking water containing *Legionella*. People at increased *risk* of *aspiration* include those with swallowing difficulties, lung disease, and similar conditions. *Legionella* infection of the lungs can result in pneumonia (called *Legionnaires' disease*) or a milder, flu-like illness (called *Pontiac Fever*). *Legionella* can also cause extrapulmonary infections when contaminated water is introduced into the bloodstream, onto the skin, and during surgery.~~*Legionella bacteria* can cause *legionellosis*. Guidance information~~

Additional guidance on *Legionella* in *building water systems* is provided in ASHRAE Guideline 12, *Managing the Risk of Legionellosis Associated with Building Water Systems*.[2]

[…]

D5 How Are Microbial Hazards Controlled?

Knowledge of the quality of the water supplied at the point of entry to the building or to the site is important determining what actions are needed to *control microbial hazards*. To *control* the *growth* and spread of *microbial hazards* (*pathogens*) in *building water systems*, *control* over water temperature, system cleanliness to minimize presence of *biofilm* and sediment, and water quality conditions should be maintained by:

1. keeping hot water hot and keeping cold water cold
2. keeping the *building water system* clean
3. keeping water moving and maintaining adequate *disinfectant residual*

[…]

D5.1 Water Temperature. … This means that if hot water is allowed to cool, other *control measures* may be necessary to address the *risk* of *microbial growth* in the absence of *disinfectant residual*. Also, when using

elevated hot water temperatures to *control microbial growth*, additional controls, such as pressure balancing and thermostatic controls, should be installed, adjusted, and maintained to address the *risk* of *scalding* (refer to Informative Appendix B, "Building Water Systems Physical Hazards Guidance"). …

[…]

D5.3 Water Quality Conditions. *Building water system* water quality characteristics, such as temperature and *disinfectant residual*, may deteriorate in low-flow or no-flow conditions which can increase *water age*. Such conditions can occur where there are *dead legs*; during periods when the building is shut down; when there is low or no occupancy; and during periods where portions of the *building water system* are not used. If these conditions occur, system flushing ~~and other actions~~ to reduce *water age* should be applied in efforts to achieve ~~to return~~ *microbial control*~~, should be applied.~~ For additional information and guidance on the impact of water quality conditions on *microbial growth*, refer to Informative Appendix F, "Potable and Process Building Water Systems Guidance."

Presence of a *disinfectant residual* in water helps prevent the *growth* of *microorganisms* and can help *control biofilm* build-up. The level of *disinfectant residual* present in water supplied to the building point of entry will depend on many factors not controlled by the building *owner* or their *designee,* so the *water utility* should be requested to provide an analysis of the water quality, including *disinfectant* type and *residual* level, and to be provided notice when maintenance or alteration to the *water utility distribution piping* could affect the quality of supplied water. There is no universal recommendation for the *disinfectant residual* level that should be maintained in *building water systems*~~, but there is evidence that shows, in general, that even low *disinfectant residual* levels provide a healthier water system compared to one where no *disinfectant* is detected.~~[6] Tracking water quality and *disinfectant residual* level trends can serve as an effective tool in establishing operational *disinfectant residual* ranges and in determining when *corrective action* is needed. *Disinfectant residual* levels should be checked near the point where water enters the building, and at points upstream and downstream of where water is stored or processed, such as before and after storage tanks, water softeners, water heaters, and recirculating lines. *Disinfectants* in water entering the building are consumed by the chemical demand placed on it by the water being *disinfected* as the water moves through different areas of the *building water system* to the *water use end points*. At some point, there may be little or no *disinfectant residual* left to provide *microbial control* for the rest of the *building water system.* In areas with little or no *disinfectant residual* or where the *disinfectant* level has been found to be ineffective in *controlling* the *hazard, supplemental disinfection* or some other *control measures* should be considered.

[…]

D6 References

~~6. Tsitsifli, S., and Kanakoudis, V. 2018. Disinfection Impacts to Drinking Water Safety–A Review. *Proceedings*, 2(11): 603. https://doi.org/10.3390/proceedings2110603~~

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INFORMATIVE APPENDIX E—GUIDANCE IF MICROBIAL TESTING IS UTILIZED IN THE ABSENCE OF SUSPECTED OR CONFIRMED FACILITY-ASSOCIATED DISEASE

E1 Reasons for Conducting Microbial Testing

Testing water samples for the presence of *microorganisms* is a common way to confirm that a *water management program* (*Program*), when implemented as designed, effectively *controls* the *hazardous conditions* associated with *microbial hazards* throughout the *building water systems* (*validation*). *Microbial testing* may also be useful for evaluating potential *growth* and *transmission* sources or confirming the results of *remedial treatment*. The results from a single *microbial* sampling may not be ~~are not~~ predictive of disease but may indicate a condition requiring further study…

E2 Targets for Microbial Testing

It is impractical for facilities to test for every potentially *pathogenic microorganism* known to be associated with *building water systems*. The building *owner* or the *Program Team* may elect to test for a limited set of *microorganisms* that can serve to indicate whether the conditions for *microbial growth* are well-controlled in an effort to perform *validation* of the *Program*. If *testing* indicates that these *microorganisms* are well-controlled, ~~it is helpful to assume~~ it could be assumed that the *growth* of some similar *microorganisms* that are not tested may also be well-controlled. ~~This limited set of *microorganisms* is often referred to as an "indicator" or "sentinel" organisms and may or may not be potential *pathogens* themselves. For *microbial hazards*, such as *Legionella*, there may not be an identified indicator or sentinel organism. The most common and commercially available test methods target the following organisms: general heterotrophic *growth*, *Legionella*, and *Pseudomonas*.~~ Facilities that serve populations at greater *risk* for disease, such as healthcare, may benefit from *testing* for additional specific *pathogens* known to affect the types of patient populations that the facility serves or for additional specific *pathogens* known to be common to the facility's location.

E2.1 Heterotrophic Plate Count (HPC). Heterotrophs are any *microorganism* that requires~~uses~~ organic carbon as a food source, as opposed to ~~auxotrophs~~ autotrophs that gain energy from sunlight or chemical reactions. The number of viable heterotrophs is considered an indirect ~~a general~~ measure of water quality and the effectiveness of the *water management program* to *control microbial growth*. HPC is a test method to assess heterotrophic counts, but other test methods exist. Although there is no universal test method to measure heterotrophs, *microbial*~~*Microbial*~~ *testing* to count the viable heterotrophs is always conducted by culture and may be performed on-site or in a laboratory according to a standard method.

[…]

E2.3 *Pseudomonas aeruginosa*. *Pseudomonas bacteria* can cause a variety of illnesses, including rashes, pneumonia, and sepsis. ~~*Pseudomonas aeruginosa* (*P. aeruginosa*) is the most common *pathogenic* species.~~ *Pseudomonas bacteria* are often ~~central and underlying members~~ primary colonizers and important components of a *biofilm*.~~, so *testing*~~ *Testing* for ~~*Pseudomonas*~~ *P. aeruginosa* can indicate whether conditions that promote establishment, *growth*, or persistence of *biofilms* exist within the *building water systems*. Due to its prevalence in *building water systems*, facilities where *at-risk individuals* are housed may find information from *P. aeruginosa testing* to be useful. Commercial test methods for generic *Pseudomonas bacteria* or the species *P. aeruginosa* are available and are usually conducted by culture methods in accredited laboratories. ~~may include~~ In addition to culture, alternative methods may be available, such as molecular methods, ~~PCR, serology~~ antibody-based methods, and other technologies. *Pseudomonas* often *grow* on the media used for HPC but cannot be definitively identified with the HPC test method.

E3 Microbial Test Methods

Microbial tests may be performed by a contracted laboratory or on-site by the user or *Program Team*. It is necessary for the user or the *Program Team* to understand the characteristics of the *microbial* test method utilized, including, but not limited to, sensitivity, limit of detection, and specificity in order to correctly interpret test results. In the case of *epidemiologically linked* suspected or confirmed facility-associated disease, consult the *AHJ* for response and *testing* requirements.

[…]

Where on-site ~~non-laboratory~~ *testing* is utilized, the provider should supply the user with documentation or evidence that the performance characteristics of the method of *testing* for the *microbial hazard* have been

validated to a recognized consensus standard, such as those available from ISO or ASTM, by a qualified, independent third party. It is important that all *microbial* test manufacturer's instructions for sample collection and transport be followed, without deviation from the test protocol.

E3.3 Culture. Culture is a broad term for test procedures that involve *growing microorganisms* on or in artificial media. Culture methods have historically been the most frequently used test methods to determine whether viable *microorganisms* are present in a sample. However, some stressors, such as the absence of adequate nutrients, exposure to *disinfectants*, and exposure to higher temperatures, can cause *microorganisms* to enter a state called "*viable but nonculturable*" (*VBNC*) where the *microorganisms* are not dead but cannot be detected by culture *testing*. Furthermore, some *microorganisms*, such as *Legionella* and *Pseudomonas aeruginosa*, require specialized artificial media for *growth* and identification, while others, such as heterotrophs, can *grow* on ordinary media. ~~Many culture tests are performed in a laboratory, however, heterotrophic plate count (HPC) tests may be conducted on site, if the conditions for incubation set by the test manufacturer can be met.~~ It should be noted that reliable culture tests are not commercially available for all known *microorganisms* or *opportunistic pathogens*. The results from culture tests are expressed as either CFU (colony forming units) or MPN (most probable number) per unit volume tested (usually milliliter or liter) and are typically available in two to fourteen days.

E3.4 ~~Polymerase Chain Reaction (PCR)~~Molecular Methods. ~~PCR *testing* is a procedure that detects~~ Molecular methods are procedures that detect the genetic material of organisms. ~~PCR~~ Molecular tests may be specific to:

a. a single *microorganism*;

b. a subset of related *microorganisms* (such as multiplex PCR tests that can detect and distinguish between *Legionella pneumophila* serogroup 1, *Legionella pneumophila* serogroups 2 through 15, and all other *Legionella* species simultaneously); or

c. a broad class of *microorganisms*.

Depending on the *microorganism*(*s*), ~~PCR~~ molecular methods can be used to detect a much larger variety of *pathogens* than culture methods. ~~PCR~~ Molecular tests for many *microorganisms* may be laboratory developed and the performance characteristics should be validated; refer to Section B3.4, "Emergent Test Methods." Molecular tests may not be able to discriminate between live and dead *microorganisms*.; ~~however~~However, ~~PCR~~ molecular tests are able to detect *VBNC microorganisms*. ~~PCR~~ Molecular tests can be an effective screening tool prior to or concurrently with culture *testing* because samples with negative ~~PCR~~ test results are extremely unlikely to yield positive results with culture *testing*. ~~PCR~~ Molecular tests are most often performed by a laboratory, but emergent technologies may allow for ~~PCR~~ molecular tests to be performed on-site by the user or *Program Team*. ~~PCR~~ Molecular test results are available within twenty-four to forty-eight hours and are expressed as GU (genomic units) per unit volume tested (generally GU/mL).

E3.5 ~~Serology~~Antibody-Based Testing. ~~Serology~~ Antibody-based *testing* uses antibodies to indicate the presence of a *microorganism*. ~~Serological~~ Antibody-based *testing* may be performed by a laboratory or may be performed on-site by the user or the *Program Team*. The most common type of antibody-based~~serological~~ test is the lateral flow platform. In this test, capillary action wicks the sample fluid through a matrix impregnated with an antibody capable of reacting with a particular *microorganism* or with a small set of closely related *microorganisms*. ~~The ability of the test antibody to react with a particular *microorganism* typically makes serological *testing* more specific than either culture or PCR *testing*.~~ If target *microorganisms* are present, the antibody reaction is usually displayed by the antibody-based~~serological~~ test as a solid line. Although it is theoretically possible for the antibodies used in antibody-based~~serological~~ *testing* to detect parts of dead cells, the impact on test results is negligible because dead cells do not remain intact for very long. Determining if the target *microorganism* is present (qualitative results) can be accomplished in minutes using antibody-based~~serological~~ *testing*, such as the lateral flow platform. Laboratory based antibody-based~~serological~~ *testing* can return results that may indicate the quantity of target *microorganisms* present in the sample (quantitative results) in two to five days. Consult the *testing* laboratory for an explanation of the units in which results are expressed.

E3.6 Emergent Test Methods. Test methodologies are constantly evolving and improving. When considering the use of emergent test methods, consider the following:

a. test results turnaround time
b. specificity: Does the method only detect the desired *microorganism* when it is present in a mixture of *microorganisms*?~~provide the desired ability to differentiate between *microorganisms*?~~
c. sensitivity: Does the method provide the ability to detect *microorganisms* at the expected *microbial* concentration?
d. false positive and false negative rates
e. ability to discriminate between live and dead *microorganisms*
f. ability to determine subtypes of *microorganisms*~~ability to determine the virulence (disease causing severity) of the target *microorganisms*~~
g. where the test method may be performed (e.g., in a laboratory, on-site, or either)~~ability of the test method to be performed on-site~~

When evaluating emergent technologies, the test method should be validated by a third party that specializes in such validations, and the performance characteristics of the test method should be well-established.

E4 Responses to Microbial Test Results

The user or the *Program Team* should determine the most appropriate responses to test results, in consultation with the *testing* laboratory or test manufacturer's instructions, before *testing* is conducted. ~~*Microbial* test results alone should never automatically trigger actions such as *remedial treatment*.~~ Whenever possible, *microbial* test results should be considered in combination with other water quality indicators when determining whether remediation is needed and how it should be conducted. Healthcare professionals may use *microbial* test results to inform clinical practices, such as the type of disease screening performed. *Microbial* test results may be useful to establish a baseline and to determine change over time. A user or the *Program Team* may use results to document and determine the effectiveness of the *water management program* over time. *Microbial* test results should be reviewed at least *annually*. *Microbial testing* schedules may be modified in accordance with the *risk* analysis of both *microbial* test results and water quality changes over time. The most common *microorganisms* that can serve to indicate whether the conditions for *microbial growth* are well-controlled are heterotrophs as measured by HPC, *Pseudomonas aeruginosa*, and *Legionella*. ~~A general guide for interpreting results from *testing* for *heterotrophs* and *Pseudomonas aeruginosa* is presented in Table B-1. Guidance for interpreting and responding to results from *testing* for *Legionella* is available in ASHRAE Guideline 12, *Managing the Risk of Legionellosis Associated with Building Water Systems*, Appendix C4, "Interpretation of Test Results," and Appendix C5, "Responses to *Legionella* Test Results."~~ However, it should be noted that there is no evidence showing *control* of HPC alone correlates to *control* of any *opportunistic pathogens* specifically discussed in this standard. Interpretation and response to HPC test results should consider baseline values of *potable* water supply at the point of entry, the *building water systems*, and how both trend over time. Specific action limits may be required by the *AHJ*.

~~**Table E-1 Interpreting Microbial Test Results for Common Indicator Microorganisms in Potable Building Water Systems[1,2,3,4,5]**~~

~~Microorganisms[a]~~	~~Growth Appears to Be Well-Controlled~~	~~Growth May Be Occurring~~	~~Growth Appears to Be Poorly Controlled~~	~~Growth Appears to Be Uncontrolled~~
~~Heterotrophs (HPC)~~	~~Not detected or <500/mL~~	~~500/mL to 999/mL~~	~~>999/mL to 10,000/mL~~	~~>10,000/mL~~
~~*Pseudomonas aeruginosa*[b]~~	~~Not detected or <1/100 mL~~		~~1/100 mL to 10/100 mL~~	~~>10/100 mL~~

~~a. State or local requirements for *microbial control* may indicate the use of different values~~

~~b. Values derived from acceptable limits for *potable water* in high-*risk* healthcare *building water systems*[3,5]~~

~~**Table E-2 Interpreting Microbial Test Results for Common Indicator Microorganisms in Nonpotable Building Water Systems**[1,2,3,4,5]~~

~~**Microorganisms**~~[a]	~~**Growth Appears to Be Well-Controlled**~~	~~**Growth May Be Occurring**~~	~~**Growth Appears to Be Poorly Controlled**~~	~~**Growth Appears to Be Uncontrolled**~~
~~Heterotrophs (HPC)~~	~~Not detected or <500/mL~~	~~500/mL to 999/mL~~	~~>999/mL to 10,000/mL~~	~~>10,000/mL~~
~~*Pseudomonas aeruginosa*~~[b]	~~Not detected or <1/100 mL~~		~~1/100 mL to 10/100 mL~~	~~>10/100 mL~~

~~a. State or local requirements for *microbial control* may indicate the use of different values~~

~~b. Values derived from European pool water values where pool water is considered drinking water~~[3,5]

~~**E5 References**~~

1. ~~GPO. 2016. Code of Federal Regulations, Title 40 CFR 141.74, "Analytical and monitoring requirements." Washington, D.C.: U.S. Environmental Protection Agency.~~
2. ~~EU. 2020. Official Journal of the European Union, Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption. Brussels, Belgium: European Union, European Parliament.~~
3. ~~UK. 2016. Department of Health, Health Technical Memorandum 04-01: Safe water in healthcare premises – Part C: Pseudomonas aeruginosa – advice for augmented care units. London, United Kingdom: Department of Health and Social Care.~~
4. ~~Italy Pool/Spa regulation – P. aeruginosa. Dipartimento di Ambiente e Connessa Pervenzione Primaria, Istituto Superiore di Sanita, Roma. http://www.iss.it/binary/publ/cont/13_46_web.pdf~~
5. ~~HPSC. 2015. Guidelines for the Prevention and Control of Infection from Water Systems in Healthcare Facilities. Dublin, Ireland: Health Protection Surveillance Centre.~~

Modify Informative Appendix G as shown. The remainder of Informative Appendix C is unchanged.

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INFORMATIVE APPENDIX G—BUILDING DESIGNER GUIDANCE

[…]

G2 Predesign Consultation

[…]

d. The designer should obtain and document the following information from the *Program Team*, the *Designated Team*, the building *owner*, or their *designee*, if it has not already been provided:

[…]

4. Measures to address *water age*:

[…]

ix. How often must the cold water in a sink be run, a hose bib utilized, or a toilet flushed to not be considered low-flow?

5. Mitigation and emergency response measures:

[…]

iii. Is *monitoring* incoming water parameters intended? If yes, define what parameters would be

monitored. Parameters may include, but are not limited to, the following: temperature, pH, conductivity, *disinfectant residual*, *turbidity*, pressure, etc.

iv. Is automatic emergency shutdown of the primary water source desired? If yes, define automatic emergency shutdown conditions (such as when a *building water system* loses pressure or *water utility distribution piping* experiences a pressure loss). This is only recommended if the facility has a secondary water source.

[…]

G3 Potable Building Water System Design

[…]

b. **Potable Building Water System Design Elements. …**

[…]

1. Both hot and cold *potable building water systems*

[…]

xvi. Create water volume calculations for the piping system (e.g., total building volume, total volume by floor)

[…]

G5 Other Building Water System Design Guidance

[…]

h. system water volume

[…]

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INFORMATIVE APPENDIX H—HEALTHCARE FACILITY GUIDANCE

[…]

H2 Program Development

H2.1 Considerations. When developing, implementing, and documenting the *risk management plan*, the *Designated Team* should consider:

[…]

g. the impact of construction *risk* factors that may occur within or around patient care environments

~~g.~~h. *physical hazards*…

~~h.~~i. *chemical hazards* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance"). Certain *chemical hazards* require special consideration because of their relationship to *control measures* used in connection with *microbial hazards.* ~~For example, *disinfection byproducts* and decay products of monochloramine, a *disinfectant* used by some *water utility treatment* facilities as a *secondary disinfectant* and sometimes added directly to *building water systems* as a *supplemental disinfectant*, can serve as a food source for a number of clinically significant *microbial hazards*. The *disinfection byproducts* and decay products that serve as food sources for some *microbial hazards* can promote the *growth* of these *microbial hazards* in the *building water systems*.~~

[…]

H2.2 Prerequisites. To prepare for developing the *risk management plan*, the *Designated Team* should identify and consider existing information, policies, programs and requirements, including:

a. existing facility documents, records, and information resources (including their location, as applicable), including:

[…]

7. list of approved projects that will impact the *water management program*

[…]

c. applicable rules, regulations, codes, accreditation requirements, public health guidance, and industry standards that may affect its *risk management plan*, including, but not limited to:

[…]

9. Facility Guideline Institute Design and Construction of Hospitals (or Outpatient Facilities, or Residential Health, Care, or Support Facilities)

[…]

H2.3 Describe the Building Water Systems.

H2.3.1 Site Plan. The following locations and information associated with the healthcare facility should be shown on schematic drawings. Each drawing should be current and accurate, uniquely titled, and should identify any associated support documents. If more than one schematic drawing is used, there should be a single overview drawing to indicate the applicable locations described by supplemental schematic drawings:

a. all buildings on the site
a. building air intakes
b. cooling towers

[…]

H4 Control Measures

[…]

H4.1.3 Measures for Controlling Water Age. The residence time of the water in one or more locations in the *building water system* is an important factor in *microbial growth*. The probability of *microbial colonization* and proliferation increases with *water age*. *Water age* is frequently associated with low-flow conditions and can result in accumulation of sediment, loss of *disinfectant residual,* and water temperatures favorable to *microbial growth*. *Water age* is affected by *building water system* design, component selection, variations in building occupancy, construction activities, and water-use patterns.

[…]

H4.1.4 Measures for Maintaining a Disinfectant Residual. …

a. **Secondary Disinfection. …**
b. **Supplemental Disinfection. …** For chlorine, chlorine dioxide, monochloramine, and copper-silver, *disinfection byproducts* should be measured on a scheduled basis. ~~In addition, when monochloramine is used for *supplemental disinfection*, routine screening for *microbial hazards* that can metabolize ammonia, nitrite, and nitrate should be implemented. Quantitative polymerase chain reaction (qPCR) is one method that can be used to detect, quantify, and type all of the *microbial hazards* listed in this standard, and that are identified by the *CDC* as clinically significant in healthcare facilities. (Refer to Informative Appendix B, "Guidance if *Microbial Testing* is Utilized in the Absence of Suspected or Confirmed Facility-Associated Disease.")~~

H4.1.5 Measures for Blocking or Preventing Direct or Indirect Transmission of Microbial Hazards from Contaminated Water. Point-of-use and inline filters validated for *7-Log reduction/F838* or validated for *total retention/F838* can provide a barrier to *transmission* of *bacteria* in *potable* water. In the United States, point-of-use and inline filters used to provide a barrier to *transmission* of *microbial hazards* in *potable* water in areas of the facility used to house or treat inpatients should be *FDA Class II*. Outside the United States, point-of-use and inline filters used to provide a barrier to *transmission* of *microbial hazards* in *potable* water in areas of the facility used to house or treat inpatients should be approved by a comparable governmental regulatory agency.

~~Point-of-use and inline filters that comply with the sterilizing grade requirements of ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*, can provide a barrier to *transmission* of *bacteria* in *potable* water. In the United States, point-of-use and inline filters used to provide a barrier to *transmission* of *microbial hazards* in *potable* water should be FDA (510 K) cleared as a Class II Medical Device to aid in infection *control* and certified to the pertinent standard, such as ASTM F838. Outside the United States, point-of-use and inline filters used to provide a barrier to *transmission* of *microbial hazards* in *potable* water should have comparable approval by a governmental agency and certification to a pertinent standard.~~

a. **Water at Water Use End Points.** Point-of-use and inline filters are sometimes used on a temporary basis, such as during an *outbreak* investigation~~,~~ or during a construction event, to provide a barrier to ~~*microbial*~~ *transmission* of *bacteria* from *water use end points*, such as showers and sink *taps*. Point-of-use and inline filters are also sometimes used as part of routine practice to provide a longer-term barrier to *transmission* of ~~*microbial hazards*~~ *bacteria* from *water use end points*, such as showers and sink *taps*, especially those in close proximity to persons~~, at relatively high *risk* of infection,~~ such as bone marrow transplant patients, at higher *risk* of infection by waterborne *bacteria* than the general patient population. The use of filters does not *control* the *growth* of *bacteria* or other *microbial hazards* in *building water systems*. Additional guidance for the use of filters to block *transmission* of *bacteria* from contaminated *potable* water is available in ASHRAE Guideline 12, *Managing the Risk of Legionellosis Associated with Building Water Systems*, Section 5.3.3, "Physical Barriers."

b. **Water Used in Medical Devices.** USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be used in medical devices. The water should meet or exceed the water quality specified in manufacturer's instructions. *Tap* water may be used in medical devices only if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.

~~*Tap* water should never be used in medical devices that use water. Only sterile water (such as water filtered by FDA-cleared Class II devices that meet or exceed the sterilizing grade requirements of ASTM F838), should be used in medical devices and the manufacturers' instructions should be followed.~~

~~All medical devices that use water should be clearly labeled: "DO NOT USE *TAP* WATER IN THIS DEVICE OR TO WASH OR RINSE THIS DEVICE. ONLY USE WATER THAT MEETS THE SPECIFICATIONS IN THE *RISK MANAGEMENT PLAN*." Examples of medical devices that should be labeled include:~~

1. ~~dental scalers~~
2. ~~enteral feeding devices~~
3. ~~heater-cooler units~~
4. ~~hydrotherapy equipment~~
5. ~~lactating equipment~~
6. ~~mechanical ventilators~~
7. ~~oral care devices~~
8. ~~respiratory therapy equipment (such as CPAP machines)~~

c. ~~**Water Used for Washing or Rinsing Medical Devices.** *Tap* water should never be used for washing or rinsing medical devices. Only sterile water (such as water filtered by FDA-cleared Class~~

~~II devices that meet or exceed the sterilizing grade requirements of ASTM F838), should be used to wash or rinse any medical devices and the manufacturer's instructions should be followed. Medical devices covered by a device categorization in the AAMI Standard TIR34 should follow the guidance in Section H4.1.5(d), "Water Used for Reprocessing Medical Devices."~~

~~All medical devices and instruments (except those covered by AAMI TIR34) that are rinsed or washed with water should be clearly labeled: "DO NOT USE *TAP* WATER IN THIS DEVICE OR TO WASH OR RINSE THIS DEVICE. ONLY USE STERILE WATER." Examples of medical devices that should be labeled include:~~

1. ~~dental scalers~~
2. ~~enteral feeding devices~~
3. ~~heater-cooler units~~
4. ~~hydrotherapy equipment~~
5. ~~lactating equipment~~
6. ~~mechanical ventilators~~
7. ~~oral care devices~~
8. ~~respiratory therapy equipment (such as CPAP machines)~~

d. **Water Used for <u>Washing, Rinsing, or</u> Reprocessing Medical Devices**

1. <u>For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions.</u>
2. <u>For medical device reprocessing not covered by AAMI TIR34, USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be used for washing, rinsing, or reprocessing. The water should meet or exceed the water quality specified in manufacturer's instructions.</u>
3. <u>*Tap* water may be used to wash, rinse, or reprocess medical devices only if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.</u>

~~*Tap* water should never be used for reprocessing *FDA Class II* or higher medical devices, medical devices categorized in the AAMI Technical Information Report, or similarly classified medical devices. Only use water that meets the more stringent of (1) the requirements of the manufacturer's instructions, (2) AAMI TIR34, *Water for the Reprocessing of Medical Devices*, or (3) the requirements of the *AHJ*. Reprocessing should be conducted in accordance with the device manufacturer's instructions. *Tap* water, without further processing, is likely not compliant with AAMI standards for water quality.~~

~~All medical devices and instruments that are to be reprocessed with water should be clearly labeled: "DO NOT USE *TAP* WATER. ONLY USE WATER THAT MEETS THE SPECIFICATIONS IN THE *RISK MANAGEMENT PLAN* FOR REPROCESSING THIS DEVICE." Examples of medical devices that should be labeled include:~~

1. ~~endoscopes (such as bronchoscopes, laparoscopes, cystoscopes, colonoscopes, and enteroscopes)~~
2. ~~cardiovascular catheters, EP cables, and introducer sheaths~~
3. ~~arthroscopic/orthopedic devices and instruments (such as arthroscopic shavers, wands, bits, burs, and blades)~~
4. ~~surgical devices and instruments (such as clamps and dissectors, infusion pressure bags, reamers, suture passers, soft tissue ablators, scissor tips, and balloon inflation devices)~~
5. ~~laparoscopic devices and instruments (such as sealers and dividers, ultrasonic scalpels, trocar babcocks, dissectors, graspers, and scissors)~~

e. **Water Supplied to or Used <u>in</u> ~~for Washing/Rinsing~~ Non-Medical Devices/Equipment Used for**

Patient or Resident Care. USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be supplied to or used in *humidifiers* (non-steam), ice machines, misters, or other items used for patient or resident care determined by the *Designated Team*. *Tap* water may be used in *humidifiers* (non-steam), ice machines, misters, or other items used for patient or resident care if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.

~~Non-medical devices/equipment used in healthcare environments that may be in contact with patients, directly or indirectly, should only be supplied with sterile water (such as water filtered by FDA-cleared Class II devices that meet or exceed the requirements of ASTM F838). The device/equipment should be regularly disinfected with an approved *disinfectant*. If there is rinsing after *disinfection*, only sterile water should be used. Do not rinse with *tap* water after being disinfected. These include, but are not limited to:~~

~~1. *humidifiers* (non-steam)~~

~~2. ice machines~~

~~3. misters~~

~~All non-medical devices/equipment in healthcare environments that may be in contact with patients, directly or indirectly, should be clearly labeled: "DO NOT SUPPLY WITH *TAP* WATER OR USE *TAP* WATER TO WASH OR RINSE THIS DEVICE. ONLY USE STERILE WATER."~~

f. **Water Used for Washing/Rinsing Non-Medical Devices/Equipment Used for Patient or Resident Care.** USP sterile water, water filtered by *FDA Class II* filters that are validated for *total retention/F838*, or water filtered by *FDA Class II* filters that are validated for *7-Log reduction/F838*, should be used for washing/rinsing in *humidifiers* (non-steam), ice machines, misters, or other items determined by the *Designated Team* in areas designated for care of *at-risk individuals*.

Tap water may be used for washing/rinsing in *humidifiers* (non-steam), ice machines, misters, or other items used for patient or resident care if such use is deemed acceptable by the *Designated Team* based on a *risk assessment*.

[…]

H7 Program Confirmation

[…]

H7.2.3.1 Microbial Testing for Validation. …

a. If results from *testing* indicate that the *Program* has not met the *microbial hazards control* objectives, the *Designated Team* should take the following steps.

[…]

5. reevaluate fundamental aspects of the *risk management plan*, including the analysis of *hazardous conditions*, construction activities, cleaning and maintenance procedures, chemical *treatment*, and other aspects of the *risk management plan* that could affect the results of *microbial testing*

[…]

H9 Microbial Testing–General. …

[…]

H9.2 In the Absence of Suspected or Confirmed Disease. …

[…]

d. *Testing* after changes or upset conditions can be used to determine the effect on the *microbial* community structure of the water and the levels of *microbial hazards.* These changes or upset conditions may include:

[…]

6. when changes in ammonia, nitrite, or nitrate levels are detected either in the supply water at the intake or anywhere in the *building water system*

~~7. when ammonia, nitrite, or nitrate are detected anywhere in the *building water system*~~

~~8.~~7. when there are upset conditions in the *water utility* distribution system or the *building water system* (such as pressure swings in the *water utility* distribution system due to fire-fighting events, water *main* breaks, or construction in or near the building.)

[…]

H13 Existing Building Review. Section 8.2.11.1, "Existing Building Review," requires the *Designated Team* to review and update the *building water system risk management plan annually* to incorporate changes, if any. The *Designated Team* should update water management documentation when changes to the *building water system* result from construction, changes in occupancy type, or functional use of space. The *Designated Team* may determine that more frequent review and update intervals are appropriate, depending on the populations served and the *building water system risk management plan* performance, as indicated by *validation testing* results.

[…]

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
Note: This table is not intended to be comprehensive. The guidance presented is intended to provide examples of areas, information, and factors for consideration when addressing healthcare facility water safety.	
HOSPITAL	
GENERAL INPATIENT CARE	
General Care (Patient Room)	The following factors should be considered in all patient care areas in hospitals, including in areas serving general patient populations: a. Scald prevention generally limits hot water temperature at patient-accessible *water use end points* in healthcare at 110°F (43.3°C) or lower at patient-accessible *water use end points* in healthcare facilities. Hot water temperatures below 120°F (48.9°C) are supportive of *microbial growth* and may require additional *control measures*. b. USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/*F838 should be supplied to or used in *humidifiers* (non-steam), ice machines, misters, or other items used for patient or resident care determined by the *Designated Team. Tap* water may be used in *humidifiers* (non-steam), ice machines, or misters used for patient or resident care if such use is deemed acceptable by the *Designated Team* based on a *risk assessment*.~~Water that supplies ice machines should be filtered using inline filters that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*.~~ c. Ice/ice machines should be screened for multiple *pathogens*.~~, especially when there is *residual* monochloramine in the *potable* cold water.~~ d. Surfaces used for storage of, preparation of, or surfaces which are in contact with sterile supplies, medication, injection vials, wound dressings, etc. should be cleaned and disinfected in accordance with *CDC* guidance and the cleaning product manufacturers' instructions for use on the USEPA Approved label. It is important that staff follows the instructions for use on the cleaning product being used. ~~These surfaces should not, subsequently, be rinsed with *tap* water. Always use caution in the use of *tap* water for such cleaning and *disinfection* processes and always follow *CDC* guidance for surface preparation.~~ If these areas are near sinks, the sink faucet should be offset from the drain, and the sink and drain should have splash guards. e. *Water use end points* (such as shower hoses) in which water may collect and stagnate should be considered as areas that may be conducive to *microbial growth*.

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
	f. Toilets that flush and spray hoppers have potential to spread contaminated *aerosols*. Where possible, toilets, spray hoppers, etc. should have a lid that is closed when the unit is flushed. The location of toilets, spray hoppers, dialysis water boxes, etc. should be considered to reduce exposure of persons to *aerosols*. g. Preventive maintenance of *water use end points* of devices and equipment that use water should include inspection of polymers and elastomers (O-rings, gaskets, diaphragms)., ~~especially when there is *residual* monochloramine in the *potable* cold water.~~ h. Clinical surveillance for waterborne disease should include infections associated with multiple *pathogens*. i. Where possible, patients in categories considered at high *risk* of infection by waterborne *pathogens* (relative to the general patient population) should be identified and special precautions for all water use, such as use only of USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be taken.~~sterile water or water filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*, should be taken.~~ j. Impacts from construction may amplify *hazardous conditions* in or near patient care units. Indoor decorative fountains are prohibited in most healthcare facilities.
	[…]
Intensive Care (Patient Room)	a. Patients with severe illness may be at higher *risk* for infection. b. Patients in neonatal intensive care units are especially vulnerable to infections because of immature immune systems, diminished functions/varying stages of development, and exposure to invasive procedures and devices. c. Severely ill patients may be given ice chips, which are associated with *aspiration risk* and could be a source of exposure to waterborne *pathogens*. 1. USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be supplied to or used in *humidifiers* (non-steam), ice machines, misters, or other items used for patient or resident care determined by the *Designated Team*. *Tap* water may be used in *humidifiers* (non-steam), ice machines, or misters used for patient or resident care if such use is deemed acceptable by the *Designated Team* based on a *risk assessment*.~~Water that supplies ice machines should be filtered using inline filters that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*.~~ 2. Ice/ice machines should be screened for multiple *pathogens*., ~~especially when there is *residual* monochloramine in the *potable* cold water.~~ d. Many ICU patients are sponge bathed in bed. Procedurally, it is suggested that "wringing-out" the sponge into the basin be near the foot to reduce proximity to the patient airway (droplets from the process-*aspiration risk*). Where the patient is known to be at high *risk* relative to the general patient population, or where the patient's *risk* ranking is unknown, consider use of bath-in-a-bag or use of USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*. ~~only sterile water or water filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*.~~
	[…]

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
Protective Environment (Patient Room)	Patients in protective environments are considered at highest *risk* of infection. Special precautions should be considered, such as: a. routine use of USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838.* ~~sterile water or water filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*~~ b. …
SPECIALIZED PATIENT CARE	
Cardiopulmonary and Respiratory Therapy	a. Patients with severe illness, especially respiratory illness, may be at higher *risk* for infection from waterborne *pathogens* b. Patients in these areas are often on immunosuppressive therapies and are at high *risk* for contracting disease after exposure to infectious agents. c. Many cardiopulmonary and respiratory therapy patients are sponge bathed in bed. Procedurally, it is suggested that "wringing-out" the sponge into the basin be near the foot to reduce proximity to the patient airway (droplets from the process-*aspiration risk*). Where the patient is known to be at high *risk* relative to the general patient population, or where the patient's *risk* ranking is unknown, consider use of bath-in-a-bag or use of USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*. ~~only sterile water or water filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*.~~ d. Respiratory therapy may include use of procedures or devices that expose patients to *aerosols*. Water used for these procedures or devices should meet or exceed the recommendations from regulatory or guidance bodies such as the U.S. Food and Drug Administration or *CDC*. USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be used during procedures or in devices that expose patients to *aerosols*. *Tap* water should only be used during procedures or in devices that expose patients to *aerosols* if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use. ~~*Tap* water should never be used for these procedures or devices.~~ ***Note:*** Refer to the Intensive Care section above for additional considerations which may be relevant in some facilities.
Dialysis[f]	a. Water for use in dialysis is regulated; AAMI Standards should be followed b. Consideration of effects of *building water system* water *treatment* on dialysis patients (*disinfection byproducts*) and on compatibility with reverse osmosis membranes c. Facilities with *supplemental disinfection* systems should consider potential effects on dialysis water, especially the exchange frequency of carbon prefiltration. **Additional Resources Typical at this Location: …**
Infusion Therapy • Chemotherapy • Nuclear • Hematology/ Oncology	a. Patients in these areas are often immunocompromised and are at high *risk* for contracting disease after exposure to infectious agents. b. Limit exposure when possible. Follow manufacturer's instructions for cleaning and maintaining any water-using devices. Consider use only of USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838.* ~~water that has been filtered by filters that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*.~~

[…]

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
Protective Environments (PE) *Treatment* (not Patient Room) • Bone Morrow Transplant • Burn Units • Solid Organ Transplant	Patients in protective environments are considered at highest *risk* of infection. Special precautions should be considered, such as: a. routine use of water filtered by *FDA Class II* filters that are validated for *total retention/F838*~~inline or point-of-use filters that are FDA-cleared 510(K) as Class II medical devices for aid in infection *control* and certified to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*, on *water use end points*, especially those (such as showers) that produce *aerosols*~~ b. …
Specialty Care • Cardiology • Gastrointestinal • Pulmonary (includes Bronchoscopy)	a. Specialty care units/areas may have specific procedures and/or devices that use water. b. Consider special-purpose devices that use or may be washed, or rinsed with water, such as heater-cooler devices. These devices should ~~ONLY~~ be cleaned or processed with USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838*~~sterile water or water filtered by inline or point-of-use filters that are FDA-cleared 510(K) as Class II medical devices for aid in infection *control* and certified to ASTM F838, Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration, as sterilizing grade~~ on *water use end points*, especially those (such as showers) that produce *aerosols*. c. For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions.~~If devices are covered in AAMI TIR34, the use water specified in TIR34 is recommended.~~

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
Surgery • OR's General and Specialized • Emergency – Trauma • Procedure Rooms • Class 2 and 3 Imaging Rooms	Patients may be immunocompromised and at high *risk* for infection, particularly in inpatient surgical settings. a. USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be used to wash or rinse equipment or surfaces used for preparation of medications or injections. The water should meet or exceed the water quality specified in manufacturers' instructions. *Tap* water should only be used if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.~~*Tap* water should never be used to wash or rinse equipment or surfaces used for preparation of medications or injections~~ ~~Equipment and device processing should follow AAMI TIR34~~ 1. Surfaces used for storage of, preparation of, or surfaces which are in contact with sterile supplies, medication, injection vials, wound dressings, etc. should be cleaned and disinfected in accordance with *CDC* guidance and the cleaning product manufacturers instructions for use on the USEPA Approved label. It is important that staff follows the instructions for use on the cleaning product being used. ~~These surfaces should not subsequently be rinsed with *tap* water. Caution should always be exercised in the use of *tap* water for such cleaning and *disinfection* processes and *CDC* guidance should always be followed for surface preparation.~~ 2. If these areas are near sinks, the sink faucet should be offset from the drain, and the sink and drain should have splash guards. b. Non-sterile ice should not~~never~~ be used in these locations. c. Consider special-purpose devices that use or may be washed, reprocessed, or rinsed with water, such as heater-cooler devices, ECMO, endoscopes, etc. These devices should ~~only~~ be cleaned or processed with USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838*. For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions. *Tap* water should only be used for washing or rinsing of special-purpose devices if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.~~ water that meets AAMI TIR34.~~
CLINICAL SUPPORT SERVICES	
[…]	
Pharmacy	a. Stringent rules for water quality in medication preparation (USP, PDA, and FDA) b. Contamination by water droplets or splashing of skin-sterilizing solutions and fresh antibiotic solution preparations made from water and powders during compounding c. Use splash guards to avoid contamination of areas with water d. USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be used to wash or rinse equipment or surfaces used for preparation of medications or injections. Water selected should meet or exceed the water quality specified in manufacturers' instructions. *Tap* water should only be used if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.~~*Tap* water should never be used to wash or rinse equipment or surfaces used for preparation of medications or injections.~~ ~~1. Equipment and device process should follow AAMI TIR34.~~

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
	2. Surfaces used for storage of, preparation of, or surfaces which are in contact with sterile supplies, medication, injection vials, wound dressings, etc. should be cleaned and disinfected in accordance with *CDC* guidance and the cleaning product manufacturers instructions for use on the cleaning product being used. ~~These surfaces should not subsequently be rinsed with *tap* water. Caution should always be exercised in the use of *tap* water for such cleaning and *disinfection* processes and *CDC* guidance should always be followed for surface preparation.~~ 3. If these areas are near sinks, the sink faucet should be offset from the drain, and the sink and drain should have splash guards.
FACILITY SUPPORT SERVICES	
Central/Decentralized Processing Services	a. For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions. b. For medical device reprocessing not covered by AAMI TIR34, USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be used for washing, rinsing, or reprocessing. The water should meet or exceed the water quality specified in the manufacturer's instructions. c. *Tap* water should only be used for washing, rinsing, or reprocessing medical devices if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use. ~~Follow standards for water quality and use when processing medical devices, consistent with the more stringent and more specific of AAMI TIR34 requirements and manufacturers' reprocessing instructions.~~ **Additional Resources Typical at this Location:** …
OUTPATIENT	
SPECIALIZED OUTPATIENT FACILITIES	
Cardiopulmonary and Respiratory Therapy	a. Patients with severe illness, especially respiratory illness, may be at higher *risk* for infection from waterborne *pathogens*. b. Patients in these areas are often on immunosuppressive therapies and are at high *risk* for contracting disease after exposure to infectious agents. c. Respiratory therapy may include use of procedures or devices that expose patients to *aerosols*. Water used for these procedures or devices should meet or exceed the recommendations from regulatory or guidance bodies such as the U.S. Food and Drug Administration or *CDC*. USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be used during procedures or in devices that expose patients to *aerosols*. *Tap* water should only be used if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use. ~~*Tap* water should never be used for these procedures or devices. Only sterile water or water that has been filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*, should be used.~~ ***Note:*** Refer to the Intensive Care section above for additional considerations which may be relevant in some facilities.
Dialysis[f]	a. Water for use in dialysis is regulated; AAMI Standards should be followed. b. Consideration of effects of *building water system* water *treatment* on dialysis patients (*disinfectants*/*disinfection byproducts*) and on compatibility with reverse osmosis (RO) processing systems, including RO membranes c. Facilities with *supplemental disinfection* systems should consider potential effects on dialysis water, especially the exchange frequency of carbon prefiltration. **Additional Resources Typical at this Location:** …

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
	[…]
Surgery • Ambulatory Surgery Centers • Freestanding ED/Trauma • Procedure Rooms • Class 2 and 3 Imaging Centers	Patients may be immunocompromised and at high *risk* for infection, particularly in outpatient~~inpatient~~ surgical settings. a. USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be used to wash or rinse equipment or surfaces used for preparation of medications or injections. The water selected should meet or exceed the water quality specified in manufacturers' instructions. *Tap* water should only be used if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.~~*Tap* water should never be used to wash or rinse equipment or surfaces used for preparation of medications or injections.~~ ~~b. Equipment and device processing should follow AAMI TIR34. For equipment/devices not covered by TIR34, consider using only sterile water or water that has been filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration.*~~ c. Surfaces used for storage of, preparation of, or surfaces which are in contact with sterile supplies, medication, injection vials, wound dressings, etc. should be cleaned and disinfected in accordance with *CDC* guidance and the cleaning product manufacturers' instructions for use on the USEPA Approved label. It is important that staff follows the instructions for use on the cleaning product being used. ~~These surfaces should not subsequently be rinsed with *tap* water. Caution should always be exercised in the use of *tap* water for such cleaning and *disinfection* processes and *CDC* guidance should always be followed for surface preparation.~~ If these areas are near sinks, the sink faucet should be offset from the drain, and the sink and drain should have splash guards. d. For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions. e. For medical device reprocessing not covered by AAMI TIR34, USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be used for washing, rinsing, or reprocessing. The water should meet or exceed the water quality specified in the manufacturer's instructions. f. *Tap* water should only be used for washing, rinsing, or reprocessing medical devices if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use. g. Non-sterile ice should not ~~never~~ be used in these locations. ~~Consider special-purpose devices that use or may be washed, reprocessed, or rinsed with water, such as heater-cooler devices, ECMO, endoscopes, etc. These devices should only be cleaned or processed with water that meets AAMI TIR34, consider using only sterile water or water that has been filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration.*~~
	[…]
CLINICAL SUPPORT FACILITIES	
	[…]
Pharmacy	a. Stringent rules for water quality in medication preparation (USP, PDA, and FDA) b. Contamination by water droplets or splashing of skin-sterilizing solutions and fresh antibiotic preparations from powders during compounding c. Splash guards should be used to avoid contamination of areas with water.

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
	d. Water filtered by *FDA Class II* filters and validated for *total retention/F838* or USP sterile water should be used to wash or rinse equipment or surfaces used for preparation of medications or injections. The water should meet or exceed the water quality specified in the manufacturer's instructions. *Tap* water should only be used if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use. ~~*Tap* water should never be used to wash or rinse equipment or surfaces used for preparation of medications or injections.~~ ~~a. Equipment and device processing should follow AAMI TIR34~~ e. Surfaces used for storage of, preparation of, or surfaces which are in contact with sterile supplies, medication, injection vials, wound dressings, etc. should be cleaned and disinfected in accordance with *CDC* guidance and the cleaning product manufacturers instructions for use on the USEPA Approved label. It is important that staff follows the instructions for use on the cleaning product being used. ~~These surfaces should not subsequently be rinsed with *tap* water. Caution should always be exercised in the use of *tap* water for such cleaning and *disinfection* processes and *CDC* guidance should always be followed for surface preparation.~~ If these areas are near sinks, the sink faucet should be offset from the drain, and the sink and drain should have splash guards. f. For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions. g. For medical device reprocessing not covered by AAMI TIR34, USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be used for washing, rinsing, or reprocessing. The water should meet or exceed the water quality specified in the manufacturer's instructions. h. *Tap* water should only be used for washing, rinsing, or reprocessing medical devices if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.
FACILITY SUPPORT SERVICES	
Central Processing Services	a. For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions. b. For medical device reprocessing not covered by AAMI TIR34, USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be used for washing, rinsing, or reprocessing. The water should meet or exceed the water quality specified in the manufacturer's instructions. c. *Tap* water should only be used for washing, rinsing, or reprocessing medical devices if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use. ~~Follow standards for water quality and use when processing medical devices, consistent with AAMI TIR34. For equipment/devices not covered by TIR34, consider using only sterile water or water that has been filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*.~~ **Additional Resources Typical at this Location: …**
RESIDENTIAL HEALTHCARE	
[…]	
Behavioral Health	a. Patients/residents in behavioral health facilities are disproportionality in categories considered at high *risk* for infection, including HIV, IV drug users, alcoholics, and cigarette smokers. These areas

Table H-1 Considerations for Water Safety—Building and General Applications[a,b,c,d,e,f]

Healthcare Environment	Considerations for Water Safety
	often have security or ligature-resistant fixtures and finishes that increase *water age* due to restrictions on flushing (e.g., use buttons, timers, fixture flow restrictors, and aerators) that might not otherwise be used in patient care settings. b. …

Notes:

a. *CDC*. Guidelines for Environmental Infection Control for Healthcare Facilities, 2003 (with updates July 2019); https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf

b. Refer to Table H-2 for information on reusable medical devices. AAMI TIR34 should be used in each stage of medical device reprocessing for each category of medical device. More specifically, AAMI TIR34 covers the quality of the water used to clean, rinse, disinfect, and sterilize medical devices. Additionally, it defines water types on the basis of hardness, pH, *microorganism* levels, endotoxin levels, and other characteristics. AAMI TIR34 annexes contain technical details pertaining to water *treatment* and *monitoring* for the benefit of water maintenance personnel.

c. Clinical Lab and Standards Institute (CLSI): The laboratory should define the type of water necessary for each of its procedures and should have an adequate amount of the same. The current edition of CLSI Guideline GP40-A4-AMD defines the following grades of water: Clinical Laboratory Reagent Water (CLRW), suitable for most laboratory procedures; Special Reagent Water (SRW), defined by a laboratory for procedures that need different specifications than CLRW; Instrument Feed Water, specified by IVD manufacturers as suitable for use with their measurement systems; and Commercially Bottled Purified Water that may be suitable for certain laboratory procedures. CLRW is not required if the laboratory is able to record reliable results with an alternate grade of water.

d. Some areas within a healthcare setting, such as food preparation, scullery (dishwashing), environmental services, and laundry also have the potential for contamination by waterborne *pathogens* from the *building water systems*.

e. ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*

f. Dialysis related AAMI 23500:2019 Series references:

1. AAMI. 2019. ANSI/AAMI/ISO 23500-1, *Preparation and quality management of fluids for hemodialysis and related therapies—Part 1: General requirements.* Arlington, VA: Association for the Advancement of Medical Instrumentation.
2. AAMI. 2019. ANSI/AAMI/ISO 23500-2, *Preparation and quality management of fluids for hemodialysis and related therapies—Part 2: Water treatment equipment for hemodialysis applications and related therapies*. Arlington, VA: Association for the Advancement of Medical Instrumentation.
3. AAMI. 2019. ANSI/AAMI/ISO 23500-3, *Preparation and quality management of fluids for hemodialysis and related therapies—Part 3: Water for hemodialysis and related therapies*. Arlington, VA: Association for the Advancement of Medical Instrumentation.
4. AAMI. 2019. ANSI/AAMI/ISO 23500-4, *Preparation and quality management of fluids for hemodialysis and related therapies—Part 4: Concentrates for hemodialysis and related therapies*. Arlington, VA: Association for the Advancement of Medical Instrumentation.
5. AAMI. 2019. ANSI/AAMI/ISO 23500-5, *Preparation and quality management of fluids for hemodialysis and related therapies—Part 5: Quality of dialysis fluid for hemodialysis and related therapies*. Arlington, VA: Association for the Advancement of Medical Instrumentation.
6. AAMI. 2020. ANSI/AAMI RD47, *Reprocessing of hemodialyzers*. Arlington, VA: Association for the Advancement of Medical Instrumentation.

Table H-2 Considerations for Water Safety—Medical Devices and Equipment Applications

Devices/Equipment/ Components	Considerations for Water Safety
Note: This table is not intended to be comprehensive. The guidance presented is intended to provide examples of areas, information, and factors for consideration when addressing healthcare facility water safety.	
MEDICAL DEVICES	
[…]	

Table H-2 Considerations for Water Safety—Medical Devices and Equipment Applications

Devices/Equipment/ Components	Considerations for Water Safety
Dental Unit Waterlines	a. Potential for the *growth* of *pathogens* in *biofilm*; for example, by *Pseudomonas* b. Potential for *transmission* of *pathogens* (but few reports in the literature) c. Surgical procedures—use of sterile water or sterile saline d. Test dental unit waterlines for heterotrophic *bacteria* on routine basis e. Nonsurgical procedures—use of water that meets the Environmental Protection Agency standard for drinking water (≤ 500 colony forming units of heterotrophic *bacteria* per milliliter) ~~f. *Residual* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM and *pseudomonas*.~~ […]
Extracorporeal membrane oxygenation (ECMO) devices	a. Potential for bacterial *colonization* of the water reservoir by NTM; for example, *Mycobacterium chimaera*, and aerosolization during operation. b. Theoretical link to isolation of *M. chimaera* from EMCO patients c. Clean and disinfect instrument following manufacturer's instructions upon receipt by facility d. Follow manufacturer's instructions for routine maintenance, cleaning, *disinfection*, and use Water filtered by *FDA Class II* filters and validated for *total retention/F838* or USP sterile water should be used to wash or rinse equipment. The water should meet or exceed the water quality specified in the manufacturer's instructions. *Tap* water should only be used if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.~~*Tap* water should never be used to wash or rinse the device. Only water that meets the requirements of AAMI TIR34 should be used.~~ **Additional Resources Typical at this Location:** Trudzinski et al. Clinical implications of Mycobacterium chimaera detection in thermoregulatory devices used for extracorporeal membrane oxygenation (ECMO), Germany, 2015 to 2016. Euro Surveill. 2016;21(46). pii: 30398
Heater-cooler devices	a. Potential for *colonization* by nontuberculous Mycobacteria (NTM), *P. aeruginosa* and other *pathogens* in the water reservoirs, with potential for *transmission* to patients if contaminated water is aerosolized during surgery b. Considerations for mitigating potential for *colonization* and *transmission*: 1. Inspect devices prior to use; remove from service if there is any appearance of bacterial *growth* in the lines 2. Follow manufacturer's instructions for the frequency and processes for cleaning and *disinfection* 3. Water filtered by *FDA Class II* filters and validated for *total retention/F838* or USP sterile water should be used to wash or rinse equipment. Water selected should meet or exceed the water quality specified in manufacturers' instructions. *Tap* water should only be used to wash or rinse equipment when identified by the *Designated Team* as a result of a *risk assessment* based on intended use.~~*Tap* water should never be used in the device and *tap* water should never be used to wash or rinse the device. Only water filtered with a filter that is FDA 510(K) cleared as a Class II medical device and certified to ASTM F838 or AAMI TIR34 should be used.~~ […]
Hydrotherapy tanks and pools	Special considerations in healthcare environments include: a. There are numerous reports of the *transmission* of water-associated *opportunistic pathogens* to patients in healthcare settings by ingestion, inhalation, or direct contact by ingestion, inhalation, or direct contact with hydrotherapy water contaminated with *pathogens* such as NTM, Pseudomonas, Acinetobacter, and Adenovirus. b. Assess the use of hydrotherapy pools on a case-by-case basis and consider alternative aseptic techniques for wound management.

Table H-2 Considerations for Water Safety—Medical Devices and Equipment Applications

Devices/Equipment/ Components	Considerations for Water Safety
	c. Always perform manufacturer's instructions for cleaning and disinfection upon receipt of instrument and before placing into use d. Consider the potential for hypersensitivity pneumonitis (such as hot tub lung) ~~b. *Residual* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM or *Pseudomonas*.~~ General water management practices applicable to whirlpools, tubs, etc. are described in this standard.
Patient/Resident showers	Special considerations in healthcare environments include: a. The potential for *transmission* of water-associated *pathogens*, such as *Pseudomonas*, NTMs from showers b. Low use of showers in some settings results in water stagnation and bacterial *growth*, such as in long-term care facility areas with low-mobility residents c. Avoid the installation of low-flow, misting showerheads to mitigate aerosolization d. Use of shower hoses may create conditions for water stagnation if hoses are not drained after use e. *Risk* of scald injury. Some facilities and jurisdictions have specific requirements for maximum water temperature to reduce the *risk* of scald injury f. *Risk* of slips and falls, for example, in long-term care facility areas with low-mobility residents ~~b. *Residual* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM or *Pseudomonas*.~~ General water management practices applicable to whirlpools, tubs, etc. are described in this standard.
Patient/Resident sinks	a. In healthcare environments, the association of these devices with infections is not well-characterized. b. Special considerations in healthcare environments include: 1. There have been reports of *colonization* of patient sinks with *pathogens* such as *Serratia*, *Pseudomonas*, and NTM 2. Potential for aerosolization of respiratory *pathogens*, such as *Pseudomonas* and NTM 3. Clean equipment and sterile supplies should not be placed in areas where they may be contaminated by sprayed or splashed water 4. Clinical staff should not dispense drinking water from patient bathroom sinks ~~c. *Residential* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM and *Pseudomonas*~~ General water management practices applicable to whirlpools, tubs, etc. are described in this standard.

[…]

Table H-2 Considerations for Water Safety—Medical Devices and Equipment Applications

Devices/Equipment/ Components	Considerations for Water Safety
Reusable medical devices • endoscopes • arthroscopes • instruments	a. Dependent on various factors, such as the device and the nature of the procedure (critical, semi-critical, non-critical), these devices may be reprocessed (in part or fully) in Central Supply or at the procedure setting. ~~Use of water for reprocessing devices should be of appropriate quality, regardless of the location at which reprocessing steps occur, such as water that meets AAMI TIR34~~ 1. For medical device reprocessing covered by AAMI TIR34, *Water for the Reprocessing of Medical Devices*, only water meeting the requirements of AAMI TIR34 should be used for washing, rinsing, or reprocessing. Washing, rinsing, or reprocessing should be conducted in accordance with the medical device manufacturer's instructions. 2. For medical device reprocessing not covered by AAMI TIR34, USP sterile water, or water filtered by *FDA Class II* filters that are validated for *total retention/F838*, should be used for washing, rinsing, or reprocessing. The water should meet or exceed the water quality specified in the manufacturer's instructions. 3. *Tap* water should only be used for washing, rinsing, or reprocessing medical devices if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use. […]
Spray hoppers	a. Plausible, but not much evidence of *transmission* of *pathogens* b. Typically located in utility regions, but some may be located in patient care areas (such as intensive care units) 1. Potential *risk* for *transmission* of enteric *pathogens*, such as *Clostridium difficile*, and carbapenemase-resistant Enterobacteriaceae 2. Manufacturer's instructions for cleaning, maintenance, and use should be followed ~~c. *Residential* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM and *Pseudomonas*~~
[…]	
OTHER EQUIPMENT AND COMPONENTS	
[…]	
Electronic sensor faucets	a. There have been reports of ~~contamination by Gram negative *bacteria*, such as contamination of faucets in a neonatal intensive care unit, and *Legionella*~~ b. ~~Potential for bacterial *growth* and *transmission* is not well defined.~~ There may be differences in the potential for *colonization* attributable to the design and materials used in different faucets c. Maintain heightened awareness, especially in areas designated for care of highest-*risk* patients/residents ~~d. *Residential* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM and *Pseudomonas*~~ **Additional Resources Typical at this Location:** National Library of Medicine. Electronic-eye faucets: *Legionella* species contamination in healthcare settings
Faucet aerators	a. Reports of contamination by Gram negative *bacteria* b. Potential for increased aerosolization, facilitating *transmission* of *bacteria* c. Some healthcare facilities and jurisdictions do not allow the use of faucet aerators in patient care areas. Alternatives include laminar flow devices. d. If aerators are used, maintain heightened awareness and implement routine maintenance and cleaning according to the manufacturer's instructions

Table H-2 Considerations for Water Safety—Medical Devices and Equipment Applications

Devices/Equipment/ Components	Considerations for Water Safety
	~~e. *Residential* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM and *Pseudomonas*~~
Humidifiers	a. In healthcare environments, follow *CDC* guidelines for environmental infection *control*. USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be supplied to or used in *humidifiers* (non-steam) for patient or resident care as determined by the *Designated Team*. *Tap* water should only be used if such use is deemed acceptable by the *Designated Team* based on the manufacturer's instructions for use or in accordance with a *risk assessment* based on the intended use.~~, and use sterile water if point of use humidification is needed for areas with *at-risk patients* (refer to *CDC* Guideline for Prevention of Hospital Acquired Pneumonia). Only sterile water or water that has been filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*, should be used.~~ b. Potential *growth* and aerosolized *transmission* of *pathogens*, such as *Acremonium killensis*, *Pseudomonas*, *Acinetobactor*, *Elizabethkingia* c. Implicated in pseudo-infections ~~d. *Residential* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM and *Pseudomonas*~~ *Humidifier* management is addressed in this standard.
Ice machines	In healthcare environments, routine maintenance and cleaning of ice machines is essential. Follow manufacturer's instructions for use and maintenance. USP sterile water or water filtered by *FDA Class II* filters that are validated for *total retention/F838* should be supplied to, used in, or used to rinse ice machines for patient or resident care as determined by the *Designated Team*. *Tap* water may be supplied to, used in, or used to rinse ice machines used for patient or resident care if such use is deemed acceptable by the *Designated Team* based on a *risk assessment*.~~Water that has been filtered by devices that are FDA cleared 510(K) as Class II medical devices for aid in infection *control* and certified as sterilizing grade to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*, should be used to feed and rinse ice machines.~~ a. Potential for *pathogen growth* and *transmission* to patients, including NTM b. *Aspiration* may occur when patients/residents ingest ice or ice chips c. ~~Consider the installation of inline filters between water sources and ice machines that are FDA 510(K) cleared as a Class II medical and is certified to ASTM F838, *Standard Test Method for Determining Bacterial Retention of Membrane Filters Utilized for Liquid Filtration*.~~ d. Activated carbon inline filters should not be used with ice machines unless followed by a *FDA Class II* filter that is validated for *total retention/F838*.~~ FDA 510(K) cleared as a Class II medical device and is certified to ASTM F838.~~ ~~d. *Residential* monochloramine decay products and *disinfection byproducts* (ammonia, nitrite, nitrate) in the water may increase the potential for contamination by certain *pathogens*, such as NTM and *Pseudomonas*~~ Ice machine management is addressed in this standard. **Additional Resources Typical at this Location:** • Graman PS, Quinlan GA, Rank, JA. Nosocomial legionellosis traced to a contaminated ice machine. *Infect Control Hosp Epidemiol.* 1997;18(9);637-640. • Yorioka, K, S. Oie, K. Hayashi, H. Kimoto, H. Furukawa. Microbial contamination of ice machines is mediated by activated charcoal filtration systems. *J Environ. Health.* 2016;78(10);32-35.

Table H-3 Measurement and Testing Considerations for Water Safety—Physical and Chemical Parameters[a]

Evaluation Parameter	Method[b]		Frequency	Notes
	Lab	On-Site		
Entry Point(s) – Prior to any Conditioning or *Treatment*				
Ammonia, free	USEPA 50.1	Salicylate 10205[c] ISE 10002[c]	Weekly	When monochloramine is the *secondary disinfectant*
Chlorine, free (FAC)	SM 4500 Cl	DPD, Colorimetry	Weekly	If there are frequent disturbances (water *main* breaks), consider daily or continuous *testing*.
Chlorine, total	SM 4500 Cl USEPA 334	DPD, Colorimetry	Weekly	If there are frequent disturbances (water *main* breaks), consider daily or continuous *testing*.
Conductivity	ASTM D1124-14A SM 2510B	8160, Conductivity Meter[d]	Weekly	
Copper	USEPA 200.8 SM 3113B	SM 3500-Cu, SM 3500-C, or SM 3500-E[c]	Quarterly	• Copper may affect chlorine chemistry • Copper may interfere with analytical methods • Copper levels at the entry point serve as a baseline for comparison of copper levels in the *building water system*
Haloacetic Acids (HAA5)	USEPA 557 SM 6251B	N/A	Quarterly	Consider *testing* more frequently in warmer weather due to faster formation kinetics in warmer water.
Hardness	USEPA 200.5 SM 3111B ASTM D511-14A	EDTA Colorimetric Titration[d]	Quarterly	
Iron	USEPA 200.5 Rev 4.2 SM 3111B SM 3113B	1-10-*Phenanthroline* 1028[d], 10229[d]	Quarterly	• Iron may affect chlorine chemistry • Iron may interfere with analytical methods • Iron levels at the entry point serve as a baseline for comparison of copper levels in the *building water system*
Lead	USEPA 200.5 Rev 4.2 or 5.4 USEPA 200.9 Rev 2.2 SM 3113B	Palintest Ltd. or Hach Company Method 1001[c]	*Annually*	Lead in the supply water is most often from leaching of lead service lines.
Nitrate	USEPA 300.1 SM 4500NO_3	Hach Company Method 10206 Rev 2.0[c] ATI Orion Method 601[c]	Quarterly	• When monochloramine is the *secondary disinfectant* • When the *water utility* practices nitrate blending, consider *testing* more frequently
Nitrite	USEPA 300.1 SM 4500NO_3	SM 4500-NO_2[c]	Quarterly	When monochloramine is the *secondary disinfectant*
NDMA	USEPA 521	N/A	*Annually*~~Quarterly~~	When monochloramine is the *secondary disinfectant*
Orthophosphate~~Phosphate~~	USEPA 300.0 ASTM D4327	SM 4500-P[c]	Quarterly	Phosphate is added by many utilities as a corrosion inhibiter.
pH	USEPA 150.1, 150.2, 150.3 SM 4500-H ASTM D1293-12	pH meter	Weekly	pH affects the antimicrobial effectiveness of chlorine.

Table H-3 Measurement and Testing Considerations for Water Safety—Physical and Chemical Parameters[a]

Evaluation Parameter	Method[b]		Frequency	Notes
	Lab	On-Site		
Temperature	N/A	Thermometer	Weekly	If there are frequent disturbances (water *main* breaks), consider continuous *testing*.
Trihalomethanes (THM)	USEPA 551.1 SM 2320	N/A	Quarterly	Consider *testing* more frequently in warmer weather due to faster formation kinetics in warmer water.
Turbidity	USEPA 180.1 SM 2130B	Nephelometry 8195[c]	Weekly	If there are frequent disturbances (water *main* breaks), consider daily or continuous *testing*.
Cold *Potable* Water Storage Tank(s)				
Chlorine, free (FAC)	SM 4500 Cl	DPD, Colorimetry	Quarterly	• Take samples from near the top and near the bottom of the tank. • If water usage declines (such as due to occupancy changes), consider more frequent *testing*. • If free chlorine measured at the intake is variable, consider more frequent *testing*.
Chlorine, total	SM 4500 Cl USEPA 334	DPD, Colorimetry	Quarterly	• Take samples from near the top and near the bottom of the tank. • If water usage declines (such as due to occupancy changes), consider more frequent *testing*. • If total chlorine measured at the intake is variable, consider more frequent *testing*.
[…]				
Representative Locations throughout Cold *Potable Building Water System*(s)				
Ammonia, free	USEPA 50.1	Salicylate 10205[c] ISE 10002[c]	Weekly~~Monthly~~	When monochloramine is the *secondary disinfectant*
			Weekly	When monochloramine is added to the cold water as a *supplemental disinfectant*
Chlorine, free (FAC)	SM 4500 Cl	DPD, Colorimetry	Weekly	When chlorine ~~or monochloramine~~ is the *secondary disinfectant*
Chlorine, total	SM 4500 Cl USEPA 334	DPD, Colorimetry or monochloramine specific test	Weekly	When monochloramine is the *secondary disinfectant* or added to the cold water as a *supplemental disinfectant*
Chlorine Dioxide	USEPA 327 Rev 1.1 SM 4500-ClO_2 D or E	ChloridoX Plus[c]	Daily	When chlorine dioxide is added to the cold water as a *supplemental disinfectant*
Chlorite	USEPA 327 SM 4500-ClO_2-E	ChloridoX Plus[c]	Daily	• Sample at three locations: proximal, midpoint, and distal • When chlorine dioxide is added to the cold water as a *supplemental disinfectant*
Copper	USEPA 200.8 SM 3113B	SM 3500-Cu, SM 3500-C, or SM 3500-E[c]	Quarterly	• Increases may indicate corrosion • Copper may affect chlorine chemistry • Copper may interfere with analytical methods

Table H-3 Measurement and Testing Considerations for Water Safety—Physical and Chemical Parameters[a]

Evaluation Parameter	Method[b]		Frequency	Notes
	Lab	On-Site		
Haloacetic Acids (HAA5)	USEPA 557 SM 6251 B	N/A	Quarterly	• The five haloacetic acids ("HAA5") regulated by USEPA under SDWA are: 1. monochloroacetic acid 2. dichloroacetic acid 3. trichloroacetic acid 4. monobromoacetic acid 5. dibromoacetic acid • Consider *testing* more frequently in warmer weather due to faster formation kinetics in warmer water.
Iron	USEPA 200.5 Rev 4.2 SM 3111B SM 3113B	1-10-*Phenanthroline* 1028[d], 10229[d]	Quarterly	• Increases may indicate corrosion • Iron may affect chlorine chemistry • Iron may interfere with analytical methods
Lead	USEPA 200.5 Rev 4.2 or 5.4 USEPA 200.9 Rev 2.2 SM 3113B	Palintest Ltd. or Hach Company Method 1001[c]	*Annually*	When lead levels at fixtures is higher than in the supply water, the cause is most often from leaching of lead from solder or metal plumbing fixtures.
Nitrate	USEPA 300.1 SM 4500-NO_3^-	Hach Company Method 10206 Rev 2.0[c] ATI Orion Method 601[c]	Quarterly	When monochloramine is the *secondary disinfectant*
			Quarterly~~Weekly~~	When monochloramine is added to the cold water as a *supplemental disinfectant*
Nitrite	USEPA 300.1 SM 4500-NO_3^-	SM 4500-NO_2^-[c]	Quarterly	When monochloramine is the *secondary disinfectant*
			Quarterly~~Weekly~~	When monochloramine added to the cold water as a *supplemental disinfectant*
NDMA	USEPA 521	N/A	*Annually*~~Quarterly~~	When monochloramine is the *secondary disinfectant*
			Quarterly[e] ~~Monthly~~	When monochloramine added to the cold water as a *supplemental disinfectant*
pH	USEPA 150.1, 150.2, 150.3 SM 4500-H ASTM D1293-12 ~~pH meter~~	pH meter	Monthly	pH affects the antimicrobial effectiveness of chlorine
[…]				
Trihalomethanes (THM)	USEPA 551.1 SM 2320	N/A	Quarterly	Consider *testing* more frequently in warmer weather due to faster formation kinetics in warmer water
Representative Locations throughout Hot *Potable Building Water System(s)*				
Ammonia, free	USEPA 50.1	Salicylate 10205[c], ISE 10002[c]	Weekly~~Monthly~~	When monochloramine is the *secondary disinfectant*
			Weekly	When monochloramine is added to the hot water as a *supplemental disinfectant*
Chlorine, free (FAC)	SM 4500 Cl	DPD 8021[c], 10002[c]	Weekly	When chlorine or monochloramine is added to the cold or hot water as a *supplemental disinfectant*

Table H-3 Measurement and Testing Considerations for Water Safety—Physical and Chemical Parameters[a]

Evaluation Parameter	Method[b]		Frequency	Notes
	Lab	On-Site		
Chlorine, total	SM 4500 Cl USEPA 334	DPD 8167[c], 10260[c]	Weekly	When chlorine or monochloramine is added to the cold or hot water as a *supplemental disinfectant*
Chlorine Dioxide	USEPA 327 Rev 1.1 SM 4500-ClO_2 D or E	ChloridoX Plus[c]	Daily	When chlorine dioxide is added to the cold or hot water as a *supplemental disinfectant*
Chlorite	USEPA 327 SM 4500-ClO_2-E	SM 4500-ClO_2C[b] (Amperometric)	Daily	• Sample at three locations: proximal, midpoint, and distal • When chlorine dioxide is added to the cold or hot water as a *supplemental disinfectant*
Conductivity	ASTM D1124-14A SM 2510B	8160, Conductivity Meter[c]	Monthly	
Copper	USEPA 200.8 SM 3113B	Bicinchoninate 10272[c], Bathocuproine 10238[d]	Quarterly	• Increases may indicate corrosion • Copper may affect chlorine chemistry • Copper may interfere with analytical methods
Haloacetic Acids (HAA5)	USEPA 557 SM 6251 B	N/A	Quarterly	The five haloacetic acids ("HAA5") regulated by USEPA under SDWA are: 1. monochloroacetic acid 2. dichloroacetic acid 3. trichloroacetic acid 4. monobromoacetic acid 5. dibromoacetic acid
Iron	USEPA 200.5 Rev 4.2 SM 3111B SM 3113B	1-10-*Phenanthroline* 1028[d], 10229[d]	Quarterly	• Increases may indicate corrosion • Iron may affect chlorine chemistry • Iron may interfere with analytical methods
Lead	USEPA 200.5 Rev 4.2 or 5.4 USEPA 200.9 Rev 2.2 SM 3113B	Palintest Ltd. or Hach Company Method 1001[c]~~PAR 10216[d]~~	*Annually*	
Nitrate	USEPA 300.1 SM 4500-NO_3^-	DMP 10206[c], ISE 8359[d]	Quarterly	When monochloramine is the *secondary disinfectant*
			Quarterly~~Weekly~~	When monochloramine is added to the cold or hot water as a *supplemental disinfectant*
Nitrite	USEPA 300.1 SM 4500-NO_3^-	Diazotization 10207[d], 10271[d]	Quarterly	When monochloramine is the *secondary disinfectant*
			Quarterly~~Weekly~~	When monochloramine added to the cold or hot water as a *supplemental disinfectant*
NDMA	USEPA 521		*Annually*~~Quarterly~~	When monochloramine is the *secondary disinfectant*
			Quarterly[e] ~~Monthly~~	When monochloramine added to the cold or hot water as a *supplemental disinfectant*
pH	USEPA 150.1, 150.2, 150.3 SM 4500-H ASTM D1293-12 ~~pH meter~~	8156[c]	Monthly	

Table H-3 Measurement and Testing Considerations for Water Safety—Physical and Chemical Parameters[a]

Evaluation Parameter	Method[b]		Frequency	Notes
	Lab	On-Site		
[…]				
Trihalomethanes (THM)	USEPA 551.1 SM 2320	N/A	Quarterly	Consider *testing* more frequently in warmer weather due to faster formation kinetics in warmer water.
Turbidity	USEPA 180.1 SM 2130B	Nephelometry 8195[c]	Quarterly	

Notes:

a. This table is not intended to be comprehensive. The information presented is intended to provide examples of evaluation parameters, frequencies, and methods for consideration when addressing healthcare facility water safety.

b. The methods referenced here are for example purposes only; the list is not intended to be exhaustive. There are multiple methods for many of these evaluation parameters published by Standard Methods (SM), USEPA, and ASTM.

c. USEPA approved/accepted/equivalent method

d. Method is not an USEPA approved/accepted/equivalent method for drinking water

e. Consider *testing annually* if NDMA is not detected and conditions in the water supply to the building are stable.

Table H-4 General Testing Considerations for Water Safety—Microbial Testing[a]

Microbe	Method[b]		Notes
	Lab	On-Site	
		[…]	
Acinetobacter	qPCR Culture method	qPCR	~~• Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Acinetobacter* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ ~~• Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ ~~• Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.
Aspergillus	qPCR SM 9610[b]	qPCR	~~• Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Aspergillus* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ ~~• Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ ~~• Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.
Burkholderia	qPCR Culture method	qPCR	~~• Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Burkholderia* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ ~~• Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ ~~• Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.
Coliform, *total*	qPCR SM 9221[b] SM 9223	qPCR	Coliforms are fecal-source organisms. They are not environmental-source or *biofilm* associated, and therefore are not the focus of this standard. However, *testing* for coliforms is included here because coliform levels are useful as a general measure of system cleanliness, though not as an indicator of infection *risk*.

Table H-4 General Testing Considerations for Water Safety—Microbial Testing[a]

Microbe	Method[b]		Notes
	Lab	**On-Site**	
E. coli	qPCR SM 9222[b] SM 9223	qPCR	*E. coli*, a type of coliform, are fecal-source organisms. They are not environmental-source or *biofilm* associated, and therefore are not the focus of this standard. However, *testing* for *E. coli* is included here because coliform levels are useful as a general measure of system cleanliness and *E. coli* are pathogenic.
Elizabethkingia	qPCR Culture method	qPCR	• ~~Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Elizabethkingia* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ • ~~Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ • ~~Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.
Fusarium	qPCR SM 9610[b]	qPCR	• ~~Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Fusarium* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ • ~~Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ • ~~Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.
[…]			
Klebsiella	qPCR SM 9221	qPCR	• *Testing* for *Klebsiella* is captured in the total coliform test method. • ~~Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Klebsiella* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ • ~~Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ • ~~Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ • Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.

Table H-4 General Testing Considerations for Water Safety—Microbial Testing[a]

Microbe	Method[b]		Notes
	Lab	On-Site	
[…]			
Nontuberculous mycobacteria (NTM)	qPCR ASTM E2563-07[b]	qPCR	• ASTM E2563-07 is Enumeration of NTM in Aqueous Metalworking Fluids by Plate Count Method ~~• Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by NTM and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ ~~• Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ ~~• Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ • Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.
Pseudomonas	qPCR ASTM D5246-92[b] SM 9213E[b]	qPCR	~~• Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Pseudomonas* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ ~~• Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ ~~• Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.
Sphingomonas	qPCR Culture method	qPCR	~~• Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Sphingomonas* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ ~~• Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ ~~• Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.

Table H-4 General Testing Considerations for Water Safety—Microbial Testing[a]

Microbe	Method[b]		Notes
	Lab	**On-Site**	
Stenotrophomonas	qPCR Culture method	qPCR	~~• Decay products and *disinfection byproducts* of monochloramine (ammonia, nitrite, nitrate) ion can be used as nutrients by *Stenotrophomonas* and promote their *growth* (refer to Informative Appendix C, "Building Water Systems Chemical Hazards Guidance").~~ ~~• Consider *testing* on a routine basis at the intake when monochloramine is used as a *secondary disinfectant*.~~ ~~• Consider *testing* on a routine basis at representative *taps* when monochloramine is used as *supplemental disinfection*.~~ Consider *testing* immediately whenever ammonia, nitrite, or nitrate are detected at representative *water use end points* at a level significantly greater than the level in the incoming water.

Notes:

a. The conditions that support the *growth* of *microbial hazards*, including tepid temperatures, excessive *water age*, lack of a *disinfectant residual*, and the presence of nutrients do not necessarily mean that any or all of the *microbial hazards* will be present.

b. The methods referenced here are for example purposes only; the list is not intended to be exhaustive. There are multiple methods for many of these evaluation parameters published by Standard Methods (SM), USEPA, and ASTM.

Modify Informative Appendix J as shown. The remainder of Informative Appendix J is unchanged.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX J—GUIDANCE ON PERSONAL PROTECTIVE EQUIPMENT FOR USE WHEN THERE IS POTENTIAL FOR EXPOSURE TO PHYSICAL, CHEMICAL, AND MICROBIAL HAZARDS~~CONTAMINATED AEROSOLS~~

The United States Occupational Safety and Health Administration (OSHA) provides both guidance and requirements for personal protective equipment (PPR) for use when there is potential for exposure to *physical*, *chemical*, and *microbial hazards*; there may also be additional state or local PPR requirements.~~described in this appendix are unique to the United States; however, other~~ Other countries may have similar applicable local, regional, or national guidance and requirements. In the absence of such requirements, complying with the OSHA requirements is recommended. Additional guidance is available from sources such as the United States Centers for Disease Control and Prevention (*CDC*) and ASHRAE Guideline 12, *Managing the Risk of Legionellosis Associated with Building Water Systems*.

The remainder of Informative Appendix J is deleted in its entirety.