



NSF International Standard

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Cooling Towers - Treatment, Operation
and Maintenance to Prevent Legionnaires'
Disease

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For Cooling Towers

Cooling Towers - Treatment, Operation and Maintenance to Prevent Legionnaires' Disease

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Foreword

Legionella bacteria grows naturally in rivers and streams and can enter the building through many modes of intrusion including the municipal water supply. Under certain conditions, legionella can rapidly multiply in all building water systems, demonstrating the need for a water management program. All building water systems should be included in such a program in order to minimize the risk of disease. Based on data from the Centers for Disease Control (CDC), the greatest number of individual cases of Legionnaires' disease results from premise plumbing, followed by cooling tower systems.

Cooling towers remove heat from recirculating water used in water-cooled chillers, heat pumps, air compressors and other equipment. Heat is rejected from recirculating water in the cooling tower primarily through evaporation. Under certain conditions, the water-associated piping, heat exchangers and other component surfaces, as well as the bulk water in cooling towers can become contaminated with microbes, including pathogenic bacteria such as *Legionella*. Appropriate treatment, operation and maintenance practices can control microbial contamination and help prevent waterborne disease, such as Legionnaires' disease, associated with cooling towers.

The technology of evaporative cooling towers has advanced steadily since its origin over 100 years ago. Drift has been reduced, fan efficiency has improved, and fill effectiveness has increased. Cooling towers are now smaller, lighter and more corrosion resistant than ever before. Cooling towers offer significant environmental benefits over alternative heat rejection systems, such as air-cooled systems, in terms of total system energy savings, carbon footprint, space and capital cost. These benefits are enhanced by appropriate treatment, maintenance, and operation consistent with the provisions of this NSF Standard.

This NSF Standard provides auditable requirements including means, methods and frequencies for treating cooling towers using readily available chemicals that are identified by their generic names. It provides simple, easy-to-implement protocols as a minimum practice, benchmark Standard. Alternative treatment protocols are allowed by this standard so long as there is independent, documentary evidence demonstrating that such alternatives can achieve at-least-equivalent efficacy to the benchmark performance of the protocols set forth here.

In some jurisdictions, there are rules, regulations and codes that cover owners and operators of buildings and other premises that are equipped with cooling towers. Where there are differences between the requirements of this Standard and such rules, regulations and codes, the more stringent or specific shall apply.

Throughout the development process of NSF 453 *Cooling Towers - Treatment, Operation and Maintenance to Prevent Legionnaires' Disease* NSF International had the pleasure of working with several different agencies, however the viewpoints expressed in the document do not necessarily represent the official position of the Agency.

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NSF Standard for Cooling Towers —

Cooling Towers – treatment, operation and maintenance to prevent Legionnaires' disease

1 Purpose

The purpose of this Standard is to set forth minimum practices required for treatment, operation and maintenance of cooling tower systems, including requirements for documentation, recordkeeping, validation and auditing, in order to prevent Legionnaires' disease.

2 Scope

This Standard covers all owners and operators of buildings and other premises that are equipped with cooling towers, including all building-associated cooling towers used in connection with HVAC systems and all industrial cooling towers used in connection with process cooling.

In order for the owner of a cooling tower to comply with this Standard, all of the applicable requirements of this Standard shall be met.

In some jurisdictions, there are rules, regulations and codes that cover owners and operators of buildings and other premises that are equipped with cooling towers. Where there are differences between the requirements of this Standard and such rules, regulations and codes, the more stringent or specific shall apply.

3 Definitions

3.1 analysis of the cooling tower system: The systematic, step-by-step evaluation of potentially hazardous conditions associated with the cooling tower system.

3.2 authority having jurisdiction (AHJ): An organization, governmental office or agency responsible for enforcing codes, rules or regulations covering the matters to which this Standard pertains.

3.3 biocides: Chemicals that kill or inhibit bacteria. Biocides include oxidizing biocides (e.g., chlorine) and non-oxidizing biocides (e.g., glutaraldehyde). Biocides may be used alone or in combinations.

3.4 bio-dispersants: Bio-dispersants (also called biopenetrants) are surfactants that promote system cleanliness by penetrating and loosening attached biofilms and associated deposits.

3.5 blowdown: Blowdown is the total of all non-evaporative water losses from the cooling tower. When water evaporates from a cooling tower, dissolved solids (such as calcium, magnesium, chlorides, and silica) are left behind in the bulk water. As more water evaporates, the concentration of dissolved solids increases. If the concentration gets too high, the dissolved solids can precipitate, cause scale deposits and contribute to corrosion and microbial growth. The concentration of dissolved solids is controlled by "blowdown", the

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process of discharging water containing high concentrations of dissolved solids, and replacing it with “make-up” water containing relatively lower concentrations of dissolved solids.

3.6 bleed off: (See blowdown)

3.7 building: Any structure used or intended for supporting or sheltering any use or occupancy. The term shall be construed as if followed by the phrase “structure, premises, lot or part thereof” and shall include the site, unless otherwise indicated by the text.

3.8 chiller: A chiller is a device that transfers heat from one medium to another by means of vapor compression or absorption-refrigeration cycles. The liquid may be re-circulated through a heat exchanger that uses water. In cooling towers, the heat from a refrigerant is transferred to water; the heat is then rejected from the heated water by means of evaporation. The cooled water, plus make-up water added to replace the water lost to evaporation (and to other, non-evaporative losses), is returned to the chiller and the process is repeated.

3.9 combined halogen: The halogen species in the water that are bound to nitrogen, such as in amines, and therefore are not necessarily available to act as disinfectants to the same extent, if at all. The halogen in covalent bonds with nitrogen comprise the “combined residual”

3.10 conductivity: Conductivity is a measure of the capacity of ions in water to carry electric current. Results of conductivity measurements are expressed as microsiemens/cm ($\mu\text{S}/\text{cm}$) or mmho/cm. Both measurements are temperature dependent. Conductivity measurement is used to estimate the amount of total dissolved solids (TDS) in the recirculating cooling water. Conductivity is used initiate blowdown, thereby managing TDS levels and determining cycles of concentration. Proper control of blowdown based on measurement of conductivity is essential to effective control of the cooling water system.

3.11 control limits: A maximum value, minimum value or a range of values to which a chemical or physical parameter associated with a control measure must be maintained in order to reduce the occurrence of a hazardous condition to an acceptable level.

3.12 control location: A point where a physical, mechanical, operational or chemical control measure is applied in order to reduce the occurrence of a hazardous condition to an acceptable level.

3.13 control measure: A practice or procedure used to maintain the physical or chemical conditions of a cooling tower water or associated components to within parameters that reduce the occurrence of a hazardous condition to an acceptable level.

3.14 cooling capacity: The amount of cooling a cooling tower can provide and is rated in tonnage. A ton is a unit of power used to describe the heat extraction capability of a chiller. A ton refers to the approximate amount of cooling power a ton of ice would provide if it melted over a 24-hour period. A refrigeration ton is equal to 12,000 BTU/hr.

3.15 cooling tower: Open cooling tower, closed-loop cooling tower, evaporative condenser or fluid cooler that is part of a recirculated water system incorporated into a building’s cooling, industrial process, refrigeration or energy production system.

3.16 cooling tower system: One or more cooling towers and all associated equipment, such as chillers, condensers and piping with shared water.

3.17 cooling tower program team (Team): One or more persons to whom the building owner delegates authority and responsibility for the actions required by this Standard.

3.18 corrective actions: Procedures that must be implemented within a specified time period when the parameters associated with control measures applied at a control location deviate from control limits.

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3.19 cycles of concentration: A key parameter used to manage cooling tower operation is "cycles of concentration", defined as the ratio of make-up water volume to blowdown water volume. Cycles of concentration can be approximated from the ratio of the conductivity of the blowdown water to the conductivity of the make-up water. From a water efficiency standpoint, the goal is to maximize cycles of concentration, minimize the quantity of blowdown water and thereby reduce the quantity of make-up water. However, the number of cycles is constrained by the chemistry of the make-up water, the heat load on the cooling tower and the quantity of environmental (e.g., airborne) contaminants captured by the water. Total dissolved solids (and conductivity) increase as cycles of concentration increase. High levels of dissolved solids can cause corrosion and buildup of scale, as well as contribute to an increase in microbial levels.

3.20 dead leg: A non-circulating, unused pipe in which the length is greater than six times the inner-diameter of the unused pipe.

3.21 dissolved solids: Soluble materials in the water, either formed from constituents of the water itself (hardness, salts, etc.) or from the local environment (airborne particles, insects, salts, etc.). The amount of dissolved solids is expressed as mg/L.

3.22 DPD: N, N-diethyl-p-phenylene diamine is a chemical indicator used in the colorimetric determination of the concentration of oxidizing biocides. DPD reacts with oxidizing biocides, including chlorine and bromine. DPD can be used to determine free and total halogen concentrations; combined residual is the difference between total and free halogen.

3.23 drift: Drift is the evaporated water in droplet form carried out of the tower with the air. The amount of drift must be controlled because the microorganisms, such as *Legionella*, carried in bio-aerosols that make up the drift can be inhaled by and infect humans. Drift is different from vapor, the pure gas phase water that is liberated by evaporation.

3.24 drift eliminator: A drift eliminator is a device used to catch and condense aerosolized water droplets that are discharged from the cooling tower as drift. Drift eliminators are designed to change the direction of airflow abruptly, imparting centrifugal force to separate water from the air and cause small droplets to coalesce into large droplets that fall back into the tower basin.

3.25 emergency treatment: (See: Off-line remedial treatment)

3.26 FIFRA: The Federal Insecticide Fungicide Rodenticide Act is the law that provides for federal regulation of pesticide distribution, sale, and use in the United States. All pesticides, including anti-microbial biocides that are distributed or sold in the United States must be registered by EPA under FIFRA. Most States have pesticide regulations that are comparable to FIFRA and also require compliance for products sold, distributed or used in such State.

3.27 fill: The component of the cooling tower that causes the circulating water to spread out over a large surface area, in order to increase the evaporation rate by exposing the water to a greater volume of air. There are two basic types of fill: splash and thin film.

3.28 free available chlorine (FAC): The total amount of hypochlorite ion and hypochlorous acid in the system available to act as disinfectants in water. When using chlorine-based biocides, FAC is the portion of the total chlorine that has not reacted with constituents of the water and is therefore available for disinfection.

3.29 free residual oxidant (FRO): The amount of available hypohalite (e.g., hypochlorite, hypobromite) ion and corresponding hypohalous (e.g., hypochlorous, hypobromous) acid in the system, available to act as a disinfectant in water.