STERAMIST™
POWERED BY BINARY IONIZATION TECHNOLOGY®

Protocol for Cooling Towers and Associated Systems

Halden Shane, DPM, FACFS, ABPS, ABQAURP
Irv Kraut, IH

TOMI™ Environmental Solutions, Inc.
World Corporate Office| 9454 Wilshire Blvd., Penthouse, G-6 | Beverly Hills, CA 90212
East Coast Office | 5111 Pegasus Court, Suite A | Frederick, MD 21704
800.525.1698 | www.tomiesinc.com

About the Authors

Halden Shane, DPM, FACFS, ABPS, ABQAURP

Dr. Halden Shane currently serves as TOMI™ Environmental Solutions, Inc., Chairman and Chief Executive Officer. He holds a Bachelor of Science from the University of Miami, a Doctorate from California College of Podiatric Medicine, and is board certified in Podiatric surgery, orthopedics and quality assurance.

Dr. Shane has served as the CEO of Tiger Management International: a Large-Cap Management company that deals in business management of private and public equity companies as a business negotiator and facilitator. In 2002, Dr. Shane created a Geo-Political hedge fund: a private equity fund specializing in oil, gold and large cap companies that are affected by geo-political issues.

He was also an expert witness and examiner for the State of California Department of Consumer Affairs. Dr. Shane has completed the John Hopkins Medical School Fellowship examination program for infectious disease and the University of California-Irvine program for internal medicine. His main mission is to bridge Medical and Environmental Science so humanity may live, work and play in a healthy indoor environment

Dr. Shane has also served as President, Founder, and CEO of Integrated Healthcare Alliance, Inc. (1988) a medical management company, which had operations in many states with hundreds of Physicians and ancillary personal under his direction. He also founded and was General Partner of Doctors Hospital of West Covina, California. Dr. Shane practiced Podiatric Surgery specializing in ankle arthroscopy and has been the author of many published articles in the medical and environmental fields.

Irv Kraut, Environmental Hygienist

Irv Kraut completed his college education at the University of Illinois. Irv has attended specialized educational courses provided by the Department of the Army at Redstone Arsenal, the ATF, FBI and the National Association of Mold Professionals.

Irv has also trained government employees for the United States Environmental Agency (EPA), Department of Defense and the Department of Energy and he has conducted training in the corporate sector for companies such as Monsanto, Abbott Laboratories, Johnson & Johnson and Service Master. Additionally, educational facilities including The University of California at San Diego and Santa Barbara have requested his consultation services.

Irv is a contributing author for the United States Environmental Protection Agency (EPA) and the American Chemical Society as well as a past Director with the Indoor Environmental Standards Organization (IESO).

As President and Senior Environmental Inspector at Clean Air Inspections, Irv Kraut provides 30 years of expertise in the Environmental field.

Issues of Concern:

Cooling towers, large plumbing systems, water features (decorative) and even hot tubs & hydrotherapy spas have the potential to facilitate the growth of pathogenic bacteria such as Legionella due to the lack of proper maintenance and/or inadequate disinfection. Since aerosolized Legionella bacteria can be carried distances beyond the source (cooling towers systems), direct inhalation of the bacteria cells has occurred and lead to serious illnesses and death due to L. Pneumonia. Adding to the issue of proper disinfection is the presence of biofilms within the systems that protect bacteria communities from both environmental conditions as well as traditional cleaning and disinfection methods. Bacteria form adhesive biofilms that allow them to become fixed to various surfaces, even in the presence of water flow and general cleaning methods. In addition to their adherence to a surface, biofilms form a protective slime like irregularly shaped protective shields that covers their communities. Legionella biofilms are not uncommon and as such require a more sophisticated multi-step approach to proper disinfection.

New York City Council has adopted legislation that requires adherence to part of ASHRAE's newly published Legionella standard.

The legislation addresses registration and inspection of cooling towers. It requires owners to create and file a plan to maintain equipment to comply with Section 7.2 of ANSI/ASHRAE Standard 188-2015, Legionellosis: Risk Management for Building Water Systems.

Objective:

To utilize the **SteraMist™ Binary Ionization Technology®** (BIT™) as either a final disinfectant methodology in cooling towers and related systems, or as a primary technology for small systems such as hot tubs, whirlpools etc. SteraMist™ BIT™ is a laboratory tested and EPA registered bacteria disinfectant that can be applied as a mist/fog into the components of a system to kill bacteria before a plume or drift occurs that carries bacterial cells into the air and consequentially to the population.

System equipment that may be decontaminated by the use of SteraMist™ BIT™ include:

Air Inlets, Basins, Canopies, Cells, Condensers, Controls, Discharge Stacks, Distribution Systems, Down Spouts, Drift Eliminators, Fans, Fill Deck, Inlet connections, Louvers, Nozzles, Splash Deflectors, Sumps, and Water Diverters & Valves.

SPECIAL ATTENTION: Roof top fresh air or make up air inlets or louvers that could draw air from the cooling towers into the building must be decontaminated.

For small scale systems such as hot tubs, whirl pools, hydrotherapy spas and water features (fountains), the systems should be drained of all water and then surface cleaned followed by disinfection by the direct application of SteraMist to the entire structure including pumps, inlets, valves and hoses.

Application Methodologies:

Generally, the portable **SteraMist™ BIT™** system is best suited when a direct application of the mist reaches the critical areas of concern. Trained field technicians can focus the Activated Ionized Hydrogen Peroxide (AIHP) mist on all observable sections of cooling tower systems (see above equipment listings) as well as other mechanisms that receive or discharge water as well as the fresh air inlets proximate to the cooling towers. The AIHP will have its best efficacy when the systems are dry and appropriate exposure time can be achieved.

History:

The history and chemical physiology behind Binary Ionization Technology® can best be described as follows: TOMI's SteraMist™ BIT™ was developed through a grant from the Defense Advanced Research Projects Agency (DARPA), L-3 - a major U.S. defense company, and the Department of Defense (DOD) for homeland security to protect first responders and building structures from a weaponized anthrax attack.

After declassification, TOMI™ purchased technology L-3 and has improved the equipment and brought it to the commercial market. Today, SteraMist™ BIT™ is used for biological and chemical decontamination in a variety of areas. The process applies cold plasma activation to a low percentage hydrogen peroxide-based solution to create an aerosolized spray containing high concentrations of Reactive Oxygen Species (ROS) and is the first two stage decontamination and hospital- healthcare disinfectant registered by the EPA.

TOMI's SteraMist™ BIT™ provides fast acting, broad-spectrum decontamination, and leaves no residue or noxious fumes. The environmentally friendly characteristics ensure further safety of all employees and equipment, while providing maximum decontamination efficacy. SteraMist™ BIT™ is safe for use on a broad range of materials. Extensive research and testing has shown no indication of material corrosion or surface degradation using the ASTM F483 protocol for 39 commonly used metals, plastics, and rubbers. BIT™ has been shown to effectively decontaminate chemical agents when applied using properly developed protocols. A summary of BIT's capabilities can be found in the U.S. Department of Homeland Security's *Guide for the Selection of Chemical, Biological, Radiological, and Nuclear Decontamination Equipment for Emergency First Responders* (2nd Edition, March 2007).

How Does SteraMist™ BIT™ Work?

SteraMist™ BIT™ assures that microorganisms (including spores) are destroyed in even the most hard-to-reach areas. The Reactive Oxygen Species created by the BIT conversion process react with double bonds in chemical agents, the spore or cell wall, or viral envelope proteins to disrupt chemical function or inactivate the agent or organism. The by-products are oxygen and water vapor. Further, testing

shows that the by-products of biological or chemical neutralization are far safer to handle than those left by conventional methods.

SteraMist™ BIT™ has been independently tested and proven to be effective in deactivating chemical compounds and quickly killing bacteria, bacterial spores, viruses, molds, and fungi in airborne environments and on surfaces. These studies include those of bacterial pathogens – such as *Clostridium difficile* (C-diff), vancomycin-resistant *enterococci* (VRE), *Klebsiella, Acinetobacter*, and the rapidly invading methicillin-resistant *Staphylococcus aureus* (MRSA) that have recently jumped from hospital settings to invade the community, along with other gram-negative and gram-positive pathogens. Results – some of which are presented in the table below – have proven its superior efficacy by consistently killing 99.9999% of test organisms (> six-log reduction) and chemical agents.

BIT™ increases the oxidation potential and converts a low percentage of H_2O_2 through conversion to hydroxyl radicals by physical means. This transformation is achieved by passing a low concentration (<8%) solution of H2O2 through an atmospheric cold plasma arc, in a process known as "activation." A secondary effect conveyed by the high energy electrical arc is the second step and as the solution passes thru the arc is activated and converted to a reactive oxygen species, classically hydroxyl radicals. The aerosolized ROS is charged in the form of a mist or fog. This charge improves the dispersive characteristics of the mist by making the individual droplets repel each other. It also improves the surface coverage of the mist through the attraction of the charged droplets to the oppositely charged items in the area undergoing remediation.

The aerosolized charge imparted to each droplet is a critical component of this technology due to its ability to attach to all the surfaces within the target and to rapidly kill the organism.

Process Applications:

Obtaining access to internal and external components of a cooling tower and/or smaller systems requires coordination with facility maintenance personnel to insure the system can be placed into a stand-by or shut down mode. Once accomplished, the SteraMist™ technician can begin equipment set up (see manual) and begin the process of disinfection. Mist/Fog applications will be focused on individual or connected components that carry, store, or discharge water. Some components may require opening access ports or closures in order to apply the disinfectant mist/fog. The most important requirement for proper disinfection of the system is confidence that all components that contact water receive a coating of the AIHP hydroxyl radical mist.

As noted above, all roof top fresh air inlets/louvers should be decontaminated as legionella. The time on target (amount of time the mist/fog is applied to a component) shall be the same as required for hospital disinfection.

Bacteria entrained in a plume or drift could be drawn into an occupied building or structure.

Types of Cooling Towers:

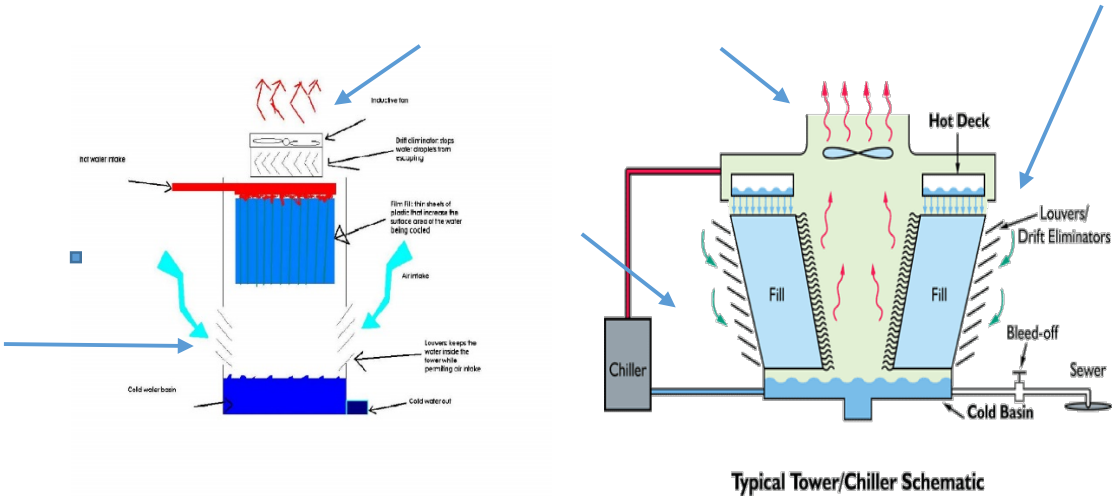
There are numerous types and sizes of cooling towers dependent on application requirements.

Examples include but are not limited to: mechanical draft, spray type, forced draft, induce draft, etc. The common issue for SteraMist™ BIT™ decontamination is access to the mechanical systems that are in contact to with the water source. In many cases Legionella bacteria breeds best in stagnant water, as such it is best to assume that the bacteria is present unless testing proves otherwise.

Sizes for Process Applications:

Simplicity is needed for SteraMist™ BIT™ applications as cooling tower systems may be placed into three basic categories for our decontamination purposes: large systems, medium sized systems, and small roof type systems.

1. Large system disinfection may be difficult due to an inability to access a generally closed system. In these cases the system owners will be attempting to decontaminate the water with free chlorine or other approved chemical disinfectants added directly into the water. The SteraMist™ BIT™ can be used to mist/fog outside louvers and other exist ports where vapors and plumes escape into the atmosphere. Also as in all units to be discussed, any rooftop or building structure fresh air intakes should be misted with a SteraMist™ BIT™ application. It is also imperative that all surfaces that receive a SteraMist™ BIT™ application be dry before the start of the decon process. As the image below reflects, the drift eliminator at the top of a cooling system (any size) is a source for potential bacterial contamination. As such all decontamination efforts must include the drift eliminator to kill surface bacterial cells.



Typical Tower/Chiller Schematic

Arrows point to SteraMist™ BIT™ Decontamination priorities.

2. **Medium size systems** will have similar priority areas for SteraMist, and some accessible entry ports where misting and fogging can be employed. As in all cases (Large, Medium and Small) the systems must be dry and not operating during SteraMist applications.

3. **Small systems** once emptied of water may be disassembled on site and misted/fogged with SteraMist. This allows for the internal mechanisms to be disinfected prior to the reintroduction of fresh water and a return to an operational status.

Clearance Testing:

An Industrial Hygienist is required to obtain surface samples from the drift eliminators and louvers post disinfection, as well as a liquid sample of water from the cooling tower (after fresh water and cleaning). Samples should be sent to an AIHA accredited laboratory with a specialty in Legionella testing.

Once laboratory results are returned with a finding of NO Legionella bacteria, the decontamination process can be documented as cleared. Please note that clearance reflects the conditions at the time of sampling and is not a warranty or guarantee that future contamination will not occur.

SAFETY GUIDELINES

The SteraMist™ BIT™ process produces a Hydroxyl Radical mist which decomposes into oxygen and water. BIT™ Solution will cause acute eye and skin irritation. Wear eye protection and gloves when handling.

Operational Safety Guidelines

1. Only qualified SteraMist™ BIT™ service technicians may repair or maintain this equipment. General system maintenance outlined in Section 5.

2. SteraMist™ BIT™ is designed to operate on a standard 120V, 15-amp grounded power receptacle. To avoid electrical hazards or damage to the machine, this minimum power requirement must be met.

3. The fine mist generated by SteraMist™ BIT™ may activate smoke detectors. Optical-based smoke sensor systems are typically the most susceptible to false alarms. Prior to treatment, the facility or asset undergoing remediation must be evaluated for the likelihood of whether the smoke detectors will be activated by the mist. Take appropriate measures prior to treatment.

4. Review and follow all labels and warnings marked on SteraMist™ BIT™ products.

5. SteraMist™ Surface utilizes high voltage transformers which generate approximately 17,500 volts at >1 milliamps.

6. Before plugging in power cord, make sure the power switch, located where the power cord plugs in the unit, is in the "OFF" position. The "OFF" position is engaged when the "O" symbol is pressed down.

7. Do not modify the power cord provided. This machine must be properly grounded to ensure safety. Improper connection of the equipment can result in mechanical failure or electrical shock.

8. Do not put fingers, tools, or any other foreign objects into the nozzle, electrode area, or high-energy electrical arc.

9. Remember, always keep the nozzle of the spray applicator pointed away from you and others at all times. Also, never operate the handheld applicator straight up.

10. Read and understand the SteraMist™ BIT™ Safety Data Sheet and retain the document in an employee-accessible location.

11. Use only BIT™ Solution in the SteraMist Surface unit for remediation. The use of other solutions poses risk of injury, machine failure, and/or unintended results, and is prohibited, and will void the warranty.

WARNING - To reduce the risk of harm: Do not aim the applicator at, or spray any person or animal. Keep hands and other body parts away from the high-energy electrical arc. Always use the nozzle tip guard. Do not spray without the nozzle tip guard in place. Only use a nozzle tip specified by the manufacturer, TOMI™. Use caution when cleaning and changing nozzle tips. In the case where the nozzle tip clogs while spraying, ALWAYS turn off and unplug the SteraMist unit. Check hoses and parts for signs of damage. Inspect hose before each use. Replace any damaged hoses or parts. Verify that all connections are secure before operating the SteraMist unit. Know how to stop the unit and be thoroughly familiar with the controls. Before transporting the SteraMist Unit, remove the BIT solution and flush unit. Make sure to unplug and remove the power cord from the unit.

Grounding Instructions:

To reduce the risks of fire or explosion, electrical shock and injury to persons, read and understand all instructions included in this manual. Be familiar with the controls and proper usage of the equipment. This product must be grounded. In the event of an electrical short circuit, grounding reduces the risk of electric shock by providing an escape wire for the electric current. This product is equipped with a cord having a grounding wire with an appropriate grounding plug. The plug must be plugged into an outlet that is properly installed and grounded in accordance with all local codes and ordinances.

AERATION PHASE – Once the SteraMist™ BIT™ application is complete and contact time has concluded, the enclosure is aerated and/or scrubbed to reduce the AIHP and hydrogen peroxide levels within the enclosure to less than or equal to a 1 ppm level (≤1.0 PPM TWA 8 hr.) prior to reentry into the enclosure by trained personnel.

TOMI™ Environmental Solutions, Inc. trained personnel are responsible for working with the owners and/or the responsible employees of the site that is undergoing SteraMist™ Binary Ionization Technology® Solution treatment to develop a site-specific Hospital Disinfectant Management Plan (HDMP) for each site that will be treated with SteraMist™ Binary Ionization Technology® Solution. Trained personnel are responsible for all tasks of the disinfection processes unless otherwise noted in the HDMP and must be on site for the entire disinfection treatment process. The HDMP must address characterization of the site, and include appropriate monitoring and notification requirements, consistent with, but not limited to, the following:

A. Inspect the structure and/or area to determine its suitability for disinfection.

B. If containment is needed, make sure structure is securely sealed, check for leaks and monitor any occupied adjacent rooms and/or buildings to ensure safety.

C. Prior to each disinfection, review any existing HDMP, MSDS/SDS, SteraMist User Manual, and other relevant safety procedures with company officials and appropriate employees.

D. Follow appropriate safety measures for nearby workers who will be in and around the area during application and aeration, if needed consult with building engineers.

E. Consult with company officials to develop an appropriate monitoring plan that will confirm that nearby workers and bystanders are not exposed to levels above the allowed limits during application, disinfection, and aeration. This plan must also demonstrate that nearby residents will not be exposed to concentrations above the allowable limits.

F. Consult with owners and or responsible employees at the site who will be responsible for development of procedures for local authorities to notify nearby residents in the event of an emergency.

G. Confirm the placement of placards to secure entrances of any area under disinfection as needed.

H. Confirm the required safety equipment is in place and the necessary manpower is available to complete disinfection.

These factors must be considered in putting a HDMP together. It is important to note that some plans will be more comprehensive than others. All plans should reflect the experience and expertise of the applicator and circumstances at and around the structure and/or area.

In addition to the plan, the trained personnel must read the entire label and this package insert, and the SteraMist User Manual and follow all directions carefully. If the trained personnel have any questions about the development of a HDMP, contact TOMI Environmental Solutions, Inc. for further assistance. A HDMP must be developed for each treated site. In the event of an emergency application, a generic HDMP may be used and updated after disinfection. TOMI Environmental Solutions, Inc. trained personnel must sign the plan indicating it was followed. The signed HDMP and related documentation, including monitoring records, must be maintained by the applicator for a minimum of two (2) years and a copy provided to the owner of the treated site.

Set up hydrogen peroxide monitoring, for safety purposes and for process verification. This must be done to verify the fogging concentrations have reached the desired level and to indicate when it is safe to re-enter. Two devices are recommended for measuring airborne hydrogen peroxide:

a. A monitor (such as a Drager) with H2O2 sensor has a dynamic range of 0-20 ppm. This H2O2 sensor is intended to be used outside the treatment area for low level leak detection and containment verification.

b. A monitor (such as a PortaSens) can be equipped with a hydrogen peroxide sensor with a dynamic range of 0-200 ppm or 0-2000 ppm.

i. When equipped with the 0-200 ppm sensor, this unit can be used in place of the Drager unit for containment verification. It is outfitted with a sample tube, which can be fitted under the door and used to monitor the treatment room concentrations of hydrogen peroxide. It can also be taken into the treatment room by the operator to verify purge is complete.

ii. When equipped with the 0-2000 ppm sensor, the PortaSens unit is used to monitor treatment room concentrations during fogging operations where hydrogen peroxide concentrations exceed 150 ppm.

iii. Limitations of electrochemical sensors (such as Drager and PortaSens) Sensors saturate and have inaccurate readings when the relative humidity exceeds 90%.

vi. Sensors may respond to other chemicals, in this case the isopropyl alcohol in the BIT Solution and the ozone produced by the high-energy electrical arc may give a false higher reading

Personal Protective Equipment:

All personnel operating the SteraMist system or observers in the decontamination zone shall wear:

1. Eye protection (Goggles, Face Shield or Safety Glasses).
2. Protective Gloves & Tyvek coveralls.
3. R95 Particulate Respirator with Nuisance Level Organic Vapor Relief