ULTRA-TECH™ LIGHTING

STERILE-BRIGHT™

High Intensity Full-Range Ultraviolet

An Aggressive Approach to COVID-19 Mitigation

Overview –

The use of ultraviolet light (UV) for sterilization is **well known** and **universally accepted**. Professor Anne Rammelsberg of Millikan University explains that UV energy initiates a reaction between two thymine molecules within DNA. Although bacteria can normally repair damaged DNA, when the damage is extensive the cell ceases to function. This same response can be engendered in viruses and fungi relative to the wavelength used and the light intensity.

Ultra-Tech™ Lighting has developed **Sterile-Bright™, a multi-tiered approach** to surface and air sterilization using a combination of powerful UV light that directly decomposes pathogens from its radiation **and** generates significant ozone (O_3) that acts as a strong sterilizing agent. This combination provides an optimum solution for sterilizing surfaces and spaces (air). Sterile-Bright™ attacks DNA and cell wall integrity. Using a specialized carrier frequency approach, ionizing radiation below 200nm can travel further through the atmosphere before being neutralized by oxygen and nitrogen. This approach provides a more effective "kill rate" at longer distances and creates ancillary sterilization agents including hydrogen peroxide (H_2O_2) from atmospheric water. The multiple sterilization pathways generated by Sterile-Bright™ combines mutually exclusive and proven disinfection and sanitization modalities for the most comprehensive and effective non-chemical approach* that addresses bacteria, viruses, fungi and spores. The light also effectively destroys larvae and other pests.

The specific application introduces disinfectants (O_3 and H_2O_2) with very short half-lives to ensure a safe post treatment environment. Ozone and hydrogen peroxide vapor quickly dissipate under normal circumstances and do not pose health hazards after treatment. Sterile-Bright™ technology is far less expensive than burst xenon UV generators and other approaches. With an operating lifecycle exceeding 100,000 hours, the service exceeds eleven years when operating 24 hours by 365 days per year.

Comparative Technologies –

Drawbacks to most UV sterilization approaches include photobiologic hazards and line-of-sight effectiveness. In particular, pathogens that are not directly exposed to UV radiation will survive and multiply. However, this is equally true for chemical treatments that do not come in direct

contact with pathogens. In addition, most UV lamps rely upon relatively weak light sources that typically range from 10-watts to 40-watts, requiring close proximity to the intended surface. By comparison, Sterile-Bright™ comes as a 300-watt or 400-watt full range UV generator that includes substantial energy below 200 nanometers (nm) in the ionizing range.

Given the known efficacy of UV pathogen eradication, many solutions have been developed, including very costly automated units such as the Xenex® pulsed xenon robot that relies upon extremely powerful short bursts of UV-C energy. These units are designed for static indoor environments and are not appropriate for all forms of deployment, in particular emergency facilities like tent hospitals and temporary treatment facilities.

Other approaches attempt to use UV-A wavelengths that pose less photobiological hazards to people such as a 405nm light emitting diode (LED) that can continuously operate while individuals and animals are present. This low energy UV relies upon continuous exposure rather than intensity to eliminate pathogens. The problem is that it can take up to sixteen hours to degrade E. coli or S.aureus. The process requires direct exposure which means shadowed surfaces will not be disinfected. Further, this lower energy UV bandwidth has less efficacy for more persistent bacteria like C. diff and viruses like coronavirus. It should be noted that an estimated 12% of women may be tetrachromatic, meaning they have an additional "cone" receptor in their eyes, making them sensitive to intense violet light. Thus, a UV light that may appear innocuous to most of us would be extremely disturbing for tetrachromats.

UV Light – Ozone – Hydrogen Peroxide –

The shorter the electromagnetic wavelength, the more energy it carries. Ultraviolet radiation covers three ranges; UV-A (315nm~400nm) UV-B (280nm~315nm), and UV-C (100nm~280nm). More than 95% of UV-C light is blocked from reaching the earth's surface by ozone. Radiation from UV-C to UV-B is called "ionizing" because it can alter chemical structures like turning oxygen into ozone (O_2 to O_3). Ozone is a powerful oxidizer and can act as an independent sterilization agent and process. UV water treatment relies upon creating ozone within water to kill bacteria, viruses and algae. Ozone concentrations as low as 0.3 parts per million (ppm) in water have a deleterious impact upon pathogens. Depending upon contamination levels, ozone between 0.5 and 2.5ppm can reduce airborne bacteria by more than 90% with just five minutes of exposure.

Sterile-Bright™ appears to modify atmospheric water (humidity) from H_2O into H_2O_2 (hydrogen peroxide) in much the same way as in aqueous solutions This process is being studied to determine the ratio of humidity to the H_2O_2 production. Although the H_2O_2 component of Sterile-Bright™ is not in the fundamental claims, it is important because once formed, H_2O_2 can form hydroxyl radicals (·OH) in the presence of UV light. As the Environmental Protection Agency (EPA) notes on its website, hydroxyl radicals are even *more effective* that O_3 alone. In an air medium, dissipation is rapid, diminishing potential negative impacts upon human and animal health. These properties would be ancillary to fundamental sterilization processes presented by Sterile-Bright™ technology and must be further investigated and substantiated.

Sterile-Bright™ technology introduces disinfectants with very short half-lives to ensure a safe post-treatment environment. Ozone, hydrogen peroxide and possibly consequential hydroxyl radicals quickly dissipate under normal circumstances and do not pose health hazards after treatment. Sterile-Bright™ technology is far less expensive than burst xenon UV generators and other approaches. With an operating lifecycle exceeding 100,000 hours, the service exceeds eleven years operating 24 hours by 365 days per year.

Objectives –

Sterile-Bright™ technology was in development prior to the COVID-19 outbreak to address widespread problems of non-chemical/non-toxic sterilization methodologies. Use of chlorine and other bleaching (oxidation) agents has come under scrutiny because of known toxicity and costly application. Sterile-Bright™ targets typical applications including hospitals, food processing and service facilities, cleanrooms, public areas like movie theaters, restaurants, religious facilities, schools and even open area stadiums. More specific applications include hog breeding and feeding operations that are highly sensitive to disease outbreaks.

The COVID-19 outbreak changed our focus toward emergency sterilization applications. Ultra-Tech™ Lighting has fast-tracked high-powered multi-functional units that combine large-volume CFM blowers with direct-exposure full-range UV generation. This takes advantage of ozone circulation in conjunction with pathogen-destroying UV radiation. These units are portable and allow multi-tasking between facilities. Once a space is treated, the pathogen-free environment can sustain as long as proper procedures are followed.

The new development track for Sterile-Bright™ can provide powerful tools to protect against spreading COVID-19 and other pathogens. This COVID-19 crisis calls for fast, cost-effective, and proven solutions. There is no time for totally new science. Efficacy of the UV/Ozone approach is known science, requiring no further extensive testing or trials. The technology can be confidently and effectively deployed immediately.

Understanding the Problem/Solution –

Pathogens like viruses, bacteria, fungi, and spores are biological macromolecules, each with different modalities. Viruses are smaller and more hardened than most bacteria; multiplying only within the host cell while bacteria can replicate independently. Fungi can be even more resilient than bacteria or viruses while spores present other unique challenges. All these pathogens can exist on surfaces and some can be airborne. Those that can exist in air are particularly dangerous because of their rapid transmission rate.

Typical sanitation routines deal exclusively with *surfaces.* How do we address airborne diseases? Properly tuned UV light can destroy all mentioned pathogens quickly, both airborne and/or on surfaces. However, in order for the UV to work, the pathogens must be *exposed to the light.* Most settings have shaded areas where light will not shine. These areas can continue harboring pathogens that can re-emerge. Ozone can circulate through an *entire space*, destroying viruses by diffusing through the protein coat into the nucleic acid core, resulting in damage of the viral RNA. At higher concentrations, ozone destroys the capsid or exterior protein shell by

oxidation. Numerous families of viruses including poliovirus I and 2, human rotaviruses; Norwalk virus, Parvoviruses, and Hepatitis A, B and non-A non-B are among many others susceptible to the viricidal actions of ozone.

Research on ozone's viricidal effects has centered upon ozone's ability to destroy lipid molecules at multi-bond sites. After the virus lipid envelope is broken apart, its DNA and/or RNA core cannot survive. Viruses that are non-enveloped (Adenoviridae, Picornaviridae), are being studied to determine threshold ozone concentrations exhibiting efficacy. These viruses without an envelope are called "naked viruses" and consist of a DNA/RNA nucleic acid core and a protein nucleic acid coat or capsid. In addition to ozone's known action upon unsaturated lipids, it interacts with particular proteins and their components like amino acids (protein subsets). Viruses and other pathogens have no protections against oxidation when ozone comes in contact with capsid proteins, protein hydroxides and protein hydroperoxides.

COVID-19 is an enveloped virus which is more sensitive to physico-chemical challenges presented by Sterile-Bright™ technology. It should be noted that ozone's effects upon unsaturated lipids is one of its *best documented biochemical actions*. Atmospheric ozone at 9 ppm for just 240 seconds has been shown to deactivate 3.3-$\log_{10}$ of MBP with an equally devastating impact upon viruses like COVID-19. Sterile-Bright™ technology is capable of ozone concentrations well in excess of 9ppm.

Safety –

Ozone at sea level is categorized as a pollutant. At high concentrations, ozone is toxic to humans and animals. It can also bleach materials through oxidation and promote corrosion in elements like metals that are subject to oxidation. People should not be in proximity to areas being treated using Sterile-Bright™ equipment without proper respiration protection like an ozone neutralizing breather. A treated area should remain vacant until ozone sufficiently dissipates with either time or by venting. Ventilation should be used *negative pressurization* to avoid re-contamination.

Since Sterile-Bright™ uses high-energy UV radiation in the ionization range (<200nm), operators should also not be in the presence of operating units. Protective eyewear should be worn if there is a risk of viewing the operating unit. Ultra-Tech™ Lighting can provide training to ensure proper use of Sterile-Bright™ technology.

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*Note: Ozone and hydrogen peroxide vapor are considered chemical sterilization agents.