

Inactivate COVID-19: Thermal Energy & UV Light Sanitation Solution to Support the Reuse of Contaminated PPE's for Health Care Workers ©

April 2020

Target Audience:

Government Agencies; FEMA, CDC, FDA, HHS, DOD, VA

Product Solution Partners:

Blue Water Innovations, Element 1 Corp (e1), US Hybrid, Mosebach Manufacturing Company

Overview:

COVID-19 is a highly contagious SARS-CoV-2 coronavirus that is rapidly spreading through both our most vulnerable and healthy populations. SARS-CoV-2 challenges existing healthcare sanitization protocols for medical equipment, patient rooms, and assisted living facilities. The rapid spread of COVID-19 is also causing significant stress on our national supply and availability of PPE for our healthcare workers.

After the SARS outbreak of 2003, medical research validated that 56°C (132.8°F) of thermal energy will inactivate SARS-CoV-2 viruses. BWR Innovations has developed a novel industrial fuel cell electrical generator/heater solution producing 50°C (122°F) thermal energy to sanitize hotel bed bug infestations. This solution can be quickly modified to produce the higher energy thermal loads required to completely sanitize COVID-19 contaminated medical equipment, patient rooms, and PPE's.

BWR's Fuel Cell Thermal Sanitizer is designed to increase the level of sanitization of COVID-19 contaminated surfaces by applying dry sterilant thermal energy (60°C/140°F) to all of the room surfaces, providing more uniform coverage on equipment and surfaces throughout the room, decreasing the rate of infection. ***The use of a dedicated sanitation room can also relieve the stress on the PPE supply for our health care workers by facilitating the sanitation and reuse of previously contaminated PPE's.***

Problem Statements:

The current COVID-19 pandemic has shed light on the challenges facing the hospital and healthcare industry in the United States, exposing the vulnerability of existing sanitization procedures, and significantly exhausting the supply of PPE's for our healthcare providers.

- 1. COVID-19 is Highly Contagious, and Stressing Healthcare:** There are three ways SARS-CoV-2 respiratory viruses are spread: direct person-to-person contact, the airborne route, and via contaminated surfaces.

These infectious particles are easily transferred from object to hand and pose a risk for infection again. A primary method of the highly contagious COVID-19 virus transmission is by touching contaminated surfaces. Research has shown the virus can typically live up to three days on surfaces, and in some environments, much longer. An effective sanitization system to reduce infection must address surface decontamination.

Federal, state, and local authorities are working to "Flatten the Curve" to reduce taxing the health care system capacity by decreasing the chances of exposure for as many people as possible. Infection prevention through the use of more effective surface and room sanitization protocols is necessary to slow the spread of COVID-19.

2. Incomplete Sanitization: One of the critical issues is the sanitization of contaminated rooms to assure the protection of the hospital staff and fellow patients. The healthcare environment is a veritable invisible cloud of particulate matter. This includes:

- Microorganisms (including spores, viruses, and bacteria)
- Volatile organic compounds (emitted by cleaning products and furniture)
- Dust
- Lint from hospital linens and fabrics
- surgical smoke
- Pollen and animal dander brought in on the clothes of staff, patients and visitors.

Surfaces can become contaminated with fallen particulate matter that can then be picked up and transferred on the hands of healthcare workers.

Current sanitization protocols involve hand cleaning of rooms and medical equipment using disinfectants. Hand cleaning is labor-intensive, and vulnerable to missing irregular shaped objects, cracks, cords, or isolated contaminated surfaces. Residual virus or bacteria in a hospital room can be very harmful, especially since the patients may be immunosuppressed and more vulnerable to new viruses and bacteria.

3. Lack of Available PPE: The United States suffers from the increasing demand for PPE for individuals who perform critical health care functions who may be in contact with COVID-19 infected patients. Of particular concern are N95 masks, which are primarily produced overseas. Overseas production is compounded by a lag in domestic production.

To conserve available supplies, hospitals, and health workers across the country currently reuse PPE significantly longer than recommended guidelines and while they treat multiple patients. This reuse not only puts healthcare providers at risk but also increases the potential that they spread COVID-19 to uninfected patients.

Background:

BWR Innovations has developed a line of small, mobile, fuel cell generator/heaters for flexible indoor, or industrial use. The BWR HFC 308 is an 8kW electrical generator that is on a movable cart. The HFC 308 weighs less than 100 lbs. and can be moved to any location and be started instantly.

The HFC 308 was developed to provide thermal decontamination to eliminate bed bugs infestations in hotel rooms. The clean-energy and portable rolling cart can discreetly sanitize one room at a time, without impacting adjoining rooms. These applications require a 50°C (122°F) thermal threshold for 30-60 minutes.

The HFC 308 incorporates fuel cell generator technology for its high-reliability, low-noise, no-emissions, and low operating costs. Although fuel cell solutions have been commercialized for decades in critical power applications requiring 95% or better uptime, recent technological advancements have made leaps in creating a cost-competitive power solution to legacy diesel power solutions. Recently, fuel cell generators have experienced a rapid adoption in mobile fuel cell electric vehicles (FCEVs) cars and trucks.

Hotels, office buildings, and ships are able to produce significant quantities of electrical power; however, 10kW to 20kW of electrical power is likely not available in any specific room or location within a building. The fuel cell generator solves the problem of power distribution to the resistive heater while also providing approximately 50% of the heat required for the room to reach the target temperature.

These same mobile units can be adapted to create an increased thermal level that will sanitize healthcare facilities and equipment that have been contaminated by the COVID-19 virus.



Thermal Energy & UV Light Sanitizing Solution Overview:

The BWR Fuel Cell Thermal Sterilizer with UV Light is a dry heat sterilizer designed to produce 60°C (140°F) thermal energy coupled with UV light to inactivate a full spectrum of biological contaminants, including viruses, bacteria, spores, and fungi, leaving no residue and no lingering odor. Compared to hand cleaning alone, there's more uniform sanitization coverage throughout the room and significantly less risk of material compatibility issues.

BWR Innovations, collaborating with e1, US Hybrid and Mosebach Manufacturing Company have adapted the HFC 308 design to produce a Fuel Cell Thermal Sanitizer that integrates four separate off the shelf technologies: **(1)** Methanol to hydrogen generator to produce hydrogen for the fuel cell; **(2)** Fuel cell power generator to produce electricity and thermal energy; **(3)** Resistive heater to convert electricity to thermal energy for primary thermal sanitization; **(4)** UV light for secondary sanitization.

Each of the primary components would be located on separate medical quality rolling carts that will be connected through quick disconnect hoses and electrical cords to create a self-contained mobile solution. For a target 500 SF room, it will take 30 to 60 minutes to set up the Fuel Cell Thermal Sanitizer solution and heat the room to the target temperature. The room will be kept at the target temperature for 30 minutes to inactivate contagions. The entire sanitization procedure will take 60-90 minutes and provide thorough thermal sanitization of the room and its contents.

BWR's Fuel Cell Heat Sanitizer is designed to supplement, not replace existing hand sanitation methods with the benefit of significantly increasing the level of sanitization of contaminated rooms by applying sanitizing heat to all of the equipment and surfaces in the room, thereby decreasing the rate of infection.

Dedicated Sterilization Room for Equipment and PPE: One efficient use for thermal sanitization is a dedicated room within a health care facility to sterilize contaminated mobile equipment and healthcare providers PPE's. Stretchers, IV poles, blood pressure cuffs, and other equipment travel from room to

room and are typically handled by numerous people between cleanings. This thermal sanitation procedure can be done multiple times per day in under 2 hours, providing a confident sanitation protocol.

PPE supply is strained, causing health care workers to deviate from optimal PPE protocols. The use of a dedicated sterilization room will facilitate the reuse of PPE and decrease the infection rate of health care workers while the supply of PPE is constrained.

Thermal Sanitation Solution Technical Details:

1. **Methanol to Hydrogen Generator:** e1 had developed a methanol to hydrogen generator to produce hydrogen on-site and on-demand to satisfy the hydrogen demands of larger-scale fuel cell modules. The generator can create hydrogen to support the fuel cell electrical generation of 20 kW or more of thermal energy. The hydrogen generator utilizes advanced fuel reforming and hydrogen purification technologies to convert a mixture of methanol and DI water into high purity hydrogen.

Hydrogen is a readily available fuel, often stored under pressure in cylinders. However, compressed hydrogen gas cylinders are expensive, heavy, have difficult logistics, and provide limited run-time per cylinder. Often local regulations limit large volumes of hydrogen storage.

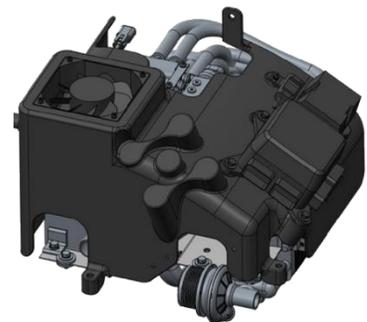
Methanol is a low-cost source of hydrogen that has straightforward logistics, is easy storage, and provides for long fuel cell run times due to its high hydrogen density. Methanol to hydrogen generators are designed to displace expensive and heavy cylinders of compressed hydrogen for critical power applications where long run times are required.

The e1 methanol-reformer to hydrogen generator is a small self-contained unit that can be easily attached to the fuel cell power generator. The methanol-reformer creates CO₂ emissions that are exhausted. No pollution (NO_x, SO_x, or particulate matter) is produced in generating hydrogen.



2. **Fuel Cell Electrical Generators:** The fuel cell electric generator provided by US Hybrid supports the large power load generated by the resistive heater to produce the high BTU's required to elevate a room's temperature to more than 60°C (140°F). Fuel cells are an electro-chemical generator that combines hydrogen and oxygen to produce electricity and heat. A fuel cell uses a chemical reaction to provide an external voltage, as does a battery but differs from a battery in that the fuel is continually supplied in the form of hydrogen and oxygen (from air) gas.

Fuel cell electrical generators utilize lithium-ion batteries as an intermediary storage device, which allows the generator only to operate when it is "truly" needed. When it is on, the generator will operate at a variable rate required to resupply the power to the batteries. The hydrogen fuel cell generator can operate efficiently at whatever level is needed at the same fuel efficiency with limited additional maintenance costs. This is entirely different than a diesel-powered generator where the generator must operate at a "near" capacity to operate efficiently and not have significant maintenance issues.



Fuel cell generators provide the flexibility, reliability, and low operating costs that are crucial for providing power for critical areas. Critical areas include internal rooms and remote areas that require quiet, discreet operations and other areas where diesel/gas-powered generators are not practical.

These generators also can operate more efficiently at all load capacities (10%-99% of load capacity). A fuel cell generator's emissions are thermal energy and water, thus is an ideal source for clean thermal energy.

Fuel cell generators have few moving parts and require less than 10% of normal maintenance required on gasoline/diesel generators while producing toxic-free emissions. With methanol as a primary feedstock source, these generators can operate virtually anywhere and under any environmental condition. Fuel cell generation offers a clean, cost-effective, and dependable technology solution to provide power in challenging environments.

- 3. Telemetry:** BWR hydrogen fuel cell generators also include a remote telemetry. The telemetry permits the ability to monitor and operate units remotely using a computer or phone. These telemetry connections (fuel cell generator, heater, and UV) provide a complete picture of the unit and all operating conditions, meaning complete control and a history of all applications.

Medical Literature:

Thermal sanitation is an accepted medical sanitation practice. A temperature range of 56°C - 60°C maintained for 15 to 30 minutes will completely inactivate focused virus and bacteria. Ultraviolet light is considered a germicide, due to its ability to effectively eliminate bacteria, virus, and even clostridium difficile (C diff). Together these two sanitation methods will effectively complement each other and allow for a more timely and complete solution.

North Dakota State University is currently in the process of completing focused laboratory tests that will validate 60°C thermal heat and UV light and recording the time to viral inactivity for the SARs-CoV-2 swine flu virus and for H1N1. Testing will utilize PPE and various health care material surfaces to test for adequate viral attenuation. Conclusive results are expected by April 15th.

Conclusions:

New challenges, like the COVID 19 virus, often present opportunities for the review and adaptation of new technologies to challenge established methodologies. New technologies result in improved techniques, improved outcomes, and reduced costs. In Summary:

- Thermal energy and UV light are independently validated and accepted sanitation solutions against a full range of viruses and bacteria, including SARs-CoV-2 coronaviruses.
- When combined, these two solutions, provide an even higher level of sanitation than utilizing each sanitization approach independently.
- The fuel cell generator is a mobile and efficient power source that makes this energy-intensive solution possible within buildings, ships, and near first responders.
- The Fuel Cell Thermal Sanitization solution will provide a safe, chemical-free application that is mobile, discrete, and free of toxic emissions.
- We believe that the BWR Fuel Cell Thermal Sanitation solution is a novel approach, utilizing proven technology to improve the sanitation options for hospital rooms, equipment, and critical care facilities.
- The use of a dedicated thermal sanitation room will allow relatively quick, thorough sanitation of hospital equipment and reusable PPE for health care workers.

→ The Fuel Cell Thermal Sanitizer is a clear and compelling alternative to the exclusive use of chemicals and cleaning agents that rely upon varying capabilities and routines to clean and sanitize a room.

Technology Partners:

BWR Innovations: BWR is an innovative technology company that has developed small mobile environmentally clean fuel cell generators that can be used where emission-free, discreet, and reliable power is needed. Fuel cell power is the "power of the future." For more information about BWR Innovations, please visit www.bwr-innovations.com.

Element 1 Corp (e1): Element 1 designs and develops novel processes and hydrogen generation technology to enable the commercialization of clean-energy fuel cell technology. Through licensing our IP to strategic partners, our mission is to significantly reduce barriers to the adoption of hydrogen technology and fuel cells for a range of applications. For more information about Element 1, please visit www.e1na.com.

US Hybrid: US Hybrid specializes in the design and manufacturing of zero-emission components for electric, hybrid, and fuel cell. US Hybrid has been developing and deploying electric, hybrid, and fuel cells for multiple applications for decades. For more information about US Hybrid, please visit www.ushybrid.com

Mosebach Manufacturing Company: Mosebach is a world leader in resistance technology, including robust, efficient, mobile electric heaters. They are the market leaders in sanitizing room heaters. For more information about Mosebach, please visit [www. https://www.mosebachresistors.com](https://www.mosebachresistors.com)

For more information, contact:

Name: Thomas Nelson
Title: Program Manager
Company: BWR-Innovations
Phone: +1.612.968.0959
Email: tom.nelson@bwr-innovations.com

For more information, contact:

Name: Robert Schluter
Title: President
Company: Element 1 Corp
Phone: +1.541.678.5943
Email: Robert@e1na.com