# Project Title

Assessing the Efficacy of a Stationary UV Device in activating micro-organisms on Stainless Surfaces

Item #10999 SES-UVCMOBI-220

## Industry Partner

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## Test Facility

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## 1. Scope of Work & Objective

This document describes the outcome of the tests conducted at Food Science Lab (240) and Biosystems Engineering lab (015), Tennessee State University (TSU), 3500 John A Merritt Blvd, during the weeks of November, 22, 2020 – December, 22, 2020. This work is an outcome of a joint proposal between Sarin Energy and Tennessee state University entitled 'Assessing the Efficacy of a Stationary UV Device in activating micro-organisms on Surfaces #1001 (Rev 1). Sarin Inc. is investigating the efficacy of UV devices against vegetative cells and model viruses. The purpose of this study was to determine the antimicrobial efficacy of Sarin Energy Solution's UVC sterilizing device Mobile UVC Sterilizer Unit XL #10999 SES-UVCMOBI-220.

UV lights are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA, EPA) as pesticide devices when sold or distributed with claims to kill or be otherwise effective against viruses and/or bacteria, unless an exception applies, and must comply with certain statutory and regulatory requirements. All UV devices must be validated and tested against the target pathogens. The appropriate and correct dose for inactivation need to be delivered to the target pathogen.

## 2. Test Device Information

**Name of Test Devices:** Mobile UVC Sterilizer Unit XL
**Manufacturer:** Sarin Energy Solutions
**Mode of Action:** UV-C Light (Germicidal)

Figure 1. Mobile UV Trolley

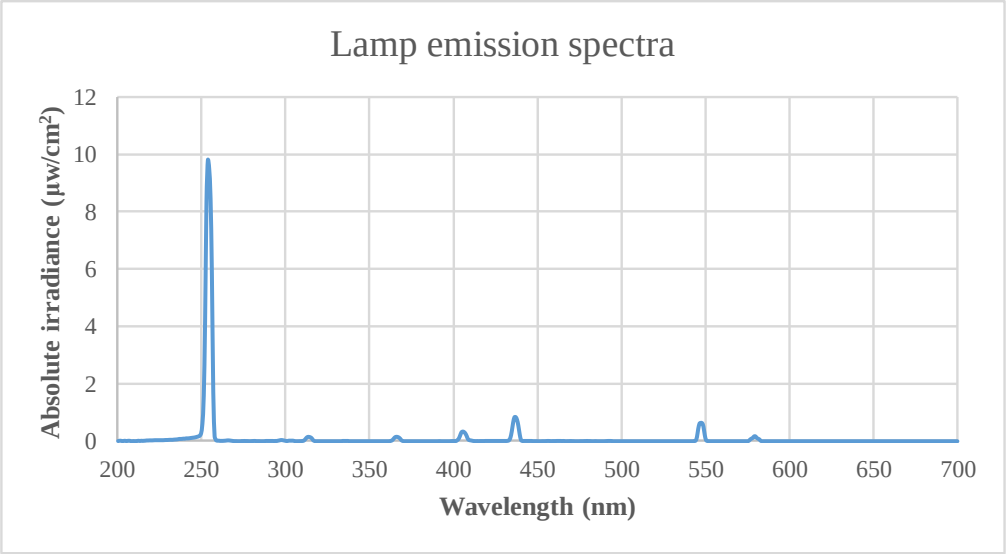


Figure 2. Lamp emission spectra

### 3. Preparation of microbial suspensions

MS2 bacteriophage and *Salmonella* enterica ser. Typhimurium ATCC 1331 were used in this study. MS2 bacteriophage (@$10^{11}$ pfu/mL), a single-stranded RNA virus, was purchased from GAP EnviroMicrobial Services Limited, London, ON, Canada. It was used as a challenge organism for biodosimetry studies. It is an environmentally stable organism, consists of an icosahedral shell of 27 nm diameter (Ward et al., 2018; Ward et al., 2019). The culture was stored at -4$^{o}$C before use. *Salmonella* enterica ser. Typhimurium ATCC 1331 was stored in 25% in cryovials at −80°C. Two loops of this strain were transferred to 10-15 mL of Tryptic Soy Broth (Oxoid Ltd., Basingstoke, UK), and incubation was done at 37 °C for 18 hours, followed by transferring the culture to 30 mL of TSB and incubation at 37°C to the stationary phase (for 18 hours). The culture was purified via centrifuge (Thermo Scientific Sorvall, ST 16 R., New Jersey, US) at 3000 rpm for 15 min and the pellets obtained was washed twice with 0.1% (w/v) phosphate buffer saline (PBS, Becton Dickinson, New Jersey, US) and re-suspended in 50 mL of PBS. The original population was evaluated by making suitable dilutions in 0.1% peptone water, plating it on Tryptic soy agar (Oxoid Ltd., Basingstoke, UK) and incubating it at 37 °C for overnight.

### 4. Irradiance measurements

Using the Ocean Optics Spectrometer, irradiance measurements were conducted on UV-C device [Figure 1]. Spectrometer is equipped with an irradiance probe – a solarization-resistant optical fiber with Spectralon cosine corrector of 180 degrees field of view, coupled to its end –. Spectralon is a Lambertian diffuse material with a higher than 95% reflectance in the 220 to 400 nm range. Spectral irradiance of the lamp was measured using an optical fiber, set about 3 meters from the device. This system is calibrated with NIST-traceable Deuterium (D2) and Quartz-Tungsten-Halogen (QTH) calibration sources with approximately 5% and 3% uncertainties. A

warm up time of 20 mins is a perquisite for any optical measurement. All measurements were done in triplicate and data was averaged [Figure 2]. At a distance of 3 metre, irradiance value of 0.01217 $mW/cm^{-2}$ was observed.

## 5. Incoculation and UV Exposure

The test microorganism(s) were propagated in the appropriate liquid broth Cell suspensions of the test microorganism were prepared to achieve a concentration of 7 $\log_{10}$ CFU/mL A known volume of inoculum (50 µl) is used to inoculate 0.5-inch diameter 316L stainless coupons (Biosurface Technologies Corporation, Bozeman, MT) to study the surface disinfection efficacy of the UV unit. The inoculated coupons were exposed to UV-C irradiation at known distance (3 meter). The UV device was turned on and samples were collected after the UV exposure. The survival microorganisms were collected, by suspending into PBS, enumerated by spread plate technique (*Salmonella*) and soft agar overlay technique (MS2). For each exposure time, separate control (without UV-C treatment) experiments were conducted and calculated log reduction. All the experiments were conducted in triplicates

**Table 1**. Inactivation of *Salmonella* Typhimurium and MS2 bacteriophage on stainless steel (316L) surface using UV-C trolley at distance of 3 meters

| **Microorganism** | **Irradiance ($mW/cm^{-2}$)** | **Exposure time (min)** | **Exposure Dose ($mJ.cm^{-2}$)** | **Log Reduction (CFU/mL)** | **Reduction (%)** |
|---|---|---|---|---|---|
| ***Salmonella* Typhimurium ATCC 13311** | 0.01217 | 10 | 7.302 | 2.42 ± 0.02 | 99.61 |
| | 0.01217 | 20 | 14.6 | 2.85 ± 0.04 | 99.85 |
| | 0.01217 | 30 | 21.9 | 3.45 ± 0.02 | 99.97 |
| **MS2 Bacteriophage** | 0.01217 | 30 | 21.9 | 1.35 ± 0.03 | 94.44 |
| | 0.01217 | 60 | 43.81 | 2.40 ± 0.01 | 99.81 |

## 6. Conclusions

UV device effectively inactivated *Salmonella* Typhimurium and MS2 bacteriophage on stainless steel (316L) at distance of 3 meters (Table 1). 3.45 log reduction was achieved *Salmonella* Typhimurium at the maximum exposure, in contrast 2.40 log reduction was observed for MS2, an RNA virus. It is hypothesis that this device can effectively inactivate other RNA viruses which has low sensitivity to UV in comparison to MS2.

| Rev | Date | Details of Changes | Created By | Checked By | Report[1] Approved By |
|---|---|---|---|---|---|
| 1 | 1, January, 2021 | Initial release under new format and numbering. | Ankit Patras | Brahmaiah Pendyala | |
| 2 | 08, January, 2021 | | | Ankit Patras | Ankit Patras |

[1]This report is only for research purposes.

Reference


1. Ward, D., Patras A., Pokharel, B., Sasges, M. (2018). Efficacy of Ultraviolet (UV-C) Light in Reducing Foodborne Pathogens and Model Viruses in Milk. Journal of Food Processing and Preservation. DOI: 10.1111/jfpe.12586
2. Ward, D., Patras A., Pokharel, B., Sasges, M. Xiao H. (2019). UV-C irradiation on the safety of skim milk: effect on bacterial, viral inactivation and cytotoxicity. Journal of Food Process Engineering, https://doi.org/10.1111/jfpe.12944