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**Result: COMPLETE**

**Report Date: July 2, 2019**

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Customer Name: Proximity Systems  
Description: UV-C Efficacy Testing Against MRSA & *Clostridioides difficile*  
Test Type: Test Only  
Job Number: J-00332837  
Project Number: 10114186  
NSF Corporate: C0478528  
Project Manager: S. Hatt

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**Executive Summary:** Proximity Systems requested NSF determine efficacy of a keyboard disinfection device which emits low-intensity ultraviolet C light against Methicillin-resistant *Staphylococcus aureus* and *Clostridioides difficile* endospores at a product height of twelve inches.

**Thank you for having your product tested by NSF International.**

Please contact your Project Manager if you have any questions or concerns pertaining to this report.

**Report Authorization:** \_\_\_\_\_

Jesse Miller – Director, Applied Research Center

## Experimental Summary:

### Challenge microorganisms:

- Methicillin-resistant *Staphylococcus aureus* (MRSA) ATCC 33592
- *Clostridioides* (formerly known as *Clostridium*) *difficile* endospores ATCC 43598

### Test Device:

- Proximity System's UV-CLEAN device. Part numbers UVC - SM, UVC - CM, UVC - SA, and UVC - RF.

### Culture Preparation:

- MRSA was cultured on Tryptic Soy Agar with 5% sheep's blood and incubated at  $35 \pm 2^\circ\text{C}$  for  $24 \pm 2$  hours.
- *Clostridioides difficile* endospores were prepared using a modification of US EPA OPP: MB-28 (December 2017) "Procedure for the Production and Storage of Spores of *Clostridium difficile* for Use in the Efficacy Evaluation of Antimicrobial Agents".

### Testing Conditions:

- For MRSA, five time points were evaluated: one, three, five, ten and fifteen-minute exposure times.
- For *C. difficile*, four time points were evaluated: ten, fifteen, twenty, and thirty minute exposure times to the UV-C disinfection device.
  - For the thirty-minute exposure time, the device was powered on for ten minutes of continuous exposure, device reset, then immediately followed by twenty minutes of continuous exposure.
- An inoculation volume of 0.015 mL of each microorganism suspension was inoculated onto a keyboard key.
  - The "left" replicate key evaluated was reinserted into the Q key spot.
  - The "center" replicate key evaluated was inserted into the P key spot.
  - The "right" replicate key evaluated was inserted into the 9 key spot.
- The UV-C device was placed at a height of 12 inches above the keyboard. UV-C intensity readings were taken prior to each exposure. The device was turned on and allowed to equilibrate for one minute before collecting the reading with the General® Digital UVC light meter.
- After insertion to the keyboard, three replicate keys at each time point were inoculated and inoculum spread using a sterile pipette tip. The inoculum was allowed to dry before exposure.
- The keys were exposed to the UV-C device for the designated exposure period. The UV-C device was manually turned off at the end of the exposure period.
- Following exposure, each key was placed in 0.45% saline, vortexed, diluted, and plated in duplicate onto microbial content agar (for MRSA) or brucella blood agar (for *C. difficile*). Plates were incubated for  $35 \pm 2^\circ\text{C}$  for  $48 \pm 2$  hours (for MRSA) and incubated anaerobically at  $36 \pm 2^\circ\text{C}$  for  $24 \pm 2$  hours.
- After incubation, colonies were enumerated and data recorded. Duplicate plates were averaged and multiplied by the dilution factor to arrive at CFU/key. Log<sub>10</sub> reduction and percent reduction were calculated and reported.

### References:

- ASTM E2315-16 "The Assessment of Antimicrobial Activity Using a Time-Kill Procedure"
- US EPA OPP: MB-28 (December 2017) "Procedure for the Production and Storage of Spores of *Clostridium difficile* for Use in the Efficacy Evaluation of Antimicrobial Agents"
- Protocol #18222-2C "An Evaluation of Antimicrobial Activity of One Test Product Using a Time Kill Procedure"

## Results

**Table 1.** Results for exposure at a 12-inch height against Methicillin-resistant *Staphylococcus aureus*. Percent and log10 reductions were calculated using the carrier density seen after 0 minutes exposure.

Exposure Time (minutes)	Carrier Density (CFU/Key)			Percent Reduction			Log10 Reduction		
	Left	Center	Right	Left	Center	Right	Left	Center	Right
0	2.50E+06	2.20E+06	3.10E+06	N/A	N/A	N/A	N/A	N/A	N/A
1	1.40E+05	1.50E+05	4.00E+05	94.400%	93.182%	87.097%	1.2518	1.1663	0.8893
3	1.80E+04	1.80E+04	6.40E+04	99.280%	99.182%	97.935%	2.1427	2.0872	1.6852
5	1.80E+04	4.90E+03	2.00E+04	99.280%	99.777%	99.355%	2.1427	2.6522	2.1903
10	2.00E+03	7.00E+01	4.60E+03	99.920%	99.997%	99.852%	3.0969	4.4973	2.8286
15	9.00E+01	8.00E+01	8.90E+02	99.996%	99.996%	99.971%	4.4437	4.4393	3.5420

**Table 2.** Results of 12-inch height control keys. Keys were inoculated with Methicillin-resistant *Staphylococcus aureus* at time zero and processed after each exposure time. Control keys were not exposed to the UV device.

Exposure Time (minutes)	Carrier Density (CFU/Key)		
	Left	Center	Right
0	N/A	N/A	N/A
1	2.80E+06	2.40E+06	4.30E+06
3	4.70E+06	2.10E+06	5.00E+06
5	3.00E+06	5.70E+06	2.10E+06
10	2.20E+06	1.60E+06	2.60E+06
15	5.60E+06	2.00E+06	2.30E+06

**Table 3.** Results for exposure at a 12-inch height against *C. difficile*. Percent and log10 reductions were calculated using the carrier density seen after 0 minutes exposure.

Exposure Time (minutes)	Carrier Density (CFU/Key)			Percent Reduction			Log10 Reduction		
	Left	Center	Right	Left	Center	Right	Left	Center	Right
0	1.20E+07	1.02E+07	1.05E+07	N/A	N/A	N/A	N/A	N/A	N/A
10	3.06E+06	9.07E+05	2.45E+06	74.505%	91.124%	76.645%	0.5935	1.0518	0.6316
15	8.33E+05	3.29E+05	8.44E+05	93.057%	96.785%	91.955%	1.1584	1.4928	1.0945
20	4.67E+05	7.07E+04	2.55E+05	96.106%	99.308%	97.567%	1.4096	2.1599	1.6139
30	6.39E+03	4.24E+02	2.91E+03	99.947%	99.996%	99.972%	3.2735	4.3817	3.5570

**Table 4.** Results of 12-inch height control keys. Keys were inoculated with *C. difficile* at time zero and processed after each exposure time. Control keys were not exposed to the UV device.

Exposure Time (minutes)	Carrier Density (CFU/Key)		
	Left	Center	Right
0	N/A	N/A	N/A
10	9.60E+06	9.60E+06	8.89E+06
15	9.89E+06	9.84E+06	1.02E+07
20	1.02E+07	1.01E+07	1.07E+07
30	1.09E+07	1.08E+07	1.07E+07

**Testing Laboratories:**

**All work performed at:**

**Lab ID**  
 Approved Subcontract

**Note**  
 GLP, non-GLP compliant