NSF International – Applied Research Center
789 N. Dixboro Rd. Ann Arbor, MI 48015, USA
1-800.NSF.MARK | +1-734.769.8010 | www.nsf.org

Send to: Mike Murphy
Proximity Systems
1301 Boudreaux Rd
Tomball, TX 77375

Result: COMPLETE **Report Date: July 2, 2019**

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

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 D. Miller

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 ± 2°C for 24 ± 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 ± 2°C for 48 ± 2 hours (for MRSA) and incubated anaerobically at 36 ± 2°C for 24 ± 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. Log10 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:

	Lab ID	**Note**
All work performed at:	Approved Subcontract	GLP, non-GLP compliant