Study on

Particle and Microbe Removal Efficacy of ClimaTemp

PACS ID#: 07124

Work Order#: 025488

Customer: ClimaTemp

Dates of Testing: 01/27/2020-01/29/2020

Date Completed: 01/31/2020

Date of Report: 02/17/2020

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EDL
Environmental Diagnostics Laboratory

PURE AIR
CONTROL SERVICES INC.

February 17, 2020

Reference: Particle Removal Efficacy of ClimaTemp including microbial

Dear Matt Davidson,

We appreciate the opportunity to provide you with our professional, environmental microbiology services. EDLab is pleased to submit this report that describes the efficacy of the ClimaTemp on specific, airborne bacteria and fungi.

This report summarizes the findings and other relevant data as per your request.

Please call me at 1-800-422-7873, ext. 301 should you have any questions. We look forward in assisting you in future projects.

Respectfully Submitted,

Joiya Mendez
Senior Microbiologist

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2.0 Experiment Report

This report describes the efficacy of the ClimaTemp spot air cooler equipped with a HEPA filtration system on the removal of microbial flora (bacteria & fungi) and particles from ambient air within a closed structure. The assessment was completed on 01/31/2020 at the request of Matt Davidson.

The testing performed in this study includes a pre and post assessment of selected bacteria and fungi which were aerosolized within an experimental compartment located inside an environmental chamber along with a baseline sample. The estimation of bacteria were analyzed by using culture techniques. Simultaneously, corresponding environmental data pertinent to this experiment were recorded for a possible correlation. This includes relative humidity, temperature, carbon dioxide and total particle counts (0.3 µm – 10.0 µm) within and around the experimental setup. Ventilation adequacy and pressure around the test site was closely monitored.

EDLab's team of microbiologists collected data sets of bioaerosols at 2 time intervals (0 hour and 1 hour) of bacteria and fungi each. Real time data of particle counts were recorded. A data logger was placed to record the temperature and relative humidity on a selected spot within the containment set-up. A total of one bacterial and one fungal organism was selected based upon the customer's request. Traceable cultures for all the organisms were obtained from *KwikStik™* through *Microbiologics®*. The viability for each organism is assessed through a pre-experimentation phase. Upon achieving a satisfactory performance, a cell suspension is prepared for testing. The concentration of the prepared test solution was estimated to be 2.24 x 10^9 CFU/ml for bacteria and 2.7 x 10^6 CFU/ml for fungi by utilizing serial dilution techniques. Approximately 20 mL of this cell suspension was aerosolized by a nebulizer each time to generate a bioaerosol of the test organism in the test compartment.

Bioaerosol samples were collected on Tryptic Soy Agar (TSA) and Malt Extract Agar (MEA) Petri plates by using single-stage, N-6 Anderson impactors for bacteria and fungi respectively. A chain of custody for all the collected samples was prepared for record purposes and submitted to the laboratory along with samples for further processing. Samples were processed by Environmental Diagnostics Laboratory (EDLab) to analyze air-borne bacterial and fungal

organisms and other environmental data such as temperature, relative humidity and Carbon dioxide collected during the experiment. Growth of isolated bacteria and fungi alongside the collected data on particles size, temperature and humidity is presented in the tables (Table 5 to 10, Graph 1 and 2).

2.0 Abbreviations and acronyms

ATCC: American Type Culture Collection

CFU: Colony forming units

CFM: Cubic feet per minute

°C: Degrees ***Celsius***

°F: ***Degrees Fahrenheit***

HEPA: High-efficiency particulate Arrestance

HP: Horsepower

L: Liter

lpm: Liters per minute

LED: L***ight-emitting diode***

m^3: Cubic meters

mL: Milliliters

mm: Millimeter

Pa: Pascal

ppm: Parts per million

psi: Pounds per square inch

SOP: Standard Operating Procedure

WC: Water Column

µl: Microliter

3.0 Test/Challenge Microorganisms

Table 1: Microorganism Organisms Selected For This Experiment

Sl. Number	Organism Description	Source
1	*Staphylococcus aureus*	*KwikStik™* Ref. 0360 P
2	*Aspergillus niger*	*KwikStik™* Ref. 0500 P

Table 2: Microbial (Bactria/Fungi) Cell Counts

	Viable Cell Counts CFU/ml
Staphylococcus aureus	2.24×10^9
Aspergillus niger	2.7×10^6

The viable cell counts of the solution to be aerosolized are determined by making a series of dilutions up to 10,000X of the stock solution for both bacteria and fungi using a TSA and MEA microbiological growth media respectively.

Table 3: Scheme of Efficacy Testing of Clima-Temp Portable A/C w/ HEPA

Challenge organism	***Sampling interval (Hrs)***	***Baseline***			***Pre-Treatment***			***Post treatment***			***Positive control***	***Negative control***
		(CFU/m^3)	Particle P/L	Temp °F	(CFU/m^3)	Particle P/L	Temp °F	(CFU/m^3)	Particle P/L	Temp °F		
Staphyloccous aureus	***0***	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
	1	*1*	*1*		*1*	*1*		*1*	*1*			
Aspergillus niger	***0***	*1*	*1*		*1*	*1*		*1*	*1*		*1*	*1*
	1	*1*	*1*		*1*	*1*		*1*	*1*			
Number of samples	*1st set*	*2*	*2*	*N/A*	*2*	*2*	*N/A*	*2*	*2*	*N/A*	*2*	*2*
	2nd set	*2*	*2*	*N/A*	*2*	*2*	*N/A*	*2*	*2*	*N/A*	*N/A*	*N/A*
	Total	*4*	*4*	*1*	*4*	*4*	*1*	*4*	*4*	*1*	*2*	*2*

4.0 Control Samples DATA and IMAGES

Results of all the analyzed samples are recorded in the corresponding observation ***Tables***. The obtained data is analyzed by using Microsoft Office's EXCEL 2013 program. Analytical results are also plotted as ***Graphs 1-2*** and represented in ***Figures 1-11***, along with some photographs of important stages from the experiment.

5.0 DATA AND IMAGESBIO-WASTE

All bio-waste generated during this experiment is disposed of in compliance per the protocol of the applicable regulation.

6.0 RESULTS

All data, statistical analysis and photographs are presented under the following *Table*s and *Figures*:

Table 4 : Media Blank and Field Blank Quality Control

Treatments	Temperature (°C)	Growth Media	Growth Pattern		Remarks
			Negative	Positive	
Media Sterility	30±2	Tryptic Soy Agar	✓		Pass
Field Blanks			✓		Pass
Negative Controls			✓		Pass
Treatments	Temperature (°C)	Growth Media			
			Negative	Positive	
Media Sterility	25±2	Malt Extract Agar	✓		Pass
Field Blanks			✓		Pass
Negative Controls			✓		Pass

Table 5: Quantitative Estimation of Isolated Bioaerosols (Bacteria)

Treatment	Hour	Sample Set	Concentration (CFU/m3)	Average	Hourly Difference (CFU/m³)	Hourly Reduction (%)
Pretreatment	0	I	≥ 4,000	≥ 4,000	≈2,000	50%
		II	≥ 4,000			
	1	I	≥ 2,000	≥ 2,000		
		II	≥ 2,000			
Post Treatment	0	I	186	≈110	≈108	98%
		II	33			
	1	I	3	≈2		
		II	0			

Table 6: Quantitative Estimation of Isolated Bioaerosols (Fungi)

Treatment	Hour	Sample Set	Concentration (CFU/m3)	Average	Hourly Difference (CFU/m³)	Hourly Reduction (%)
Pretreatment	0	I	399	≈395	≈145	37%
		II	390			
	1	I	240	≈250		
		II	260			
Post Treatment	0	I	380	≈388	≈381	98%
		II	395			
	1	I	6	≈7		
		II	7			

Table 7: Environmental Parameters during Bacterial aerosolization

Treatments	Sampling Hour	Temperature (°F)	Relative Humidity (%)	CO_2 (ppm)	Particulate (count/L)	Reduction in particle (%)	ETC Pressure (Pa)
Baseline	0	78	65.93	681.80	790,931	96	60
Pretreatment	0				444,324,221		
	1				163,675,125		
Post treatment	0				21,225,999		
	1				1,334,542		

Table 8: Environmental Parameters during Fungal aerosolization

Treatments	Sampling Hour	Temperature (°F)	Relative Humidity (%)	CO_2 (ppm)	Particulate (count/L)	Reduction in particle (%)	ETC Pressure (Pa)
Baseline	0	78	65.93	681.80	706,765	93	60
Pretreatment	0				125,991,792		
	1				22,250,242		
Post treatment	0				7,912,841		
	1				2,598,570		

7.0 PHOTOGRAPHS and FIGURES

The following section contains photos and figures of some important observations as well as other experimental stages, including graphs based off the experimental findings.

Figure 1*: Experimentation Site*

A. Experimentation Chamber

B. Test Compartment

C. Access Door to Compartment

D. Duct Connection

***Figure 2*: Clima Temp**

	
A. Front View	**B. Back View**

Figure 3*: Quality Control Samples for TSA (*Staphylococcus aureus)

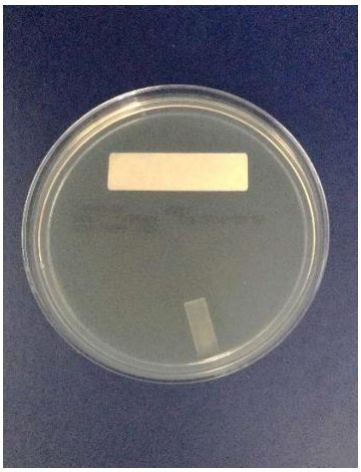
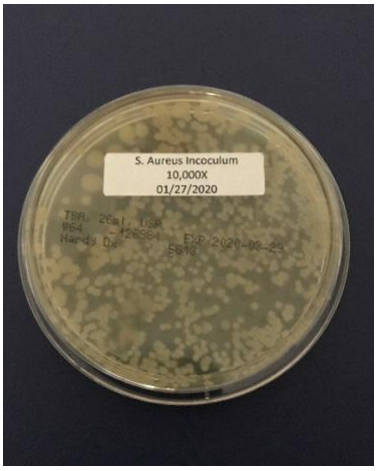
	
A. Negative Control – TSA (Front View)	**C. Positive Control - TSA (Front View)**
	
B. Negative Control - TSA (Rear View)	**D. Positive Control - TSA (Rear View)**

Figure 4*: Quality Control Samples for MEA (*Aspergillus niger)

	
A. Negative Control – MEA (Front View)	**C. Positive Control - MEA (Front View)**
	
B. Negative Control - MEA (Rear View)	**D. Positive Control - MEA (Rear View)**

***Figure 5*: Bioaerosol TSA (Bacteria) Samples - Baseline and Blank**

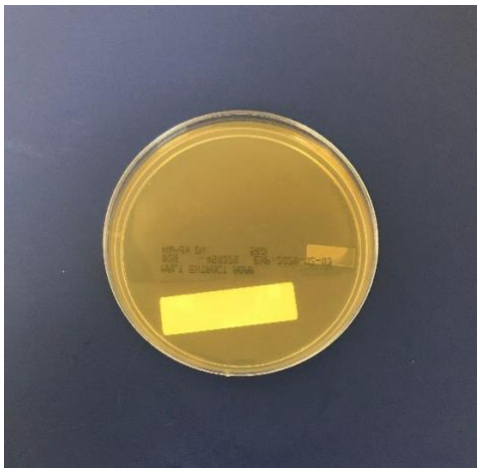
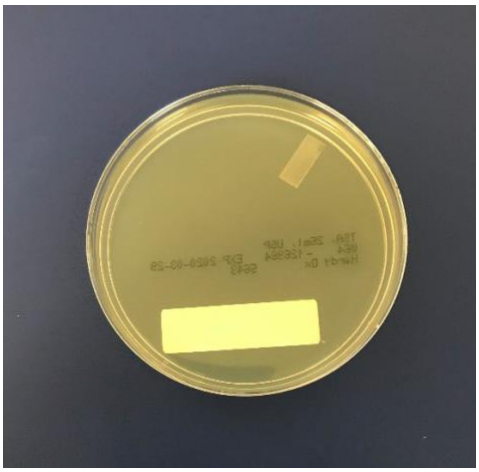
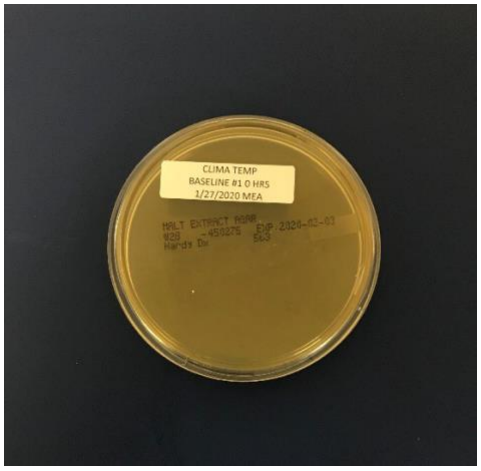
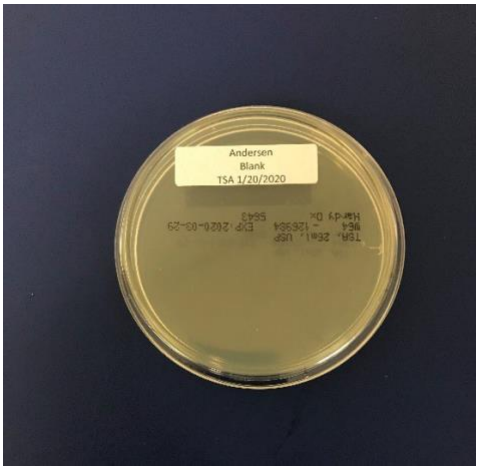
	
A. Sample Plate at 0 hour (Front View)	**E. Sample Plate (Blank) at 0 hour (Front View)**
	
B. Sample Plate at 0 hour (Rear View)	**F. Sample Plate (Blank) at 0 hour (Rear View)**

***Figure 6*: Bioaerosol TSA (Bacteria) Samples Pre-treatment**

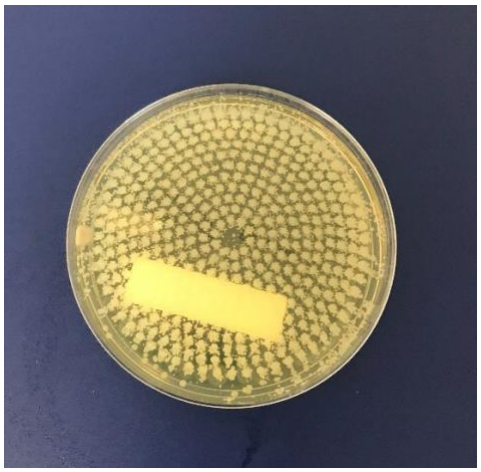
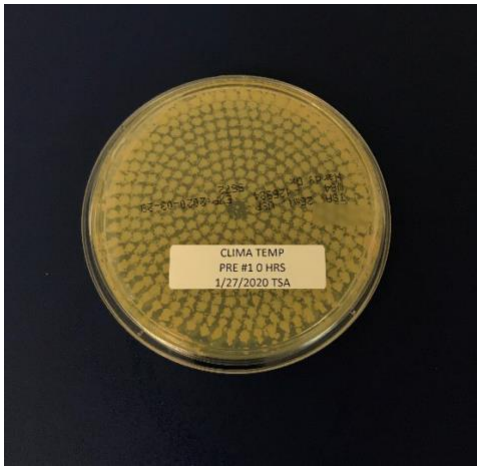
	
A. Sample Plate at 0 hour (Front View)	**C. Sample Plate at 1 hour (Front View)**
	
B. Sample Plate at 0 hour (Rear View)	**D. Sample Plate at 1 hour (Rear View)**

***Figure 7*: Bioaerosol TSA (Bacteria) Samples Post-treatment**

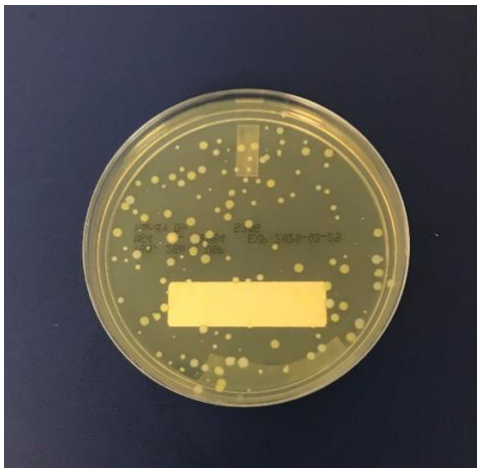
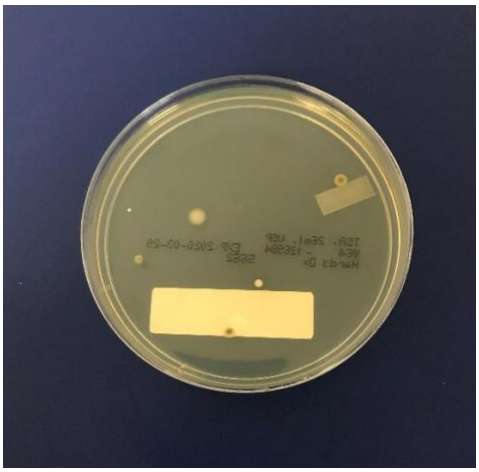
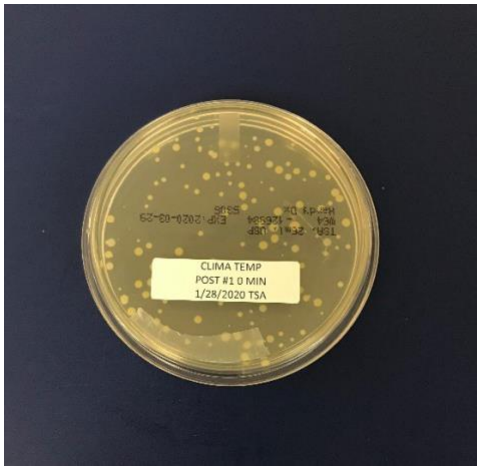
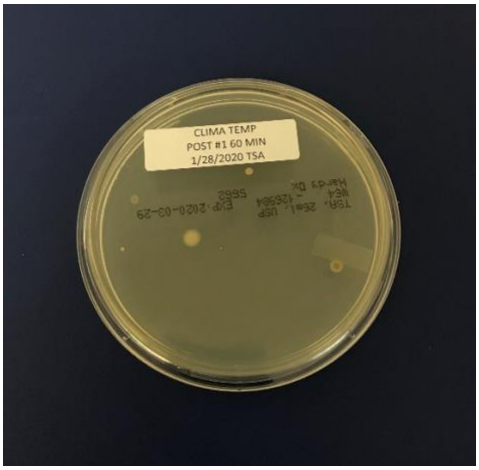
	
A. Sample Plate #1 at 0 hour (Front View)	**E. Sample Plate at 1 hour (Front View)**
	
B. Sample Plate #1 at 0 hour (Rear View)	**F. Sample Plate at 1 hour (Rear View)**

***Figure 8*: Bioaerosol MEA (Fungi) Samples - Baseline and Blank**

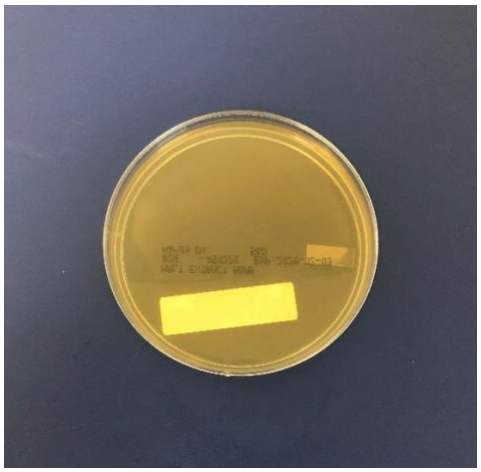
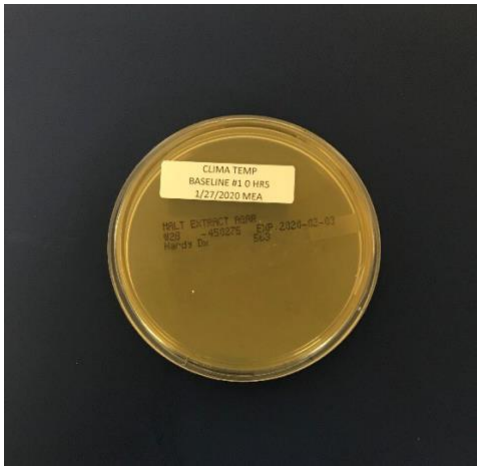
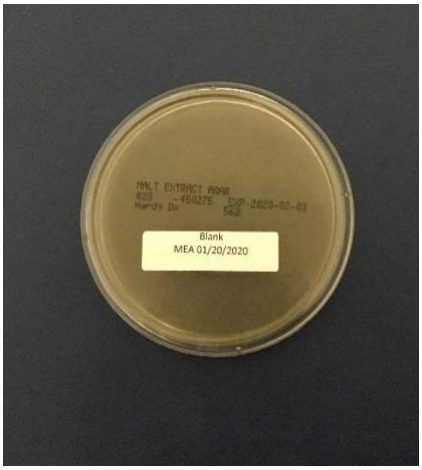
	
C. Sample Plate at 0 hour (Front View)	E. Sample Plate (Blank) at 0 hour (Front View)
	
D. Sample Plate at 0 hour (Rear View)	F. Sample Plate (Blank) at 0 hour (Rear View)

***Figure 9*: Bioaerosol MEA (Fungi) Samples Pre-treatment**

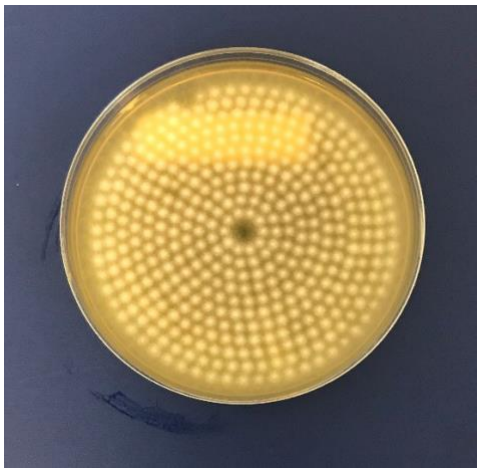
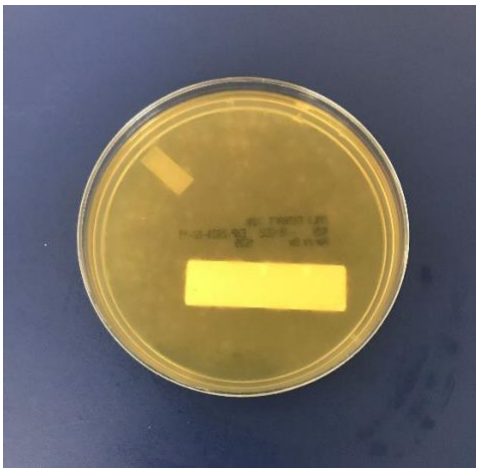
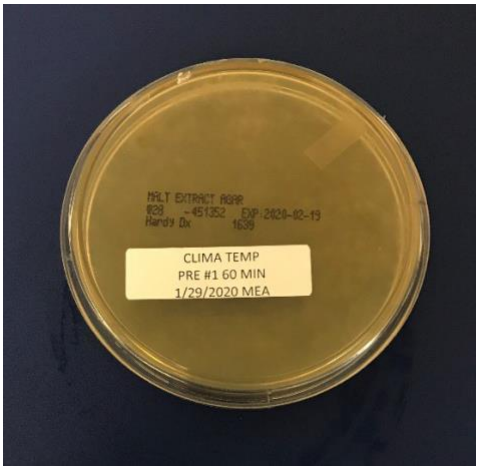
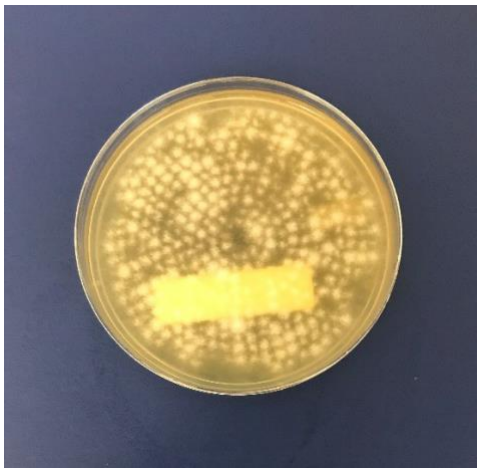
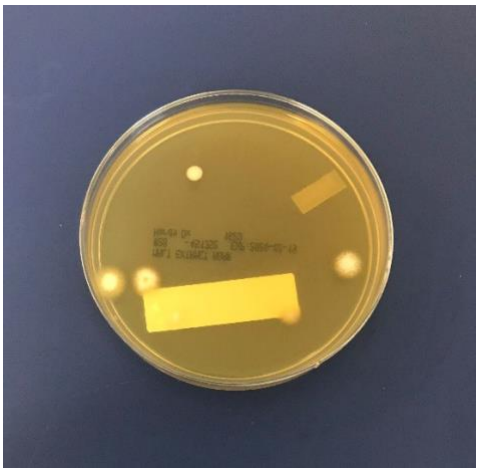
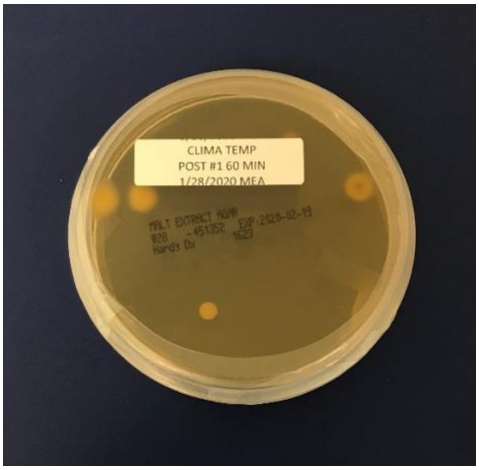
	
C. Sample Plate at 0 hour (Front View)	**C. Sample Plate at 1 hour (Front View)**
	
D. Sample Plate at 0 hour (Rear View)	**D. Sample Plate at 1 hour (Rear View)**

***Figure 10*: Bioaerosol MEA (Fungi) Samples Post-treatment**

	
C. Sample Plate #1 at 0 hour (Front View)	**E. Sample Plate at 1 hour (Front View)**
	
D. Sample Plate #1 at 0 hour (Rear View)	**F. Sample Plate at 1 hour (Rear View)**

8.0 CONCLUSION

The goal of this study was to examine the ClimaTemp spot cooler, with installed HEPA filter, performance in reducing particle counts and microbial propagules of bacteria and fungi (Table 5-10 and Graph 1 and 2). The results indicate that this device reduces particle counts overall however, a more comprehensive test is encouraged to determine the efficacy of this equipment in a specific scenario.

9.0 REFERENCES

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END OF REPORT