

## **AIR CARE O2 for microbial disinfection and its efficacy against bacteria and molds in a cinema theater**

### **Executive Summary:**

Widely perceived as potential COVID-19 infection hotspots due to their nature as crowded, closed spaces, cinemas are struggling to woo back customers after being shuttered for over a year. In an industry-first, unique experiment, Cinema City commissioned Tadiran's AIR CARE O2 solution to ensure that the air in its theaters is safe from airborne molds, and bacteria. Conducted with a live audience present in the theater, the system was used successfully to actively cleanse the air via patented technology which converts water molecules in the air to contaminant-neutralizing hydrogen peroxide. AIR CARE O2 dramatically reduced levels of airborne pollutants, including molds and bacteria, cutting their presence by high percentages.

### **Hydrogen Peroxide Technology for Indoor Air Purification**

Tadiran's new AIR CARE O2 is a unique air purification technology that is effective in neutralizing airborne microorganisms (Figure 1). The AIR CARE O2 technology fractures Oxygen (O2) into two separate "O" atoms by using a discharge current. These "free O" atoms combine with the H2O molecules in the airflow, transforming into hydrogen peroxide (H2O2) at a concentration of smaller than 7 ppb. The H2O2 is distributed through the indoor unit of the air conditioner into the air conditioned space. Hydrogen peroxide (HP) is an oxidizing agent and is commonly found in cosmetics, bleaching agents, toothpaste, and detergents. In alkaline solutions, it reacts by producing free hydroxyl radicals, which react with lipids, proteins, and DNA [1]. The literature reports numerous accounts of the properties, germicidal effectiveness, and potential uses for stabilized HP in health-care settings. Research ascribes effective germicidal activity to hydrogen peroxide and attest to its bactericidal, virucidal, sporicidal, and fungicidal properties [2-4].

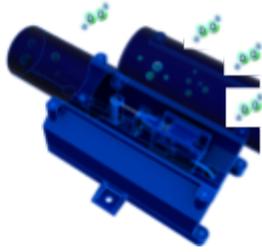


Figure 1: Tadiran's Air Care O<sub>2</sub> air treatment technology

### **Efficacy of Tadiran Air Care System against Aerosolized *Aspergillus Niger* (Mold Spore) in a lab setting**

This experiment evaluated the efficacy of the Tadiran Air Care device to eliminate *Aspergillus niger* [mold] aerosol from the air. Testing was conducted in a m<sup>3</sup> custom bioaerosol exposure chamber. The net LOG reduction of viable aerosol was estimated after activation of the Tadiran Air Care device. There were a total of four independent trials in this study. *A. niger* was aerosolized into the test chamber at a concentration of  $3.4 \times 10^9$  cfu/gr. Three samples were collected at each predetermined time point (every 30 min) throughout each trial (120 min). An aerosol sampler (AGI-30 impinger, Ace Glass Inc.) was used to collect biological aerosols and to determine the chamber *A. niger* concentration. The collected samples were serially diluted and plated in triplicate (multiple serial dilutions) onto tryptic soy agar plates using a standard spread plate assay technique. The plated cultures were incubated for 24 hours at 32°C. Colony forming units (cfu) were counted and recorded. Trials with the air care device turned on and compared to control trials in order to determine net LOG reduction of viable bioaerosols within the chamber. All trials show individual and group average +/- standard deviations for Net LOG reduction on a per trial basis. Figure 2 shows the LOG reduction of *A. niger* for the control and test trials over the 120-minute testing periods. Tadiran Air Care System trials showed a drastic reduction in *A. niger* concentration with the unit activated. In 120 minutes there was an average reduction of 98.93 % over the three test trials. The performance of the device was consistent

and the standard deviation between the triplicate trials conducted was low. This testing confirms that the Tadiran Air Care system could be effective in reducing the presence of toxic black mold species in air conditioning systems thus may affecting pulmonary infections caused by airborne *A. niger* in closed recirculating air systems

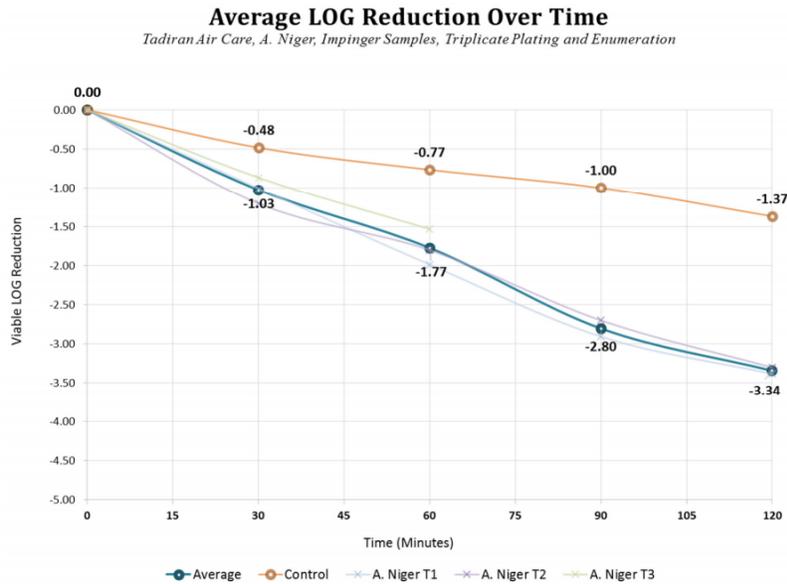


Figure 2: LOG Reduction of *A. Niger* in control and Air Care System test trials.

### **Efficacy of Tadiran Air Care System against bacteria in a lab setting**

In addition to assessing the effects of this system on the spread of *A. niger*, we also evaluated the efficacy of the Tadiran Air Care device in removing viable vegetative bacterium *Methicillin Resistant Staphylococcus epidermidis* from the air. Testing was conducted in a m<sup>3</sup> custom bioaerosol exposure chamber. The net LOG reduction of viable aerosol was estimated after activation of the Tadiran Air Care device. There were a total of twelve independent trials in this study. *Methicillin Resistant Staphylococcus epidermidis* (MRSE) was aerosolized into the test chamber at a concentration of 1 x 10<sup>9</sup> cfu/ml. Three samples were collected at each predetermined time point (every 30 min) throughout each trial (150 min). An aerosol sampler (AGI-30 impinger, Ace Glass Inc.) was used to collect biological aerosols and to determine the chamber MRSE concentration. The collected samples were serially diluted and plated in

triplicate (multiple serial dilutions) using a standard spread plate assay technique onto tryptic soy agar plates. The plated cultures were incubated for 24 hours at 37°C, a colony forming unit (cfu) counted and recorded. Trials with the air care device turned on were compared to control trials in order to determine net LOG reduction of viable bioaerosols within the chamber. All trials show individual and group average +/- standard deviations for Net LOG reduction on a per trial basis. Figure 3 shows the LOG reduction of MRSE for the control and test trials over the 150 minutes testing periods. In 150 minutes, over the three test trials, there was an average reduction of 99.99%. When compared to the control, the Tadiran device showed a net LOG reduction of 6.32 +/- 0.37 LOG. Figure X shows the LOG reduction of MRSE for the control and test trials over the 150 minutes testing periods.

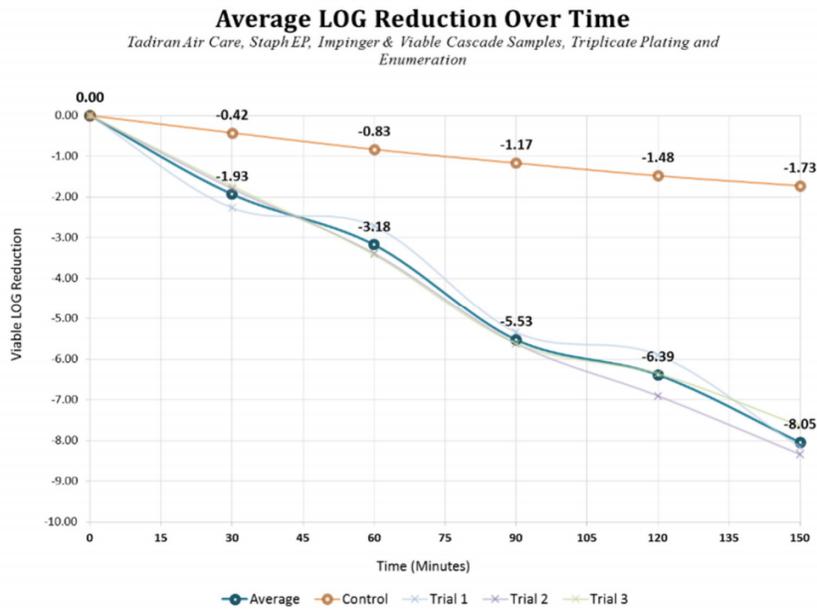


Figure 3: LOG Reduction of MRSE in control and Air Care System test trials.

## Efficacy of Tadiran Air Care System against Total Bacteria and Molds in a Cinema Theater

This study evaluated the efficacy of the Tadiran Air Care device at removing viable microbes (total bacteria and molds) from the air. Testing was conducted in a cinema auditorium about 700 m<sup>3</sup> size. The auditorium was divided into six different sections, where air was collected using air samplers (SAS Super ISO 180 Air Sampler/ORUM(A)). A1 is in the auditorium entrance, A2 is right next to the screen, A3 is on the left side of the screen, A4 is in the back row, A5 is in the center of the auditorium and A6 is the returning air point (Figure 4a).

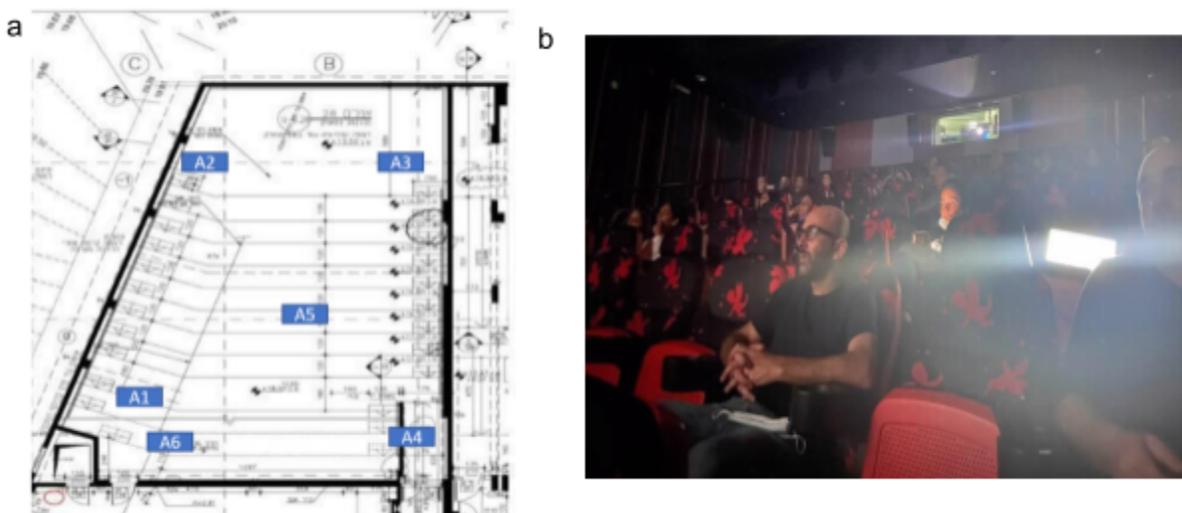


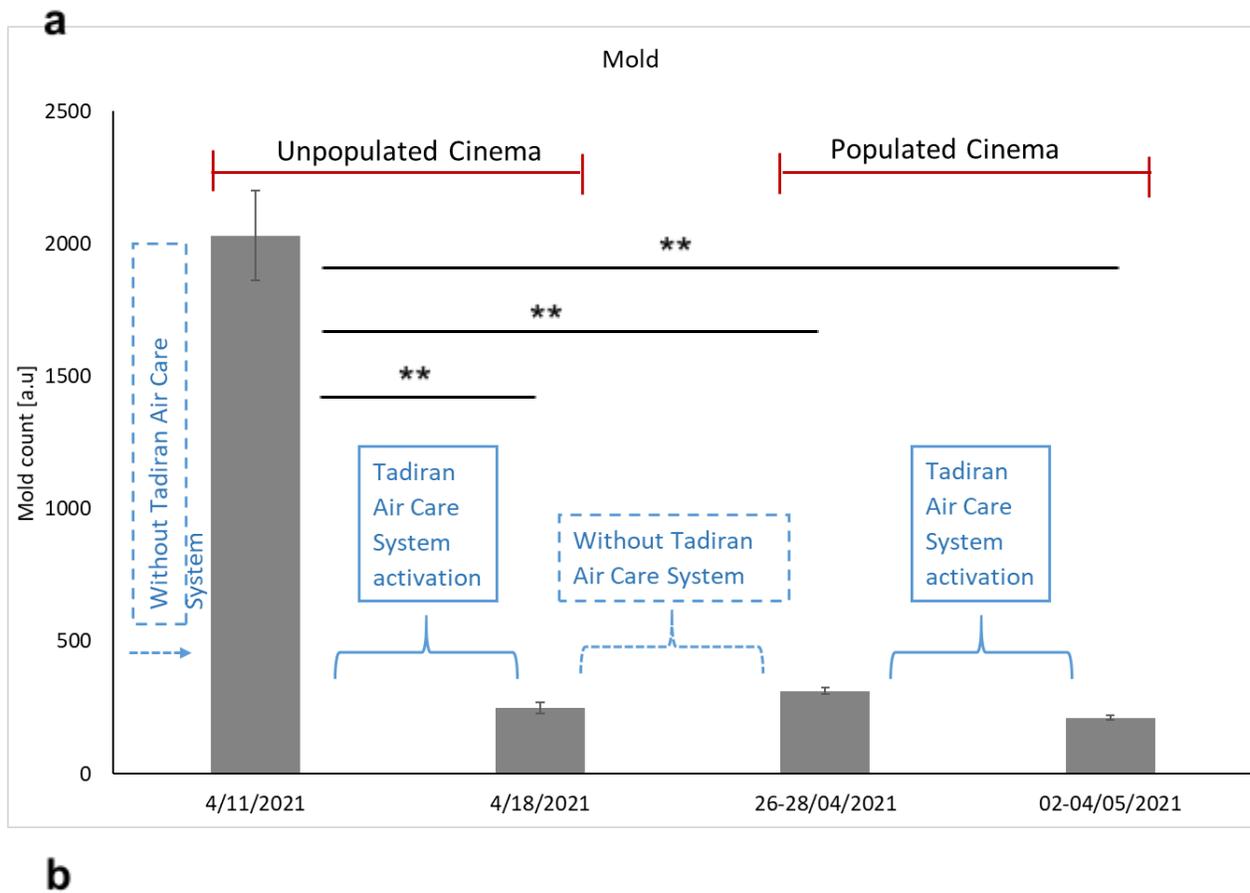
Figure 4: (a) A cinema theater sketch with labeled air sampler's locations (A1 to A6). (b) A picture of the cinema during movie screening.

The samplers pumped air four times during the screening of the two hour movie:

1. 100 Liter/min at the beginning of the movie.
2. 100 Liter/min 50 minutes after the first sample.
3. 100 Liter/min at the end of the movie.

4. 500 Liter/min at the end of the movie.

The pumped air was incubated on agar plates for bacterial and mold count. About 35 people were present in the theater throughout the experiment (Figure 4b). The samples were collected prior to the population of the auditorium (following a long period without cinema activity) and after the Tadiran Air Care system was activated for three days in a row. Once the audience attended the cinema, samples were taken again during three days without the Tadiran Air Care system being activated and finally again during three days in which the Tadiran Air Care system was active (Figure 5).



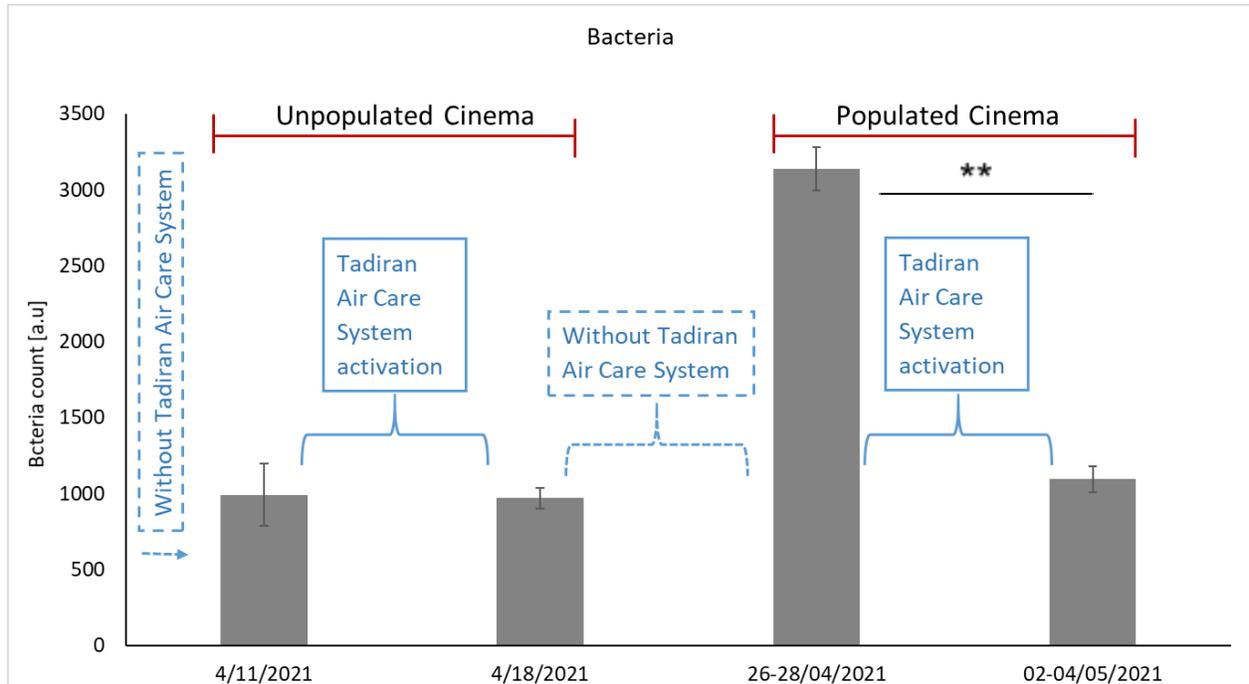


Figure 5: Colony forming unit (CFU) of total bacteria and mold count in the cinema with or without population and Air Care System activation. Data are expressed as the mean  $\pm$  standard deviation of the mean (SD). \*\*  $P < 0.0001$  between 22/04/2021 value to each date separately (a) and between 26-28/04/2021 to 02-04/05/2021 (b).

After a year in which the cinema had barely any visitors and without operation of the Tadiran Air Care System, the mold count showed high values of 2030 CFU/m<sup>3</sup>. After three days of running the Air Care O2 system, we saw a reduction of 87.3% of CFU on average that continued to maintain itself during the population of the cinema (Figure 5a;  $p < 0.0001$  compare initial mold count at April 22<sup>nd</sup>). When examining the bacteria count, it seems that the bacterial source is the people attending the movies and therefore the bacterial count was high only after the population of the cinema. Three days of the Air Care system activation in a populated cinema resulted in an average of 66.5% reduction in the bacteria count (Figure 5b;  $p < 0.0001$ ). These results confirm that the Tadiran Air Care system is effective at reducing airborne mold and bacteria. When looking at the bacterial count at different time measurements (Figure 6), we observed the dynamics of the bacterial count. At the beginning of the movie, shortly after the audience entered the cinema; we did not observe a significant decrease in the bacterial count. Nevertheless, by the middle of the screening the Air Care System activation resulted in a significant decrease in the bacterial count (81% decrease;  $p < 0.0001$ ). At the end of the movie

once the audience left the cinema, there was no difference in the bacterial count compared to the middle. This result confirms our previous conclusion that the majority of bacteria originate from the people that populate the theater, and that the Tadiran Air Care system is effective at reducing airborne bacteria.

Figure 6: Bacteria count (Y-axis) during different time points (X-axis) at the center of the cinema location (A5). Data are expressed as the mean  $\pm$  standard deviation of the mean (SD). \*\*  $P < 0.0001$ .

### Conclusions

This report demonstrates the Air Care O2 system's ability to remove *A. niger* and *Methicillin Resistant Staphylococcus epidermidis* aerosols from the air in high efficiency in controlled laboratory experiments. Moreover, a field experiment in a populated uncontrolled environment (compared to lab settings) proved the Tadiran Air Care O2 system's ability to reduce molds and bacteria in the cinema theater.

