

# The Capability of the Genesis Air 2002B.mil to Remove and Neutralize High Concentrations of Airborne Biological Contaminants

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## Abstract

The Genesis Air 2002B.mil is an air purification system using GAP™ technology to remove harmful particulate and organic contaminants of air. This system was tested by the U.S. Army in rigorous controlled studies for its ability to remove biological agents from room air. Two separate studies were conducted using fungal spores and bacterial spores, at concentrations far beyond normal atmospheric levels of these agents. The results consistently demonstrated that the Genesis Air 2002B.mil removes and destroys an average of 93.5% of airborne fungal spores, and greater than 98% of airborne bacterial spores.

## Introduction

Indoor air quality issues are of increasing concern to American business owners, building managers, employees, and the general public. Indoor air pollution is among the top five environmental health risks.<sup>(1)</sup> Office buildings and other types of indoor workplaces have significant sources of air pollution due to inadequate ventilation.<sup>(2)</sup> The three basic strategies for improving indoor air quality are pollution source control, improving ventilation, and the use of air cleaners.<sup>(3)</sup>

Indoor air pollutants generally consist of particulate matter (dust, smoke, pollen, bacteria, mold spores, etc.) and gaseous elements (vehicle exhaust, gas stove emissions, paint and varnish fumes, etc.) There are many types of air purification systems available, though not all are effective and some (ozone generators) may actually be harmful. The most advanced and innovative technology combines particulate removal with pollutant destruction. The Genesis Air 2002B.mil is a three-stage system that purifies air by trapping particles in the first stage, and inactivating them in the second and third stages. The second stage is a powerful UV light and the third stage uses a photocatalytic reaction of the UV light with titanium oxide to create hydroxyl radicals as the cleaning agents that convert biologicals and hazardous chemical pollutants into harmless compounds.

The U.S. Army Developmental Test Command performed a series of controlled studies designed to test the Genesis Air 2002B.mil's capability of neutralizing high levels of airborne biological contaminants. The results prove the effectiveness of the system in reducing challenge concentrations of these agents by greater than 93.5% to 98%.<sup>(4)</sup>

## Materials and Methods

The U.S. Army Dugway Proving Ground in Dugway, UT, was provided with one Genesis Air 2002B.mil unit for testing. The system utilizes GAP™ technology, a three-stage germicidal and air-cleaning process. In the primary filtering stage, particles of .3 microns or larger are trapped and removed. Particles smaller than .3 microns are subjected to the second stage, an ultraviolet (UV) light tube, and the third stage, a titanium oxide-coated pleated membrane that is activated by the UV light to photocatalytically convert biologicals and dangerous chemicals into inert compounds. The test unit was fitted with 6 sampling ports (two ports in each stage of the system) and all three stages of the system were active in each study.

The first study was designed to test the effectiveness of the Genesis Air system in removing fungal spores from room air. The study was performed in a room-sized fungal test chamber at  $28 \pm 5^\circ\text{C}$ . *Aspergillus Niger*, a common fungus causing mold contamination of food, was used as the challenge organism. A disseminator was used to generate and maintain a dense cloud of fungal spores within the chamber. The concentration of spores with and without the Genesis Air system operating was measured using Aerodynamic Particle Sizer® (APS™) spectrometers, in units of agent-containing particles per liter of air (ACPLA). In addition, all-glass impingers (AGI's) attached to sampling ports were used to collect air from the test chamber, within the Genesis unit, and in the Genesis unit exhaust to test for viable fungal organisms. A total of 14 separate challenges were conducted, with the concentration of spores allowed to return to background levels and AGI's changed between challenges.

The second study was designed to test the effectiveness of the Genesis Air system in removing bacterial spores from room air. The study was performed in a room-sized Aerosol Simulant Exposure Chamber (ASEC) at  $28 \pm 5^\circ\text{C}$ . *Bacillus subtilus var. Niger*, a rod-shaped bacterium that forms spores, was used as the challenge organism. A disseminator was used to generate and maintain a dense cloud of bacterial spores within the chamber. The concentration of spores within the chamber and from the Genesis Air system exhaust was measured using Aerodynamic Particle Sizer® (APS™) spectrometers, in units of agent-containing particles per liter of air (ACPLA). In addition, all-glass impingers attached to sampling ports were used to collect air from the Genesis unit intake and the Genesis unit exhaust to test for viable bacteria. Five challenges were conducted, with the concentration of bacterial spores allowed to return to background levels and AGI's changed between challenges.

## Results

### Graph Figure B.2

Without the Genesis Air system operating, the particle concentration at 1000 and 2000 ACPLA within the test chamber rises quickly and remains fairly constant. With the Genesis Air system operating, the particle concentration is reduced by an average of 93.5% over 14 trials. While there was live fungus detected in the test chamber air, no viable fungus was detected in the Genesis Air exhaust stream.

### Graph Figure 3.2

The Genesis Air system removed and neutralized more than 98% of airborne bacterial spores from the ASEC air. AGI data indicated that live bacteria in the Genesis Air exhaust was not present or was below the detection limits of the laboratory analysis methodology.

## Conclusions

The Genesis Air 2002B.mil is highly effective in removing and neutralizing biological contaminants, a major source of indoor air pollution. In numerous sophisticated controlled trials conducted by the U.S. Army, high concentrations of airborne fungal and bacterial spores were reduced by over 93.5% and 98%, respectively. In addition, no live organisms were detected in the system exhaust, demonstrating the germicidal properties of the unique three-stage GAP™ technology utilized by the Genesis Air 2002B.mil.

## References

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# Reduction of Indoor Airborne Mold Spores in a Hospital Facility by the Genesis Air Photocatalysis System

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## Abstract

Genesis Air Photocatalysis (GAP™) is an advanced, high capacity air purification system designed to remove harmful and allergenic particulate and organic contaminants of air. The present study was a test of the GAP™ technology to improve indoor air quality in a health-care setting. Indoor and outdoor air levels of non-viable and viable mold spores were measured at a VA hospital. The air handling units of the hospital were then retrofitted with GAP™ panels and were operated as usual for approximately seven weeks. Post-installation samples demonstrated that despite a significant increase in outdoor mold spore counts, indoor air fungal spores were reduced by an overall average of 66.4 % within the hospital work spaces and patient care areas.

## Introduction

Indoor air quality issues are of increasing concern world-wide. While outdoor air pollution issues have received attention for decades, the quality of indoor air has only recently been acknowledged as important in health and well-being. Indoor air pollution is now recognized as being among the top five environmental health risks.<sup>(1)</sup> It is estimated that in industrialized nations, people spend as much as 80%-90% indoors. Modern buildings are tightly sealed and often poorly ventilated, allowing pollutants to become trapped and concentrate to levels 2-5 times those found outdoors.<sup>(2)</sup> Indoor air pollutants generally consist of gaseous elements (vehicle exhaust, gas stove emissions, paint and varnish fumes, etc.) and particulate matter (dust, smoke, pollen, bacteria, mold spores, etc.) Of these, fungi and molds have recently been the focus of numerous studies demonstrating their many detrimental effects on human health.

There are over 1000 species of fungi that have evolved to thrive in building environments.<sup>(3) (4)</sup> While most are not pathogens in healthy individuals, many cause allergic processes such as perennial rhinitis and eye irritation and can exacerbate existing conditions such as asthma. Fungi produce mycotoxins, volatile organic compounds (VOCs), and spores which are largely responsible for many of the adverse health effects caused by molds. Spores of commonly occurring molds such as *Alternaria*, *Cladosporium*, *Drechslera*, and *Rhizopus* spp. are on the order of greater than 5 microns in diameter and are readily inhaled when airborne.<sup>(5)</sup> However, this particle size is effectively removed by the use of high efficiency air cleaning systems, such as the Genesis Air Photocatalysis (GAP™) System.

While there are many types of air purification systems available, not all are effective and some (ozone generators) may actually be harmful. The most advanced and innovative technology combines particulate removal with pollutant destruction. GAP™ technology is a three-stage germicidal and air-cleaning process that purifies air by trapping particles 3 microns or larger in the first stage, and inactivating them in the second and third stages. The second stage is a powerful UV light and the third stage uses a photocatalytic reaction of the UV light with a titanium dioxide coated pleated membrane to create hydroxyl radicals as the cleaning agents which convert hazardous biological and chemical pollutants into harmless compounds.

This system was initially tested by the U.S. Army in rigorous controlled studies for its ability to remove biological agents from room air. The impressive results from these studies, in which the GAP™ system removed and destroyed an average of 93.5% of airborne fungal spores in a controlled setting,<sup>(6)</sup> led to the testing of the system in a more "real-world" situation. GAP™

technology was tested for its ability to improve indoor air quality in a health-care setting. Indoor and outdoor air levels of non-viable and viable mold spores were measured at a VA hospital. The air handling units of the hospital were then retrofitted with GAP™ panels and were operated as usual for approximately seven weeks. Post-installation sampling demonstrated that indoor air fungal spores were reduced by an overall average of 66.4 % within the hospital work spaces and patient care areas, even as outdoor spore levels had increased by over 50% to nearly 70% during the same time frame.

## **Materials and Methods**

The Veteran's Administration (VA) Hospital in El Paso, Texas, was the site chosen to test the system. In September of 2007, various sites within and outside the hospital were sampled using spore-trap (non-viable fungi) and culturable (viable fungi) methodologies, and samples submitted to a reference laboratory for analysis. The hospital's 15 air handling units were then retrofitted with 114 Populated Catalyst Panels (PCP) Standard which had 264 Ultraviolet germicidal (UVGI) lights installed. The hospital's air handlers were operated as usual until late October of 2007, at which time sites within and around the hospital were again sampled. Post-installation samples were submitted to the same reference laboratory for analysis. The spore trap data is a measure of total fungal airborne debris (hyphal fragments, spores, etc.) and does not differentiate between viable and non-viable fungal spores. The culturable fungi analysis measured the live fungal spores in colony-forming units (cfu) and allowed for the identification of the fungi recovered.

## **Results**

Non-viable methodology:

Total fungal airborne particles, as measured by the spore trap analysis, were reduced by an overall average of 66.4% across all sites within the hospital. The GAP™ system was able to significantly reduce the indoor fungal particles despite an apparent increase of 55.3% in outdoor fungal particles in an outdoor site immediately adjacent to the hospital facility (loading dock). The reduction of indoor particles at the various sites ranged from 49.8% (lobby 2<sup>nd</sup> floor) to 81.8% (HVAC room 4-2) (Fig. 1).

Viable methodology:

The viable fungal airborne particles, as measured by the culture and identification of the molds recovered, were reduced by an average of 63.4% across all sites within the hospital. As two outdoor sites again showed a significant increase (loading dock, 69.1% and main entrance, 75%) in viable fungi, the indoor reduction in mold particles can be attributed to the GAP™ panels. The reduction of indoor viable fungi ranged from 42.1% (HVAC Room C) to 95.8% (A327 Supply AHU) (Fig 2).

## **Conclusions**

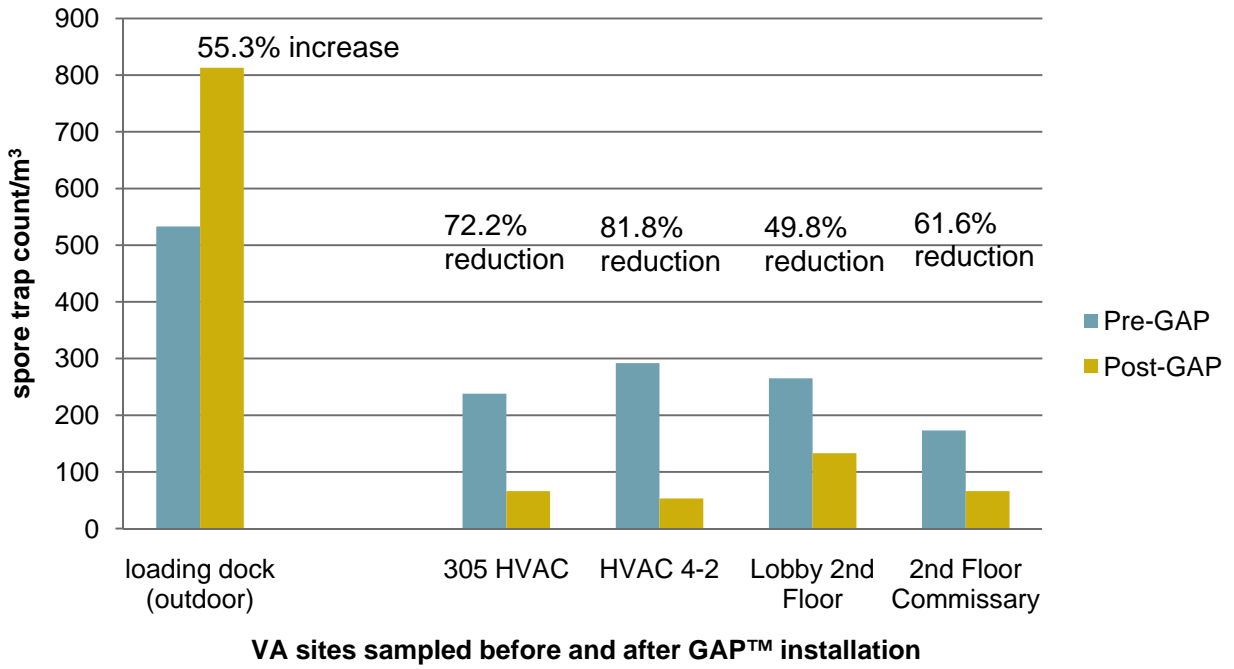
The Genesis Air Photocatalysis (GAP™) System significantly reduced both viable and total indoor airborne fungal elements in a large VA Hospital Facility in El Paso, Texas. The existing air handlers were easily retrofitted to accommodate the GAP™ panels, thus allowing the installation of the advanced three-stage germicidal and air-cleaning process. Subsequent normal operation of the facility's air handling units resulted in a dramatic reduction of indoor fungal particles.

As an ever-increasing number of studies indicate that fungal particles and by-products adversely affect the health of building occupants, Genesis Air Photocatalysis (GAP™) Systems may be used to improve the health and comfort of personnel and patients in a hospital or other type of patient-care setting.

## References

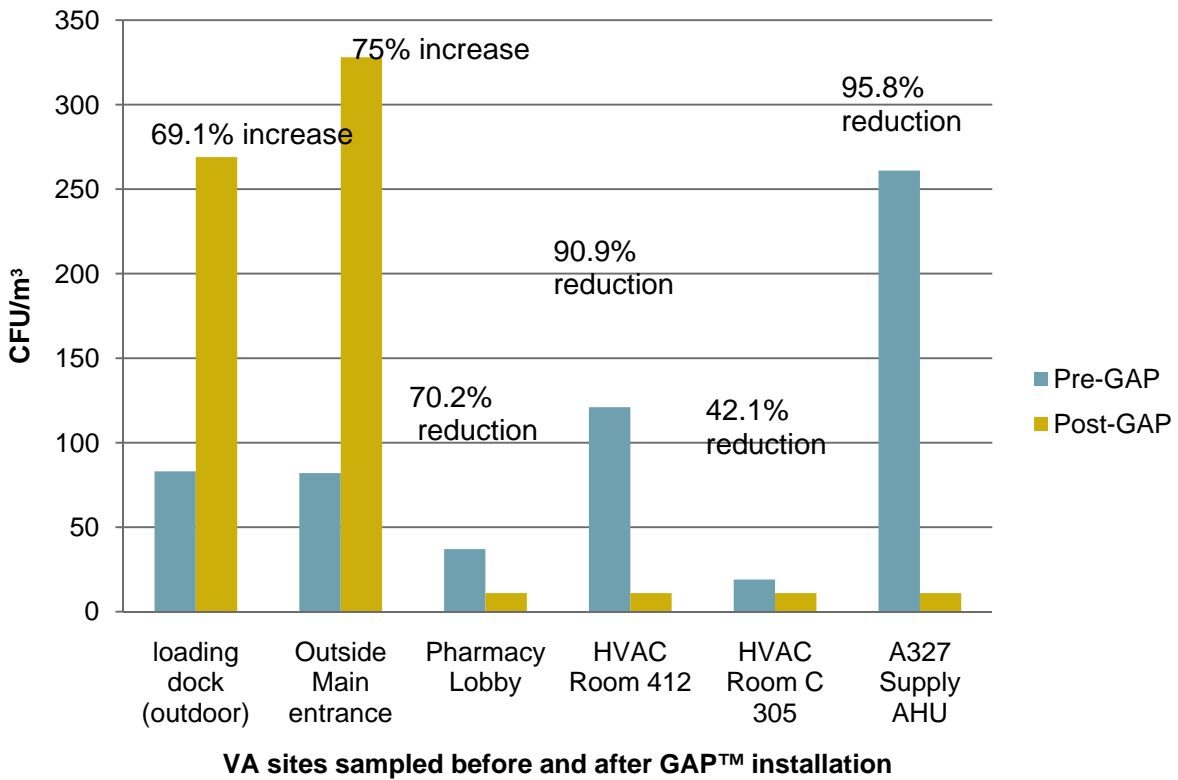
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### Figure 1 - Non-viable methodology



VA sites sampled before and after GAP™ installation

### Figure 2 - Viable methodology



VA sites sampled before and after GAP™ installation