The Use of a Broad-Spectrum, Durable Antimicrobial For Protecting Ceiling Tile From Microbial Growth

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INTRODUCTION

The public faces a broad array of problems associated with microorganisms — bacteria, mold, mildew, yeasts, and other one-celled organisms. Microorganisms are diverse in their lifestyles and aggressive causative agents of corrosion, deterioration, staining, odors, and health effects ranging from allergy stimulation to disease. In this profile of problems, we recognize that the benefits of control to these organisms are both engineered (performance based) and emotive (perceived).

For the construction industry this range of problems reaches into the lives of every man, woman, and child. Whether at work or in the confines of their homes, the demand for a cleaner indoor environment is paramount.

The ÆGIS Microbe Shield™ Program utilizes ÆGIS™ Antimicrobial developed by Dow Corning Corporation that has been registered by the EPA since 1976. It is also used under a number of FDA listings. The technology provides the ability to modify surfaces so that bacteria, fungi, and algae will not grow on the surface. The chemical reactions that allow for the bonding to surfaces and polymer formation are similar to those of the silane-coupling agents in high performance coatings and adhesives, which are utilized in applications such as the space shuttle heat shield panels. This bonding and homopolymerization provides unusual durability and has made "for the life of the product" protection claims possible for products such as carpeting, medical garments, socks, and sporting equipment. High performance applications, where safety is paramount, such as the wound area of surgical drapes, have also been successfully commercialized. Companies such as Baxter Healthcare, Dupont, Allied Signal, Burlington Industries, and many others have found the safety and antimicrobial performance of this technology to be ideal for a wide variety of applications.

The public and press awareness of indoor environmental problems and the importance of microorganisms as causative of these problems is high and is escalating rapidly. Bacteria in hamburger, bacteria that eat skin, and other health and press events magnify the public paranoia and desire for more assurances of protection. The ÆGIS Microbe Shield technology provides confidence as well as protection against microbial problems.

Microorganisms are an ever present problem in all kinds of building environments. They cause deterioration, staining, odors, and human health problems. They are also the major causative agent of "Sick Building Syndrome" (SBS). Health issues aside, microorganisms cause billions of dollars of damage in buildings every year.

The ÆGIS Microbe Shield Program is a systems approach to controlling microbial problems and is a powerful performance and emotive tool for the construction industry.

This paper will discuss the issues surrounding Indoor Environmental Quality (IEQ) and how the ÆGIS Microbe Shield technology has been proven to diminish these concerns.

IEQ: A PROBLEM OF TODAY

Microbes are a part of our everyday lives. They are present in the air we breathe, in the water we drink, on the clothes we wear, and on the surfaces we touch. Microorganisms play a key role in the issues surrounding Indoor Environmental Quality (IEQ); particularly the more widely known concern of SBS and "Building Related Illness" (BRI).

According to the EPA, indoor air pollutants have been ranked among the top five environmental risks to the public health. The reality of an occupied and useful building is that these pollutants will always be present at some level. Much like weeds, many pollutants are normal until their levels or locations make them undesirable.

The term SBS is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be widespread throughout the building. In contrast, the term BRI is used when symptoms of diagnosable illness are identified and can be attributed directly to building contaminants.

A 1984 World Health Organization Committee report suggested that up to 30% of new and remodeled buildings worldwide may be the subject of excessive complaints related to indoor air quality (IAQ). Often this condition is temporary, but some buildings have long-term problems. Frequently, problems result when a building is operated or maintained in a manner that is inconsistent with its original design or prescribed operating procedures. Sometimes indoor air problems are a result of poor building design or occupant activities.

The Building Biosphere

A building can be thought of as a biosphere, the organisms are in a constant flux. Nutrient and humidity changes and alteration of life-limiting (toxic) surfaces allow microbes to adjust and often adapt to the ever-changing conditions in their environment. Air conditioners, bathrooms, wall-to-wall carpets, draperies, wall coverings, furniture, bedding, and ceiling components create ideal habitats for microbes. To live and multiply, microbes need three things: food, a reasonable temperature, and moisture. Building materials and furnishings provide the food and microbes flourish at the same temperature and humidity levels which people find comfortable. As a result, the basic needs of microorganisms are present in every building.

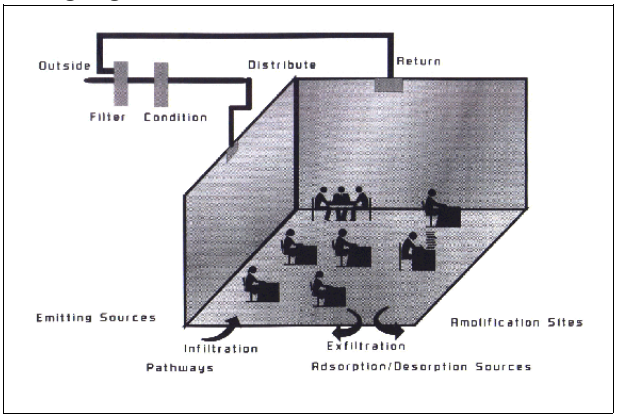


Figure 1: Interior Environmental Factors

Working within these pollutant-laden enclosed spaces, it is no wonder that many of the world's employees develop symptoms such as headaches, dizziness, burning eyes, and

upper respiratory complaints. Over time, the severity of these symptoms often becomes worse as exposure is prolonged. Reactions to indoor pollutants usually occur 1 to 2 hours after building occupants arrive and last 3 to 4 hours after they leave the facility.

The problems of SBS and BRI are serious and cause an economic impact on everyone involved in the buildings marketplace. The billions of dollars of direct and indirect damage caused by indoor pollutants can affect every surface, manufacturing process, piece of operating equipment, and person in a building.

What Causes Microbial Growth?

The microorganisms represented in a building are complex. Every element of a building, its furnishings and its occupants offers a home for microorganisms. Microorganisms need moisture and nutrients and more than 95% of them need to be associated with a surface.

Moisture can come from catastrophic or normal events - a leaking roof, a sweating pipe, a leaking radiator, condensation on windows, condensation on more subtle surfaces where dew points are reached, humidified air from the HVAC system, or any of hundreds of other sources. A hotel or resort facility compounds the problem with the moisture from pools, spas, individual air conditioners, and literally hundreds of bathrooms. This moisture, coupled with wall-to-wall carpeting, draperies, wall coverings, furniture, bedding and ceiling components, creates ideal habitats for microorganisms.

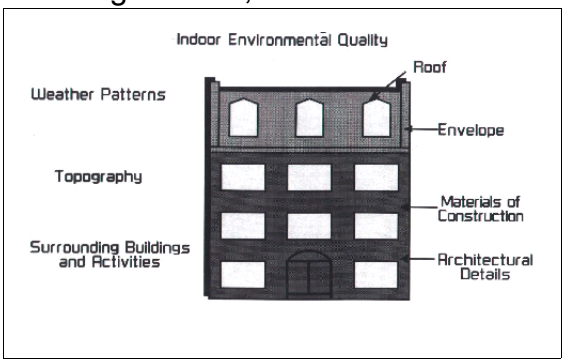


Figure 2: Exterior Environmental Factors

Nutrients utilized by microorganisms can be organic material, inorganic material, and/or living tissue. For example, bacteria play an important role as part of the body's microflora and, with skin, are shed continuously. Given favorable growth conditions, some types of microorganisms can multiply from one organism to more than one billion in just 18 hours.

A building may be infested during construction and catastrophic events (particularly with fungi), but more commonly its occupants or air infiltration routes routinely bring the organisms into the building. Fungi (typically outdoor organisms known as mold, mildew, and yeasts) enter the building on clothing, are wafted in through open doors, or are pulled in as "make up" air by the HVAC system. Bacteria follow these same routes but are primarily associated with human carriers and with very wet areas such a drain pans and places with constant or standing water.

IEQ and The Buildings Marketplace

Unfortunately, most people think that since they cannot see these organisms, they offer no real threat to humans or building materials. In reality these microscopic pests, among other factors, are being implicated as primary and contributory factors leading to an array of health concerns in the home and workplace.

The broad-spectrum of microbes is particularly potent because it can cause a full breadth of discomfort, irritation, sensitization, toxic reaction, and disease. When building occupants start to develop symptoms associated with SBS they point the finger at anything or anybody. From this stems many company problems; low morale, loss of productivity, and unwanted employee turnover.

The “out of sight, out of mind”, but real cost of microorganisms for building owners and facility managers is the loss of building materials due to deterioration and staining.

For architects, designers, and specifiers, building materials can no longer be rated or specified only on their aesthetic or physical performance characteristics. Litigation and customer demands have made ”pollutant potential” part of their concerns for all professionals in the buildings marketplace.

Fortunately, most problems occur when the building structure experiences unusual or catastrophic events, such as flooding. Historically, both unusual and catastrophic events have been dealt with by both traditional and non-traditional methods.

TRADITIONAL SOLUTIONS

The issues surrounding indoor environmental pollution have generated to a variety of "solutions". For years, indoor environmental remediation has involved tactics ranging from tearing out offensive materials to improving air filtration and circulation. Generally, the first attempt to resolve indoor environmental pollution is to "cover up" offensive odors with the extensive use of air fresheners, deodorizers, and disinfectants. In 1995, the American public spent over $900 million on such products and the worldwide market for these products is exploding.

Over the years there has been a broad array of products, cleaners, chemicals, devices, strategies, and methods available to combat microbial problems. Unfortunately, the majority of these products only cover up the problem at best. These products work by either masking offensive odor, as demonstrated with air fresheners and deodorizers, or they administer a "one-time kill", as exhibited in household cleaners (such as bleach) and conventional antimicrobials.

No matter how effective these products may be initially, they do not offer any lasting solution. The process must be repeated continuously. The use of these types of chemistries is not only a short-term solution, but also has the potential to harm other life forms or surfaces. This has been recognized by all areas of the building industry and the legal profession.

Killing microbes is easy; doing it safely and effectively is tough.

THE ÆGIS APPROACH: A NON-TRADITIONAL SOLUTION

In 1969, researchers at Dow Corning Corporation discovered a unique way to attach biocidal agents permanently and directly to a wide variety of surfaces. The resulting antimicrobial, the keystone of the ÆGIS Microbe Shield Program, is unique among antimicrobial treatments in that it does not leach onto other surfaces and does not dissipate over time.

An odorless antimicrobial with extraordinary efficiency, safety and durability, is at the heart of the ÆGIS Microbe Shield Program. EPA-registered in 1976 for virtually all-indoor surfaces, ÆGIS Antimicrobial forms an insoluble and nonvolatile coating which remains effective over time because it polymerizes with the treated surface. These features and it's superior performance differentiates the ÆGIS Microbe Shield from conventional antimicrobial technologies.

The ÆGIS Microbe Shield technology has a 25-year history of safety, durability, and effectiveness. Literally millions of pounds of the antimicrobial have been used over the past 25 years to treat consumer goods and thousands of homes and buildings. The durability of the ÆGIS Microbe Shield has been extensively tested; providing for life of the product claims on most treated goods.

How does it Work? / What's So Different?

The ÆGIS Microbe Shield technology acts by mechanically rupturing the cell membrane of the microorganism — when the microbe comes in direct contact with the antimicrobial. Without question, ÆGIS Antimicrobial is significantly different from conventional antimicrobials, sanitizers, or disinfectants. The differences lie in its chemical nature, how it works, its effectiveness, durability, low toxicity, and history of safety.

ÆGIS Antimicrobial – Mode of Action

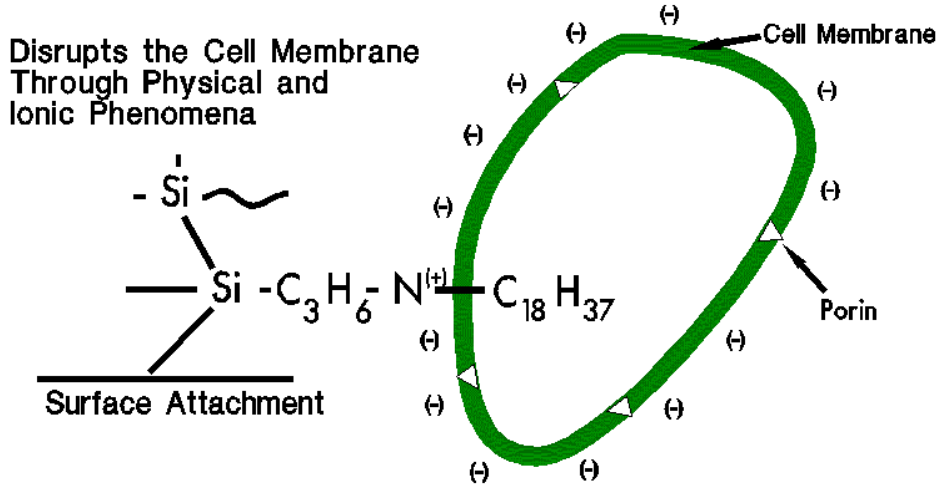


Figure 3

Historical Support

The ÆGIS Antimicrobial has been used on a variety of surfaces with extraordinary success. Starting with socks produced by Burlington Industries in the 1970s, the use of this antimicrobial has grown to items ranging from kitchen scrubbing pads and air filters to surgical gowns and undergarments.

In addition to the varied consumer and medical goods that utilize the ÆGIS technology, many construction and building products have benefited from the ÆGIS Microbe Shield Program. Not only is the antimicrobial applied to virtually all interior surfaces of a building, but products such as wall covering, carpeting, and ceiling tile have all benefited from applying this antimicrobial during the manufacturing process.

By protecting the interior, surface-building products from microbial contamination, an overall improvement of a facility's IEQ can be realized. Treated interior products decrease the microbial growth on the building surfaces where they are used. This provides a cleaner indoor environment for everyone. In addition, with the above ceiling space and the HVAC system being the "lungs" of a building, protection against microbial growth in this area is essential to the well being of an entire facility.

The application of the ÆGIS Antimicrobial on ceiling tile manufactured by USG Interiors, Inc. dramatically aids in providing an improved environment for everyone and has the potential to extend the useful life of the treated good.

A prime example where the application of the ÆGIS Microbe Shield technology played a key role in the preservation of a new building is the Arthur G. James Cancer Hospital and Research Institute at Ohio State University in Columbus, Ohio.

Protecting An Entire Medical Environment

In January 1990, just 6 days before its scheduled grand opening, a roof-level water pipe froze and broke flooding the 12-story Arthur G. James Cancer Hospital and Research Institute with an estimated 500,000 gallons of water. The water flowed down stairwells, elevator shafts and utility service shafts and spread out over and under each of the fully furnished floors. Water moving along the floors wicked up into the wallboard and insulation, and soaked the carpeted areas in offices, patient rooms, and hallways. The water running in the under-surface of floors dropped onto the acoustical ceiling tiles below. Prior to this catastrophic event, the building had not been treated with the ÆGIS Microbe Shield technology.

Microbial sampling began early in the restoration process and by day 7 the facility had developed a distinctive odor. By week 3 there was gross fungal contamination. Active fungal growth was clearly visible on most surfaces on the lower floors. Aeromicrobial sampling retrieved >2800 colony forming units (cfu's) of fungi per cubic meter of air on most of the floors of the facility. Because of the contamination, university and hospital officials considered demolishing the new structure.

Fortunately for the university, the decision was made to keep the facility and a microbial prevention plan using the ÆGIS Microbe Shield technology was implemented. This treatment was used as an on-site application to reduce the microbial populations and continuously maintain them at low levels.

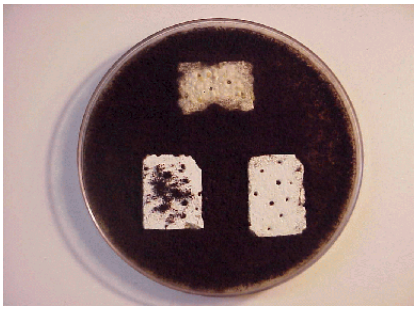
Everything from the carpeting to the ceiling was treated and to this day the building and it's components continue to be free of microbial odors. Airborne and surface fungal levels have remained consistently below 7 cfu's per cubic meter on all floors throughout the facility. A 5-year evaluation of hospital-acquired infection data was conducted in 1996 with results showing no fungal infections. This is far superior to other cancer hospitals. The ÆGIS Microbe Shield technology continues to be utilized for control of microbial contamination in numerous hospitals, heart institutes, and care facilities.

Technical Support

Over the past year, various and numerous tests have been conducted using ÆGIS Antimicrobial in ceiling tile manufactured by USG.

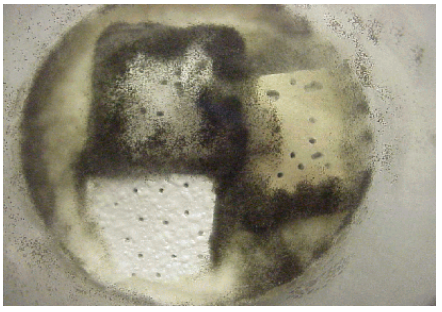
Below are a few photos of treated and untreated samples. The following pages contain test data and test reports.

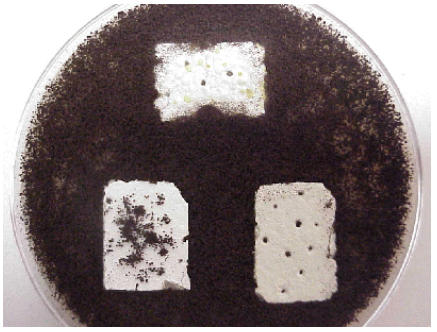
Lower right: USG product protected by ÆGIS Antimicrobial. Top: Non-USG product treated with a different antimicrobial. Lower left: Untreated USG product.



The hydrophobic nature of the treated USG ceiling tiles is depicted above.

Lower left: USG product protected by ÆGIS Antimicrobial. Top: Non-USG product treated with a different antimicrobial. Right: Untreated USG product.





Lower Right: USG sample protected by the ÆGIS Antimicrobial. Lower Left: Untreated USG sample. Top: Competitor sample treated with a different antimicrobial

#	Description Athena/UK	Microbiological Analysis	Chemical Analysis				Pass/ Fail
		Microbial Growth[1] (Observed)	Bromophenol Blue[2]				
		On Surface	Procedure		% Uniformity	% Intensity	
			EXT	DS			
1	Non-USG Sample-53	4		X	0%	0%	**Fail**
2	USG Control Sample-45	3		X	0%	0%	**Fail**
3	USG w/ AEM 5700 Sample-51	0		X	100%	90%	**Pass**

1. ÆGIS AATCC 30 Modified

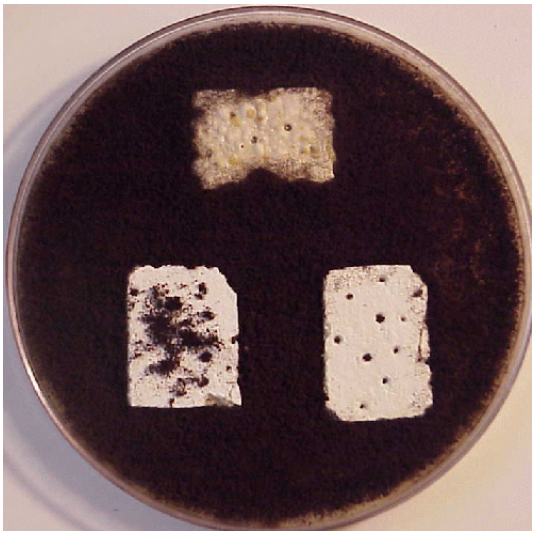
Observed Growth and Discoloration	Grade
None	0
Growth visible to the naked eye-	
Trace (less than 10%)	1
Light growth (10-30%)	2
Medium growth (30-60%)	3
Heavy Growth (more than 60%)	4

2. ÆGIS BPB Direct Stain (DS)
   2.0g sample
   0.025% BPB dH_2O solution
   2 minute exposure time

BPB Direct Stain

A. Non-USG product
B. USG control
C. USG w/ AEM 5700*

A.



B. C.

* AEM 5700 Antimicrobial (EPA Reg. No. 64881-1) is the same formulation as ÆGIS Antimicrobial

ÆGIS Environments Laboratory
10-18-99

USG Ceiling Tile

Antimicrobial Developmental Studies
ÆGIS Environments Laboratory

Effects of ÆGIS ™ Antimicrobial treatment on Surface/edges of tile.

Test Organism:
Aspergillus niger

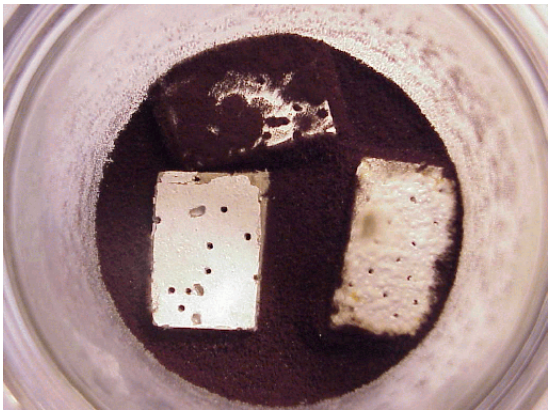
Methods:
Molten Potato Dextrose agar was seeded with $1x10^5$/ml *Aspergillus niger* fungi and poured into sterile round bottles. Square pieces were cut from each sample and imbedded into the agar before the agar hardened so that the surface of the sample is less than 5 mm above the agar surfaces. The plate was then incubated for 5 days to allow for the fungi to bloom. Samples were examined for growth on the surface of the tile and rated accordingly.

Results:
The untreated USG sample had clear fungal growth on the surface and on the sides of the tile. The ÆGIS treated USG sample had no growth on the surface or the sides of the tile. A competitor's sample treated with a different antimicrobial had heavy visible growth on all sides of the sample while the surface remained free of fungal growth.

Conclusions:
Rapid growth was observed on 90% of the USG control sample. The competitor sample was resistant to the fungus on the surface of the sample, but the sides and interior of the sample remained susceptible to fungal growth. Also note the fungal and bacterial contamination on the surface of the competitor's sample. The surface of the ÆGIS treated sample was clearly protected against this type of microbial insult. No growth on the treated sample surface or the treated sides was observed. This ÆGIS treated USG sample displayed very good, uniform Bromophenol Blue activity which indicates a well treated sample. This treated sample passes the quality control standards and criteria for the ÆGIS Microbe Shield™ Program.

Untreated/Control

USG - Treated



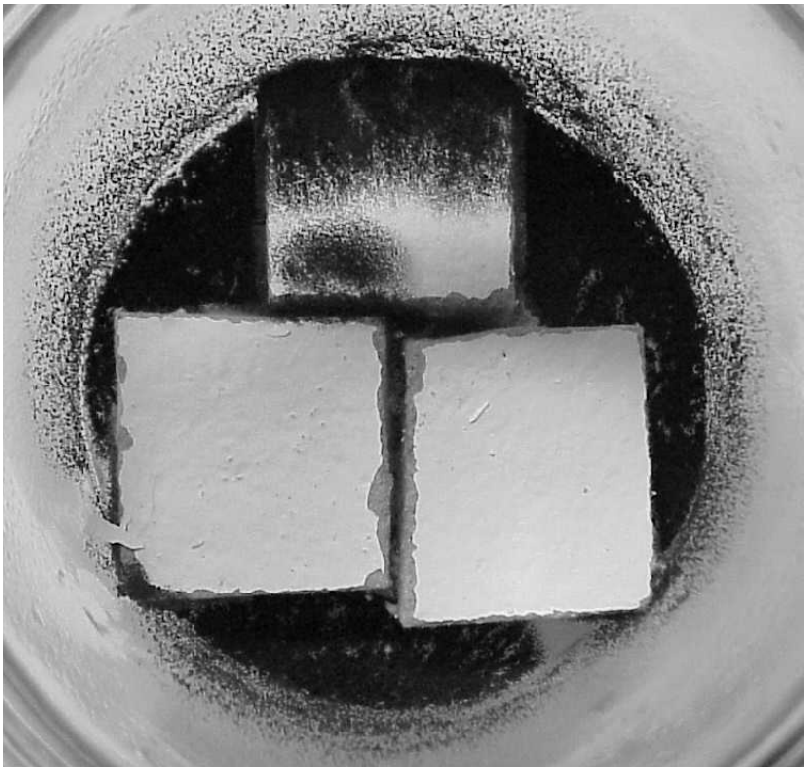
Competitor

USG Ceiling Tile
Antimicrobial Developmental Studies
ÆGIS Environments Laboratory
USG - whole sample 03-07-00

AATCC-30 Modified

USG / No Treatment

USG Level 1 Treatment



USG Level 2 Treatment

USG Ceiling Tile

Date received: 8-12-99

#	Description USG Ceiling Tile	Microbiological Analysis	Chemical Analysis				Pass/ Fail
		Fungal[1] (Observed Growth)	Bromophenol Blue[2]				
		On Surface	Procedure		% Uniformity	% Intensity	
			EXT	DS			
1	Untreated	3		X	0%	0%	**Fail**
2	AEM5700	0		X	100%	80%	**Pass**

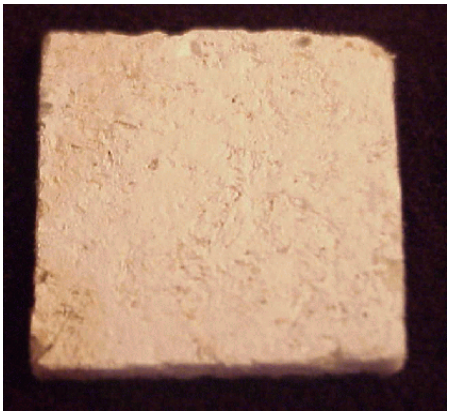
1.ÆGIS AATCC 30 Modified

Observed Growth		Grade
None		0
Growth visible to the naked eye-		
Trace (less than 10%)	1	
Light growth (10-30%)		2
Medium growth (30-60%)		3
Heavy Growth (more than 60%)		4

2. ÆGIS BPB Direct Stain (DS)
2.0g sample
0.025% BPB dH_2O solution
20 minute exposure time

Untreated

Treated



Summary
Reflecting on the ÆGIS Antimicrbial and what it has been proven to do, the following is a list of highlights and the benefits this product has to offer anyone concerned with improving the overall indoor environmental quality of any building interior and the life of intact treated goods.

The ÆGIS Microbe Shield technology will:

- Dramatically reduce mold, mildew, and bacteria levels on treated surfaces.
- Control the growth of microbial contamination on treated surfaces which have been exposed to flooding or high moisture conditions
- Control the odors, damage, and deterioration typically caused by mold and mildew growth on surfaces
- Lessen the risk of airborne microbial contamination spreading throughout a building.
- Save thousands of dollars in restoration costs after catastrophic events such as hurricanes, floods, or building equipment failures.

Benefits of the ÆGIS Antimicrobial:

- Broad-Spectrum control — Fungi, Mold, Mildew, Bacteria, Yeasts, Algae
- Odorless
- Durable — “For the life of the surface”
- Unmatched safety profile
- Will not leach into the environment or transfer to other articles or to the skin
- Contains no arsenic, heavy metals, or polychlorinated phenols
- Improves “cleanability” of the surface
- Controls or eliminates microbial staining and deterioration
- The confidence of more than 25 years of effective use in thousands of buildings and manufactured goods