

**The ÆGIS Microbe Shield Treatment for Carpets:  
Effectiveness and Durability  
In Field and Laboratory Testing**

By:

W. Curtis White and James B. McGee

## **Introduction**

Laboratory tests, field tests, and field experience with carpet installed in challenging environments have shown that the SYLGARD Antimicrobial Treatment (now known as the ÆGIS Microbe Shield™) is remarkable effective and durable in controlling microorganisms. These organisms cause odors, defacement, and deterioration of carpet. Many of these microorganisms are associated with allergic reactions and potentially infectious diseases.

The ÆGIS Microbe Shield is the only carpet treatment available today that protects floor coverings against mildew and odors caused by microorganisms, while retaining its effectiveness after stain removal and cleaning. The ÆGIS Microbe Shield lasts for the lifetime of the carpet.

Many hospitals, schools, and other institutions favor carpeting over vinyl flooring. Carpeting improves aesthetics, reduces noise, and helps prevent slips and falls. But hospitals are also concerned about the possible spread of infectious diseases and odors caused by microorganisms, and the threat of allergies resulting from uninhibited growth of microorganisms.<sup>1,2,3,4,5</sup>

In the home, odors caused by microorganisms may be troublesome in bathroom and kitchen carpets, and in child and pet areas. Restaurants, hotels, and motels face similar odor problems in bathrooms, guest rooms, and public areas.

## **Antimicrobial Additives in Cleaning Products**

To combat these problems, both institutions and homemakers have established housekeeping practices which include the use of cleaning products containing antimicrobial additives. These additives are based on halogenated salicylic acid anilides, organotin compounds, quaternary ammonium compounds, and quaternary ammonium sulfonamide derivatives. These treatments base their activity on leaching or diffusion into the surrounding environment. Since most of them are water-soluble, they lack cleaning durability and have to be constantly reapplied. Many have limited biological activity against specific microorganisms and have to be applied in combination with other products. And laboratory tests have shown that, although these products are effective against some bacteria, both gram-negative and gram-positive bacteria readily adapt to many of them, lessening their effectiveness over time. This has led to a general disenchantment with these products and a search for an antimicrobial which can combine effectiveness with durability.

## **A New Approach**

The ÆGIS Microbe Shield is a silicone quaternary amine with broad-spectrum antimicrobial activity. The active ingredient (3-trimethoxysilylpropyldimethyloctadecyl ammonium chloride) controls a broad range of bacteria and fungi responsible for odors, rot, and mildew. This compound destroys microorganisms by disrupting the delicate cell membranes, and therefore, does not need to be absorbed in solution to be effective. In addition, the ÆGIS Microbe Shield is unique because it combines this property with an important new technology developed by Dow Corning Corporation scientists. They have learned how to bond biologically active molecules to inert surfaces.<sup>6</sup> This means that the ÆGIS Microbe Shield not only

destroys microorganisms but also remains effective through cleaning a stain removal. The combination of these two technologies- antimicrobial treatment bonded to carpet fibers- has given the ÆGIS Microbe Shield durability unmatched by other antimicrobials on the market today. Other mill-applied treatments such as organotin compounds, bis-chlorinated phenols, and arsenicals are not durable to repeated washings. They leach or migrate from the carpet when the carpet is washed or when it is wet in service. In addition, these treatments generally are effective against a narrower spectrum of microorganisms than is the ÆGIS Microbe Shield.

## **Laboratory Testing**

Extensive laboratory testing has confirmed the effectiveness and durability of the ÆGIS Microbe Shield. One test involved conditions simulating a tropical environment, ideal for the growth of fungi. Table I illustrates the effects of cleaning on the anti fungal power of the ÆGIS Microbe Shield.

The true test of a product, however, is how it performs in the real world. In a study jointly designed by a major carpet retailer, Certified Testing Labs, and Dow Corning, the durability of the ÆGIS Microbe Shield was evaluated on nylon carpet samples installed in the Atlanta International Airport. The ÆGIS Microbe Shield was applied to the residential-style carpet at Burlington industries and Aladdin Mills using three variations of recommended spray treatments. Burlington also supplied tufted and dyed carpet pieces were still biologically active after 35,000-foot traffics and two cleanings. Conditions of this walk-on test were much more severe than those encountered in a typical residential installation.

## **Hospital Tests**

In other testing, the antimicrobial activity of the ÆGIS Microbe Shield was evaluated under conditions that more closely simulated actual use. Here, untreated control samples and treated samples were installed at a major Southeastern hospital for a 36-month study. Table II shows that the effectiveness of the treatment was not diminished through normal wear and cleaning.

Another example of the effectiveness and durability of the ÆGIS Microbe Shield was demonstrated at Barnes Hospital at the Washington University Medical Center. Barnes Hospital was one of the first hospitals in the U.S. to install carpeting of any type. Problems developed because of the tendency for carpet to harbor food for bacteria and fungi, leading to odors and staining. In addition, matting, dirt retention, and pattern loss adversely affected appearance. To avoid these problems in a replacement carpet, architects began searching for the appropriate type of carpet and antimicrobial treatment for this application. Not satisfied with product claims, the hospital was determined to do its own testing before choosing the replacement carpet.

Eleven different nylon carpet samples of various constructions were installed in 11 patient rooms in October 1983. The samples included five different antimicrobial treatments and several without treatment. Small samples of each were also glued to the concrete floor of a hospital supply room to evaluate the effectiveness and durability of the antimicrobial treatments.

The 11 small samples were washed every weekday for 6 weeks to simulate 10 to 15 years of in-service cleaning. Each of the samples was then injected with different odor- and stain-causing live-organism solutions. Table III lists these microorganisms.

After the inoculation, the organisms were incubated at room temperature for ten days. The samples were then subjected to standard removal procedures for each type of stain, followed by two rotary scrubblings and two hot-water extractions. Finally, they were allowed to dry for two days before being taken up for evaluation. Included in this final evaluation were a visual test for staining and color retention, and a “sniff” test for odors.

When the results were in, the samples with the ÆGIS Microbe Shield were judged to have the least odor retention, the best color retention, and minimum staining. Antimicrobial effectiveness was retained throughout the cleaning cycles. Particularly important was the effectiveness against a wide variety of organisms capable of spreading infection. Because of these results, the carpeting eventually chosen by the hospital used the ÆGIS Microbe Shield.

The microorganisms used in the Barnes Hospital study indicate the broad spectrum of activity exhibited by the ÆGIS Microbe Shield. Table IV illustrates further the effectiveness of the ÆGIS Microbe Shield.

### **Do Microorganisms Adapt to it?**

Another concern of institutions requiring antimicrobial protection in their floor coverings is the adaptation of microorganisms to the antimicrobial treatment. In the case of standard water-soluble antimicrobials, the microorganisms can become immune to the treatment, and the effectiveness of the treatment may be gradually reduced. Table V shows the results of adaptation studies on treated and untreated carpeting.

Through these laboratory and field tests, the ÆGIS Microbe Shield has been shown to be effective in protecting carpet from the adverse effects of microorganisms, and to be durable through numerous cleanings. In addition, the ÆGIS Microbe Shield is safe and essentially nontoxic with minimal potential for adverse impact on the environment.

**Table I**  
**Antifungal Activity of Nylon Carpet**  
**With the ÆGIS Microbe Shield-**  
**Twelve-Week Tropical Chamber Exposure**

*Percent Covered by Fungi, Number of Weeks Exposure<sup>1</sup>*

<i>High-Density Nylon Control Sample</i>	<i>1 Week</i>	<i>6 Weeks</i>	<i>12 Weeks</i>
No Shampooing	100	100	100
7 Shampoo Cycles <sup>2</sup>	100	100	100
14 Shampoo Cycles	100	100	100
21 Shampoo Cycles	100	100	100
<i>High-Density Nylon Sample with the ÆGIS Microbe Shield</i>	<i>1 Week</i>	<i>6 Weeks</i>	<i>12 Weeks</i>
No Shampooing	0	0	0
7 Shampoo Cycles	0	0	0
14 Shampoo Cycles	0	0	0
21 Shampoo Cycles	0	0	0

<sup>1</sup>Samples were rechallenged with a spore suspension of *Aspergillus niger* and *Penicillium* variable at 3, 6, and 9 weeks of the study.

<sup>2</sup>Cleaning agents used included Fiber Fresh, Fiber Flow, Blue Lustre, HR3, and Woolite. Data are representative of all test conditions.

Carpeting with ÆGIS Microbe Shield Treatment showed no loss in antimicrobial activity after 21 cleanings.

**Table II**  
**Antimicrobial Activity of Nylon Carpet With The ÆGIS Microbe Shield in a 36-Month Use Study at a Major Hospital**

*Percent Bacterial Insult<sup>1</sup> Reduction<sup>2</sup>*

<i>Sample Nylon Carpet</i>	<i>Before Installation</i>	<i>12 Month Wear, 1.5 Million Traffics</i>	<i>22 Month Wear, 3 Million Traffics</i>	<i>36 Month Wear, 4.5 Million Traffics</i>
Untreated Control	0	0	2.3	3.8
Treated With The ÆGIS Microbe Shield	85	91	78	87

<sup>1</sup>Bacterial inoculum was *Klebsiella pneumoniae*.

<sup>2</sup>Average of triplicate tests.

**Table III**

***Microorganisms Used in Barnes Hospital Study***

*Pseudomonas aeruginosa* in tryptic soy broth.

*Enterobacter aerogenes* in tryptic soy broth.

*Klebsiella pneumoniae* in tryptic soy broth.

*Serratia marcescens* in tryptic soy broth.

*Proteus Mirabilis* in tryptic soy broth.

*Staphylococcus aureus* in tryptic soy broth.

*Aspergillus niger* in Sabouraud's broth.

*Penicillium sp.* in Sabouraud's broth.

*Streptomyces sp.* in Sabouraud's broth.

*Streptomyces sp.* in Sabouraud's broth.

*Pseudomonas aeruginosa* in urine.

Human blood mixed with tryptic soy broth.

**Table IV**  
***Efficacy of the Active Ingredient of the AEGIS Microbe Shield***  
***Against Gram-Positive and Gram-Negative***  
***Bacteria, Yeasts, and Fungi***

<b><u>Bacteria:</u></b>
<i>Staphylococcus aureus</i>
<i>Streptococcus faecalis</i>
<i>Escherichia coli</i>
<i>Salmonella typhosa</i>
<i>Salmonella choleraesuis</i>
<i>Pseudomonas aeruginose</i>
<i>Mycobacterium smegmatis</i>
<i>Mycobacterium tuberculosis</i>
<i>Streptococcus mutans</i>
<i>Klebsiella pneumoniae</i>
<i>Enterobacter agglomerans</i>
<i>Staphylococcus epidermis</i>
<i>Acinetobacter calcoaceticus</i>
<b><u>Yeasts:</u></b>
<i>Saccharomyces cerevisiae</i>
<i>Candida albicans</i>
<b><u>Fungi:</u></b>
<i>Aspergillus niger</i>
<i>Aspergillus flavus</i>
<i>Aspergillus terreus</i>
<i>Chaeromium globosum</i>
<i>Penicillium funiculosum</i>
<i>Trichophyton interdigitale</i>

*This table represents only a small number of the total microorganisms which are controlled.*

**Table V**  
***Bacterial Adaptation Studies on Nylon Carpet***  
***Processed With the ÆGIS Microbe Shield***

<i>Using the CTM 0923 shake flask test</i>	<i>% Reduction Klebsiella pneumoniae</i>	<i>% Reduction Staphylococcus aureus</i>
Exposure <sup>2</sup>	1 , 2 , 3 , 4 , 5	1 , 2 , 3 , 4 , 5
Untreated Nylon Control	0 , 0 , 0 , 0 , 0	0 , 0 , 0 , 0 , 0
Treated With The ÆGIS Microbe Shield	99.8 - 99.6 - 98.8 - 97.5 -99.9	98.6 - 97.5- 96.3 - 99.4 - 98.8

<sup>1</sup>CTM0923 shake flask test.

<sup>2</sup>Shake flask survivors were used for subsequent exposures.

These tests indicate that there is no reduction in the effectiveness of ÆGIS Microbe Shield Treatment upon repeated exposure to the microorganisms.

**References**

- 1) Snyder, J. *Canadian Hospital*, Vol. 13, 1966, p.56.
- 2) Walter, W.G., *Health Lab Sci.*, Vol. 3, 1969, p.140.
- 3) Baker, P.G.H., *New Zealand Medical*, 1977, p.88.
- 4) Schaffer, J.G., *Health Lab Sci.*, Vol. 3, 1965, p.80.
- 5) Lanese, R.R., *Amer. J. Pub. Health*, Vol. 63, 1978, p.171.
- 6) Plueddemann, E.P., *Journal of Adhesion* Vol. 2, 1970, p.184.