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Protection Branch Report of Test No. 6-69

Comparison of Microbial Contamination Levels on  
Barbac and Cotton Herringbone Twill Cloth

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Prepared by:

Approved by:

DOROTHY H. PORTNER  
Decontamination Section

ROBERT K. HOFFMAN  
Chief, Decontamination Section

HERBERT M. DECKER  
Chief, Protection Branch

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CHARLES R. PHILLIPS  
Chief, Physical Defense Division

DEPARTMENT OF THE ARMY  
Fort Detrick, Frederick, Maryland 21701

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At the request of Dr. James K. Ferguson, Preventive Medicine Office, Manned Spacecraft Center, a brief investigation of a special cloth called barbac, from which the Biological Isolation Garment is made, was undertaken (i) to determine whether the cloth repels microorganisms and (ii) to recommend a decontamination procedure for the Biological Isolation Garment. When the astronauts return from lunar exploration, the tentative plan is for each to don a Biological Isolation Garment in the raft, after emerging from the spacecraft. The purpose of the Biological Isolation Garment is to restrain or isolate any lunar contamination on the bodies of the astronauts from the earthly environment. A previous test (i) has indicated that the Biological Isolation Garment is capable of restraining at least 93% of 0.45 $\mu$  particles for a 2-hour period of wearing. However, since it is probable that some contamination from the astronaut could be transferred onto the exterior of the Biological Isolation Garment when it is donned, a cloth that repels microorganisms and/or a decontamination

procedure is desirable. Conventional chemical or heat treatments are not practicable for decontaminating the garment on astronauts in a raft, but the contamination could be adhered to the cloth by spraying the garment with a suppressant such as hair spray. Such a treatment, however, would close some of the pores of the cloth and might make the garment uncomfortable to wear.

In this investigation, the air resistance of the cloth was tested before and after treatment with a hair spray to measure the degree of hair spray clogged the weave. To test whether microorganisms are repelled, pieces of cloth, both in vertical and horizontal positions, were contaminated by natural aerial fallout by an artificially produced bacterial-spore aerosol. The results of these tests are reported herein for both barbac and cotton herringbone twill cloth. The herringbone twill was used only for comparative purposes.

#### MATERIALS AND METHODS

For this test, an equal number of squares (1 x 1 inch) of barbac cloth (Angelica Uniform Co., St. Louis, Mo.) and of cotton herringbone twill cloth were laid horizontally or hung vertically while exposed to the artificial or natural microbial contamination. Artificial contamination was obtained in a chamber by exposure to a Bacillus subtilis var niger spore aerosol for two hours at approximately 60% RH. The natural contamination was obtained in the laboratory by the accumulation of

microorganisms from aerial fallout during a 14-day period at an ambient RH between 30 to 40%. After contamination, each square was placed in a test tube containing 10 ml of 0.05% Tween-20 solution and shaken mechanically for 10 minutes. To determine the level of natural contamination, 5 ml of the suspending fluid were plated with trypticase soy agar; but for the artificial spore-contaminated samples, serial dilutions of the suspending fluid were plated. Colony counts were made after 48-hour incubation at 32 C.

The air resistance across barbac or cotton herringbone twill cloth was measured both before and after treatment with hair spray applied at a distance of about one foot. The cloth, with a circular area of 18 square inches, was clamped between two metal funnels and the joined edges sealed to prevent air leakage. The air flow through the apparatus was regulated to 10 liters per minute as determined by a flowmeter attached to the inlet opening. To measure the resistance, the pressure drop across the cloth was determined by a water manometer attached to the outlet.

#### RESULTS AND DISCUSSION

The results of the contamination level obtained on the barbac and cotton herringbone twill cloth exposed to natural aerial fallout and artificial bacterial-spore aerosol are summarized in Table I. The contamination level obtained on barbac cloth was not significantly different statistically from that obtained with cotton herringbone

twill cloth for any one position by either method of contamination. The difference in the level of natural contamination on the two cloths is more apparent than real. One highly contaminated sample out of ten assayed for each position, vertically and horizontally, caused the relatively higher arithmetic average for cotton herringbone twill cloth exposed to natural contamination. As one would expect the level of contamination was greater when the cloth was exposed in a horizontal position than in a vertical one.

The air resistance as measured by pressure differential was appreciably greater for barbac cloth than for cotton herringbone twill (Table II). After treatment with hair spray, the air resistance of both cloths were increased. The increase resistance of barbac cloth however does not seem so great that the Biological Isolation Garment would be intolerable to wear after treatment with hair spray. To determine this, though, the entire Biological Isolation Garment itself would have to be treated with hair spray and worn.

The use of a suppressant such as hair spray or even the use of a somewhat sticky or tacky surfaced cloth garment has much merit for the purpose intended here. That purpose of course is to prevent the release of unwanted microorganisms that might be returned from the moon or Mars. Suppression is an excellent method of preventing their release. After use, the garment with its contaminating microorganisms could readily be

destroyed by incineration. Chemical sterilization of a garment, on a person, is less certain. First because of a suitable method of applying and secondly, and even more important, is the uncertainty of whether chemicals that are highly active against earth microorganisms would be active against microorganisms that originate on the moon or another planet.

The results indicate that barbac cloth does not repel microorganisms and thus contamination probably would be transferred onto the exterior of the Biological Isolation Garment when it is donned.

#### Reference

1. Protection Branch Report of Test No. 3-38: "Evaluation of Two NASA Biological Isolation Garments". Physical Defense Division, Fort Detrick, Maryland. December 1967.

Table I.

Comparison of Contamination Levels on Barbac  
and Cotton Herringbone Twill Cloth

Type of Cloth	0 organisms per Square Inch			
	Artificial Contamination <sup>a</sup>		Natural Contamination <sup>b</sup>	
	Vertical	Horizontal	Vertical	Horizontal
Barbac	27,200	85,900	4.3	13.0
Cotton Herringbone Twill	18,000	96,900	19.4	47.4

a Each entry is an average of 5 samples exposed to a B. subtilis var niger spore aerosol for 2 hours at about 60% RH.

b Each entry is an average of 10 samples exposed to aerial fallout for 14 days at an ambient RH between 30 to 40%.

Table II.

Air Resistance of Barbec and Cotton Herringbone Twill Cloth  
Before and After Treatment With Hair Spray

	Pressure Differential (millimeters of water) <sup>a</sup>	
	<u>Barbec Cloth</u>	<u>Cotton Herringbone Twill</u>
Before Treatment	7.9	1.6
After 1 Hair Spray Treatment	9.5	2.4
After 2 Hair Spray Treatments	11.1	2.4
After 3 Hair Spray Treatments	-	2.4

<sup>a</sup> At an air flow rate of 10 liters/minute across 16 square inches of cloth.

- Omitted.