Chemical Corps Board Report

on

Project 828

TEST OF PROTECTIVE CLOTHING (U)

26 January 1956

ARMY CHEMICAL CENTER, MARYLAND

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CHEMICAL CORPS BOARD REPORT

on

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26 January 1956
Army Chemical Center, Md.

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CHEMICAL CORPS BOARD REPORT

ON

PROJECT 828

26 January 1956

A B S T R A C T

I. TITLE:

1. Test of Protective Clothing (U).

II. OBJECTIVE:

2. To compare poplin, sateen, and herringbone twill (HBT) garments with respect to:

a. Suitability for impregnation by the following methods:

(1) Standard M2 plant method.

(2) Experimental M2 plant low-binder method.

(3) Standard M3 clothing impregnation chemical set.

b. Suitability in actual wearing tests with respect to:

(1) Physiological reactions.

(2) Comfort.

(3) Deterioration of fabric and decline of impregnite content during wear.

(4) Decontamination, laundering, and reimpregnation of garment.

c. Degree of protection afforded by the three types of clothing with the following variations in garment design or ensemble:

(1) Garments with special protective flaps versus standard design garments.

(2) Protective long underwear versus protective knit cotton shorts.

(3) Protective hoods versus M5 ointment on exposed skin area.

d. Storage stability of garments impregnated by the above methods with respect to fabric and impregnite deterioration.

III. DISCUSSION:

3. An extensive series of tests of permeable, protective, fatigue clothing has shown that, insofar as can be determined by these tests, the present state of development of this clothing and methods used to impregnate it is generally satisfactory. A possible exception is that the clothing is not comfortable to wear, especially under the hot, humid conditions of the test, and may cause skin irritation. Controlled chamber tests involving exposure of test subjects to an aerosol of sodium fluorescein, to an aerosol of B. globigii, and to mustard vapor under hot, humid conditions have indicated the need for a thorough field evaluation of the protection furnished by these various clothing ensembles.

IV. CONCLUSIONS:

4. HBT, poplin, and sateen fatigue clothing can be satisfactorily impregnated according to CMLC SIP-M28-1 by either the standard or the low-binder M2 plant methods or by the standard M3 clothing impregnation chemical set.

5. When HBT, poplin, and sateen impregnated garments are worn for extended periods under hot, humid conditions, marked irritation of the skin occurs in many wearers and appears to be worse when the standard M3 clothing impregnation chemical set is used for impregnation or when protective long underwear is worn.

6. Impregnated clothing is generally more uncomfortable to wear than unimpregnated clothing.

7. After an extended period of wear under hot, humid conditions, all fabrics tested retain their bursting strength and impregnite content to a satisfactory degree.

8. HBT, poplin, and sateen impregnated clothing can be decontaminated satisfactorily at first, second, and third echelon levels.

9. Impregnated clothing can be laundered satisfactorily by the formula given in Change 1, 3 March 1952, to FM 10-16, "Quartermaster Laundry Company, Semimobile."

10. The standard M3 clothing impregnation chemical set can be used satisfactorily to reimpregnate HBT and poplin protective clothing. Although sateen clothing and other reimpregnation processes were not tested, there is no reason to suspect that all types of clothing would not have been satisfactorily reimpregnated at least once.

11. No absolute measure of the protection afforded by any of the ensembles worn in the chamber tests carried out under this project was determined; such data can be determined only by a field evaluation.

12. Comparative evaluation of clothing ensembles worn in chamber tests conducted under this project show:

a. Increased protection is afforded by clothing with protective flaps compared to standard design clothing and is most clearly evident in the reduction of agent penetration at jacket closures; impregnated, long-sleeved undershirts afford equal or greater chest protection.

b. Long protective underwear provides increased protection against BW aerosols compared to knit cotton shorts.

c. M5 ointment and a helmet are unsatisfactory for protection of the head and neck against mustard vapor, since no protection is afforded the scalp; and impregnated or impermeable hood furnishes satisfactory protection.

13. When impregnated HBT and sateen clothing are stored under tropical conditions for more than 6 months, a significant decline in CC2 content of clothing can be expected. Fabric strength retention under tropical conditions of storage is satisfactory.

V. RECOMMENDATIONS:

14. That HBT, poplin, and sateen be considered as suitable for impregnation by the standard M2 plant method, the experimental M2 plant low-binder method, and the standard M3 clothing impregnation chemical set.

15. That, of the methods tested, the standard M2 plant method be considered the most suitable process for the impregnation of HBT, sateen, and poplin.

16. That training publications, particularly TM 3-290, "Individual Protective and Detection Equipment," be changed to reflect the difficulties to be expected, particularly skin irritations, when permeable protective clothing is worn under hot, humid conditions. Recommendations for skin hygiene should be included.

17. That the Assistant Chief Chemical Officer for Planning and Doctrine direct the preparation of coordinated general and technical objectives for comparative field test and evaluation of protection utilizing a significant number of personnel in field test operations. That these objectives be submitted to Dugway Proving Ground for preparation of test plans and implementation of appropriate test projects.

CHEMICAL CORPS BOARD REPORT

ON

PROJECT 828

26 January 1956

I. TITLE:

1. Test of Protective Clothing (U).

II. AUTHORITY:

2. First Indorsement, CMLWO-1, Chief Chemical Officer, 12 June 1951, on letter, CMLEK, Chemical Corps Board, 31 May 1951, subject: "Test of Protective Clothing."

III. OBJECTIVE:

3. To compare poplin, sateen, and herringbone twill (HBT) garments with respect to:

a. Suitability for impregnation by the following methods:

(1) Standard M2 plant method.

(2) Experimental M2 plant low-binder method.

(3) Standard M3 clothing impregnation chemical set.

b. Suitability in actual wearing tests with respect to:

(1) Physiological reactions.

(2) Comfort.

(3) Deterioration of fabric and decline of impregnite content during wear.

(4) Decontamination, laundering, and reimpregnation of garment.

c. Degree of protection afforded by the three types of clothing with the following variations in garment design or ensemble:

(1) Garments with special protective flaps versus standard design garments.

(2) Protective long underwear versus protective knit cotton shorts.

(3) Protective hoods versus M5 ointment on exposed skin area.

d. Storage stability of garments impregnated by the above methods with respect to fabric and impregnite deterioration.

IV. REFERENCES:

4. TDMR 1286, "Report of Engineering Tests on Gas Protective Clothing: Phase I - Camp Blanding Wear Test, July 1945; Phase II - Man Gas Chamber Tests," by [redacted], et al, dated 27 September 1948, subject unclassified, document confidential.

5. Edgewood Proving Ground Report, Test 37-a (828), subject: "Test of Protective Clothing," dated 22 June 1953, subject and document confidential.

6. MLRR 167, CmlC Medical Laboratories, "The Physiological Effects of Permeable Impregnated Clothing on Troops Performing Routine Duties in Tropical Conditions," by [redacted], dated 20 February 1953, subject and document unclassified.

7. Comment Nr 2, CMLRE-ML(TO) (2 June 1953), CmlC Medical Laboratories, subject: "Request for Data on Regular and Special Sateen and HBT Garments," 8 June 1953, with 4 incl, on DF, CMLRE-ED Test 37, Edgewood Proving Ground, subject: "Request for Data on Regular and Special Sateen and HBT Garments," 2 June 1953[1], subject unclassified, document confidential.

8. Camp Detrick Memorandum Report, "BW Evaluation of Protective Suits under Edgewood Proving Ground Test 37," by [redacted], [redacted]rter, and [redacted], dated 8 April 1953[2], subject and document confidential.

1 - Appendix F of reference 4
2 - Appendix E of reference 5

9. Chemical Corps Board Report on Project 830, "Test of Chemical Set, Clothing Impregnation, M3," dated 26 May 1953, subject unclassified, document confidential.

10. Chemical Corps Board Report Nr 3 on Project 740, "Test of Field Methods to Decontaminate Clothing and Fabrics," dated 27 February 1953, subject unclassified, document confidential.

11. Edgewood Proving Ground Report, Test 24-b (740, 4), subject: "Test of Field Methods to Decontaminate Clothing and Fabrics," dated 19 December 1952, subject unclassified, document confidential.

12. MLRR 343, CmlC Medical Laboratories, "Protection Afforded by CC2 Impregnated Sateen Clothing Against Daily Exposures to H Vapor," by [redacted], [redacted], [redacted], [redacted] and [redacted], dated February 1955, subject unclassified, document confidential.

V. BACKGROUND:

13. The principal characteristics and gas-protective capabilities of impregnated HBT clothing were thoroughly studied during and shortly after World War II (reference paragraph 4). Little, if any, testing of protective clothing in wearing trials has been performed since that time. This project was established to collect information on the suitability of poplin and sateen fabrics for use as impregnated clothing and to evaluate a revised aqueous suspension impregnation process in which the normal amount of binder was reduced.

VI. PROCEDURES:

14. User-type tests: Service tests of the three impregnating procedures were conducted, using the 111th Chemical Processing Company at Fort McClellan, Alabama. This station was also the site of a 27-day wearing trial of impregnated clothing, using Chemical Corps troop units, and a test to determine suitability of the impregnating methods for reimpregnation and laundering. These tests are reported in reference paragraphs 5 and 6.

15. Tests of protection afforded by clothing: The protection afforded by various sateen clothing ensembles impregnated by standard M2 plant methods against agents was determined with volunteer human subjects in three types of controlled chamber tests, as follows:

a. Chamber exposure to an aerosol of sodium fluorescein in ethylene glycol.

b. Chamber exposure to an aerosol of B. globigii, a simulant BW agent.

c. Chamber exposure to HD vapor under hot, humid conditions. The above tests are reported in reference paragraphs 7, 8, and 12.

16. Surveillance tests: Storage characteristics of impregnated HBT and sateen clothing, using various storage methods, were determined in a tropical storage chamber at 113°F and 85 percent relative humidity and are reported in reference paragraph 5. The storage methods used were:

a. Clothing stored in E13 gas-resistant sacks.

b. Clothing folded and stacked on a shelf.

c. Clothing unfolded and hung on a clothesline.

Additional long-term surveillance tests are being carried out at Fort Amador, Canal Zone. Both HBT and sateen garments have been stored by stacking neatly folded garments indoors. This storage was begun in April 1953, and to date six tests to determine the CC2 content and fabric strength of the stored garments have been reported. A statistical summary of available data is given in the attached Appendix. The "t" test was used to determine the statistical significance of decline in CC2 content and fabric strength.

17. Clothing: All outer clothing of the three fabric types were two-piece fatigue-type garments supplied by the Office of the Quartermaster General. The protective features incorporated in some of the garments consisted of flaps added to the inside of the clothing to cover the breaks occurring at the front closures of jackets and the fly closures of the trousers. All of the underwear, socks, gloves, hoods, and boots used in this test were current standard types.

18. Methods of impregnation: All impregnations using the standard M2 aqueous suspension method were performed according

to applicable Chemical Corps directives. The experimental low-binder impregnation method was carried out by the same procedures, except that the amount of chlorinated paraffin in the suspension was reduced by one-half. The M3 sets used contained Santomerse 80 as dispersing agent, and the 20-gallon formula originated by Edgewood Proving Ground in Test 35 (see reference paragraph 9) was used.

VII. RESULTS:

19. The following evaluations of test data are made with respect to project objectives:

a. Objective a, the suitability of clothing for impregnation by the various impregnation methods. All clothing and impregnation methods were satisfactory. Some of the clothing impregnated with the M3 set was greenish-black in color and blackened the hands and body on contact. This effect has been noted in previous work (reference paragraph 9), and action was recommended to correct this deficiency.

b. Objective b (1), the suitability of impregnated clothing in respect to physiological reactions during wear. Irritation of the skin of persons wearing clothing, the only important physiological reaction during the Fort McClellan wearing tests, affected 26 percent of the test subjects seriously enough that they were relieved by medical authority of responsibility for completing the wearing period. The fact that the test was conducted during the hottest part of the summer probably contributed considerably to the prevalence of these irritations, and it was known that skin rashes and mild fungus infections of the skin [redacted] (b) (6) [redacted] period. No differences in susceptibility to skin troubles were noted among men wearing the different types of fabrics; however, long underwear contributed significantly to skin reactions, and there was also evidence that men wearing clothing impregnated with the M3 set developed skin rashes more rapidly than others.

c. Objective b (2), comfort of impregnated clothing. All types of impregnated clothing were uncomfortable to wear. The morale and efficiency of troops wearing impregnated uniforms were noticeably affected, according to observers.

d. Objective b (3), deterioration of fabric and decline of impregnite content of clothing during wear. Analysis of samples cut from uniforms periodically during the test showed that all fabric and impregnation method combinations satisfactorily retained their CC2 content and fabric strength (fabric strength was determined by Mullen bursting strength test). The CC2 content of all clothing impregnated by the M2 plant low-binder method and the M3 set declined at a more rapid rate than did that of clothing impregnated by the standard M2 plant methods. This rate was only slightly faster for the M2 plant low-binder method while considerably greater for the M3 set. The results are given in reference paragraph 5.

e. Objective b (4), suitability of the various fabrics for decontamination, laundering, and reimpregnation. All garments were satisfactorily laundered during the tests by following the laundry formula given in Change 1, dated 3 March 1952, to FM 10-16, "Quartermaster Laundry Company, Semimobile," and the poplin and HBT uniforms were satisfactorily reimpregnated using the M3 set. Sateen clothing and the two M2 plant methods were not used in reimpregnation tests at Fort McClellan because the CC2 content of all sateen clothing and all other clothing impregnated by the M2 plant methods did not become low enough to require reimpregnation. Decontaminability was not determined in these tests; however, see paragraph 20 below.

f. Objective c (1), determination of the protection afforded by garments with protective flaps compared to that of standard design garments. Chamber tests with sodium fluorescein and B. globigii as simulant agents showed that the use of flaps on garments produced a marked reduction in the quantity of agent penetrating to the skin. The improvement in protection against mustard vapor gained by flaps was not as marked but was still discernible, especially in the reduction of chest burns caused by vapor penetration of the jacket closure. Detailed results are provided in reference paragraphs 5, 7, 8, and 12.

g. Objective c (2), determination of the protection afforded by protective long underwear compared to that of protective knit cotton shorts. Upon exposure of test subjects to a simulant BW aerosol, long underwear caused a significant reduction in skin contamination density compared to knitted shorts. This reduction was directly related to the larger skin area covered by long underwear. The wearing of long protective undershirts in the mustard vapor exposure test produced a similar effect. The value

of long protective drawers was not determined in this test, however, because all of the test-disqualifying erythema which developed in the subjects first occurred above the waistline except for one subject, who had erythema on his knees. This objective was not resolved in the sodium fluorescein exposure test.

h. Objective c (3), comparison of protection afforded by protective hoods with helmets compared to M5 ointment with helmets on exposed skin areas. In the mustard chamber tests, there were very few cases of erythema on the head or neck of any subject, which fact precluded complete evaluation. However, at the time of discontinuing exposures of men wearing ointment for protection, it was noted that there was considerable redness of the scalp, a condition not noted on other subjects who wore M4 or M1952 hoods (the headdress consisted of steel helmets with liners; impregnated caps were not worn). No evaluation of ointment was attempted in the sodium fluorescein or the B. globigii exposures.

i. Objective d, storage stability of impregnated clothing. Only HBT and sateen were tested. Data obtained from the tropical storage chamber test indicate that the loss in CC2 content of impregnated clothing stored under this condition is practically the same regardless of the method of impregnation used. Also, loss in fabric strength, as determined by the Mullen bursting strength test, was not great enough to render the clothing unserviceable. The method of storage did not significantly influence the fabric strength but did affect the CC2 content, with retention of CC2 decreasing in the following order: (1) storage in E13 sacks; (2) storage of folded, stacked clothing; (3) storage of clothing unfolded and hanging on a line. Detailed results are given in reference paragraph 5. Statistical analysis of surveillance test data collected at Fort Amador, Canal Zone, at 3-month intervals reveals the following:

(1) There was no significant decline in the CC2 content of either fabric during the first 3 months of storage. The decline was significant after the 3-month test for HBT but not until after the 6-month test for sateen.

(2) There was no significant decline in the fabric strength of HBT during the first 6 months of storage; however, the fabric strength of sateen did decline significantly.

Data are not available to bracket to a 3-month interval the time when the decline in fabric strength of sateen became significant.

VIII. DISCUSSION:

20. Although the comparative decontaminability of the three outer-wear fabrics was not tested under this project, decontamination tests were conducted by Edgewood Proving Ground under Chemical Corps Board Project 740. In the first phases of this test, HBT, poplin, and sateen garments were impregnated by the standard M2 plant method or experimental foam process, contaminated with HD, and then decontaminated by boiling water, by special washing formulae in the Quartermaster mobile laundry, and by aeration. It was determined in these tests that there were no adverse effects on fabric strength or shrinkage as a result of the decontamination. Decontamination by boiling lowered the CC2 content of the clothing somewhat more than the other methods, but there were no apparent differences between the three fabrics with respect to retention of CC2 after any method of decontamination. Differences in CC2 reduction caused by various methods of decontamination are considered inconsequential, since reimpregnation will always be required following decontamination. These tests have been fully reported in reference paragraph 10.

21. In the mustard chamber tests, differences in ease of attaining head and neck protection with M5 ointment and the M4 of the M1952 hoods were very much in evidence. Ointment was generally very messy, disagreeable to the men, and required at least 5 minutes for a single application of a satisfactory coating. Both hoods tested, on the other hand, could be donned together with the mask in approximately 30 seconds. There was no clean-up problem when hoods were worn, while men who wore M5 ointment required 5 to 10 minutes to remove the ointment from the skin.

22. An additional undesirable effect of using M5 ointment was its tendency to become smeared accidentally in a variety of undesirable locations on personnel, clothing, and equipment. In particular, the lenses of the M9 mask were frequently clouded with traces of ointment from the fingers during mask adjustment, thus creating interferences with the vision.

23. The chamber tests reported herein indicate that policy on protective clothing for general troop use should be revised to provide for: (a) a hood for protection of the head and the neck; and (b) a flap at the closure of impregnated jackets or an impregnated undershirt to provide protection for the chest. However, this constitutes such a significant change in policy that it could hardly be justified on the basis of chamber tests alone. Furthermore, such action relative to policy change should not be taken without consideration of the requirements for protection against highly toxic percutaneous CW agents.

24. Although chamber tests are useful in making comparative evaluations of the protection afforded by clothing, it is unsound to attempt an extrapolation of such data to field conditions. It is readily apparent that many factors which assume considerable importance in the field are completely eliminated in chamber tests; e. g., local variations in meteorological conditions, vegetation, and terrain. Other factors are limited; e. g., number of test subjects participating and type of activity. It is desirable that test work upon which decisions concerning changes in policy are to be based be conducted under conditions as similar as possible to the anticipated conditions. In evaluating protective clothing, there can be no accurate substitute for a typical environment, a significant number of test subjects, and actual or simulated chemical munitions. At the same time, it must be recognized that suitable field tests are difficult to conduct, because of the many factors which are uncontrollable and the precautions necessary to insure the safety of participating personnel.

IX. CONCLUSIONS:

25. HBT, poplin, and sateen fatigue clothing can be satisfactorily impregnated according to CMLC SIP-M28-1 by either the standard or the low-binder M2 plant methods or by the standard M3 clothing impregnation chemical set.

26. When HBT, poplin, and sateen impregnated garments are worn for extended periods under hot, humid conditions, marked irritation of the skin occurs in many wearers and appears to be worse when the standard M3 clothing impregnation chemical set is used for impregnation or when protective long underwear is worn.

27. Impregnated clothing is generally more uncomfortable to wear than unimpregnated clothing.

28. After an extended period of wear under hot, humid conditions, all fabrics tested retain their bursting strength and impregnite content to a satisfactory degree.

29. HBT, poplin, and sateen impregnated clothing can be decontaminated satisfactorily at first, second, and third echelon levels.

30. Impregnated clothing can be laundered satisfactorily by the formula given in Change 1, 3 March 1952, to FM 10-16, "Quartermaster Laundry Company, Semimobile."

31. The standard M3 clothing impregnation chemical set can be used satisfactorily to reimpregnate HBT and poplin protective clothing. Although sateen clothing and other reimpregnation processes were not tested, there is no reason to suspect that all types of clothing would not have been satisfactorily reimpregnated at least once.

32. No absolute measure of the protection afforded by any of the ensembles worn in the chamber tests carried out under this project was determined; such data can be determined only by a field evaluation.

33. Comparative evaluation of clothing ensembles worn in chamber tests conducted under this project show:

a. Increased protection is afforded by clothing with protective flaps compared to standard design clothing and is most clearly evident in the reduction of agent penetration at jacket closures; impregnated, long-sleeved undershirts afford equal or greater chest protection.

b. Long protective underwear provides increased protection against BW aerosols compared to knit cotton shorts.

c. M5 ointment and a helmet are unsatisfactory for protection of the head and neck against mustard vapor, since no protection is afforded the scalp; and impregnated or impermeable hood furnishes satisfactory protection.

34. When impregnated HBT and sateen clothing are stored under tropical conditions for more than 6 months, a significant

decline in CC2 content of clothing can be expected. Fabric strength retention under tropical conditions of storage is satisfactory.

X. RECOMMENDATIONS:

35. That HBT, poplin, and sateen be considered as suitable for impregnation by the standard M2 plant method, the experimental M2 plant low-binder method, and the standard M3 clothing impregnation chemical set.

36. That, of the methods tested, the standard M2 plant method be considered the most suitable process for the impregnation of HBT, sateen, and poplin.

37. That training publications, particularly TM 3-290, "Individual Protective and Detection Equipment," be changed to reflect the difficulties to be expected, particularly skin irritations, when permeable protective clothing is worn under hot, humid conditions. Recommendations for skin hygiene should be included.

38. That the Assistant Chief Chemical Officer for Planning and Doctrine direct the preparation of coordinated general and technical objectives for comparative field test and evaluation of protection utilizing a significant number of personnel in field test operations. That these objectives be submitted to Dugway Proving Ground for preparation of test plans and implementation of appropriate test projects.

(Cml C Bd Project 828)

APPROVAL RECOMMENDED:

(b) (6)

Colonel, Cml C
Acting President

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Major, CmlC
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APPROVED:

W. R. CURRIE
Brigadier General, USA
Asst CCmlO for Planning & Doctrine

SUBMITTED BY:

(b) (6)

Colonel, Cml C
Director, Basic Studies

EXCEPT THAT IN PARAGRAPH 38 (AND IN PARAGRAPH 17 OF THE ABSTRACT) THE WORDS "CHEMICAL CORPS BOARD TO PREPARE" WILL BE DELETED AND THE FOLLOWING SUBSTITUTED THEREFOR: "PREPARATION OF"

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APPENDIX

STATISTICAL SUMMARY OF TROPICAL SURVEILLANCE DATA

COLLECTED AT FORT AMADOR, CANAL ZONE

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SIGNIFICANCE OF SURVEILLANCE RESULTS

As Determined by "t" Test

Test variable	Fabric	Comparison	t	Approximate percent *	Interpretation of difference
CC2 Content	HBT	0 vs 3 mo	0.83	30	Not significant
		0 vs 6 mo	2.15	3.5	Significant
		0 vs 9 mo	4.06	< 0.1	Highly significant
		0 vs 12 mo	4.27	< 0.1	Highly significant
		0 vs 15 mo	3.38	< 0.1	Highly significant
	Sateen	0 vs 3 mo	1.35	17	Not significant
		0 vs 6 mo	0.49	50	Not significant
		0 vs 9 mo	4.38	< 0.1	Highly significant
		0 vs 12 mo	2.47	1.5	Significant
		0 vs 15 mo	2.76	0.7	Highly significant
Mullen Strength	HBT	0 vs 6 mo	0.76	30	Not significant
		0 vs 9 mo	2.74	0.6	Significant
		0 vs 12 mo	9.85	< 0.1	Highly significant
		0 vs 15 mo	7.67	< 0.1	Highly significant
	Sateen	0 vs 6 mo	3.04	0.1-0.5	Significant
		0 vs 9 mo	3.38	0.1	Significant
		0 vs 12 mo	18.4	< 0.1	Highly significant
		0 vs 15 mo	6.75	0.1	Highly significant

* Percent figures obtained from table of percentage points of the t-distribution, Engineering Agency Manual No. 1, 1 May 1952

AVERAGE CC2 CONTENT AND MULLEN BURSTING STRENGTH
AFTER TROPICAL SURVEILLANCE STORAGE

CC2 Content

Storage period	HBT fabric		Sateen fabric	
	Percent CC2	Percent standard deviation	Percent CC2	Percent standard deviation
Initial	5.59	1.69	6.48	2.45
3 months	5.34	1.82	6.58	2.56
6 months	4.95	1.77	6.69	2.55
9 months	4.49	1.45	4.90	1.69
12 months	4.42	1.49	5.53	2.02
15 months	4.31	1.42	5.46	1.90

Mullen Bursting Strength

Storage period	HBT fabric		Sateen fabric	
	Mullen strength (lb/sq. in.)	Standard deviation (lb/sq. in.)	Mullen strength (lb/sq.in.)	Standard deviation (lb./sq.in.)
Initial	306	30	314	19
3 months	*	-	*	-
6 months	302	31	299	36
9 months	292	30	300	28
12 months	270	24	245	25
15 months	267	31	280	38

* Data were not obtained due to failure of Mullen tester.

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1. President, Chemical Corps Board, Army Chemical Center, Maryland

2. Chief Chemical Officer, Washington 25, D. C.
   ATTN: Asst CCmlO for Planning and Doctrine

3. Commanding General, CmlC Materiel Command,
   Army Chemical Center, Maryland

4. Commanding General, CmlC Research and Development Command,
   Washington 25, D. C.

5. Commanding Officer, CmlC Engineering Command,
   Army Chemical Center, Maryland

6. Commanding Officer, CmlC Field Requirements Group,
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13. Commanding General, Continental Army Command,
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    ATTN: ATDEV

14. President, Board Number 3, Continental Army Command,
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    ATTN: Chemical Officer

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15. Commanding Officer, Naval Unit, Army Chemical Center, Maryland

16. Commandant, Marine Corps, Washington 25, D. C.,
ATTN: Captain E. C. Frey, Room 4132, Arlington Annex, Code CSD

17. British Liaison Officer, Army Chemical Center, Maryland

18. Canadian Army Technical Representative,
Army Chemical Center, Maryland

19. The Surgeon General, Department of the Army,
Washington 25, D. C.

20. The Quartermaster General, Department of the Army,
Washington 25, D. C.

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