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TECHNICAL REPORT
67-89-CM

SEALING OF SEAMS AND HYDROSTATIC TEST REQUIREMENTS IN SPECIFICATIONS

by
Frank H. Babers

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UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

Clothing & Organic Materials Division
C&OM-35

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by

Frank H. Babers
Chief, Rubber, Plastics & Leather Engineering Division

April 1967

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Clothing and Organic Materials Laboratory
U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts 01760

FOREWORD

As used in specifications prepared for procurement by U. S. Government agencies, the term "hydrostatic test" refers to various tests using water under pressure to determine degrees of waterproofness. The requirement for the test has been objected to by a number of contractors over the years.

As a result of those objections, the requirement has been re-examined and re-evaluated. To assist in this evaluation, this report has been prepared to gather together in one place the available data on the requirements.

It is believed that the report will be of interest to R&D personnel who develop requirements for specifications, personnel who prepare the specifications, contracting officers and contractors.

S. J. KENNEDY
Director
Clothing and Organic Materials Laboratory

APPROVED:

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ABSTRACT

Hydrostatic tests are used to determine the degree of waterproofness of water-repellent-treated fabrics, coated fabrics and items made therefrom. Water-repellent-treated fabrics and seams in coated fabrics are usually evaluated by the Suter test which measures the pressure in inches of water, while the continuity of coating in coated fabrics is measured by the Mullen test which utilizes pressures from 20 to 400 pounds per square inch. The specification requirements were adopted, based on numerous laboratory reports and standard commercial practices. Included in the report are lists of specifications using the tests, laboratory reports correlating rainroom tests with laboratory data, and reports from commercial outfits requiring the tests. The validity of the tests is considered to have been established.

SEALING OF SEAMS AND HYDROSTATIC TEST
REQUIREMENTS IN SPECIFICATIONS

I. INTRODUCTION

Manufacturers of waterproof items made from coated fabrics have repeatedly raised objections to the hydrostatic test requirements contained in U. S. Government specifications. Government procurement agencies have been sympathetic to these objections and this document has been prepared to consolidate and summarize the available information and data that relate to the problem. It should be noted that complaints have not been received by Natick Laboratories regarding the test requirement when applied to procurements of uncoated fabric items.

2. DISCUSSION OF TEST METHODS

There are four terms in frequent commercial usage relating to degrees of water resistance: shower resistant; rain resistant; storm resistant; and waterproof. Appropriate hydrostatic test methods for these several degrees of water resistance are described in Federal Specification CCC-T-191, "Textile Test Methods," and ASTM and AATCC publications. A detailed discussion of the hydrostatic tests used in Government specifications with applicable background information is provided as follows:

a. In the past it has been the policy of NLABS Clothing and Organic Materials Laboratory that, because of the time and effort required, the minimal requirements items must meet to give satisfactory service have not been established. When a developed item proves satisfactory in use tests, the specification has been written around the item. In some cases, this may have resulted in items being slightly over-engineered, but it must be remembered that there are no known laboratory tests that can be used to determine field service life and, in order to determine minimal requirements, extensive field tests must be run using items with varying requirements.

b. For uncoated, water-repellent-treated textiles, the Suter hydrostatic test as described in Method 5514 or 5516 of CCC-T-191 is frequently used. In Method 5514, the circular sample area, 4½ inches in diameter, is subjected to a head of water which is increased at the rate of one centimeter per second. The height in centimeters at which water appears through the fabric is determined. When Method 5514 is used, the minimum average values for water-repellent-treated fabrics at which leakage may occur range from 25 to 40 cm, depending on the fabric and treatment method. When Method 5516 is used, the requirements range from a low of "No leakage in ten minutes at eight inches (20.32 cm) fixed hydrostatic pressure" for fabrics under 14 oz/sq yd, to a high value of "No leakage in ten minutes at 20 inches (50.8 cm)" for fabrics over 20 oz/sq yd in weight. A list of textile specifications using Method 5514 or 5516 is shown in Appendix A.

c. In general, where "waterproofness" combined with flexibility is a requirement in an item, coated fabrics are used. Since there is no known method of achieving waterproof seams in coated fabrics by simple stitching, seams are made by sealing electronically, by cementing, or stitching, and when stitched, are then waterproofed by applying several coats, (generally three) of a sealant made by dissolving some of the coating compound in a volatile solvent. Adequacy of sealing is then determined either by the Suter method slightly modified as described in Method 5514 or 5516 of CCC-T-191, or AATCC method 35-52, or by ASTM I, II, or III of D583-63. In these methods, a 4.5-inch diameter circular sample is exposed to a specified head of water for a certain time and any leakage is determined either visually or by weight, depending on the method. U. S. Government specifications use the methods in CCC-T-191. A few Government specifications require cemented seams and test by the Mullen Method 5512. Some commercial concerns also use CCC-T-191 and others require one of the other methods. A list of U.S. Army specifications for coated fabric items using the hydrostatic test to determine adequacy of sealing the seams is given in Appendix B. In the rainwear specifications, leakage is defined as "the appearance of water in three or more spots in the test area." Up to the present, that definition has also been used in the specification for the pouch, human remains (MIL-P-10808). However, in the revision now being prepared, the requirement will be tightened to "no appearance of water in any part of the test area." This more rigid requirement is deemed necessary to assure that no leakage of body fluids will occur during normal use. The requirement of "no appearance of water in any part of the test area" is also used in the specification for the bag, waterproof MIL-B-3108. The bag is primarly used as a carrier for the sleeping bag and any leakage will result in loss of insulative quality in the sleeping bag.

d. Leakage after abrasion of the coating in coated fabrics is also determined by the Suter test. Army specifications requiring the test for this purpose are listed in Appendix C.

e. In general, the Suter method is not considered suitable for determining continuity of coating or water resistance of the coated fabric itself because of the low hydrostatic pressure available. In the Suter method, the applied hydrostatic head applied is measured in inches or centimeters of water. The maximum height normally used indicates a pressure of about 0.7 lb/sq in. The Mullen test as described in Method 5512 of CCC-T-191 is used where higher pressures are needed. In this test the pressures applied range from 20 to about 400 pounds per square inch. Obviously fabrics that have passed a 40 lb/sq in. test would not be expected to fail a 0.7 lb/sq in. test. However, in MIL-C-40039, the specification for the coated fabric used in the poncho, both the Suter and the Mullen tests are required. The Suter method was included because certain poncho manufacturers objected to including the fabric adjoining the seams in the test area of the poncho, their argument being that the

fabric had already passed the Mullen test and leakage in the fabric adjoining the seams was okay so long as the seams did not leak. If leakage does occur in the coated fabric after passing the Mullen test, the most probable reason is considered by NLABS to be the result of poor manufacturing techniques, abrasions, etc. Two coated fabric specifications requiring the Suter test are listed in Appendix D.

f. The Mullen test mentioned above is used in coated fabric specifications to assure compliance with the "continuity of coating requirement." U. S. Army specifications using the Mullen test are listed in Appendix E.

g. The poncho, lightweight with hood, is used in the field for rain protection, a ground cloth, an expedient litter and, on occasion, a foxhole cover, or with another poncho as a tent. To be effective as a ground cloth on wet ground, a waterproof item is deemed to be required. This requirement, as pointed out above, has limited the material used to a coated fabric. Since commercial manufacturing techniques do not produce coated fabrics of sufficient width for a one-piece item and because of the hood, stitched seams have been required to impart strength and these have been cemented. In order to test for adequacy of sealing these seams, since adoption of specification MIL-P-3003, the Suter hydrostatic test has been specified. The original requirement was for 20 cm for one minute by Method 5514 and this was changed to 50 cm for 10 minutes in the "B" revision of the specification dated 1 April 1952. It had been found that three coats of sealant would provide a waterproof seam, and seams so sealed would consistently pass the 50 cm for 10 minutes requirement. Up to this time, the requirement was for "no leakage." At an Industry Advisory Meeting in August 1960, the definition that "Leakage ---- is appearance of water at three different areas in any of the 4½-inch diameter test areas," was agreed upon. This definition was put in the "E" revisions of MIL-P-3003 dated 27 June 1961 and has been continued. Millions of ponchos have been procured under specifications containing the requirements and no Unsatisfactory Equipment Reports regarding leaking seams have been received. One manufacturer objected to the use of "appearance of water" and wished to specify the definite amount of leakage that is permitted (Appendix M).

h. The cost of the hydrostatic test, as regards its use in the specification for the poncho, seems to warrant discussion in view of the objections raised to the test. In MIL-P-3003G, an inspection level of S-2 is required. According to the MIL-STD-105D, this indicates a sample size of eight ponchos in lots varying from 1201 to 35,000 ponchos. Each poncho is tested for leakage in seven locations and the time required for each poncho is about 1½ hours. Thus, for testing the eight samples of each lot, 20 hours would be required. During much of the time, the tester could be doing other duties. Even at $5.00 per hour ($2.50 to $3.00 is considered more realistic) the cost per lot would be

$100.00 or from $0.00286 to $0.083 per end item based on lot size.

Compare this to the seam-sealing operation, again using the poncho as an example. One operator can seal about four ponchos per hour with three coats of sealant. At about $2.00 to $2.50 per hour, this runs the labor cost to about $0.50 per item with an additional cost of about $0.30 for sealant (20 ponchos/gal at $6.00 per gal); this makes the total sealing cost about $0.80 per item. When one considers that the total price per poncho in the more recent procurement is about $6.25, it becomes probable that the objection by the manufacturer is to the necessary quality control during this operation -- not to the hydrostatic test.

i. In the purchase description for the Taupe 179 raincoat, dated 24 January 1956, the hydrostatic requirement was for "no leakage when held 10 minutes at 50 cm head of water." During the production test, it was decided the requirement was too rigid and it was dropped to 25 cm for one minute in the specification MIL-R-14508 dated 18 April 57. In June 1957, because of urgent requirements for raincoats and because, in the opinion of the Military Clothing and Textile Supply Agency, requiring three coats of sealant with adequate drying time for each would slow production and raise the cost, the requirement was reduced from three coats of seam sealant to one coat with the hydrostatic test no longer being required. This change was reflected in MIL-R-14508A dated 27 June 57. The fiasco of the leaking raincoats followed and newspapers all over the country carried headlines "The QM Buys Leaking Raincoats." A modification work order was issued requiring that all seams on the raincoats be strapped and sealed; the raincoat was redesigned, sealed seams were required, and the test reinstated in the Purchase Description (PD) dated April 1959 and continued in PD 10 November 1959, MIL-R-14508B and MIL-R-14508C. The definition (paragraph 2f) for leakage was first used in the April 1959 PD for the raincoat. Since that time no Equipment Improvement Reports indicating leakage at the seams have been received.

j. More recently, IP/DES-S-55-5 dated 3 September 1965 for the jungle hammock M-1965 contained the requirement for sealed seams in the coated fabric canopy to show no leakage in 10 minutes at a 50 cm head of water. During the Production Test, two manufacturers, both inexperienced in handling coated fabrics, stated that the test was "impossible" to meet in production and this position was apparently concurred in by Defense Personnel Support Center (DPSC). Personnel from U.S.Army Natick Laboratories (NLABS) and DPSC visited the plants where very poor sealing techniques were observed. The third Production Test contractor, experienced in handling coated fabrics, consistently met the specification requirements. In any event, the jungle hammock was redesigned and all sealed seams eliminated and this also eliminated the requirement for any hydrostatic test.

3. BASIS FOR TEST REQUIREMENTS

The requirements for hydrostatic testing in Army specifications were adopted based on the following:

a. McQuade and DeMarco in the former Textile, Clothing and Footwear Division of NLABS showed that raincoats with seams sealed with two or more coats of sealant did not leak in the rainroom (Appendix F). The use of water-repellent-treated coated fabrics or water-repellent-treated threads did not prevent leakage at the seams; sealant was still required (Appendix G). Other later tests showed that seams in raincoats passing the hydrostatic test requirements did not leak in the rainroom, and conversely, those that failed usually leaked (Appendix H).

b. Macy's of New York requires that seams of their waterproof garments withstand a hydrostatic pressure of 50 cm for 1 hour using the Suter method (Appendix I).

c. At the Industry Advisory Meeting held at NLABS 11 Aug 1960, the committee members concurred that the Suter requirement of 50 cm for 10 minutes in the poncho specification MIL-P-3003 was valid (Appendix J).

d. The J. C. Penney Company, Inc., also of New York, used the hydrostatic test to determine the waterproofness of their garments, and requirements are that they show no penetration of water after one hour at a head of 50 cm of water (Appendix K).

e. During the production tests of the raincoat and poncho, it was demonstrated that the requirements could be met under production conditions.

f. At the time in question, and until a few years ago, Sears, Roebuck and Company also used the Suter method to determine waterproofness. For a garment to be labeled waterproof, the garment and seams should not leak at a 50 cm head for one hour. However, the company now uses AATCC method 35-52, a simulated rain test, and requires a coated fabric and "penetration not exceeding one gram at a three-foot water level for five minutes." The sample area tested is 6 x 6 inches or 36 inches square. In the Suter, the sample is circular, 4½ inches in diameter or 15.9 sq inches (Appendix L).

4. REQUIREMENTS OF OTHER MILITARY SERVICES

The other U. S. Armed Services also use the hydrostatic tests. The Marine Corps' raincoat specification MIL-R-16402B has a construction requirement similar to that of the Army, i.e., sewn and sealed seams. The seams are then tested by Method 5514 with no leakage at 25 cm for three minutes. The Air Force raincoat specification MIL-R-38213A also uses Method 5514 with a requirement of no leakage at 25 cm for one minute.

On the other hand, the Navy requires cemented seams in the construction of their raincoat (MIL-R-17657A), and the parka, wet weather (MIL-P-82277SA), and overalls, wet weather (MIL-O-22776SA), and the seams in these items are then tested for leakage by the Mullen Method 5512, and must show no leakage at 100 psi.

5. CONCLUSIONS

It is evident that those manufacturers objecting to the hydrostatic test are protesting against the specifications' requirement that "the seams be sealed with three coats of sealant." They claim it is too time-consuming, requires considerable hard labor and a large drying area, resulting in an expensive operation. But since there is no known method of stitching coated fabrics to obtain a waterproof seam without subsequent sealing by some method, it must be concluded that so long as a waterproof seam is required, a test for waterproofness is also required. It is further concluded, on the grounds that over the years no Unsatisfactory Equipment Reports regarding leaking seams have ever been received on items that have met the hydrostatic test requirements, that the validity of the hydrostatic tests has been fully established.

6. SUMMARY

Available information on the problem of the hydrostatic test for waterproofness has been presented. Several test methods have been developed to detect seam leakage. The Mullen and Suter tests are usually used in Government specifications. Techniques and costs of applying seam sealants and hydrostatic testing are discussed.

Rainwear articles passing the hydrostatic test requirements did not leak in the rainroom or in extensive field tests. Conversely, those failing the hydrostatic test frequently leaked in the rainroom. Thus the validity of such tests applied by NLABS as well as many commercial manufacturers has been established.

Other U.S. Armed Services using the hydrostatic tests include the Air Force, Marine Corps, and the Navy. This is indicative of the value of such tests.

APPENDIX A

TEXTILE SPECIFICATIONS USING HYDROSTATIC TESTS TO DETERMINE WATER REPELLENCY

MIL-C-12095D	Cloth, Wind-Resistant Sateen, Cotton, Fire and Water Resistant
MIL-C-557E	Cloth, Wind-Resistant, Sateen, Cotton
MIL-C-332E	Cloth, Balloon, Cotton
MIL-C-003924C (GL)	Cloth, Oxford, Cotton Warp, Nylon Filling, Quarpel Treated
MIL-C-43191	Cloth, Wind-Resistant, Sateen, Cotton and Nylon
MIL-C-484E	Cloth, Wind-Resistant, Oxford, Cotton Quarpel Treated
MIL-C-342E	Cloth, Wind-Resistant, Twill and Poplin, Cotton
CCC-D-950c	Dyeing and After Treating Processes for Cotton Cloths
MIL-C-7219C	Cloth, Duck, Nylon, Parachute Packs
CCC-C-428D	Cloth, Duck, Cotton, Fire, Water, Weather, and Mildew Resistant
MIL-C-41808A	Cloth, Cotton Duck, Fire, Water, Weather, and Mildew Resistant (Special)
MIL-C-43329 (GL)	Cloth, Cotton Duck; Treatments for Fire, Water, Weather and Mildew Resistance
MIL-C-43319 (GL)	Cloth, Cotton Duck, Fire, Water, Weather and Mildew-Resistant Treated, Lightweight Finish, (Government Furnished)
MIL-C-43482 (GL)	Cloth, Poplin, Cotton and Polyester (Quarpel Treated)

APPENDIX B

SPECIFICATIONS PREPARED BY NLABS FOR ITEMS MADE OF COATED FABRICS FOR WHICH THE "SUTER" IS REQUIRED

MIL-B-3108D	Bag, Waterproof, Clothing (25 cm, 1 min) no leakage
MIL-P-10808B	Pouch, Human Remains (50 cm for 10 min) no leakage
MIL-P-3003G	Poncho, Lightweight with Hood (50 cm for 10 min) no leakage
MIL-R-14508	Raincoat, Man's Lightweight, Taupe 179 (25 cm for 1 min) no leakage
MIL-P-703	Parka & Trousers, Wet Weather (25 cm i. 1 min) no leakage

APPENDIX C

SPECIFICATIONS IN WHICH THE SUTER HYDROSTATIC TEST IS USED TO DETERMINE RESISTANCE TO LEAKAGE AFTER ABRASION

MIL-C-10799	Cloth, Coated, Cotton, Vinyl Coated, Fire and Mildew Resistant
MIL-C-20696	Cloth, Coated, Nylon Waterproof

APPENDIX D

COATED FABRICS SPECIFICATIONS REQUIRING THE SUTER TEST TO SHOW RESISTANCE TO WATER PENETRATION

MIL-C-40039	Cloth, Coated Nylon, Vinyl Coated
CCC-C-501	Cloth, Coated, Pyroxylin Coated

APPENDIX E

COATED FABRICS SPECIFICATIONS PREPARED BY NLABS REQUIRING THE "MULLEN" HYDROSTATIC TEST

MIL-C-10797	Cloth, Coated, Glass, Silicone Rubber Coated
MIL-C-10799	Cloth, Coated, Cotton, Vinyl Coated, Fire and Mildew Resistant
MIL-C-12189	Cloth, Coated, Butyl Coated, Toxicological Agents, Protective
MIL-C-14366	Cloth, Coated, Nylon, Polyvinyl Butyral
MIL-C-20696	Cloth, Coated, Nylon Waterproof
MIL-C-40039	Cloth, Coated Nylon Vinyl Coated
MIL-C-43062	Cloth, Coated Cotton, Resin Modified Butyl Coated, Acid and Fuel Resistant
MIL-C-43086	Cloth, Coated, Nylon, Vinyl Coated (for Air-Supported Shelters)
MIL-C-43285	Cloth, Coated (Chloroprene Base Coat Chloro-Sulfonated Polyethyl Top Coated)
MIL-C-43410	Cloth, Coated, Cotton, Vinyl Chloride or Chloroprene Coated
ZZZ-C-450	Cloth, Coated (Rubber and Plastic) and Plastic Sheeting for Hospital Use

APPENDIX F

COPY OF DISPOSITION FORM

QMRE-TT Rain Resistance of Taupe 179, Raincoat Seam

TO: Ch, Chem & Plas Division FROM: Ch, Tex, Clo & Ftwr Division DATE: 7 Aug 57 Cmt 1 CCDeMarco/567

1. References:

a. Material Examination Report TF-127-57 dated 1 May 57.

b. DF from your Office dated 23 May 57, subject as above.

2. Attached herewith as Table I are the results of Rainroom studies conducted on both coated and uncoated seams. The samples used in this test were received under DF of reference b. As requested, the seams were exposed to the rainfall intensities of .1 in/hr and 1.0 in/hr for a maximum period of 6 hours. For the purpose of this specific test a failure was considered to be the first visible evidence of wetting of the backing fabric.

3. In reviewing the values presented, it is apparent that there is a distinct advantage, from a standpoint of rain resistance, in applying a sealant to the seams of the Raincoat, Man's, Lightweight, Taupe 179. Further, although no failures were observed for the seam having one coat of sealant at the 0.1 in/hr intensity, the resistance to rainfall of the seams coated with one layer of sealant is marginal at the higher intensity of 1.0 in/hr. In this regard, it would appear that two coats of sealant would be more desirable. The performance of three coats of sealant at these two intensities was not significantly superior to warrant further consideration.

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Table I

S. J. KENNEDY
Chief
Textile, Clothing & Footwear Division

CCDeMarco

AJMcQuade

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APPENDIX F (Cont'd)

TABLE I

Number of Seam Failures of Raincoat, Man's, Lightweight, Taupe 179
As a Function of Rainroom Exposure Time and Intensity

	Coats of Sealant			
Intensity	0	1	2	3
0.1 in/hr	20 (60 min.) 11 (60 min.) 9 (45 min.)	no failures (360 min.)	no failures (360 min.)	no failures (360 min.)
1.0 in/hr	20 (30 min.) 12 (20 min.) 6 (25 min.) 2 (30 min.)	6 (240 min.) 14 (360 min.) 5 (240 min.) 1 (120 min.)	2 1 (120 min.) 1 (300 min.)	1 (120 min.)

Note: 19 of 20 tests were set at 210 min.

Note: 20 samples were used for each test.

Note: checked at 30 minute intervals

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APPENDIX G

HEADQUARTERS QUARTERMASTER RESEARCH AND ENGINEERING LABORATORIES
CHEMICALS AND PLASTICS DIVISION
NATICK, MASSACHUSETTS

Elastomer Branch Report No. 34

LABORATORY AND RAINROOM EVALUATION OF COATED FABRIC RAINCOATS WITH A WATER-REPELLENT FINISH

by

S. J. Shurtleff

C. F. Macy

Project Reference:
AE-511

March 1960

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FOREWORD

As part of the long range raincoat fabric development program, the potential of water repellent treatments has been considered. One concept concerned the possibility of water repellent treatment of the coated fabric after coating, and of water repellent treatment of the thread, as a means of eliminating the necessity for applying seam sealant to the inside of the finished raincoat. If possible, such an approach would result in cost savings in manufacture and would speed up production effecting additional savings.

This report presents a laboratory and rainroom comparison of coated fabric raincoats, with and without a water repellent finish, sewn with water repellent treated thread.

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SUMMARY

While raincoats with a water repellent finish and no sealant on the seams kept the test subjects dry for a longer period of time than raincoats without a water repellent finish and no sealant on the seams, the test subjects were not effectively protected for the one hour exposure in the rainroom at a simulated rainfall of one inch per hour.

Raincoats with one coat of seam sealant on the seams kept the test subjects dry for a longer period of time than the same raincoat with no sealant on the seams.

Raincoats with one coat of seam sealant, carefully applied, and a water repellent finish protected the test subjects during a one hour exposure in the rainroom, whereas, raincoats with one coat of seam sealant, carefully applied, and no water repellent finish showed a small percentage of seam leakage.

All raincoats with two coats of sealant, carefully applied, showed no seam leakage when exposed in the rainroom for one hour. These raincoats, with a water repellent finish showed slight leakage in the unsealed seam areas, (i.e., collar stand joining seam, pocket-pocket welt joining seam, and button stitching) in only one of 24 raincoats, whereas, raincoats without a water repellent finish showed slight leakage in the unsealed seam areas of 21 of 27 raincoats tested. Test data indicated that raincoats with no water repellent finish but sewn with water repellent treated thread tend to leak more after repeated wettings in the rainroom in these unsealed seam areas.

The water repellent finish causes a change in the shade Taupe 179 and thus offers another variable for consideration when trying to attain a suitable Taupe 179 shade.

MATERIALS

The raincoat material consists of a 1.6 ounce per square yard nylon twill dyed with special nylon dyes to match shade Taupe 179. This fabric is spread coated with polyvinyl butyral to an overall weight of 3.5 ounces per square yard to meet the physical properties specified in MIL-C-14366A (QMC) and Amendment 1. The pigmentation and viscosity of the polyvinyl butyral compound is adjusted to provide a resulting shade of Taupe 179.

One hundred twenty yards of this coated fabric were obtained from each of three different manufacturers currently supplying contractors furnishing the stitched, sealed and strapped raincoat under Specification MIL-R-14508A and Amendment 1. Sixty yards from each lot were retained as untreated controls and 60 yards were water repellent treated with a conventional wax emulsion water repellent treatment by the Textile Functional Finishes Branch, TC&F Division.

The thread used in the fabrication of the raincoat was manufactured to conform to the requirements of Type IA3 of Federal Specification V-T-276 and was treated with pyridinium type of water repellent treatment.

These materials were supplied to one raincoat manufacturer who currently is fabricating raincoats under a MC&TSA production test of the "shirt sleeve" construction specified in Purchase Description dated 1 April 1959.

The materials used and the raincoats manufactured were assigned the following code numbers:

Materials

CF-1-C	Coated Fabric Manufacturer 1 - Control-No water repellent finish
CF-1-WR	Coated Fabric Manufacturer 1 - Water repellent finish
CF-2-C	Coated Fabric Manufacturer 2 - Control-No water repellent finish
CF-2-WR	Coated Fabric Manufacturer 2 - Water repellent finish
CF-3-C	Coated Fabric Manufacturer 3 - Control-No water repellent finish
CF-3-WR	Coated Fabric Manufacturer 3 - Water repellent finish
TR	Water repellent treated thread

Finished Raincoats - (All fabricated by raincoat manufacturer A)

Raincoat	Material
9 each -R-1-C	Coated fabric CF-1-C used
9 each -R-1-WR	Coated fabric CF-1-WR used
9 each -R-2-C	Coated fabric CF-2-C used
9 each -R-2-WR	Coated fabric CF-2-WR used
9 each -R-3-C	Coated fabric CF-3-C used
9 each -R-3-WR	Coated fabric CF-3-WR used

Seam Sealant - ARCCO RF34-85A by the Borden Co.

TEST PROCEDURES

1. The hydrostatic test was performed in accordance with Method 5514 of CCC-T-191 where the hydrostatic head was raised to 25 centimeters and held for one minute. The appearance of water at three different locations in the test area was considered to be a leak. The raincoats were tested in the 10 areas specified in IP/DES-S-113-9.

2. The raincoats were worn by test subjects in the rainroom in a simulated rainfall of one inch per hour for one hour. The test subjects were examined every 15 minutes to determine whether or not the raincoats were leaking. The heads of the test subjects were covered to insure that wet areas appearing were from raincoat leakage and not from water running down their necks.

3. A few initial hydrostatic tests were performed on the raincoats as received initially from the manufacturer. All the raincoats were then tested in the rainroom as specified in par. 2 above. The raincoats were then thoroughly dried and one coat of seam sealant was carefully applied to all the seams specified in IP/DES-S-113-9. The seams of the raincoat were again checked for hydrostatic resistance as specified in IP/DES-S-113-9 and par. 1 above. The raincoats were then retested in the rainroom as specified in par. 2 above. A few of the raincoats were given a second coat of seam sealant after the raincoats were thoroughly dried. The raincoats receiving the second coat of sealant were again tested in the laboratory and rainroom as specified in paragraphs 1 and 2 above.

4. The method utilized in the photometric evaluation of the coated fabric with and without water repellent finish, as reported in Materials Evaluation Report No. 100-0367, dated 3 March 1960 is described in Textile Series Report 101 dated 1959 The equipment used in the evaluation was a General Electric spectrophotometer in conjunction with a librascope tristimulus integrator.

TEST RESULTS

1. Table I expressed rainroom leakage as percent of sealable seam areas leaking on all the test raincoats of one type. There were 23 areas checked on each raincoat. The raincoats were treated with no coats of sealant, one coat of sealant, and two coats of sealant applied to the seams of the raincoat.

2. Table II shows the result of the hydrostatic test as a percent of areas leaking on all the test raincoats of one type. There were 10 test areas on each raincoat. The raincoats tested had no seam sealant, one coat of seam sealant and two coats of seam sealant applied to the seams of the raincoat.

TABLE I

Rainroom Tests

Raincoat	Coats of Sealant	Percent Leakage
R-1-C	0	84.7
R-1-WR	0	56.9
R-2-C	0	37.5
R-2-WR	0	36.1
R-3-C	0	51.4
R-3-WR	0	48.6
R-1-C	1	23.6
R-1-WR	1	1.6
R-2-C	1	0
R-2-WR	1	0
R-3-C	1	6.3
R-3-WR	1	0
R-1-C	2	0
R-1-WR	2	0
R-2-C	2	0
R-2-WR	2	0
R-3-C	2	0
R-3-WR	2	0

TABLE II

Hydrostatic Resistance of Seams

Raincoat	Coats of Sealant	Percent Leakage
R-1-C	0	100
R-1-WR	0	100
R-2-C	0	100
R-2-WR	0	100
R-3-C	0	100
R-3-WR	0	100
R-1-C	1	82.2
R-1-WR	1	55.6
R-2-C	1	35.6
R-2-WR	1	22.9
R-3-C	1	47.8
R-3-WR	1	21.3
R-1-C	2	0
R-1-WR	2	0
R-2-C	2	0
R-2-WR	2	0
R-3-C	2	0
R-3-WR	2	0

3. Table III is a compilation of leakage data noted on the unsealed areas of the raincoats with no water repellent finish. The unsealed areas recorded are the collar stand joining seam and the pocket welt joining seams. Raincoats with no water repellent finish and no sealant on the seams were first tested. The coats were then given one coat of seam sealant and retested. Some of the coats were again retested in the rainroom with leakage areas noted.

TABLE III

Leakages of Unsealed Areas in Raincoat (Repeated Wettings)

Raincoat	One Hour Exposure in Rainroom	Two Hour Exposure in Rainroom	Three Hour Exposure in Rainroom
R-3-C	37.0%	51.9%	85.7%
R-2-C	52.4$	63.0%	88.9%

DISCUSSION

The use of water repellent thread alone in the construction of raincoats is not effective in keeping the wearer dry when subjected to a rainfall of one inch per hour for one hour. While raincoats with a water repellent finish applied to the coated fabric and with water repellent treated thread kept the test subjects dry for a longer period of time than similar raincoats with no water repellent finish on the coated fabric, the wearers were quite wet after the one hour exposure in the rainroom.

A static test of puddling water on a piece of seamed coated fabric is of little value as it does not simulate actual wear conditions. The coat with its seamed areas are flexed when worn thus putting an intermittent strain on the various seamed areas. The strain causes the needle holes to become elliptical in shape so that the thread will no longer fill the hole and water will seep through the seam. All the seams of the raincoat must be sealed to meet the hydrostatic requirements as specified in Purchase Description IP/DES-S-113-9, dated 10 November 1959 in order that the wearer be kept dry.

CONCLUSIONS

1. Water repellent treatment of the coated fabric and thread will not produce waterproof seams in coated fabric raincoats.

2. A minimum of two coats of seam sealant, carefully applied, are necessary to waterproof seams of coated fabric raincoats, whether or not the coated fabric has been water repellent treated.

3. The current specification requirement of "sufficient coats of seam sealant to meet the seam hydrostatic requirement" should not be changed.

4. Water repellent treatment of both the coated fabric and the thread will reduce wicking through seams which cannot be sealed (i.e., collar stand joining seam, pocket-pocket welt joining seams, and button stitching).

5. Water repellent treatment of the thread only will reduce wicking through the seams which cannot be sealed (i.e., collar stand joining seam, pocket-pocket welt joining seams, and button stitching).

6. With repeated wetting, the water repellent treated thread in the collar stand joining seams, the pocket-pocket welt joining seams and the button stitching wet out quicker than originally, indicating a loss of efficiency of the water repellency of the specific thread used due to repeated wetting.

7. A water repellent finish produces a change in color of the coated fabric of from 40 to 60% of that represented by the entire range of tolerances applicable to the taupe raincoat. Color change of this magnitude is large enough to be significant in that should raincoats be procured with a water repellent finish, a new standard and full range of tolerances would have to be established for a water repellent treated coated fabric. (Reference Materials Evaluation No. 100-0367 dated 3 March 1960 from TC&F Division titled "Color Changes Due to Water Repellent Treatment of Experimental Cloth, Nylon, Polyvinyl Butyral Coated, Taupe 179").

RECOMMENDATIONS

1. It is recommended that no change to the current specification for the coated raincoat fabric (MIL-C-14366A QMC) to require water repellent treatment after coating be made for the following reasons:

a. Because of the effect of water repellent treatment on the resulting shade Taupe 179. Under existing contracts difficulty has been

encountered by all coating manufacturers to hold to the shade tolerances established. The addition of a further variable (i.e., water repellent treatment) would aggravate this situation.

b. Because of the low gain in water resistance of the finished raincoats which had been water repellent treated, compared with those coats fabricated from non-water repellent treated coated fabric.

2. It is recommended that no change be made to the current specification for the coated raincoat fabric (MIL-C-14366A QMC) to require water repellent treatment of the nylon base fabric prior to coating. Such treatments are known to have a detrimental effect on the adhesion of the coating to the fabric which would manifest itself in an increase in scuff marks generated during the manufacture of the raincoat.

3. That no action be taken to include water repellent thread in the current raincoat specification (IP/DES-S-113-9 dated 10 November 1959) until the following points can be clarified:

a. The effect of rewetting on the water repellency of the thread or the tendency of the thread to increase in water wicking.

b. The effect on water repellency of oil applied to the thread or to the fabric during sewing of the finished raincoat.

c. Action is taken to change the thread Specification V-T-276 or the seam and stitch type Specification (FED-STD-751) to specifically prohibit oiling of either the thread or the seam area during stitch formation.

Prepared by:

S. J. SHURTLEFF, Chief, Films and Coated Fabrics Section

CHARLES F. MACY, Technologist

Reviewed and Approved by:

JUAN C. MONTERMOSO, Chief
Elastomer Branch,
Chemicals & Plastics Division

APPENDIX H

MEMO REPORT 20 May 1959

SUBJECT: Comparison of Rainroom Tests on Raincoats to Laboratory Evaluation of the Waterproofness of Raincoat Seams

Foreword

In order to obtain a realistic seam requirement and test method for use in the purchase description for Raincoat, Man's Lightweight, Taupe 179, dated 1 April 1959, raincoats were exposed to simulated rainfall of a known intensity and checked for seam leakage. The seams of the raincoat were then evaluated in the laboratory in an attempt to establish a correlation between rainroom tests and evaluation of raincoat seams utilizing laboratory equipment.

This report presents a comparison of the performance of raincoats in a rain test chamber with results obtained on raincoat seams evaluation performed in a laboratory.

Summary

Sixty-eight raincoats were obtained from Manufacturing Division, MC&TSA constructed in accordance with purchase description dated 27 January 1959 and titled, "Raincoat, Man's, Lightweight, Taupe 179". Eight coats were tested as received. The armhole seams were resealed on 60 coats with an additional coat of the same seam sealant as had been previously applied.

Fifty raincoats were obtained from two commercial raincoat manufacturers (25 each) who make a similar stitched and sealed seam coat for commercial sale. The coats were made in accordance with the purchase description dated 1 April 1959 and the seams sealed with the sealant specified in Par. 3.6.6. It was requested that one contractor use a sealant made by one supplier and that the other contractor use a sealant made by another supplier.

The coated fabric utilized in making the raincoat is a cured polyvinyl butyral on a 1.6 oz. nylon twill. The seams were sealed with a minimum of two coats of a polyvinyl butyral seam sealant.

Raincoat seams that meet the hydrostatic test requirement of no leakage when the hydrostatic head is raised to 25 centimeters and held for one minute will not leak when the raincoat is exposed to a rainfall of one inch per hour for one hour.

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Introduction

The primary purpose of the raincoat is a rain shield. Reports from the field indicate that there was some leakage on the raincoat in the shoulder area when the coat was made in accordance with MIL-R-14508A.

The leakage in the armhole area was primarily due to insufficient quantity of seam sealant on the seams, faulty construction of the armhole seams and repaired seam areas that had not been resealed.

The sleeve and armhole of the raincoat were redesigned to a one-piece sleeve utilizing a shirt sleeve type of seam to join the sleeve to the coat. It became necessary to utilize a seam requirement that could be checked in the laboratory to make certain these seams are water tight.

Materials

The following materials were tested during this evaluation:

1. Eight raincoats (Q-1 through Q-8) made by Manufacturing Division, MC&TSA in accordance with purchase description dated 1 April 1959, titled "Raincoat, Man's Lightweight, Taupe 179". The seams on some coats were not adequately sealed (Q-1 and Q-6) and repairs made on other coats resulted in stitch holes which were not sealed (Q-7 and Q-8).

2. At a MC&TSA Meeting on 9 January 1959, it was agreed that sixty raincoats, with no seam sealant, would be made at the MC&TSA factory in accordance with the requirements of IP/Description S-6-9 dated 27 January 1959. In an attempt by the MC&TSA factory to develop seam sealing techniques, two coats of seam sealant were applied to all seams. Hydrostatic tests showed that the two coats of sealant applied by the factory in the armhole area failed to meet the proposed hydrostatic requirement. An additional coat of the same seam sealant was applied to the armhole seams only by QMR&E laboratory personnel inexperienced in seam sealing techniques. Table I gives the results of hydrostatic tests and rainroom tests using live test subjects at a rainfall intensity of 1 inch per hour.

3. Fifty raincoats were purchased, 25 each from two commercial raincoat manufacturers (Blauer Manufacturing Company and Cable Raincoat Company) who make a similar stitched and sealed seam coat for commercial sale. The coats were made in accordance with purchase description dated 1 April 1959 with the seams sealed as specified in Paragraph 3.6.6 of the purchase description. It was requested that one contractor use a sealant supplied by one manufacturer and the other contractor use a sealant supplied by another manufacturer. Table II gives a summary of the results of the rainroom test and the seam hydrostatic test.

Test Procedures

The hydrostatic test was performed in accordance with Method 5514 of CCC-T-191 where the hydrostatic head was raised to 25 centimeters in height and held for one minute. The appearance of water at three different locations in the test area was considered to be a leak.

The raincoats were worn by live test subjects in the rainroom under a simulated rainfall of one inch per hour for one hour. The test subjects were examined every 15 minutes to determine whether or not the raincoats were leaking. The heads of the test subjects were covered to insure that wet areas appearing on the test subjects were from raincoat leakage and not from water running down the neck.

Test Results

The test data of this evaluation are shown in Table I and Table II.

Discussion

An analysis of Table I indicates that raincoats meeting the seam hydrostatic requirement (P-12, P-13, P-15, P-18, P-31, etc.) (hydrostatic head raised to 25 centimeters and held for one minute - Method 5514 of CCC-T-191) will also show no leakage when exposed to a simulated rainfall of one inch per hour for one hour.

Raincoats (P-9, P-10, P-11, P-22, P-23, etc.) showing leakage according to the hydrostatic test did not show leakage when tested in the rainroom indicating that the seam hydrostatic requirement assures a quality of garment slightly in excess of that necessary to produce a raincoat that will remain waterproof when exposed to a rainfall of one inch per hour for one hour. It is considered necessary that raincoats must meet this seam hydrostatic requirement in order for the raincoat to remain waterproof during heavy rainfalls that might be encountered after the garments have been worn for a period of time.

Raincoats (Q-1 through Q-8) completely failing to meet the seam hydrostatic requirement will leak when exposed to a rainfall of 1 inch per hour for one hour thus emphasizing the necessity that all raincoats meet the seam hydrostatic requirement. Raincoats made by manufacturers who make similar commercial raincoats meet the seam hydrostatic test, and give rain protection as the results in Table II indicate.

Conclusions

1. Raincoat, Man's, Lightweight, Taupe 179 meeting the seam hydrostatic requirement specified in purchase description dated 1 April 1959 for subject item will result in a garment with waterproof seams when exposed to heavy rainfall.

2. Raincoat manufacturers who produce commercial raincoats of similar construction (stitched and sealed seams) can produce raincoats that will meet the seam hydrostatic requirements of purchase description dated 1 April 1959.

TABLE I

Cost Number	Hydrostatic Test on Seams				Rainroom Test on Raincoats (Armhole Seams Only)			
	Right Front Armhole	Right Back Armhole	Left Front Armhole	Left Back Armhole	Right Front Armhole	Right Back Armhole	Left Front Armhole	Left Back Armhole
P-9	pass	pass	fail	pass	no leak	no leak	no leak	no leak
P-10	"	"	"	"	"	"	"	"
P-11	"	fail	pass	"	"	"	"	"
P-12	"	pass	"	"	"	"	"	"
P-14	"	"	"	"	"	"	"	"
P-15	"	"	"	"	"	"	"	"
P-18	"	"	"	"	"	"	"	"
P-22	"	"	fail	"	"	"	"	"
P-23	"	"	pass	fail	"	"	"	"
P-25	fail	fail	"	pass	"	"	"	"
P-27	"	pass	"	"	"	"	"	"
P-29	pass	"	"	fail	"	"	"	"
P-31	"	"	"	pass	"	"	"	"
P-36	"	"	"	"	"	"	"	"
P-41	"	"	"	"	"	"	"	"
P-43	"	"	"	"	"	"	"	"
P-45	"	"	"	"	"	"	"	"
P-46	"	"	"	"	"	"	"	"
P-48	"	"	"	"	"	"	"	"
P-49	"	"	"	"	"	"	"	"
P-51	"	"	"	"	"	"	"	"
P-54	"	"	"	fail	"	"	"	"
Q-1	fail	fail	fail	"	"	fail	"	fail
Q-2	"	"	"	"	fail	"	fail	"
Q-3	"	"	"	pass	"	"	"	"
Q-4	"	"	"	fail	no leak	"	no leak	"
Q-5	"	pass	"	pass	fail	fail	fail	"
Q-6	"	fail	"	fa[illegible]	"	"	"	"
Q-7	"	"	"	"	"	"	"	"
Q-8	"	"	"	"	"	"	"	"

TABLE II

Coat Number	Hydrostatic Test on Seams: Right Front Armhole	Hydrostatic Test on Seams: Left Front Armhole	Rainroom Test on Raincoats (Armhole Seams Only): Right Front Armhole	Right Back Armhole	Left Front Armhole	Left Back Armhole
B-18	pass	pass	no leak	no leak	no leak	no leak
B-17	"	"	no leak	no leak	no leak	no leak
B-22-	"	"	"	"	"	"
B-7	"	"	"	fail	"	fail
B-16	"	"	"	no leak	"	no leak
B-21	"	"	"	"	"	"
B-19	"	"	"	"	"	"
B-10	"	"	"	"	"	"
B-24	"	"	"	fail*	"	"
B-6	"	"	"	no leak	"	"
B-20	"	"	"	"	"	"
B-23	"	"	"	"	"	"
B-4	"	"	"	"	"	"
B-9	"	"	"	"	"	"
B-5	"	"	"	"	"	"
C-18	"	"	"	"	"	"
C-14	"	"	"	"	"	"
C-31	"	"	"	"	"	"
C-32	"	"	"	"	"	"
C-19	"	"	"	"	"	"
C-16	"	"	"	"	"	"
C-20	"	"	"	"	"	"
C-17	"	"	"	"	"	"
C-51	"	"	"	"	"	"
C-15	"	"	"	"	"	"

* Small leak confined to an area 1" in diameter or less.

APPENDIX I

MACY'S

New York

Executive Offices Herald Square, New York 1, N.Y.

March 15, 1963

Mr. Stanley J. Shurtleff
C. & O. M. Division
U.S. Army
Natick, Massachusetts

Dear Mr. Shurtleff:

This is in reply to your inquiry of this date regarding Macy's specifications for water resistance of seams of water proof garments such as those made of rubber, rubberized or other coated fabrics, or of plastic.

Macy's specifications require that the seams withstand a hydrostatic pressure of fifty (50) centimeters for a period of one hour when tested by the methods set forth in AATCC Standard Test Method 18-1961, using the suter hydrostatic pressure tester.

If you desire any further information, please do not hesitate to contact me.

Cordially yours,

Ephraim Freedman
Director, Macy's Bureau of Standards
Management Councillor

EF:jw

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APPENDIX J

AMXRE-CRP 30 September 1966

MEMORANDUM FOR RECORD

SUBJECT: Hydrostatic Resistance Requirements in Coated Fabric Specifications and in End Item Specifications which call for Coated Fabrics in their Fabrication

1. On 24 February 1956 an industry advisory committee meeting on coated fabrics was held at Philadelphia Quartermaster Depot. In summary, the verbatim minutes show that this was a review of the detailed requirements in Specification MIL-P-3003C and on page 19 the chairman, Dr. Oesterling, asked for detailed comments on the Mullen Hydrostatic Tests and the following comments evolved:

Mr. Davis, duPont Company: "The procedure was straight forward and we have no question about the procedure, and we haven't been coating poncho and therefore I have no comment on the values set up by the specification". Dr. Oesterling: "Do you use this particular test in any of your work?" Mr. Davis: "Yes". Mr. Thompson, Standard Coated Products, had no question concerning the test method, but has some question about the values or at least how you get them. Mr. Hedges, Columbus Coated Fabrics; "There is nothing wrong with the test procedure at all." Mr. Martin, Aldan Rubber Company: "In our lab we have run the Mullen as it is written." Mr. Haas, Hodgman Rubber Company: "That's true with us too." Mr. Lund, Crawford Manufacturing Company" "The test method is acceptable to us." Mr. Beaver, Electro Plastics: "The method itself is a very simple straight-forward method. I can see no improvement on it so to speak." Mr. Russell, Pantasote: "I agree with the method, the method is all right." The comment on hydrostatic testing runs from that page to approximately page 32 with the concensus of opinion of the industry advisory committee that the hydrostatic testing as measured by the Mullen at 40 psi is a realistic figure.

2. With reference to seam hydrostatic testing, an industry advisory committee meeting on coated fabric rainwear was held in August 1960 at Natick and summary minutes of this meeting show that the meeting was held to review Specification MIL-P-3003D and specifically, the construction and water resistance requirements of the finished poncho. Page 14 of this summary indicates a concurrence of the major industry advisory committee members in the Suter hydrostatic test and a recommendation that the same Suter test requirement be added to the base fabric specification.

FRANK H. BABERS
Chief, Rubber, Plastics & Leather
Engineering Branch
Clothing & Organic Materials Division

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APPENDIX K

J. C. PENNEY COMPANY, INC.
330 West 34th Street, New York 1, N. Y.

April 11, 1963

Mr. Stanley J. Shurtless
C. & D. M. Division
U. S. Armay Natick Laboratory
Natick, Mass.

Dear Mr. Shirtless:

Sometime ago, I'm ashamed to think how long ago it really was, I promised to drop you a note regarding the Penney Laboratory requirements for waterproofness of fabrics and garments. In the turmoil of the retail laboratory existance I somehow managed to lose your address in my files and only recently discovered it with the shocking realization that I had not as yet fulfilled my promise. Please accept my apology. It certainly wasn't intentional.

Directly following our telephone conversation I discussed the matter with Mr. P. J. Fynn, Director of our Laboratory, and he agreed that what I had told you on the phone was essentially correct. We use hydrostatic pressure tests for determining waterproofness of fabrics and of garments and our requirements are that the fabrics show no penetration after an hour under pressure of 50 centimeters.

We have had some criticism of our requirements from various suppliers. Particularly those people who are promoting so-called breathable waterproof fabrics. However, we take the position that since we did have waterproof fabrics that passed this test with no difficulty, that it really isn't fair to classify other fabrics that don't pass these requirements as waterproof materials.

If I can be of any further assistance in this matter, don't hesitate to call on me, and I assure you that my response will not be delayed again.

Very truly yours,

J. C. PENNEY COMPANY, INC.

EJS:gea

E. J. Stavrakas
Laboratory Manager-Soft Goods

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APPENDIX L

Staff Offices

SEARS, ROEBUCK AND CO. Chicago 7, Illinois

925 S. Homan Avenue
Department 817

March 15, 1963

Mr. Stanley Shurtleff
C and OM Division
Quartermaster Research and Development Center,
U. S. Army
Natick, Massachusetts

Dear Mr. Shurtleff:

Enclosed are copies of the Sears Standards for Water Resistance of Wearing Apparel. As I had mentioned in our phone conversation, one is the old standard including the Suter Hydrostatic Tester for waterproof claim and the other is the revised standard.

I hope these will be of some use to you.

Very truly yours,

SEARS, ROEBUCK AND COMPANY

J. Bejda
Textile Testing Laboratory

JB:mg
Enc.

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1. SCOPE

1.1 This standard applies to outerwear apparel and to two classes of fabrics for such apparel.

(1) Air permeable fabrics - such as poplin, gabardine.

(2) Air impermeable materials including coated and laminated fabrics as well as plastic film and sheeting.

2. TERMINOLOGY

2.1 The following promotional terms may be used to describe apparel and apparel fabrics, when the merchandise so described conforms to the standards outlined in accompanying chart.

(1) Resistant to Non-oily Stains or Water Repellent Treated.

(2) Shower Resistant or Good Water Resistance.

(3) Rain Resistant or Better Water Resistance.

(4) Storm Resistant or *Superior Water Resistance.

(5) Waterproof

2.2 "Durable" as a qualifying adjective may be used in conjunction with any of the terms listed above (except waterproof) if the item conforms to requirements stated in par. 4.2.

3. TEST METHODS

3.1 Water Resistance: The following test methods are used in evaluating apparel and fabrics for apparel for conformance to claims for water resistance:

(1) Spray Test A.A.T.C.C. 22-52 Standard Test Method for Resistance to Wetting.

(2) Impact Penetration A.A.T.C.C. 42-52 Tentative Test Method for Resistance to Penetration.

*Note: The qualifying adjective used is "superior" rather than "best" because fabrics of higher water resistance are possible.

3.1 Water Resistance (Cont'd)

(3) Rain Test A.A.T.C.C. 35-52 Standard Test Method for Resistance to Penetration.

(4) Hydrostatic Pressure Test - A.S.T.M. D-583-52T Method No. 1 par 21 to 23 with a head of 50 centimeters held for one hour.

3.2 For durability of the finish, the following methods are used for washing and dry cleaning.

(1) Durability to Washing

(1) Cotton, linen and all washfast fabrics - Use Sears Test Procedure TP-1-18 - Shrinkage of Woven Cotton and Linen fabrics. Repeat the washing cycle twice for total of 3 times. Be sure to rinse thoroughly.

(2) Other fabrics Use A.A.T.C.C. 40-52 Dimensional Changes of Fabrics other than Cotton or Linen. Repeat twice for a total of 3 times. Be sure to rinse thoroughly.

(2) Durability to Dry Cleaning

Use method described in Sears Test Procedure TP-1-59 par 4.1 to 4.3. This method is presumed to be equivalent to three dry cleanings.

4. STANDARDS FOR EVALUATION

4.1 Fabrics and combination of fabrics shall be evaluated using the accompanying chart.

4.2 Use of the term "durable" as a qualifying adjective: The term "durable" may be used with any of the promotional terms listed in the chart (except waterproof) if the fabric or combination of fabrics, in addition to meeting the requirements in the original state, meets the following requirements after being subjected to the washing or dry cleaning procedure listed above. (It should be clearly stated whether the finish is durable to washing or dry cleaning or both).

For unlined garments: The outer fabric must have a spray rating (A.A.T.C.C. 22-52) of at least 70 after dry cleaning or washing.

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For lined garments

(1) The outer fabric must have a spray rating (A.A.T.C.C. 22-52) of at least 70 after dry cleaning or washing.

(2) The combination of the outer fabric and the lining must meet the same requirements (listed in accompanying chart) in the water penetration tests as they did in the original state.

Prepared by L. P. Erick 1/14/54
Revised by J. Dressal 4/6/56

Sears Roebuck & Co., Dept. 817
Merchandise Testing and Development Laboratory
Textile Division

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Chart I

STANLARDS FOR EVALUATION

Promotional Term	Resistant to Non-oily Stains or Water Repellent Treated	Shower Resistant or Good Water Resistance	Rain Resistant or Better Water Resistance	Storm Resistant or Superior Water Resistance	Waterproof
Test Designation					
1. Resistance to wetting minimum rating	A.A.T.C.C. 22-52 (Spray test) 80	A.A.T.C.C. 22-52 (Spray test) 80	A.A.T.C.C. 22-52 (Spray test) 80	A.A.T.C.C. 22-52 (Spray test) 80	This promotional term is limited to material having discernible water resistant barrier as opposed to the conventional water repellent treatment
2. Resistance to water penetration	No test required	A.A.T.C.C. 42-52 (impact penetration test)	A.A.T.C.C. 35-52 (Rain test)	A.A.T.C.C. 35-52 (Rain test)	
minimum rating		Penetration not exceeding 1 gm.	Penetration not exceeding 1 gm. at a 2 ft. water level for 1 min.	Penetration not exceeding 1 gm. at a 3 ft. water level for 5 min.	Same requirements as Storm Resistance in addition where machine washing or drycleaning applies the material must meet requirements in para 4.2
Type of apparel term is applicable	Dresses, skirts, slacks, suits, scarves, etc.	Rainwear and snow wear	Rainwear and snow wear	Rainwear and snow wear	Rainwear and snow wear

NOTE 1: In all cases where the garment is lined, the Resistance to Water Penetration tests are done on the combination of the outer fabric and the lining. Resistance to wetting tests should be done on both the lining and the outer fabric. Minimum rating is based on outer fabric only.

NOTE 2: In case of "storm resistant" and "waterproof", the water penetration tests should be done on a seamed area also. Crucial seams, such as shoulder, armseye and center back should meet the minimum requirements to merit a claim. In snow wear leg seams shall also meet this requirement.

Sears Standard for Water Resistance of Wearing Apparel (Including rain and snow wear) and of fabrics for apparel

1. SCOPE

1.1 This standard applies to outerwear apparel and to two classes of fabrics for such apparel.

(1) Air permeable fabrics - such as poplin, gabardine.

(2) Air impermeable materials including coated and laminated fabrics as well as plastic film and sheeting.

2. TERMINOLOGY

2.1 The following promotional terms may be used to describe apparel and apparel fabrics, when the merchandise as described conforms to the standards outlined in accompanying chart.

(1) Resistant to Non-oily Stains or Water Repellent Treated.

(2) Shower Resistant or Good Water Resistance.

(3) Rain Resistant or Better Water Resistance.

(4) Storm Resistant or *Superior Water Resistance.

(5) Water proof.

2.2 "Durable" as a qualifying adjective may be used in conjunction with any of the terms listed above (except waterproof) if the item conforms to requirements stated in par. 4.2. On Waterproof apparel fabrics where machine washing or drycleaning applies the requirements outlined in paragraph 4.2 are a part of the standards for this promotional term.

3. TEST METHODS

3.1 Water Resistance: The following test methods are used in evaluating apparel and fabrics for apparel for conformance to claims for water resistance:

(1) Spray Test A.A.T.C.C. 22-52 Standard Test Method for Resistance to Wetting.

*Note: The qualifying adjective used is "superior" rather than "best" because fabrics of higher water resistance are possible.

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3.1 Water Resistance (Cont'd)

(2) Impact Penetration A.A.T.C.C. 42-52 Tentative Test Method for Resistance to Penetration.

(3) Rain Test A.A.T.C.C 35-52 Standard Test Method for Resistance to Penetration.

3.2 For durability of the finish, the following methods are used for washing and dry cleaning.

(1) Durability to washing

(1) Cotton, linen and all washfast fabrics -
Use Sears Test Procedure TP-1-18 - Shrinkage of Woven Cotton and Linen Fabrics. Repeat the washing cycle twice for total of 3 times. Be sure to rinse thoroughly.

(2) Other fabrics -
Use A.A.T.C.C. 40-52 Dimensional Changes of Fabrics other than Cotton or Linen. Repeat twice for a total of 3 times. Be sure to rinse thoroughly.

(2) Durability to Dry Cleaning

Use A.A.T.C.C. 86-1957T - Durability of applied Designs and Finishes.

4. STANDARDS FOR EVALUATION

4.1 Fabrics and combination of fabrics shall be evaluated using the accompanying chart.

4.2 Use of the term "durable" as a qualifying adjective: The term "durable" may be used with any of the promotional terms listed in the chart if the fabric or combination of fabrics, in addition to meeting the requirements in the original state, meets the following requirements after being subjected to the washing or dry cleaning procedure listed above. (It should be clearly stated whether the finish is durable to washing or dry cleaning or both).

For unlined garments: The outer fabric must have a spray rating (A.A.T.C.C. 22-52) of at least 70 after dry cleaning or washing.

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For lined garments

(1) The outer fabric must have a spray rating (A.A.T.C.C. 22-52) of at least 70 after dry cleaning or washing.

(2) The combination of the outer fabric and the lining must meet the same requirements (listed in accompanying chart) in the water penetration tests as they did in the original state.

Prepared by L. P. Erick 1/14/54
Revised by J. Dressal 4/6/56
Revised by J. Bejda 4/17/62

Sears Roebuck and Co., Dept. 817
Merchandise Testing and Development Laboratory
Textile Division

mg

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Chart I

STANDARDS FOR EVALUATION

Promotional Term	Resistant to Non-oily Stains or Water Repellent Treated	Shower Resistant or Good Water Resistance	Rain Resistant or Better Water Resistance	Storm Resistant or Superior Water Resistance	Waterproof
Test Designation					
1. Resistance to wetting minimum rating	A.A.T.C.C. 22-52 (Spray test) 80	A.A.T.C.C. 22-52 (Spray test) 80	A.A.T.C.C. 22-52 (Spray test) 80	A.A.T.C.C. 22-52 (Spray test) 80	No test required
2. Resistance to water penetration minimum rating	No test required	A.A.T.C.C. 42-52 (impact penetration test) Penetration not exceeding 1 gm.	A.A.T.C.C. 35-52 (Rain test) Penetration not exceeding 1 gm. at a 2 ft water level for 1 min.	A.A.T.C.C. 35-52 (Rain test) Penetration not exceeding 1 gm. at a 3 ft water level for 5 min.	ASTM D583-52T (Hydrostatic pressure test) Penetration none or slight after 1 hour with 50 cm head
Type of apparel is applicable	Dresses, skirts, slacks, suits, scarves, etc.	Rainwear and snow wear	Rainwear and snow wear	Rainwear and snow wear	Rainwear (rubber coated, vinyl or other material not air permeable)

Note 1: In all cases where the garment is lined, the Resistance to Water Penetration tests are done on the combination of the outer fabric and the lining. Resistance to wetting tests should be done on both the lining and the outer fabric. Minimum rating is based on outer fabric only.

Note 2: In case of "storm resistant" and "waterproof", the water penetration tests should be done on a seamed area also. Crucial seams, such as shoulders, armseye and center back should meet the minimum requirements to merit a claim. In snow wear leg seams shall also meet this requirement.

APPENDIX M

ELECTRO PLASTIC FABRICS, INC.

- - - - - - - - - - - - - - Vinyl Coated Fabrics - - - - - - - - - - - - - -

Industrial Protective Clothing and Covers

64 First Street, N. E.
Pulaski, Virginia

December 2, 1966

Mr. H. J. McIsaac
U. S. Army
Natick Laboratories
Natick, Massachusetts

RE: AMXRE-CSS/NDP

Gentlemen:

In reply to your letter of November 1 concerning proposed revision of poncho specification MIL-P-3003H, we have reviewed the proposed changes and believe they are realistic.

We note, however, you have not made any changes in the Hydrostatic testing procedure and requirements. In our opinion, the procedure and requirements as now written are unrealistic and should be changed. We believe that the present concept of permitting one or two or three leaks in the given test area is wrong. We believe that in place of this you should place a maximum value metric requirement on the water permitted to pass through the tested seam area. Obviously, under the present requirement, a seam area could have one leak and virtually pass a stream of water through and not be scored as rejectionable, whereas if it had five minute seepages it would be scored as objectionable. I think it follows that from the standpoint of serviceability the seam that permitted the passage of one large stream of water as opposed to five very small seepages, is less desirable, however, under the present interpretation it is the acceptable one. We, therefore, recommend that you incorporate a value metric requirement; in other words, that the water, if any, that passes through the test area be collected and if it exceeds a specific specified amount, it is rejectionable, and if it does not, it is not rejectionable.

Very truly yours,

ELECTRO PLASTIC FABRICS, INC.

Richard Beaver
President

RB/ew

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Natick
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U. S. Army Natick Laboratories
Natick
Massachusetts 01760

13. ABSTRACT

Hydrostatic tests are used to determine the degree of waterproofness of water-repellent-treated fabrics, coated fabrics and items made therefrom. Water-repellent-treated fabrics and seams in coated fabrics are usually evaluated by the Suter test which measures the pressure in inches of water, while the continuity of coating in coated fabrics is measured by the Mullen test which utilizes pressures from 20 to 400 pounds per square inch. The specification requirements were adopted, based on numerous laboratory reports and standard commercial practices. Included in the report are lists of specifications using the tests, laboratory reports correlating rainroom tests with laboratory data, and reports from commercial outfits requiring the tests. The validity of the tests is considered to have been established.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Evaluation	8		8			
Validity	8					
Hydrostatic tests	8,9		10			
Fabrics	9		9			
Coatings	9		9			
Seams	9		9			
Sealing compounds	9		9			
Specifications	4		4			
Military requirements	4		4			
Moistureproofing			8,9			

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