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USATECOM PROJECT NO. 6-6-3300-04

ENGINEERING TEST OF CLOTHING SYSTEM (SUMMER UNIFORM) FOR ARMY AVIATION CREW MEMBERS.

FINAL REPORT,

BY

DONALD G. MERCER
SCIENTIFIC AND ENGINEERING

DECEMBER 1968

73 p.

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U S ARMY
GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

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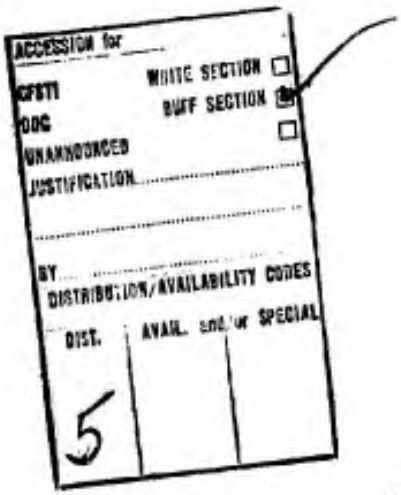


DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-BG

21 MAR 1969

SUBJECT: Reports of Engineering Test, Service Test, and Tropic Service Test, Clothing System (Summer Uniform) for Army Aviation Crewmembers, USATECOM Project Nos. 4-6-5300-03/04/05

Commanding General
U. S. Army Materiel Command
ATTN: AMCRD-JI
Washington, D. C. 20315

1. References:

a. Final Report, Tropic Service Test of Clothing System (Summer Uniform) for Army Aviation Crewmembers, dated January 1969, USATECOM Project No. 4-6-5300-03. (Inclosure 1)

b. Final Report, Engineering Test of Clothing System (Summer Uniform) for Army Aviation Crewmembers, dated December 1968, USATECOM Project No. 4-6-5300-04. (Inclosure 2)

c. Final Report, Temperate Service Test of Clothing System (Summer Uniform) for Army Aviation Crewmembers, dated November 1968, USATECOM Project No. 4-6-5300-05. (Inclosure 3)

d. Department of the Army (DA) Approved Small Development Requirement (SDR) for Clothing System for Army Aviation Crewmembers, dated 5 April 1967.

e. Technical Characteristics for Clothing System for Army Aviation Crewmembers, dated April 1966.

2. Subject reports are approved by this headquarters, except as noted herein.

3. Background of Tests:

a. The test item consisted of shirt, trousers, and belts. The shirt and trousers were each made from two layers of polyamide fabric,

each layer having a weight of 4.4 ounces per square yard. One belt was made of cotton, treated with a fire retardant chemical. The other belt was made of polyamide fabric. All remaining garments of the summer uniform were standard Army issue. A jacket, which is considered a part of the summer and winter uniform, was not available for test. It will be evaluated at a later date. Gloves were originally considered a test item; however, since they were type classified Standard A shortly after the test began, they have been dropped from the test item listing. Derogatory test results concerning the gloves were brought to the attention of the developer previously and product improvement tests are currently in progress at the U. S. Army Aviation Test Board.

b. Testing was conducted simultaneously by the U. S. Army Aviation Test Board (ATB), the U. S. Army Tropic Test Center (TTC), and the U. S. Army General Equipment Test Activity (GETA). Other agencies which participated in the tests, in support of the Aviation Test Board service test, were U. S. Army Aviation School, U. S. Army Board for Aviation Accident Research, and U. S. Army Aeromedical Research Unit. All testing was conducted during the period April 1968 through October 1968.

c. During the Tropic service test at TTC (reference 1a) ambient temperatures ranged from 66°F to 100°F and the relative humidity ranged from 64 percent to 100 percent. During the service test at ATB (reference 1c) temperatures ranged from an average low of 64°F to an average high of 88°F. Relative humidity averaged 73 percent.

d. Primary criteria used were the approved Small Development Requirement (SDR), reference 1d, and the approved Technical Characteristics (TC's), reference 1e. In addition, the TTC compared the test item with the standard U. S. Air Force flight suit, and GETA compared the test item with the standard U. S. Army field uniform worn by ground soldiers. ATB evaluated the test item against the criteria documents of reference 1d and 1e only. Included in the ATB report, reference 1c, is a comparative heat stress evaluation of the test item and the standard Air Force flight suit, conducted by the U. S. Army Aeromedical Research Unit.

e. A total of 87 test uniforms was provided to TECOM for testing. ATB evaluated 40 sets and TTC evaluated 35 sets. GETA conducted

engineering tests on the remaining 12 uniforms. Testing of the uniform by TTC was accomplished in Army O-1A, U-1A, U-8, U-21A, UH-1, OH-13, and OH-23 aircraft. Testing of the uniform by ATB was accomplished in Army OV-1, U-6, U-8, U-9, U-21, UH-1, AH-1G, OH-6A, OH-13, CH-34, and CH-47 aircraft.

4. The test item met all the requirements of the Small Development Requirement and the Technical Characteristics except as noted below:

a. The test uniform was considered unacceptable by test subjects because of the excessive heat build-up, poor ventilation characteristics, interference in breathing, excessive bulk, and poor perspiration absorption/evaporation characteristics. (service test, tropic service test)

b. Design features for adjusting sleeve cuffs were inadequate and caused interference with AH-1G helicopter cockpit controls (engineering and service test reports). TTC reported that sleeve cuff adjustments were adequate; however, AH-1G helicopter was not available to test participants at TTC.

c. The test clothing generated a static charge (service test). However, engineering test results indicated test item met surface resistivity requirement of the Technical Characteristics.

d. Pockets on the upper portion of the uniform were not the required slash-type and were not accessible in flight without loosening the parachute harness and/or shoulder harness. (service test)

e. There were no provisions for safe (one-hand) ventilation adjustment while in flight (service test). Tropic service test report stated test item met this requirement. However, the only means to ventilate the uniform was to unzip the front shirt and this is considered unsafe in a fire situation.

f. Upper portion of the uniform separated from the lower portion and the trouser legs separated from the boot tops exposing the skin to fire hazards.

g. Shirt pockets were difficult to open and close with one hand while wearing gloves (service test, tropic service test).

h. Grease and oil stains were not easily removed (service test, tropic service test).

i. The test uniform did not display the required order of light-fastness (tropic service test, engineering test).

5. The following deficiencies were found:

a. The uniform was too hot, too bulky and had inadequate perspiration absorption and evaporation characteristics. Also, the ventilation characteristics were unacceptable. Test results and analysis concerning this deficiency are as follows:

(1) Tropic Test Center reported that 33% of test subjects stated they had difficulty breathing. Also, 87% of test subjects said the uniform was inadequate in protection from heat build-up. Heat build-up was believed caused by insufficient evaporation of body perspiration resulting in retention of body heat. Compared to the standard Air Force flight suit, 93% of test subjects considered the Air Force flight suit equal or better than the test uniform with respect to heat build-up. All test subjects preferred the Air Force flight suit over the test uniform with respect to ventilation. With respect to bulk, 76% of test subjects considered the uniform excessively bulky.

(2) Aviation Test Board reported that 91% of test participants considered the test uniform too hot for summer wear, too bulky and heavy when soaked with perspiration. Also, test participants complained that perspiration remained on the inner layer of the uniform and that the evaporation rate was inadequate.

(3) U. S. Army Board for Aviation Accident Research reported (flight surgeon) that the test uniform was excessively warm on the ground and during hovering flight. This contributed to fatigue and excessive sweating with attendant body water loss (reference 1c, page 3-V-5).

(4) U. S. Army Aeromedical Research Unit reported that there is probably a significantly greater heat stress on the individual wearing the test uniform as compared with the same individual wearing the standard Air Force flight suit. The basis for their conclusion was the results of their heat stress comparative test, page 3-V-9 of reference 1c.

(5) General Equipment Test Activity test data of Tables 1, 2, and 3 of reference 1b provides a clue to the heat problem of the test uniform. Engineering test shows that the technical characteristics of polyamide fabric is equal to or superior to cotton fabric in the areas of air permeability and vapor transmission, but that it was inferior in the area of vapor absorption.

b. Fly zipper construction was unsatisfactory. Approximately one-half of test participants reported zipper separations from the fly seam.

c. Zipper flaps constantly caught in the zippers when closed with one hand.

d. Design features for adjusting sleeve cuffs were inadequate.

e. Upper portion of the uniform separated from the lower portion and trouser legs separated from boot tops resulting in an unsafe condition during a fire situation.

f. Shirt pockets were not slash-type as required by the SDR and were not accessible in flight without loosening the parachute harness and shoulder harness.

g. The polyamide belt, because of its color and type buckle, did not conform to basic uniform of the ground soldier.

h. Thigh pockets were difficult to open and close with one hand.

i. Shirt pockets were difficult to button and unbutton while wearing gloves.

6. The following shortcomings of the test uniform were noted:

a. Grease and oil stains were not easily removed. This was reported as a deficiency by the Aviation Test Board and a shortcoming by the Tropic Test Center. While retention of grease and oil stains is definitely undesirable, it is not considered serious enough to be a deficiency.

b. The uniform generates an offensive odor when wet. This was reported as a deficiency by the Aviation Test Board; however, the

Tropic Test Center reported that the odor was no more offensive than the odor of the standard Air Force flight suit when wet.

c. Uniforms generated an electrostatic charge. Aviation Test Board reported this as a deficiency. General Equipment Test Activity found the uniforms to meet the technical characteristics with respect to surface resistivity. In view of GETA's findings, this is reclassified as a shortcoming.

d. Location and angle of attachment of the left sleeve pocket were awkward in appearance and use.

e. Shirt pocket buttons were not adequately fastened to the shirt.

f. The uniform did not display a high order of color fastness. This was reported as a deficiency by the TTC since they found the test uniform to fade much faster than the Air Force flight suit. GETA found the test uniform to exhibit less color change due to laundering than the standard ground soldier's uniform. In view of GETA's findings, the color fastness deficiency is reclassified as a shortcoming.

g. The uniform had a high infrared reflectance value and was considered subject to detection by infrared detection devices. GETA found the polyamide fabric to exhibit a much greater infrared reflectance than the standard uniform of the ground soldier.

h. Personnel may develop rashes as a result of wearing the uniform. ATB reported this as a deficiency since 17% of their participants experienced rashes. TTC did not experience rashes. Due to lack of detailed medical reports on the severity of the ATB rashes and the absence of rash experience in the harsher environment of the Tropic, this item is reclassified as a shortcoming.

7. The maintenance package and instructions which accompanied the test uniform were adequate. The test uniform did not require maintenance in excess of that required by the standard Air Force flight suit. Repairs were accomplished by test participants.

8. Significant good features of the test uniform are:

a. The polyamide fabric of the test uniform is inherently fire retardant. This characteristic remains for the life or the material

regardless of washing, etc. Air Force flight suit is treated with a fire retardant chemical which washes out in time. The fatigue uniform of the ground soldier is not fire retardant.

b. With the exception of zipper failures, the test uniform is more durable than the cotton fatigue uniform of the ground soldier.

c. The test uniform is generally equal in appearance and basic design to fatigue uniform of the ground soldier. Air Force flight suit does not meet this requirement of the SDR.

9. Results of Value Analysis are discussed as follows:

a. ATB reports that the suspender attaching loops of the test uniform are unnecessary (reference 1c).

b. TTC reports that the double lining in the back of trousers and shirt is unnecessary. This is not a valid conclusion. The double layer uniform is required to meet the crash fire protection requirements of the SDR.

10. This headquarters concludes that the test uniform is unsuitable for Army use.

11. This headquarters recommends:

a. That the deficiencies cited in paragraph 5 above be corrected.

b. That all shortcomings cited in paragraph 6 above be corrected if technically and economically feasible.

c. That check tests be conducted by this command following correction of deficiencies and shortcomings.

FOR THE COMMANDER:

3 Incls
as (dupe)

WILLIAM H. HUBBARD
Colonel, GS
Deputy Chief of Staff

AMSTE-BG

SUBJECT: Reports of Engineering Test, Service Test, and Tropic Service Test, Clothing System (Summer Uniform) for Army Aviation Crewmembers, USATTCOM Project Nos. 4-6-5300-03/04/05

Cy Furn: (w/incls)
CG USAMC, AMCSU,
AMCMA, AMCMI, AMCPP,
AMCQA, AMCAD-S, AMCPO-LSE (1 cy ea)
CG USA Natick Labs, AMXRE-CEE (5 cy)
USACDC LnO, USATECOM (12 cy)

RDT&E PROJECT NO. 1M643303D547

USATECOM PROJECT NO. 4-6-5300-04

ENGINEERING TEST OF CLOTHING SYSTEM (SUMMER UNIFORM) FOR ARMY AVIATION CREW MEMBERS

TEST REPORT

BY

SP4 DONALD G. MERCER
SCIENTIFIC AND ENGINEERING
Engineering Test Division

DECEMBER 1968

U. S. ARMY
GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

U. S. ARMY GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

USATECOM 4-6-5300-04

Final Report of Engineering Test of Clothing System (Summer Uniform) for Army Aviation Crew Members

Conducted at Fort Lee, Virginia

December 1968

Abstract

An Engineering Test of Clothing System (Summer Uniform) for Army Aviation Crew Members was conducted during the period of 10 June - 15 November 1968 to determine the technical performance and safety characteristics as described in the SDR, the Technical Characteristics, and as indicated by the particular design, and to determine the technical and maintenance suitability of the uniform for service test.

It was concluded that: the summer uniform, as described in the report, meets the operational requirements to a degree sufficient to warrant service testing.

It was recommended that: the sleeve fastener be altered to allow a snug fit; the patch-type sleeve pocket zipper be replaced with a velcro fastener alleviating the accessibility problem; serious consideration be given to failure of material to exhibit a high degree of light fastness not only to the resultant color change, but also to the extreme loss of strength before the uniform is approved for issue.

FOREWORD

The U.S. Army General Equipment Test Activity was responsible for preparing the test plan, conducting the test, and preparing the final test report. Fort Lee, Virginia, was utilized as the test site.

The test was authorized by letter, AMSTE-BG, Headquarters, U. S. Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland, 8 November 1967, subject: "Test Directive, Engineering and Service Tests of Clothing System (Summer Uniform) for Army Aviation Crewmembers."

TABLE OF CONTENTS

SECTION 1. INTRODUCTION

1.1 BACKGROUND

Since World War II, U. S. Army Aviation crew members have worn flying suits of U. S. Air Force or Navy origin. These aviator flying suits are restrictive, bulky, and cumbersome. The Army Concept Team in Vietnam has declared these suits unsatisfactory with respect to functional suitability and appearance.

The SDR for the subject clothing describes a uniform which will have superior fire protection features in addition to being similar in appearance to the uniform of the ground soldier. The uniform, with the exception of head gear, flight gloves, etc., will be worn by aviation crew members while performing ground functions.

The Army Concept Team in Vietnam has conducted two separate clothing evaluations in connection with the development phase of a clothing system which will meet the SDR.

The SDR requires both summer and winter uniforms to provide year round environmental protection in the aircraft or on the ground. This test will involve only the summer uniform. The winter uniform will be tested when it becomes available. The transitional jacket will be tested with winter uniforms.

1.2 DESCRIPTION OF MATERIEL

The summer uniform consists of shirt, trouser, gloves, belt, and transitional jacket along with the standard Army issue footwear, headwear, and undergarments.

a. The shirts and trousers are made from two layers of Nomex (polyamide) fabric 4.4 ounces, OG 106, which will protect against high intensity flash or flame.

b. The glove is a four finger and thumb gauntlet style, long enough to protect the wrist and lower forearm. The back of the glove and the back of fingers and thumb is made from 9.10 ounces, simplex knitted fire resistant Nomex fabric. The palm and front of the fingers and thumb will be made from sheep hair leather.

c. The standard tropical, combat uniform consists of shirt and trousers and is made from cotton WRS Poplin OG 107 fabric.

1.3 TEST OBJECTIVE

To determine the technical performance and safety characteristics of the summer uniform for aviation crew members as described in the SDR, the Technical Characteristics, and as indicated by the particular design, and to determine the technical and maintenance suitability of the uniform for service test.

1.4 SUMMARY OF RESULTS

a. The functional summer uniform for aviation crew members was furnished in the normal combat clothing tariff of sizes which can adequately fit at least the 5th to 95th percentile. When properly fitted, the wearer presents a military appearance which is similar to the standard tropical combat uniform.

b. The uniform is compatible with standard footwear, headgear, and other head and face protective devices now under development. It is further compatible with the existing CBR protective items.

c. The aviation crew members uniform met all requirements of the SDR except:

(1) The uniform design did not comply with the SDR in the following ways (shortcomings).

(a) The sleeve cuffs of the basic garment could not be adjusted to a snug fit.

(b) Patch-type pockets located on the sleeves are not accessible because of poor zipper design.

(2) The uniform does not display a high order of light fastness.

(3) The polyamide belt, because of color, did not conform to the basic uniform of the ground soldier.

(4) The fly-zipper is not adequate.

(5) The material has a significantly higher infrared reflectance value than a standard uniform.

1.5 CONCLUSIONS

The summer uniform, as described herein, meets the operational requirements to a degree sufficient to warrant service testing.

1.6 RECOMMENDATIONS

a. The sleeve fastener be altered to allow a snug fit.

b. The patch-type sleeve pocket zipper be replaced by velcro fastener alleviating the accessibility problem.

c. Serious consideration be given to failure of material to exhibit a high degree of light fastness not only to the resultant color change, but also to the extreme loss of strength. Every effort should be made to improve this characteristic before the uniform is approved for issue.

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

The scope of the individual subtests included laboratory tests and studies to determine the extent to which the test item met the requirements set forth in the Technical Characteristics. The standard tropical combat uniform was used as a standard of comparison when applicable.

2.2 INSPECTION AND IDENTIFICATION

2.2.1 Objective

To code mark each individual test item, standard and experimental, for identification throughout the test, and to assure that no obvious defects are present in items subjected to test.

2.2.2 Criteria

a. Each individual test item will be identified.

b. Test items with apparent defects will not be subjected to test.

2.2.3 Method

Each of the experimental and standard test items submitted were closely inspected for visible or functional defects and immediately marked with indelible code letters and/or numbers for identification. Items judged defective were to be removed from the test.

2.2.4 Results

a. Close visual inspection of the aviation crew members uniforms/ gloves, and belts revealed no defects in materials or workmanship that would invalidate test results.

b. Each uniform was measured in accordance with Appendix I-A. Appendices I-B and I-C present the data obtained in chart form and by plot.

2.2.5 Analysis

a. There were no defects in material or workmanship that would invalidate the test results.

b. It is concluded that all uniforms are properly labeled by size.

2.3 WEIGHT

2.3.1 Objective

To determine the average weight of the experimental uniforms.

2.3.2 Criteria

TC paragraph C4 - "(Essential) This clothing system must be constructed of material which is compatible in appearance, color, and basic function with the combat uniform issued to the ground combat soldier. Any changes to the combat soldier's uniform such as Lightweight Individual Combat Clothing and Equipment (LINCLOE) occurring during development of this clothing system must be considered."

2.3.3 Method

The 30 uniforms were weighed to the nearest ounce before use.

2.3.4 Results

a. Appendices I-C and I-D present the data in chart form and by plot.

b. The fabric weight is 9.0 oz/sq yd compared to the standard 5.8 oz/sq yd.

2.3.5 Analysis

The experimental uniform is considered to have met the weight (oz/sq yd) requirement.

2.4 DESIGN FEATURES - INSPECTION

2.4.1 Objectives

a. To determine if the exterior of the outer garments is free of design features which may be a safety hazard.

b. To determine if provisions for adjusting the sleeve cuffs are acceptable.

2.4.2 Criteria

a. TC paragraph C2 - "(Essential) The exterior of these garments shall be free of design features which may catch or snag on objects, control

or switches in the aircraft, thereby hindering emergency exit, normal egress, or safe operation of the aircraft."

b. TC paragraph C6a - "(Essential) provisions, without the use of buttons, to adjust sleeve cuffs of the basic garment and jacket for a snug fit."

2.4.3 Method

a. Each of the experimental uniforms was visually inspected to determine if there were any undesirable design features such as gaping front closure, loose-fitting cuff, open shoulder strap, or open exposed pocket.

b. Actual adjustments were made and inspected visually.

2.4.4 Results

a. Close visual inspection revealed that the provisions for adjusting the sleeve cuff were inadequate. See Appendix II-A, Figures 1 and 2.

b. The patch-type pocket or sleeve is not easily accessible due to poor zipper construction. See Appendix II-B, Figures 1 and 2.

2.4.5 Analysis

The uniform is considered to have met the SDR design requirements with the exceptions noted.

2.5 UNIFORM SIZING, FITTING, AND COMPATIBILITY

2.5.1 Objective

To determine the sizing and fitting characteristics of the test uniform.

2.5.2 Criteria

The tariff sizes of uniform available for issue should satisfactorily fit the 5th and 95th percentile anthropomentric group.

2.5.3 Method

a. Approximately 200 enlisted personnel were made available from transit holding units at the U. S. Army Quartermaster Center, Fort Lee, Virginia. These participants were required to undress, to their

summer underwear and socks, and process through a series of measuring stations to obtain their following anthropometric dimensions: weight, height, chest, waist, sleeve, hip, and inseam. All measurements were taken as defined in TM 700-8400-1, Fitting of Uniforms, except sleeve length, for which Natick Laboratories most current "two-fisted-touch" method was substituted. Sleeve and inseam measurements were made on the right limbs.

b. Based on these measurements and size prediction chart contained in Appendix I-E, an initial try-on size uniform was issued to and donned by each participant. Adequacy of fit was evaluated by project leader.

c. The summer uniform was judged, in the majority of instances, when simply worn as the outer garment over summer underwear with leg cuffs over leather boot tops. To assess compatibility, participants were randomly chosen to don, in addition to the test uniforms, one of the following systems:

Jungle: Boot, Combat, Tropical 8430-889-3585/3600
Hat, Jungle with Head Net 8415-935-2888/2892

Combat: Armor, Body, Frag. Prot. (product improvement type)
Armor, Body, Frag. Prot. (T61-5 comp. w/titanium plates)

CB: Clothing Outfit, Chem. Prot. 8415-782-3240/3244
Mask, Protective M-17 4240-542-4450/4452
Hood, Gas Mask, M-4 8415-281-2558

Work: Cap, Utility, OG-106 8405-082-5743/5749
Gloves, Sheep, Leather 8415-269-5700/5702

d. All participants were required, in addition to standing erect, to perform the following movements while wearing the uniform:

(1) Hands and arms extended to the sides.

(2) Hands and arms extended overhead.

(3) Hands and arms forward with full knee bend.

(4) Hands and arms forward, touch toes.

(5) Don and doff fitted uniform, while booted.

In addition each participant was questioned on their feeling of comfort, freedom of movement, and fit. Their comments plus those of the project leader were recorded.

2.5.4 Results

a. The data presented in Appendices I-F and I-G shows the averages and ranges of the body measurements of the men fitted by each uniform size. Of the 200 men completing the study 196 (98 %) were satisfactorily fitted in the available clothing sizes. All of the participants not fitted satisfactorily did not fall within the 5th to 95th percentile group.

b. The uniform when fitted in proper size is adequately comfortable from neck to crotch. The uniform provides its wearer with freedom of movement.

c. Figure 1, Appendix II-C shows a soldier attired in the test uniform and tropical combat boots and hat plus head net. Compatibility is adequate.

d. Figure 2, Appendix II-C shows a soldier dressed in the armored vest. The compatibility is adequate.

e. Figures 3 and 4, Appendix II-C show a soldier dressed in the CB protective liner system under the test uniform.

f. The polyamide zipper tape unraveled and ripped out at the seam because the tape selvage was not properly bound. This problem was noted during sizing and fitting after the uniforms were tried on 15 times in case #1 and 20 times in case #2. See Appendix II-D.

2.5.5 Analysis

a. The aviation crew members uniform is available in tariff sizes for issue that will satisfactorily fit the 5th to 95th percentile group.

b. The aviation crew members uniform is compatible with the required accessory items.

2.6 FLAMMABILITY

2.6.1 Objective

To determine if all components of the experimental uniform will provide for protection from high intensity flash or flame for 10 second's duration.

2.6.2 Criteria

TC paragraph C1 - "(Essential) All components must be fire retardant to a degree which will provide for protection from high intensity flash or flame for 10 seconds duration. The degree of protection must last for the life of the garment."

2.6.3 Method

a. Five new samples were tested by Method 5903 CCC-191b. The five samples were retested after 20 non-worn laundering cycles by the same method. Also, samples which had been exposed to sunlight for [illegible] days were tested by the same method.

b. Five new samples experimental and standard uniforms were tested for resistance to thermal transmission and burn due to contact with high heat fuels of MOGAS, Napalm, and yellow phosphorous. Dual recorders yielded instantaneous temperature variations picked up by thermocouples placed above the sample (in the fuel) and below the sample (for thermal transmission). Maximum fuel temperature and the time required for a 12.6°F rise in fuel temperature and in thermal transmission through the sample was noted.

c. Reference Summary Report, "Effectiveness of Aviation Garments in Protecting Against Gasoline Fires." U. S. Army Natick Laboratories, Natick, Massachusetts.

2.6.4 Results

a. Uniforms.

Three two-way analyses of variance were conducted to test flaming time, glow time and char length. In all three cases the standard uniform had significantly higher readings. There was no significant difference* in the readings after laundering. The data collected are shown in Appendix I-H, Table 2.

b. Gloves.

Three one-way analyses of variance were conducted to test flaming time, glow time, and char length. No significant difference is evident between the flaming properties of the Nomex and Leather. The data collected are shown in Appendix I-H, Table 2.

*This statement and all other significance statements are significant at 95% level.

c. Belts.

Three one-way analyses of variance were conducted to test the flaming time, glow time and char length. In all three cases the standard belt had significantly higher flaming properties than either of the two experimental types. There was no significant difference between the two experimental belts. The data collected are shown in Appendix I-H, Table 2.

d. The experimental fabric consistently revealed a greater resistance to thermal transmission than the standard uniform. The data collected are shown in Appendix I H, Table 1.

e. Reference Summary Report, "Effectiveness of Aviation Garments in Protecting Against Gasoline Fires, " U.S. Army Natick Laboratories, Natick, Massachusetts.

f. Summary of exposure data is shown in Appendix I-H, Table 7.

2.6.5 Analysis

a. The experimental uniform has superior fire retardant characteristics, when tested against the standard cotton uniform.

b. The experimental gloves have excellent fire retardant characteristics with no significant difference between the Nomex and leather.

c. The experimental cotton belt and Nomex belt have superior fire retardant characteristics when tested against the standard cotton belt. No significant difference between the two experimental belts is noted.

2.7 THERMAL PROTECTION

2.7.1 Objective

To determine if the uniforms will have the capability of providing protection to test animals to 10 cals/cms^2 of high intensity radiant energy applied in 1.0 second.

2.7.2 Criteria

TC paragraph C1 - "(Essential) The material will, when tested for high intensity radiant energy on the solar furnace, have the capability of providing protection to test animals to 10 cals/cms^2 of high intensity radiant energy applied in 1.0 second.

2.7.3 Method

Input data will be obtained from NLABS, based on prior tests or from samples of the subject test item submitted.

2.7.4 Results

This subtest has not been completed. A subsequent report will be issued when this information is available.

2.8 COLOR AND APPEARANCE

2.8.1 Objective

To determine if clothing system is compatible in color and appearance with combat uniform.

2.8.2 Criteria

TC paragraph C4 - "(Essential) This clothing system must be constructed of material which is compatible in appearance, color and basic function with the combat uniform issued to the ground combat soldier. Any changes to the combat soldiers uniform such as Lightweight Individual Combat Clothing and Equipment (LINCLOE) occurring during the development of this clothing system must be considered."

2.8.3 Method

Two experimental uniforms and five control uniforms were subjected to the following test:

a. Colorfastness to perspiration according to FTM CCC-T-191b 5680.1.

b. Infrared Reflectance using a Beckman DK2A Spectrophotometer.

c. Color difference between original standard and experimental Air Crewmen Uniforms was measured according to ASTM D2244 utilizing the Gardner (Hunter) Color Difference Meter, Model AC-2A. Variation from original lightness and chromaticity values was noted after 5, 10, 15, and 20 launderings, after crocking, after 120 days natural weather exposure, and after xenon-arc light and weathering exposure (as performed according to ASTM E240-64T and E239-64T, utilizing the Atlas Weatherometer, Model 60X-WRC).

2.8.4 Results

a. The experimental uniforms exhibited noticeably less color change due to laundering than standard uniforms. A small degree of color loss due to crocking was evidenced by both sets of uniforms. A comparable degree of color loss was noted in both the standard and experimental items due to light and weather exposure, though the experimental samples showed a significant color change upon visual observation. This phenomenon was due to the nature of the chromaticity changes noted. The standard uniform (in Xenon light exposure) showed a 7% increase in lightness and a 41% loss of yellow reflectance with relatively little variation in green reflectance. Therefore, the resulting hue was merely a bluer green tint of the original color. The experimental uniforms revealed a comparable 7% increase in lightness and 37% loss in yellow reflectance, but also exhibited a 94% loss in green reflectance, resulting in a more readily identifiable hue change due to increased red reflectance. See photo, Appendix II-E.

b. In both the standard and experimental samples there was no perceptible color change in the fabric due to perspiration.

c. A two-way analysis of variance was conducted, showing significantly higher percent infrared reflectance for the experimental uniform. See Appendix I-H, Table 3.

2.8.5 Analysis

a. There is a color change in the experimental fabric due to poor light/fastness. However, the basic color OG106 and resultant color meet camouflage requirements.

b. The infrared reflectance is greater than in the standard uniform. Therefore, the experimental uniform can be distinguished from the standard uniform by infrared detection devices.

2.9 FABRIC STRENGTH AND DURABILITY

2.9.1 Objective

To determine the fabric strength and durability characteristics of the experimental uniform.

2.9.2 Criteria

TC paragraph C4 - "(Essential) This clothing system must be constructed of material which is compatible in color, appearance, and basic function with combat uniform issued to the ground combat soldier.

2.9.3 Method

Test	Equipment	Method	Testing Sequence
Abrasion Test	(STOLL)	ASTM D1175	New and 5, 10, 15, 20 launderings
Breaking Strength	(INSTRON)	CCC-T-191b Method 5100	New, 20 cycles 120-day exposures
Tearing Strength	(INSTRON)		New, 20 cycles
Fungus Resistance		Mixed Spores	New, 20 cycles

All launderings were completed as prescribed in Appendix I-I.

2.9.4 Results

a. Abrasion: See Appendix I-H, Table 4.

b. Breaking Strength: See Appendix I-H, Table 5 and Graph 1.

c. Tearing Strength: See Appendix I-H, Table 6.

d. Fungus Resistance: The experimental uniform showed no apparent loss in strength and elongation due to fungus growth, even in samples which had been laundered 20 times previous to innoculation. The standard uniform, however, revealed a 24% loss and 64% loss in strength in the original and 20 laundered samples respectively.

2.9.5 Analysis

a. Abrasion Test: The experimental uniform (double-layer) exhibits significantly higher abrasion resistance than the standard uniform in the original and after 20 launderings.

b. Breaking Strength:

(1) The experimental uniform has a significantly higher breaking strength initially and after 20 launderings than the standard uniform.

(2) The experimental Nomex fabric when exposed for 120 days in natural sunlight shows a significant loss of strength.

c. Tear: The experimental uniforms exhibit a significantly higher resistance to tear than the standard uniform.

d. Fungus Resistance: The experimental uniforms reveal no significant deterioration when tested for fungus resistance.

2.10 ENVIRONMENTAL PROTECTION

2.10.1 Objective

To determine if the experimental uniform affords the necessary environmental protection and is compatible with the basic function of the combat uniform.

2.10.2 Criteria

TC paragraph C4 - "(Essential) This clothing system must be constructed of material which is compatible in appearance, color and basic function with the combat uniform issued to the ground combat soldier."

2.10.3 Method

Five new experimental uniforms and five control uniforms were tested by the following methods:

a. Air permeability using Method 5450 CCC-T-191b.

b. Water vapor transmission using FTM UU-P-31b Method 182: Vapor transmission was denoted by recording the time (sec) required for a 1% change in RH above the sample due to permeability from a 100°F water reservoir below the sample.

c. Absorption using AATCC 70A-196T method.

2.10.4 Results

a. Air permeability: See Results, Appendix I-J, Table 1.

b. Water absorption: See Appendix I-J, Table 2.

c. Water Vapor Transmission: See Appendix I-J, Table 3.

2.10.5 Analysis

a. Air permeability: A two-way analysis of variance was conducted, showing the experimental uniform significantly more permeable than the standard uniform.

b. Water absorption: The standard uniform has a significantly higher water absorption than the experimental uniform.

c. No discernable change in MVT was noted in the experimental uniform due to laundering. A high degree of water permeability was exhibited in all instances.

2.11 SHRINKAGE

2.11.1 Objective

To determine the shrinkage characteristics of the experimental uniform.

2.11.2 Criteria

Material will not shrink more than 2% when tested by Method 5550 of CCC-T-191b.

2.11.3 Method

Five new experimental uniforms were marked and liner measurements made after laundering.

2.11.4 Results

For summary of percent shrinkage for Aviation Crewmen's Uniform, see Appendix I-J, Table 4.

2.11.5 Analysis

The shrinkage in the warp direction is slightly greater than specified by test criterion. Though the shrinkage is greater than specified, an engineering judgment based on knowledge of other fabrics, allows the conclusion that shrinkage is within a tolerable limit.

2.12 STATIC ELECTRICITY

2.12.1 Objective

To determine that the test clothing will not generate a static charge and the resistivity at a temperature not exceeding 32°F and a relative humidity below 40 percent shall not be higher than 1.0×10^{10} ohms per square inch.

2.12.2 Criteria

TC paragraph C4 - "(Essential) The clothing will not generate a static charge. Resistivity at a temperature not exceeding 32°F and a

relative humidity below 40 percent shall not be higher than 1.0×10^{10} ohms per square inch.

2.12.3 Method

The AA TCC test method 76-1904.

2.12.4 Results

See Appendix I-K.

2.12.5 Analysis

Although the antistatic compound tends to wash out of the fabric, the uniform still meets the static electricity requirement.

2.13 VALUE ANALYSIS

2.13.1 Objective

To determine if the experimental uniform has any unecessary, costly, or nice-to-have features which may be eliminated without adversely affecting the essential performance requirements, reliability, quality, and safety (USATECOM Reg. 700-1).

2.13.2 Criteria

Judgment of qualified supervisory personnel.

2.13.3 Method

Examination of the test item and observance of the performance of the test item relative to value improvement and features which may be eliminated.

2.13.4 Results

All the features were judged to be necessary.

2.13.5 Analysis

The experimental uniform does not have any unnecessary or nice-to-have features which could be eliminated.

2.14 SAFETY

2.14.1 Objective

To determine if any safety hazard exists in the use of the experimental uniform.

2.14.2 Criteria

The use of the test item will impose no unusual or pertinent safety hazard.

2.14.3 Method

Observations will be made of the performance of all activities involving the use of the test item to detect any present or potential hazards.

2.14.4 Results

Observations indicated that there were no safety hazards incorporated into the test uniform.

2.14.5 Analysis

The uniform is not considered to be a safety hazard.

SECTION 3. APPENDICES

APPENDIX I - TEST DATA

- A Diagram of Uniform Measurements
- B Summer Uniform Measurements
- C Summer Uniform Measurements
- D Weight of Summer Uniform
- E Anthropometric/Size Conversion Table
- F Body Measurements by Fitted Uniform Size
- G Graph of Body Measurements by Fitted Uniform Size
- H Materials Analysis Data
- I Laundry Method
- J Environmental Data
- K Surface Resistivity Data

APPENDIX II - PHOTOGRAPHS

- A Uniform Closure Devices
- B Sleeve Pocket
- C Compatibility
- D Trousers Zipper Failure
- E Color Difference

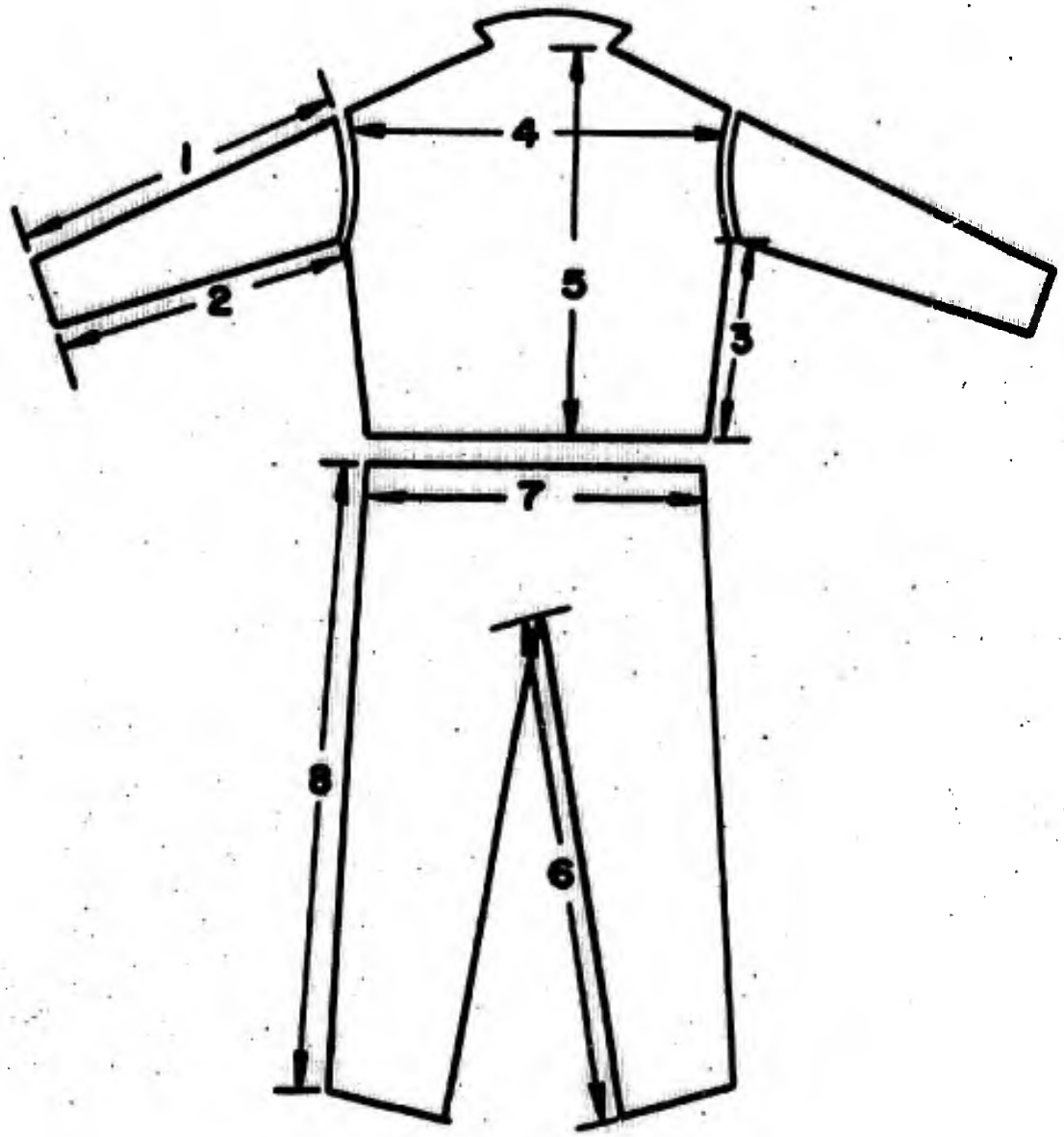
APPENDIX III - FINDINGS

APPENDIX IV - DEFICIENCIES AND SHORTCOMINGS

APPENDIX V - REFERENCES

APPENDIX VI - DISTRIBUTION LIST

APPENDIX I-A
DIAGRAM OF UNIFORM MEASUREMENTS



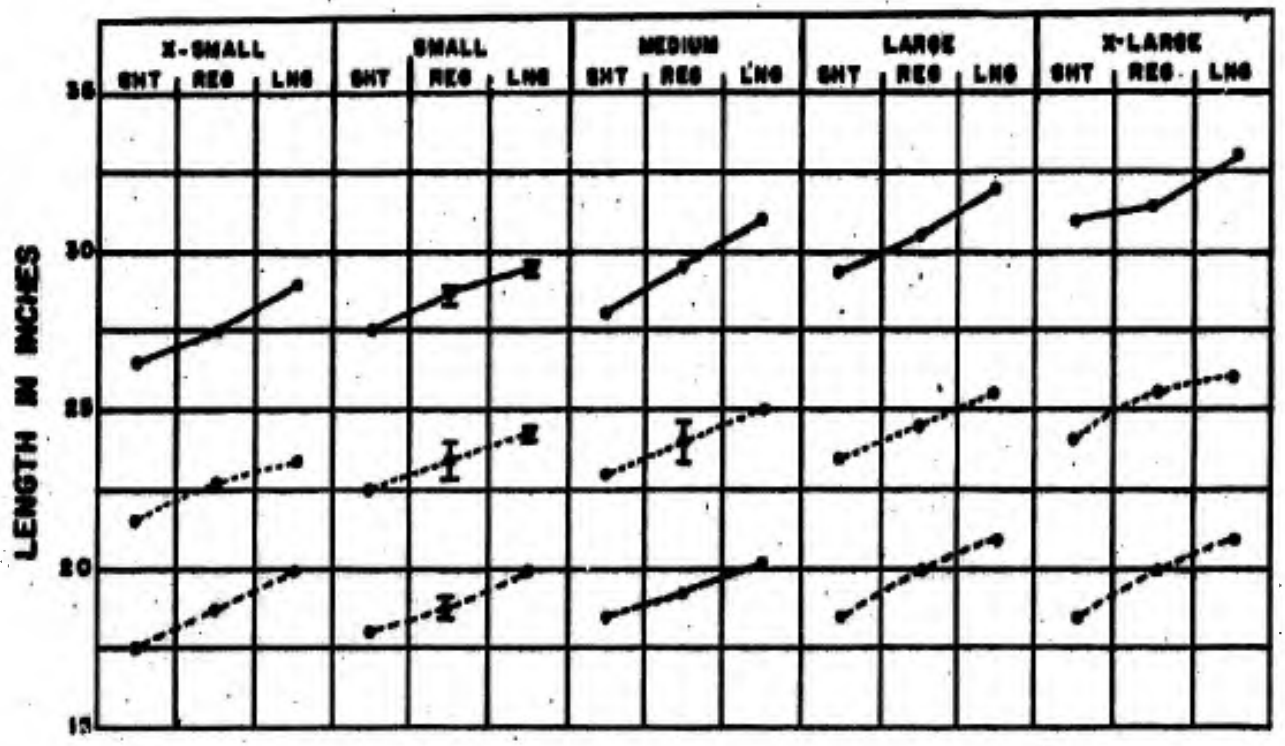
1-SLEEVE TOP
2-ARM INSEAM
3-SIDE SEAM
4-HALF CHEST
5-BACK
6-INSEAM
7-HALF WAIST
8-OUTSEAM

APPENDIX 1-B

SUMMER UNIFORM MEASUREMENT

Uniform Size	Ounces Weight		Inches (Average)							
	Shirt	Trousers	Sleeve(Top)	Arm Inseam	Side Seam	Half Chest	Back	Inseam	Half Waist	Outseam
X-SMALL										
Short	10.0	16.9	21.5	17.5	17.0	19.0	26.5	29.0	13.5	39.0
Regular	11.3	17.2	23.0	18.75	18.0	19.0	27.5	31.0	14.5	40.5
Long	11.7	17.8	23.5	20.0	19.0	19.0	29.0	33.0	14.0	43.0
SMALL										
Short	11.7	16.4	22.5	18.0	18.0	21.0	27.5	29.0	15.5	39.0
Regular	11.6	17.6	23.5	18.75	18.5	21.0	28.5	31.0	16.75	41.25
Long	12.5	18.3	24.25	20.0	20.0	21.0	29.5	33.0	16.5	43.5
MEDIUM										
Short	12.0	18.1	23.0	18.5	18.5	23.0	26.0	29.5	19.0	39.0
Regular	12.7	18.0	24.0	19.5	19.5	23.0	29.5	31.25	18.25	41.25
Long	13.0	19.0	25.0	20.0	20.0	23.0	31.0	32.75	18.0	44.0
LARGE										
Short	13.6	18.8	23.5	18.5	20.0	25.0	29.5	29.5	21.0	40.0
Regular	13.5	18.3	24.5	20.0	20.5	25.0	31.5	30.5	20.75	42.5
Long	13.7	20.0	25.5	21.0	21.0	25.0	32.0	33.0	20.0	45.0
X-LARGE										
Short	14.6	19.7	24.0	18.5	20.5	27.0	31.0	28.5	22.5	40.0
Regular	14.3	20.0	25.5	20.0	22.0	27.0	31.5	31.5	22.0	42.5
Long	15.8	21.0	26.0	21.0	22.5	27.0	33.0	33.0	22.5	45.0

APPENDIX I-C



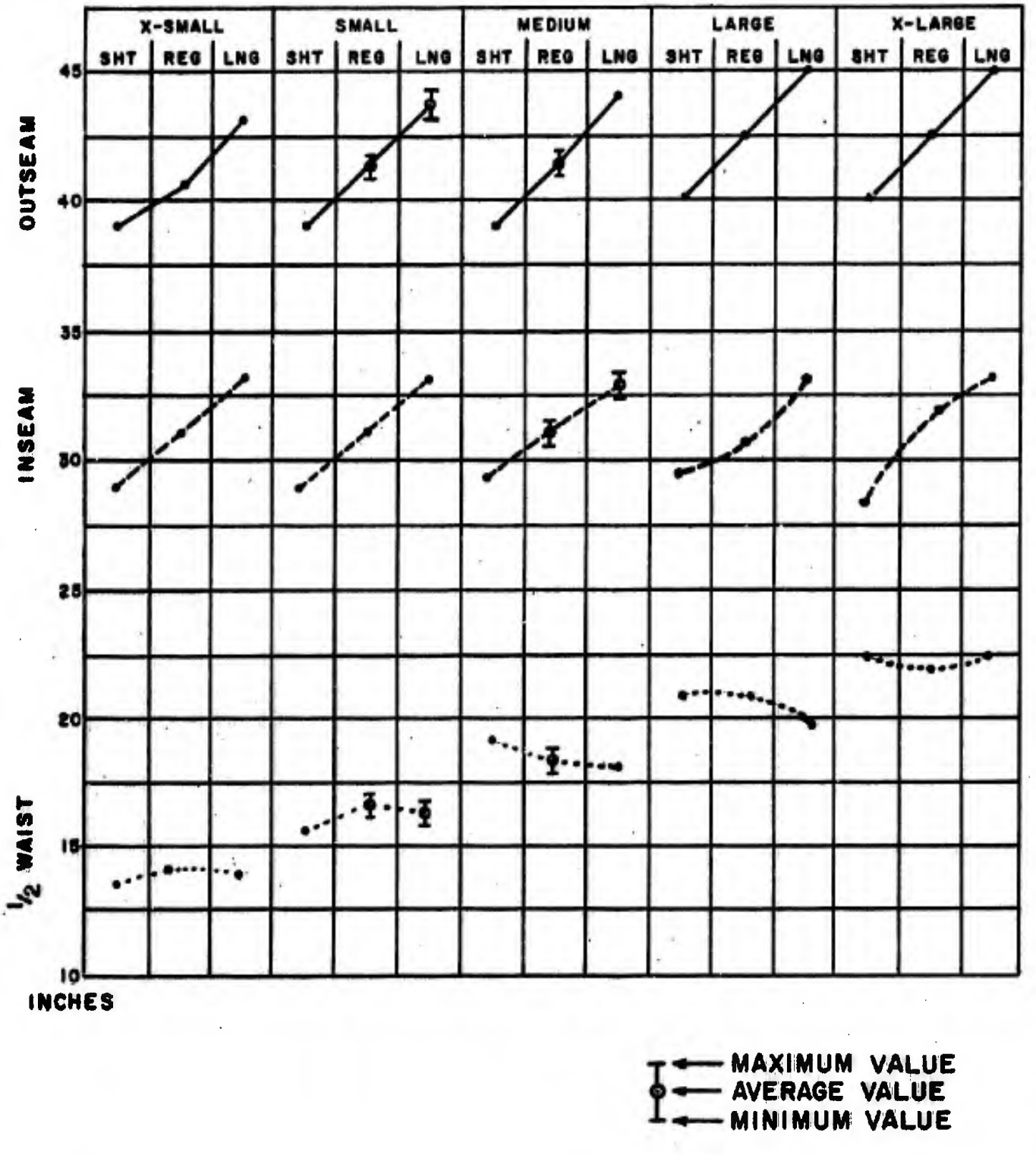
MAXIMUM VALUE
AVERAGE VALUE
MINIMUM VALUE

SLEEVE BOTTOM
SLEEVE TOP
BACK

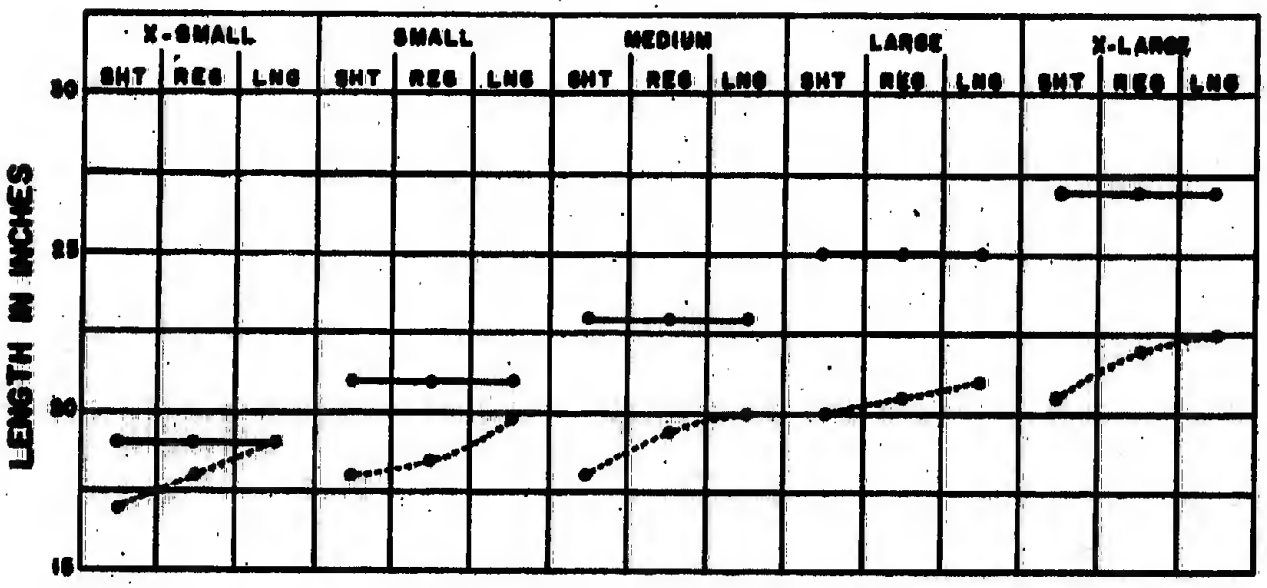
I-C-1

APPENDIX I-C

SUMMER UNIFORM MEASUREMENTS



APPENDIX I-C

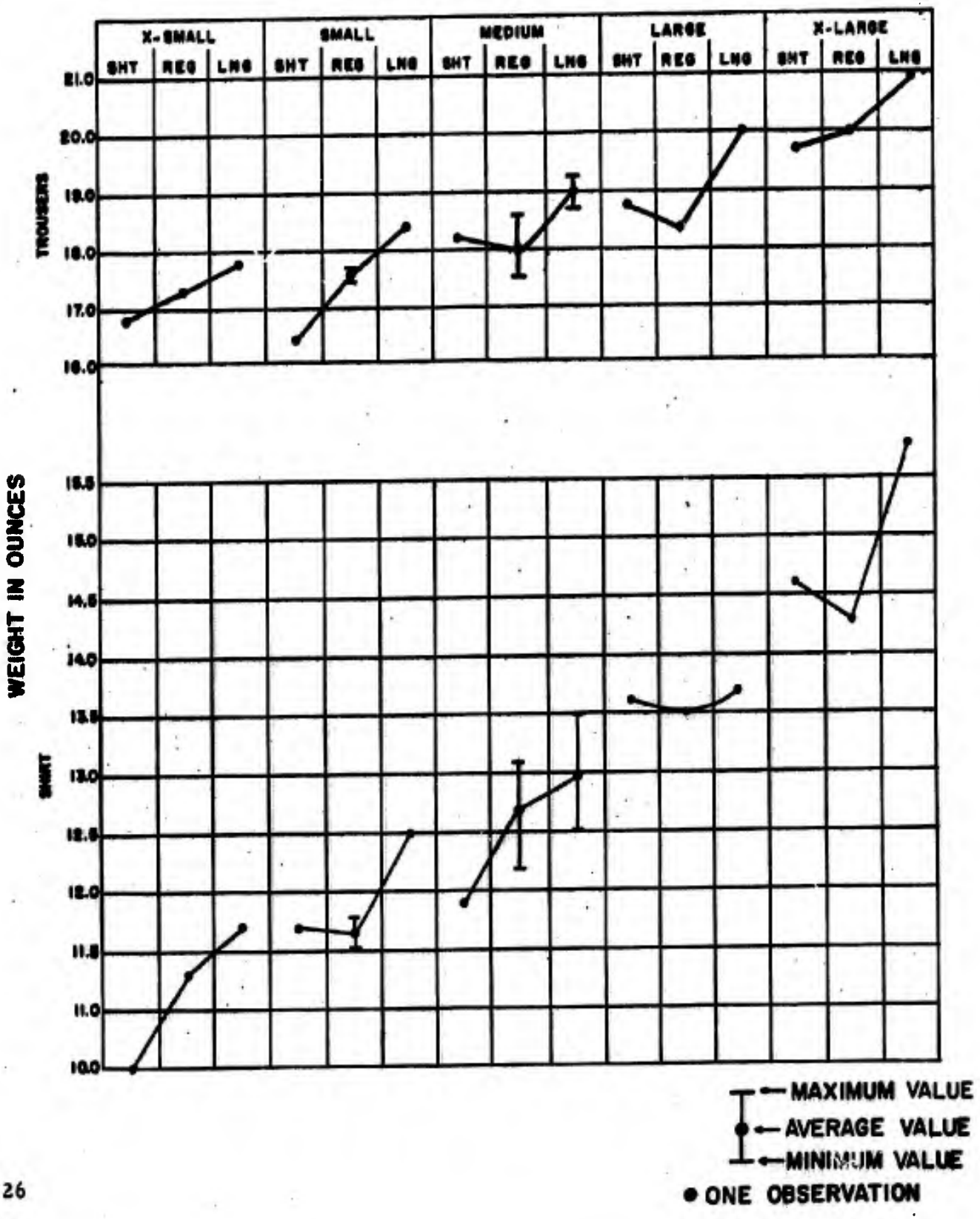


1/2 CHEST

SIDE SEAM

APPENDIX I-D

WEIGHT OF SUMMER UNIFORM



APPENDIX I-E

ANTHROMETRIC/SIZE CONVERSION TABLE

Name _____ Date _____ Participant No. _____

Uniform No. _____ Organization _____ Observer/Recorder _____

Weight _____ Height _____ Inseam _____ Arm _____ Waist _____

Chest _____ Hip _____ Predicted Size _____ Fitted Size _____

Test Officer's Comments: _____

_____

CLOTHING PREDICTION CHART

UPPER TORSO

Sizes		Short Standard	Short Measured	Regular Standard	Regular Measured	Long Standard	Long Measured
X-Small	Chest	Up to 33in		Up to 33in		Up to 33in	
	Height	Up to 67in		67 to 71in		71 and Up	
	Arm	Up to 31in		31 to 32in		32 and Up	
Small	Chest	33 to 37in		33 to 37in		33 to 37in	
	Height	Up to 67in		67 to 71in		71 and Up	
	Arm	Up to 31in		31 to 32in		32 and Up	
Medium	Chest	37 to 41in		37 to 41in		37 to 41in	
	Height	Up to 67in		67 to 71in		71 and Up	
	Arm	Up to 32in		32 to 33in		33 and Up	
Large	Chest	41 to 45in		41 to 45in		41 to 45in	
	Height	Up to 67in		67 to 71in		71 and Up	
	Arm	Up to 33in		33 to 34in		34 and Up	
X-Large	Chest	45 and Up		45 and Up		45 and Up	
	Height	Up to 67in		67 to 71in		71 and Up	
	Arm	Up to 33in		33 to 34in		34 and Up	

APPENDIX I-E

CLOTHING PREDICTION CHART

(Continued)

LOWER TORSO

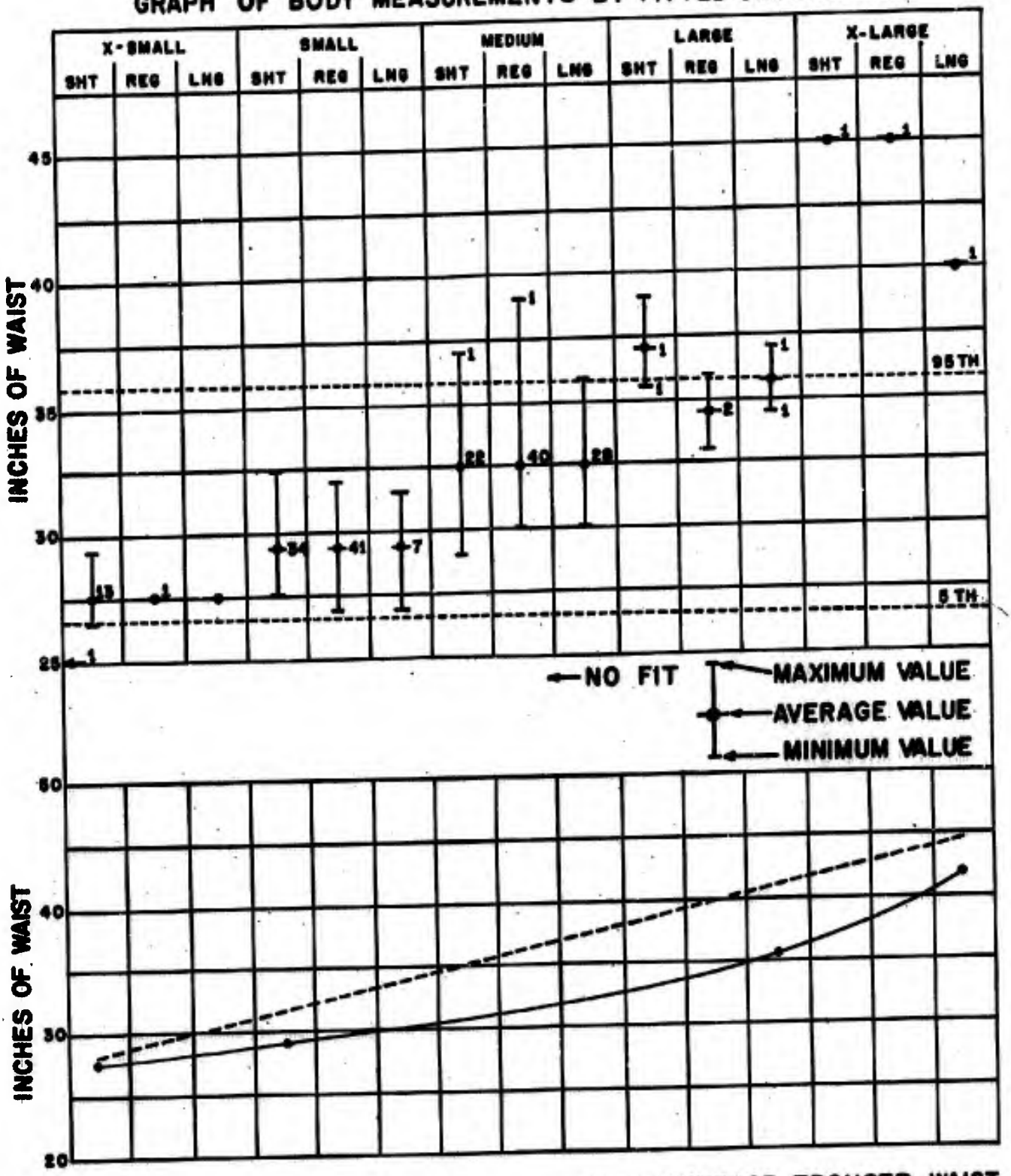
Sizes		Short Standard	Short Measured	Regular Standard	Regular Measured	Long Standard	Long Measured
X-Small	Waist	Up to 27in		Up to 27in		Up to 27in	
	Inseam	Up to 29in		29 to 31in		Over 31in	
	Height	Up to 67in		67 to 71in		71 and Up	
Small	Waist	27 to 31in		27 to 31in		27 to 31in	
	Inseam	Up to 29in		29 to 31in		Over 31in	
	Height	Up to 67in		67 to 71in		71 and Up	
Medium	Waist	31 to 35in		31 to 35in		31 to 35in	
	Inseam	Up to 29in		29 to 31in		Over 31in	
	Height	Up to 67in		67 to 71in		71 and Up	
Large	Waist	35 to 39in		35 to 39in		35 to 39in	
	Inseam	Up to 29in		29 to 31in		Over 31in	
	Height	Up to 67in		67 to 71in		71 and Up	
X-Large	Waist	39 to 43in		39 to 43in		39 to 43in	
	Inseam	Up to 29in		29 to 31in		Over 31in	
	Height	Up to 67in		67 to 71in		71 and Up	

APPENDIX I-F
BODY MEASUREMENTS BY FITTED UNIFORM SIZE

Fitted Uniform Size	No. Shirt	No. Trouser	BODY MEASUREMENTS: Weight Min	Weight Avg	Weight Max	Waist Min	Waist Avg	Waist Max	Chest Min	Chest Avg	Chest Max	Hip Min	Hip Avg	Hip Max	Height Min	Height Avg	Height Max	Arm Inseam Min	Arm Inseam Avg	Arm Inseam Max	Inseam Min	Inseam Avg	Inseam Max
SHORT																							
XSmall	4	11	108.0	116.0	129.5	25.0	27.5	29.5	29.5	32.5	38.0	30.5	32.1	33.0	59.8	63.3	66.0	28.7	31.0	32.2	25.5	28.0	31.0
Small	33	32	114.0	134.9	152.5	27.5	29.5	32.5	34.0	35.0	38.0	33.0	35.1	38.0	61.5	64.9	66.8	29.7	31.8	34.7	26.0	28.5	31.0
Medium	24	24	132.0	157.0	180.3	29.0	32.5	37.0	36.5	38.0	40.5	34.0	37.8	40.0	63.5	65.4	67.0	29.7	32.4	35.2	25.0	28.5	31.0
Large	4	2	170.3	175.0	179.0	35.5	37.0	39.0	41.0	41.5	42.5	39.0	40.2	42.0	64.0	65.3	66.8	30.7	32.1	33.7	26.5	28.0	29.0
XLarge	1	2	175.0	189.0	190.0	-	45.0	-	-	47.5	-	-	42.0	-	-	65.0	-	-	31.7	-	28.0	28.5	29.0
REGULAR																							
XSmall	1	1	-	130.0	-	-	27.5	-	-	-	-	-	-	-	-	66.0	-	-	32.6	-	-	31.0	-
Small	48	42	124.0	144.0	165.0	27.0	29.5	32.0	33.5	35.5	40.0	33.0	35.8	39.0	65.5	67.9	70.5	31.2	33.6	35.2	24.0	30.5	32.5
Medium	41	42	133.0	161.5	185.0	30.0	32.5	39.0	37.0	38.5	42.0	35.0	37.6	40.0	63.8	68.3	70.5	30.2	33.7	37.2	27.0	30.5	33.5
Large	2	1	162.0	185.0	200.3	33.0	34.5	36.0	41.0	41.5	42.0	39.0	40.4	42.0	67.8	69.4	71.0	31.7	34.2	35.7	30.0	31.5	32.5
XLarge	3	2	188.3	190.0	195.0	-	45.0	-	45.0	47.0	51.5	40.5	41.5	42.5	68.8	70.0	71.0	31.8	34.3	36.0	-	30.0	-
LONG																							
XSmall	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Small	3	6	138.5	150.8	166.0	27.0	29.5	31.5	35.0	36.0	37.0	33.5	36.2	38.0	67.3	70.6	74.0	32.2	34.5	37.2	31.0	32.5	34.0
Medium	21	26	146.0	170.8	198.0	30.0	32.5	36.0	34.0	38.5	40.5	35.5	38.1	40.5	67.3	71.3	74.3	33.2	35.3	39.2	31.5	32.5	34.0
Large	6	3	163.3	191.7	215.0	34.5	36.0	37.0	41.0	42.0	44.5	37.5	40.5	42.0	70.5	72.5	75.3	34.2	35.7	37.2	28.5	32.0	33.5
XLarge	-	1	-	205.0	-	-	45.0	-	-	-	-	-	41.0	-	-	72.0	-	-	36.0	-	-	32.5	-

APPENDIX I-G

GRAPH OF BODY MEASUREMENTS BY FITTED UNIFORM SIZE



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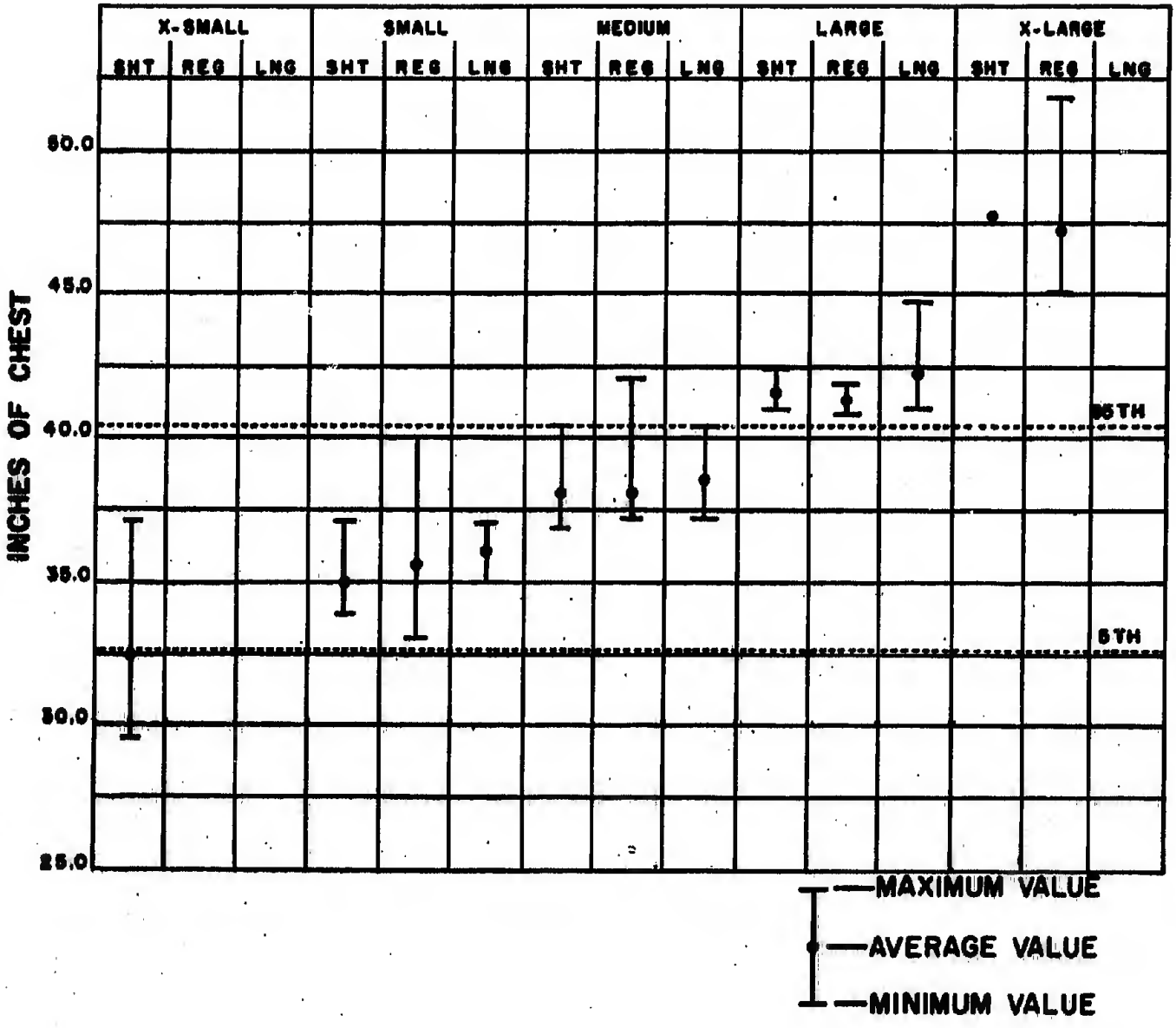
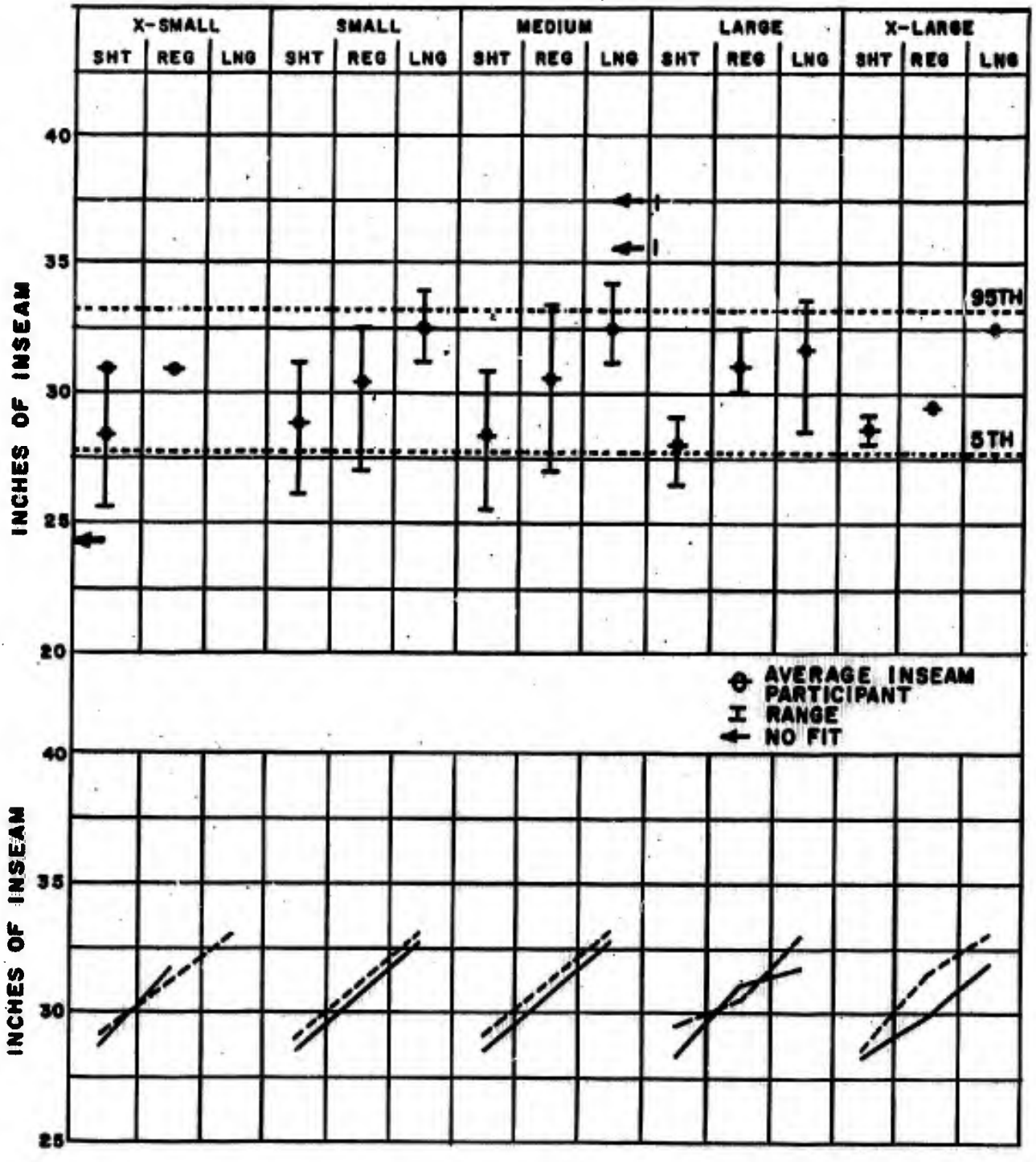
APPENDIX I-G


X-SMALL
SMALL
MEDIUM
LARGE
X-LARGE
SHT
REG
LNG
INCHES OF CHEST
50.0
45.0
40.0
35.0
30.0
25.0
95TH
5TH
MAXIMUM VALUE
AVERAGE VALUE
MINIMUM VALUE

APPENDIX I-G



I-G-3

APPENDIX I-H

MATERIALS ANALYSIS DATA

TABLE 1. THERMAL TRANSMISSION

	Experimental				Standard			
Type of Fuel	Max °F	Time to obtain max °F (sec)	Time to obtain 12.6° F rise (sec)		Max °F	Time to obtain max °F (sec)	Time to obtain 12.6° F rise (sec)	
			Fuel	Below Sample			Fuel	Below Sample
Mogas	1123°	4.8	0	0.4	1374°	2.2	0	0.2
Napalm	1137°	17.5	0	4.7	1340°	14.2	0	2.8
Yellow Phosphorus	1396°	7.1	0.4	1.2	1216°	10.9	0.3	0.5

TABLE 2. FLAME RESISTANCE

Type of Flame Measurements	Fabric-Std		Fabric-Exp			Glove-Exp		Belt		
	Orig	20 Lndrys	Orig	20 Lndrys	120 Day Exp	Fab	Leath	Exp Cotton	Exp Poly	Standard
Glow Time (sec)	133.8	72.9	8.2	0.52	1.9	3.35	20.03	0.0	11.2	1056.0
Char Length (in)	12.0	12.0	0.37	0.13	0.23	0.18	0.15	0.0	0.0	10.9
Flaming Time (sec)	39.9	33.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	155.5

TABLE 3. INFRARED REFLECTANCE IN PERCENT

	Standard	Experimental
800 mu	11.80	64.20
900 mu	23.80	74.20
1000 mu	44.80	78.60

APPENDIX I-H

TABLE 4. ABRASION: CYCLES TO DESTRUCTION

Type	Number of Laundering Cycles				
	Orig	5	10	15	20
Standard	63.40	35.40	35.80	44.40	43.00
Experimental (Single Layer)	62.40	66.40	86.40	84.00	91.80
Experimental (Double Layer)	469.00	415.20	339.20	319.60	344.20

TABLE 5. BREAKING STRENGTH (LBS), ELONGATION (%)

Type		Original		20 Launderings		120 Days Exposure		Weatherometer	
		(lbs)	Elong(%)	(lbs)	Elong(%)	(lbs)	Elong(%)	(lbs)	Elong(%)
Std	Warp	137.00	20.0	121.0	21.7	-	-	128.0	17.0
	Fill	91.40	15.3	73.0	14.7	-	-	-	-
Exp Single Layer	Warp	191.60	47.0	176.0	44.0	32.9	8.0	103.30	23.67
	Fill	200.60	35.3	202.0	36.3	35.9	11.7	-	-
Exp Double Layer	Warp	373.0	46.7	-	-	-	-	-	-
	Fill	375.0	35.0	-	-	-	-	-	-
Belts	Std Cot	694.67	30.33	-	-	-	-	-	-
	Exp Cot	620.20	24.80	-	-	-	-	-	-
	Exp Poly	2796.25	29.33	-	-	-	-	-	-

APPENDIX I-H

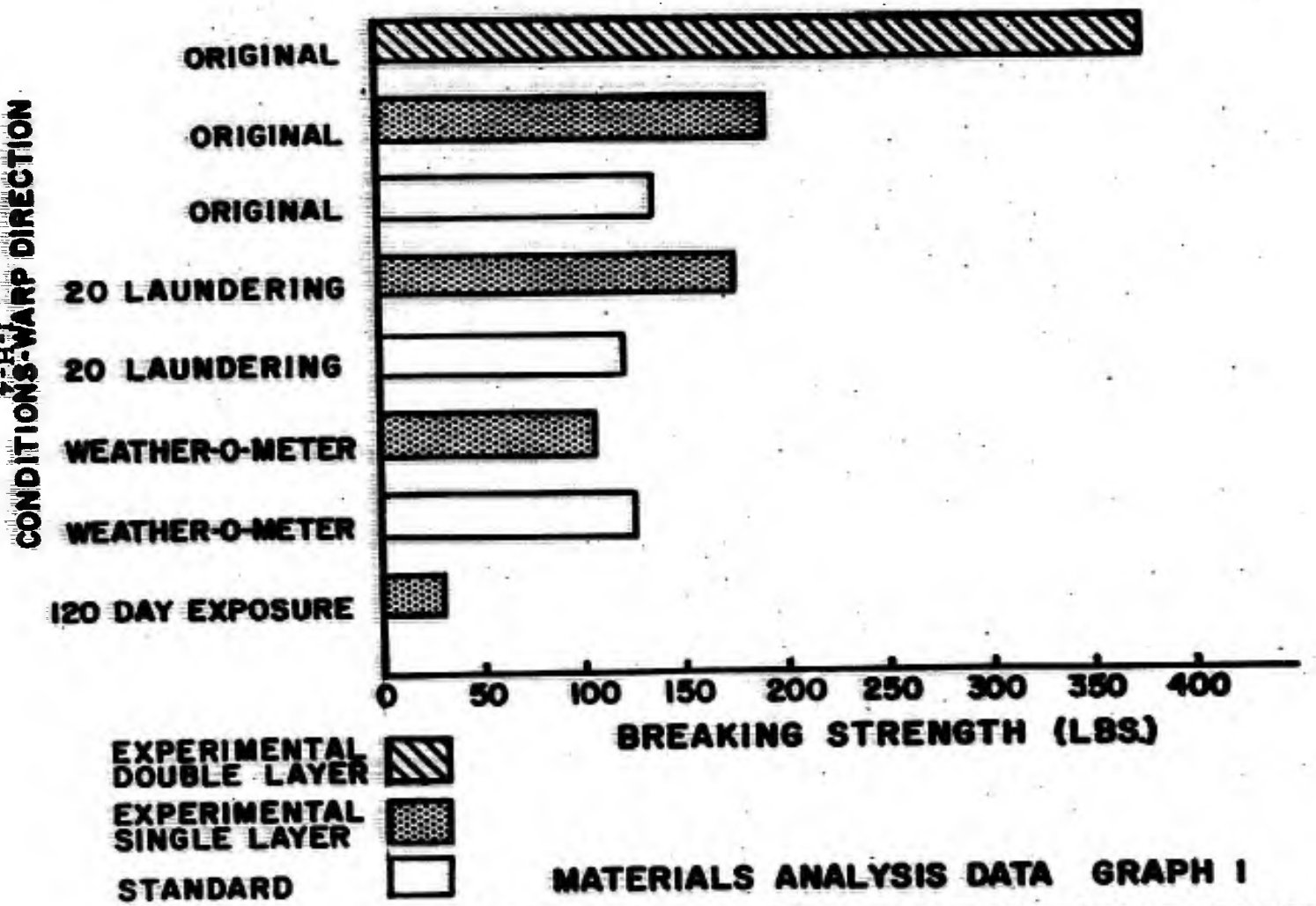
TABLE 6. TEARING STRENGTH (lbs)

Type		Original	10 Launderings	20 Launderings
Standard	Warp	8.7	-	3.3
	Fill	6.6	5.1	3.1
Experimental Sing Layer	Warp	17.0	12.2	10.8
	Fill	16.3	11.8	9.8

TABLE 7. FABRIC EXPOSURE DATA

Total South Radiation in Langleys	31,569
Total Precipitation in Inches	14.83
Total Fabric Surface Moisture in Hours	696

APPENDIX I-H



MATERIALS ANALYSIS DATA GRAPH I

COMPARATIVE BREAKIN STRENGTH OF EXPERIMENTAL AND STANDARD UNIFORM

APPENDIX I-I

LAUNDRY METHOD

The Aviation Crewmens Uniform was laundered in a Single Trailer Mounted Field Laundry Unit, M532, using natural stream water and Standard Laundry Detergent (MIL D-12182 D).

The laundering operation followed standard military procedures as set forth in TM 10-3510-208-12, page 21, table 3. (See attached table)

Following wet wash operation the uniforms were then dryed in the tumbler for 11 minutes at 160° F.

APPENDIX I-I

TABLE I

Operation	Water Level	Time (Min)	Temp (°F)	Supplies
Suds	8 inches	5	100°	Detergent 6 oz
Suds	8 inches	5	130°	Detergent 3 oz
Suds	8 inches	5	130°	Detergent 2 oz
Rinse	11 inches	2	130°	
Rinse	11 inches	2	130°	
Rinse	11 inches	2	100°	
Pre-extract		10 Seconds		
Extract		5 Minutes		
Drying		11 Minutes	180°	

APPENDIX I-J

ENVIRONMENTAL DATA

TABLE 1. AIR PERMEABILITY:

All Readings Expressed in Cu. Ft., 1 Min., 1 Ft.^{2}

Type	Original	20 Launderings
Standard	11.9	9.4
Experimental	172.2	157.8

TABLE 2. WATER ABSORPTION

% Total Weight

Type	Original	20 Launderings
Standard	34.4%	38.9%
Experimental	19.9%	23.6%

TABLE 3. VAPOR TRANSMISSION

Type	Original		20 Launderings	
	MVT	Sec	MVT	Sec
Standard	95	2.6	99	3.4
Experimental Single Layer	97	1.8	97	1.8
Experimental Double Layer	95	2.6	95	2.6

TABLE 4.

	Average % Shrinkage Between Cycles					
	0 - 2	2 - 4	4 - 6	8 - 10	10 - 12	0 - 20
Warp	.72	.63	.15	.15	.09	1.90
Filling	1.12	1.15	.38	.48	.15	3.50

APPENDIX I-K

SURFACE RESISTIVITY: OHMS/SQ. IN.

Surface Resistivity Measurements at 32° F - 40% RH

Number of Launderings	Type	
	Standard ohms/sq. in.	Experimental ohms/sq. in
Original	5.20×10^6	7.24×10^8
5	6.60×10^6	6.70×10^9
10	7.90×10^6	1.07×10^{10}
15	9.20×10^6	7.90×10^9
20	8.00×10^6	4.00×10^8

APPENDIX II. PHOTOGRAPHS

APPENDIX II-A

UNIFORM CLOSURE DEVICES

Figure 1. View of sleeve cuff adjustment.

Figure 2. View of sleeve cuff adjustment.

APPENDIX II-B

SLEEVE POCKET

Figure 1. Sleeve patch-type pockets.

Figure 2. Sleeve patch-type pockets.

APPENDIX II-C

COMPATIBILITY

Figure 1. Tropical combat boots and hat.

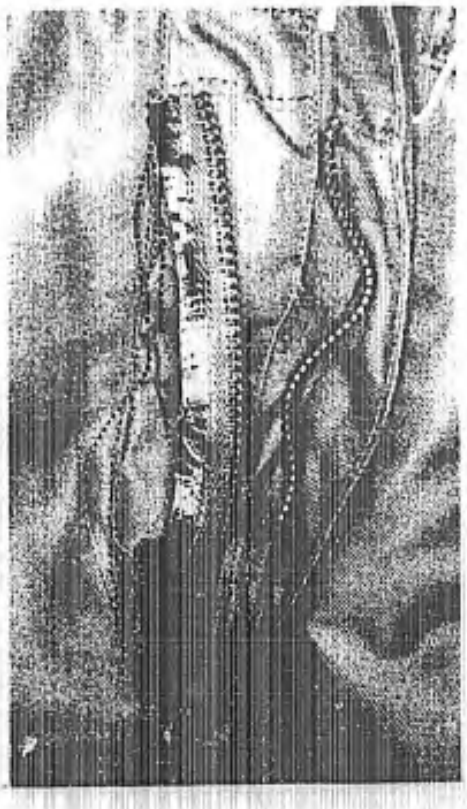
Figure 2. Armored vest.

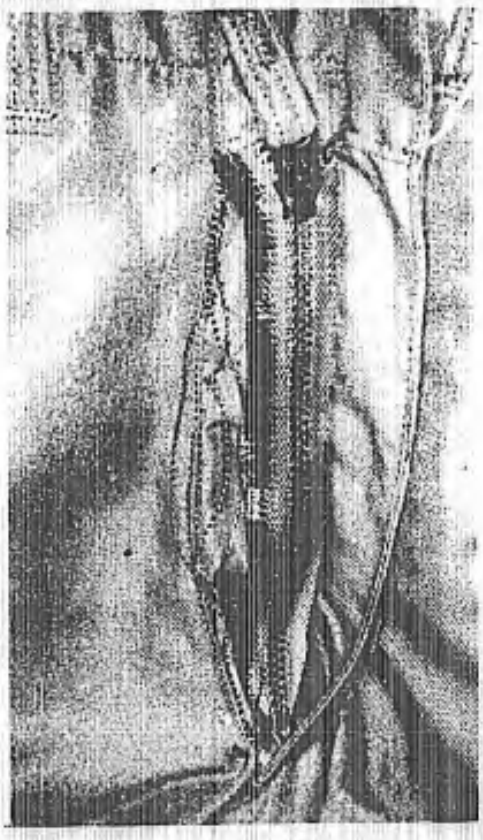
Figure 3. CB protective liner, mask, and hood.

Figure 4. Protective mask and liner system.

APPENDIX II-D

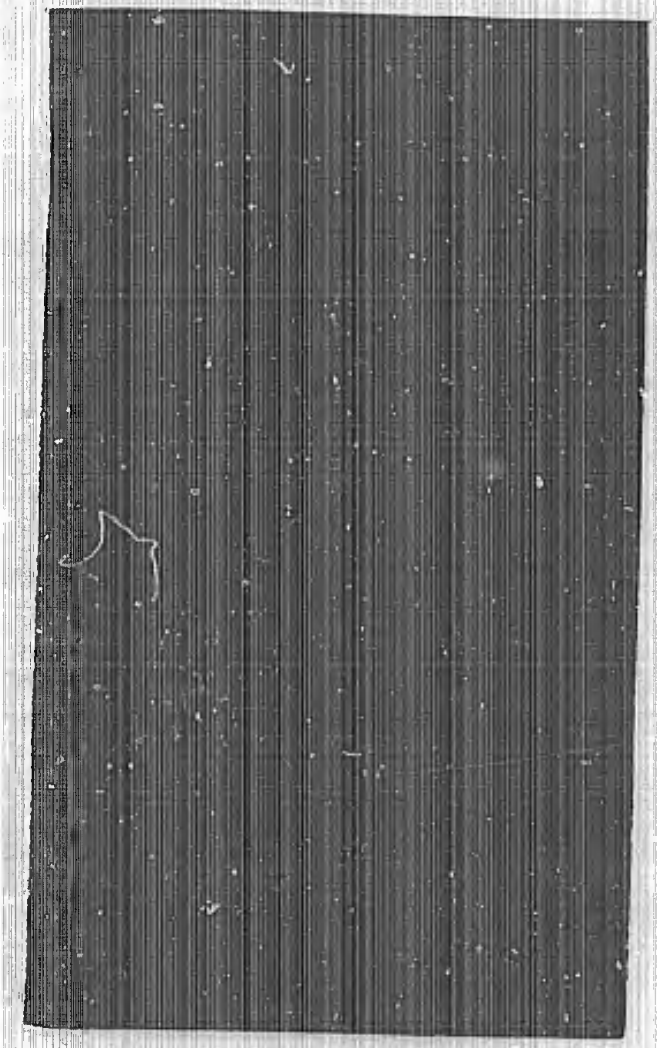
TROUSERS ZIPPER FAILURE



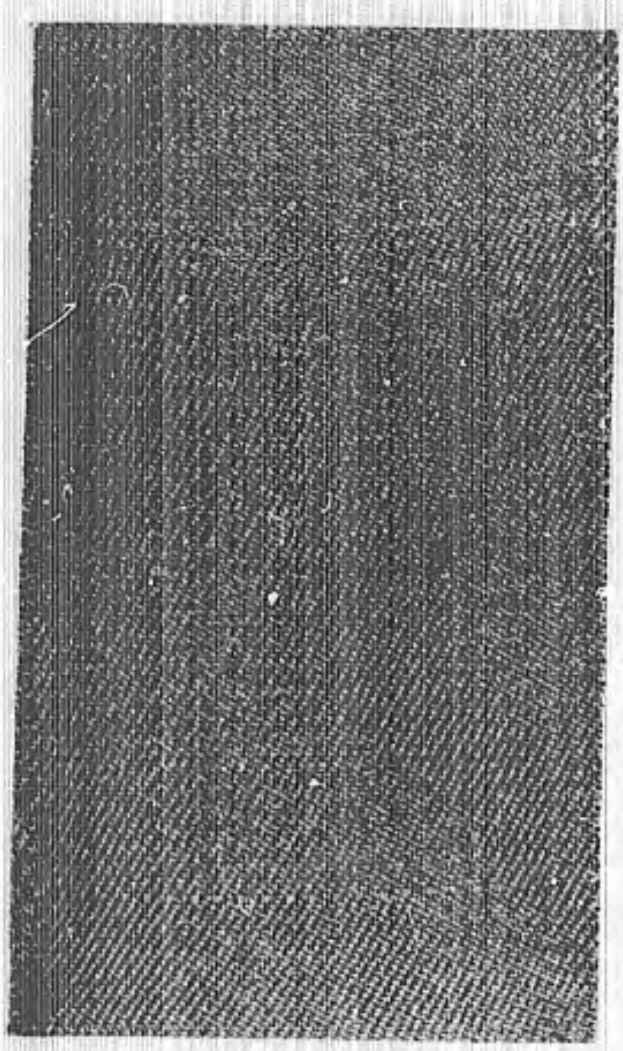


APPENDIX II-E

COLOR DIFFERENCE



UNEXPOSED



120 DAY EXPOSURE

APPENDIX III. FINDINGS

SDR, ITC REQUIREMENTS FOR SUMMER AVIATION UNIFORM	FINDINGS
1. "(Essential) All components must be fire retardent to a degree which will provide for protection from high intensity flash or flame for 10 seconds duration. This degree of protection must last for the life of the garment."	Requirement met. See paragraph 2.6.4.
2. "(Essential) The exterior of these garments shall be free of design features which may catch or snag on objects, controls or switches in the aircraft, thereby hindering emergency exit, normal egress, or safe operation of the aircraft. Examples of such undesirable features are gapping front closures, loose-fitting cuffs, open shoulder straps on the upper part of the garment or open, exposed pockets on the lower part of the garment."	Requirement met except as noted. See paragraph 2.4.4.
3. "(Essential) This clothing system must be constructed of material which is compatible in appearance, color and basic function with the combat uniform issued to the ground combat soldier. Any changes to the combat soldier's uniform such as Lightweight Individual Combat Clothing	Requirement met except as noted in paragraphs 2.8.4, 2.9.4 and 2.10.4.

APPENDIX III

SDR, ITC REQUIREMENTS FOR SUMMER AVIATION UNIFORM	FINDINGS
and Equipment (LINCLOE) occurring during development of this clothing system must be considered."	Requirement met except as noted in paragraph 2.4.4.
4. "(Essential) Patch type pockets located on the sleeves of the basic garment and jacket. These pockets shall be accessible in flight and shall be designed to hold such items as cigarettes, pencils, and pen lights.	
5. "(Essential) Provisions, without the use of buttons, to adjust sleeve cuffs of the basic garment and jacket for a snug fit."	Requirement not met. See paragraph 2.4.4.
6. "(Essential) Be shrink and fade resistant."	Requirement met except for light/fastness. See paragraphs 2.8.4 and 2.11.4.

APPENDIX IV. DEFICIENCIES AND SHORTCOMINGS

1. DEFICIENCIES

	Deficiency	Suggested Corrective Action	Remarks
1.1	None	None	None

2. SHORTCOMINGS

	Shortcoming	Suggested Corrective Action	Remarks
2.1	The sleeve cuffs of the basic garment could not be adjusted to a snug fit.	Should be redesigned.	Discovered during feature design subtest.
2.2	Patch type pockets located on the sleeves are not accessible because of poor zipper construction.	Should be replaced by Velcro fastner.	None
2.3	The polyamide belt because of color did not conform to basic uniform of the ground soldier.	The belt should be dyed black if this belt is to be used.	This problem was apparent and a supplementary experimental cotton belt has been tested.
2.4	The uniform does not display a high order of light/fastness.	None	None

APPENDIX IV

2. SHORTCOMINGS (CONT)

	Shortcoming	Suggested Corrective Action	Remarks
2.5	The uniform has a significantly higher infrared reflectance value than the standard uniform.	None	None
2.6	The fly zipper unravelled and ripped out.	Use a different type of zipper tape.	This problem was discovered during sizing and fitting subtest.

APPENDIX V. REFERENCES

1. DA Approved SDR for Clothing System for Army Aviation Crewmembers, dated 5 April 1962.

2. Technical Characteristics for Clothing System for Army Aviation Crewmember, dated April 1966.

3. Letter, AMCRD-J1, dated 29 June 1967, subject: "Formal IPR #4(PSR) Uniform Air Crewman."

4. Letter, AMIB-AAD, dated 16 May 1967, subject: "Final Report - Evaluation of Crew Member's Improved Fire Resistance Flight Coveralls (ACA-45/67I)."

5. Letter, AVIB-AAD, dated 12 January 1967, subject: "Final Report - Evaluation of Crew Member's Fire Resistance Flight Coveralls ACA-11/67."

6. USATECOM Test Phasing Schedule, USATECOM Project No. 4-6-5300-04, dated 19 July 1967, with one attachment.

AD Accession No.

U. S. Army General Equipment Test Activity, Fort Lee, Virginia.

FINAL REPORT OF ENGINEERING TEST OF CLOTHING SYSTEM (SUMMER UNIFORM) FOR ARMY AVIATION CREW MEMBERS by SP4 Donald G. Mercer, December 1968, 56 p. -tables, -illus, 6 Appendices p21-56. (TECOM Proj. No. 4-6-5300-04) Unclassified Report

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