

TECHNICAL REPORT
68-4-PR

AD 658 034

**HUMAN FACTORS EVALUATION OF
BODY-SUPPORTED AIRCREWMAN'S BUTTOCKS
AND CROTCH PROTECTIVE UNITS**

*Comparison of Two Heights of Crotch
Protector and Three Suspension Systems*

by

Richard L. Burse

July 1967

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760



Pioneering Research Laboratory
Research Study Report EPR-14

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HUMAN FACTORS EVALUATION OF BODY-SUPPORTED
AIRCREWMAN'S BUTTOCKS AND CROTCH PROTECTIVE UNITS:
(Comparisons of two heights of crotch
protector and three suspension systems)

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Project Reference:
1C024701A121-02

Research Study Report:
EPR-14

January 1967

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FOREWORD

This report is the second in a series concerned with the Human Factors implications of body armor for U. S. Army aircrewmembers. This series is to assist the designer of body armor by specifying design criteria, human factors evaluation methods and test results. The research described in this report evaluates one concept for lower body protection of aircrewmembers, wherein the protective unit is attached to the user's body rather than to the aircraft seat structure.

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CONTENTS

	<u>Page No.</u>
Foreword	ii
Abstract	iv
Introduction	1
Objectives	1
Description of the Study	1
Results	6
Conclusions	13
Appendices:	
I - Preliminary human factors analysis of a body-supported aircrewman's buttocks and crotch armored protective unit.	
II - Rating scales used to evaluate buttocks and crotch protective units.	

ABSTRACT

The research described was an evaluation of body-supported aircrewmen's buttocks and crotch protective units in which two heights of crotch protector and three different suspension systems were compared with respect to fit, comfort, ease of use, estimated length of time the system could be used and the adequacy of several dimensions of the protective units. In general, both types of protective units and all three suspension systems were equally satisfactory. One type of suspension system and one height of crotch protector were significantly easier to use, however, while both crotch protectors were too wide. Subjects desired that the longer crotch protector be shortened and the shorter crotch protector be lengthened to approximately the same length. This desired change apparently was based on factors other than physical discomfort.

**Human Factors Evaluation of Body-Supported
Aircraftmen's Buttocks and Crotch Protective
Units: Comparisons of Two Heights of Crotch
Protector and Three Suspension Systems**

1. INTRODUCTION:

The Anthropology Laboratory has reported previously that the concept of a body-supported aircraftmen's buttocks and crotch protective unit appeared to be feasible from the standpoint of fit, comfort, and compatibility (See Appendix I). In October, 1966, the Clothing and Equipment Development Branch of the Clothing and Organic Materials Division at U. S. Army Natick Laboratories provided the Anthropology Laboratory with two models of suspension systems for evaluation.

2. OBJECTIVES:

The objectives of the study were:

- a. To determine which of two buttocks and crotch armored protective units, differing only in the height of the crotch protector, had the better fit and comfort.
- b. To determine which of three different suspension systems was the most comfortable and the easiest to use for each of the two buttocks and crotch protective units.
- c. To determine the location and cause of discomfort for each protective unit and suspension system combination.
- d. To determine what dimensional changes to each buttocks and crotch protective unit were required to increase fit, comfort and compatibility.

3. DESCRIPTION OF THE STUDY:

a. Materials:

(1) Buttocks and crotch protective units:

The Clothing and Equipment Development Branch, C&EMD, fabricated a single weighted, cushioned and covered wooden model from each of two designs for buttocks and crotch protective units. The sitting surfaces of both designs were identical, being approximately oval in outline, generally flat with a slight upward curvature along the rearmost edge and cushioned by a $\frac{1}{2}$ -inch thick layer of "Ensolite" foam (see Figure 1). The two designs did differ, however, in the height and curvature of the crotch protective portion. This portion extended vertically from the mid-point of the forward edge of the sitting surface and was slightly curved, with the concave side towards the sitting surface. The major dimensions of both designs were as shown in Table I.



Figure 1. Method of Use of Body-Supported Aircrewmen's
Buttocks and Crotch Protective Unit.

Table I: Principal dimensions of the buttocks and crotch protective units.

<u>Dimension</u>	<u>Unit with Long crotch protector</u>	<u>Unit with short crotch protector</u>
Side-to-side width (in.)	14.25	14.25
Front-to-rear depth (in.)	11.25	11.25
Width crotch protector (in.)	3.90	3.90
Height crotch protector (in.)	11.00	9.00
Radius of curvature of crotch protector (in.)	13.50	10.50
Weight (lb.)	15.5	15.4

(2) Suspension systems:

Three different suspension systems were fabricated for test:

(a) The first system (Suspension W) consisted of a simple fabric waist band with a "Velcro" closure from which the buttocks and crotch protective unit was suspended by four attachment straps. One pair of straps was of elastic material and was sewn to the waistband in the rear. The other pair of waistband straps was constructed of non-elastic fabric, such that each strap could be adjusted to any point along the waistband. In addition to the waist attachments, a third pair of straps was attached to the rear of the sitting surface, ran forward over the wearer's thighs and secured to the crotch protector. These thigh straps were designed to prevent horizontal movement of the protective unit when the wearer was standing.

(b) The second suspension system (Suspension B) was similar to Suspension W in principle and design, except that a standard U. S. Army pistol belt was used in place of the waistband and the rearmost pair of waist straps were looped around the belt in a manner similar to the attachment of the front straps. All other attachments and the manner of use were identical to Suspension W.

(c) The third suspension system (Suspension H) was quite different from the first two, having no waist attachments. It was a harness composed of two straps very similar to the thigh straps of Suspensions W and B, but longer and wider. These straps were sewn together in the form of an "X" and attached to the rear of the protective unit so that the straps crossed behind the wearer, passed across his hip bones, and attached to the top of the crotch protector. The angle of pull created by crossing the straps in the rear provided a horizontal force component pressing the straps tightly against the wearer's hips.

b. Subjects:

Five U. S. Army enlisted scientists and engineers from the staff of the Psychology Laboratories volunteered as test subjects. Their heights, weights, ages and torso armor sizes were as shown in Table II. Stature and weight were both measured with the subjects fully clothed in the laboratory white uniform, less footgear. Measured weight was converted to estimated nude weight by subtracting three pounds and rounding the result to the nearest pound. Height was measured in millimeters and converted to the nearest 0.1 inch.

Table II: Heights, weights and ages of test subjects and sizes of torso armor worn.

Subject	Height (in.)	Weight (lbs)	Age last birthday(yrs)	Size of Torso armor
1	65.4	152	21	short
2	70.6	157	22	regular
3	66.0	129	23	short
4	71.8	171	26	regular
5	73.7	164	23	regular

c. Method:

(1) Experimental Design:

The experiment was conducted under a counterbalanced treatment by subjects factorial design. The two lengths of crotch protector were used as one treatment (Treatment P) and the three types of suspension system as the other (Treatment Sy). Each subject evaluated each of the six possible combinations of protective unit and suspension system in random order, three on one day and three on another. The dependent variables of general fit (FIT), over-all comfort (COMFORT), and ease of using the suspension system (EASE OF USE), were measured by subject ratings on five-point scales, as shown in Appendix II. Another variable, the length of time a particular protective unit/suspension system combination could be worn under combat conditions (ESTIMATED LENGTH OF TIME), was estimated by each subject on the basis of a twenty minute wearing period. Desirable changes to the major dimensions of each protective unit were also indicated by each subject.

(2) Procedure:

Each subject was dressed in the appropriate size of prototype U. S. Army Nomex flight suit with front and back torso armor. After instruction in putting on the protective unit/suspension system combination, each subject was asked to respond to the questions shown in Appendix II. The general comments concerning discomfort induced by the evaluated combinations were recorded. After the last combination had been evaluated, each subject was asked to indicate his preference among both protective units and suspension systems.

(3) Analysis:

Separate mixed model analyses of variance were conducted for FIT, COMFORT, EASE OF USE, ESTIMATED LENGTH OF TIME, and the desirable changes to the dimensions of the protective units. When either of the treatment by subject interaction terms was found to be non-significant, it was pooled with the error term as indicated by means of parentheses in each analysis of variance table. The treatment interaction and the main effects were then tested against the pooled error term. Mean ratings were calculated for each treatment category when significant ($p < .05$) treatment effects were found, while mean values and standard deviations were computed for the desirable changes to protective unit dimensions. Subject comments for each protective unit/suspension system combination were tabulated.

4. RESULTS:

a. General fit:

The analysis of variance for FIT indicated that the subjects (Ss) by length of crotch protector (P) interaction (Ss x P) and the Ss by type of suspension system (Sy) interaction (Ss x Sy) were not different from the error mean square (MS error) at the .05 level of significance. The Ss x P and Ss x Sy interactions were pooled to test the P x Sy interaction and the main effects. Only the main effect of Ss was significant ($F=3.61$; d.f.=4,20; $p < .05$). There was no indication that length of crotch protectors or type of suspension system had any individual or joint effect upon the subjective ratings of fit. The overall mean rating of fit was 3.73, corresponding to an opinion intermediate between "the fit is somewhat poor" and "the fit is reasonably good".

b. Overall comfort:

The analysis of variance for COMFORT indicated that the Ss x P and Ss x Sy interactions were not significantly different from the MS error. Again only the main effect of Ss was significant ($F=7.57$; d.f. = 4,20; $p < .01$). There was no indication that length of crotch protector or type of suspension system had any individual or joint effect upon the subjective ratings of comfort. The overall average rating for comfort was 3.70, corresponding to an opinion intermediate between "slightly uncomfortable" and "reasonably comfortable".

c. Ease of use of suspension system:

The analysis of variance for EASE OF USE indicated that the Ss x P and Ss x Sy interactions were not significantly different from MS error. The main effects of both Ss and Sy were significant at the .01 level, while the P effect was just barely significant at the .05 level, as shown in Table III. The mean ratings of Sy were compared by means of the Newman-Keuls procedure outlined in Winer⁽¹⁾. The results of this test were outlined as shown in Table IV. The mean rating for Suspension H (Hip Strap) was significantly different from the mean ratings for both Suspension W (Waist Band) and Suspension B (Pistol Belt) at the .01 level. Suspension W differed from Suspension B at the .05 level. Suspension H appeared to be much easier to use than Suspension B or W, which is understandable in view of Suspension H's relative simplicity. The mean rating for Suspension H was 4.70, between "reasonably easy to use" and "quite easy to use". For Suspension W, the rating was 3.90 very near "reasonably easy to use". For Suspension B, the rating was 3.40, between "somewhat difficult to use" and "reasonably easy to use". The significant difference in mean rating for the two heights of crotch protector was quite small. The mean rating for the shorter crotch protector was 4.20, while that for the longer was 3.80. The two ratings are slightly more and less favorable, respectively, than "reasonably easy to use".

(1) Winer B.J., "Statistical Principles in Experimental Design", McGraw-Hill, New York, 1962, Chapter 3.

Table III: Analysis of variance table for subjective ratings for ease of use of suspension system.

Source of variation	SS	df	MS	F-ratio
Subjects (S _s)	9.33	4	2.33	8.63**
Protective Unit (P)	1.20	1	1.20	4.44*
Type of Suspension System (S _y)	8.60	2	4.30	15.92**
S _y x P	1.40	2	0.70	2.59
(pooled error)	(5.47)	(20)	(0.27)	
S _s x P	0.80	4	0.20	1.00
S _s x S _y	3.07	8	0.38	1.90
error	1.60	8	0.20	
<hr/> Total	<hr/> 26.00	<hr/> 29		

*F-ratio significant at .05 level.
 **F-ratio significant at .01 level.

Table IV: Multiple range test table for differences between mean ratings for ease of use of suspension systems. Newman-Keuls method for multiple range test. Wholly significant difference =

$$WSD_{\alpha} = \left(\sqrt{\frac{MS \text{ error}}{n}} \right) (q_{1-\alpha, r, d.f.})$$

truncated range, r	1	2
$q_{.99, r, 20}$	4.02	4.64
$WSD_{.01}$	0.66	0.77
$q_{.95, r, 20}$	2.95	3.58
$WSD_{.05}$	0.49	0.69

Suspension System		Pistol Belt	Waist Band	Hip Strap
	Mean	3.40	3.90	4.70
Pistol Belt	3.40	--	0.50*	1.30**
Waist Band	3.90		--	0.80**
Hip Strap	4.70			--

*difference significant at .05 level.
 **difference significant at .01 level.

d. Estimated length of time system could be worn:

The anova for Est LOT indicated that the Ss x Sy interaction was significantly different from MS error ($F=11.03$; d.f.= 8,8; $p < .01$) while the Ss x P interaction was not. When tested against MS error (pooled), the Ss effect was significant ($F=76.00$; d.f.=4,12; $p < .01$), while the P effect and the P x Sy interaction were not. The Sy effect was found to be non-significant when tested against the Ss x Sy interaction. There was no indication that either protective units or suspension systems had any effect upon the estimated length of time a combination could be worn. The mean estimate for all combinations was 5.20 hours, which appears to be sufficient for most operational missions. Field testing, of course, will determine whether or not these estimates were reasonable and also test the validity of the estimator as a predictive tool.

e. Desirable changes in height of crotch protector:

The analysis of variance for the desirable changes in height of crotch protector indicated the only significant differences to have been between subjects ($F=51.36$; d.f.=4,20; $p < .01$) and between protective units ($F=33.92$; d.f.=1,20; $p < .01$). The mean desirable changes to height of crotch protector were a reduction of 0.33 inches for the higher (11 inch) protector and an increase of 1.30 inches for the lower (9 inch) protector. If these changes were made, the higher protector would be 10.67 inches high and the shorter protector would be 10.30 inches high. This degree of agreement suggests that an optimum crotch protector height exists (approximately $10\frac{1}{2}$ inches) and that subjects can determine its difference from either a larger or smaller value.

f. Desirable changes in width of crotch protector:

The analysis of variance table for desirable changes in crotch protector width indicated that the Ss main effect was the only significant effect or interaction ($F=9.67$; d.f.=4,20; $p < .01$). The overall mean desirable change in width of crotch protector was a reduction of 1.15 inches. Such a reduction is probably impossible without destroying the structural integrity of the crotch protector, but the subjects' mean rating does emphasize the necessity for reducing the crotch protector width as much as is consistent with structural requirements.

g. Other dimensions:

The ratings given by test subjects to the dimensions common to the two types of protective unit differing only in length of crotch protectors were as shown in Table V. The dimensions shown in Table V were identical for both types of protective unit (cf. Table I). Each type of protective unit was rated by each subject three times, once with each type of suspension system. In general, the specified dimensions appeared to be adequate for both protective units, no matter which of the tested suspension systems was used.

Table V: Tabulated frequencies of ratings for dimensions of buttocks and crotch protective units varying only in length of crotch protector.

Dimension	Susp.	Rating					
		Long Crotch Protector:			Short Crotch Protector:		
		Dimension should be:			Dimension should be:		
		increased	left alone	decreased	increased	left alone	decreased
Seat Width (Side-to-side)	W	0	5	0	0	5	0
	B	0	4	1	0	5	0
	H	0	4	1	0	5	0
	Total	0	13	2	0	15	0
Seat Depth (Front-to-rear)	W	1	4	0	1	4	0
	B	1	3	1	1	3	1
	H	0	4	1	0	5	0
	Total	2	11	2	2	12	1
Angle between seat surface and crotch protector.	W	0	4	1	0	4	1
	B	0	4	1	0	5	0
	H	0	5	0	1	4	0
	Total	0	13	2	1	13	1
Firmness of cushion.	W	0	3	2	0	4	1
	B	0	3	2	0	4	1
	H	0	4	1	0	4	1
	Total	0	10	5	0	12	3

h. Comments concerning discomfort:

(1) The comments concerning discomfort were recorded during the study and were consolidated into Table VI. The majority of subjects reported discomfort from the crotch protector contacting one or both thighs, which was consistent with their reporting that the crotch protector seemed too wide and should be made narrower. The discomfort induced by the weight of the protective unit pulling on the suspension system was not surprising, either, but apparently was not overly severe as evidenced by the results for ESTIMATED LENGTH OF TIME.

(2) The reported discomfort to the back of the thighs from the edge of the sitting surface was unexpected, however. The apparent cause of the discomfort, as determined by inspection, was lack of cushioning where the edge contacted the thighs. The edge of the cushion appeared to deform very readily when subjects rose to the standing position and provided little or no protection. The slight contour of the edge appeared to produce a pressure point on some men, which could be reduced by providing the sitting surface with a straight edge. When coupled with additional cushioning, a straight edge could well eliminate this source of discomfort. The sensation of the protective unit being unsteady when the subjects rose from the sitting position was most probably a result of the flexibility of the suspension systems. Such unsteadiness might well have been inherent in any suspension system sufficiently flexible to permit both the standing and sitting positions. Use of less flexible materials for the suspension systems to reduce unsteadiness must be carefully investigated to insure that reducing unsteadiness does not increase restriction to body movement. Discomfort due to the length of crotch protector occurred for only one subject under one condition. This appeared to indicate that even though most subjects felt the long crotch protector was too long (paragraph e., above), they experienced no real discomfort. Similarly, the seat cushion was rated as being too firm by several subjects under varying conditions, but only one subject reported discomfort from this source. A single subject reported discomfort from pressure of the crotch protector against his crotch. The use of a padded plastic cup with an athletic supporter appears to offer advantages in reducing possible injury as well as discomfort. Such a cup would increase protection of the crotch area if a projectile deflected the crotch protector toward the user or if the user was thrown towards the crotch protector during a hard landing.

i. Final choice:

When each subject was asked to choose the single protective unit and the single suspension system he preferred, there was no pattern of preference. Three subjects preferred the protective unit with the long crotch protector, each subject preferring a different suspension system. Two subjects preferred the unit with the short crotch protector, again each subject preferring a different suspension system. The overall result was that each of the five subjects chose a different protective unit/suspension system combination from the six possible combinations. A much

Table VI: Summary of test subject comments concerning discomfort for each protective unit/suspension system combination (L= protective unit with long crotch protector, S= protective unit with short crotch protector, W= waistband suspension, B= pistol belt suspension and H= hip strap suspension).

Comment concerning discomfort	Number of subjects making comment					
	<u>LW</u>	<u>LB</u>	<u>LH</u>	<u>SW</u>	<u>SB</u>	<u>SH</u>
1. When standing, crotch protector presses against or chafes inside of thigh.	4	4	4	5	3	4
2. When standing, edge of sitting surface presses against or chafes back of thighs.	2	2	2	3	2	3
3. When standing, suspension presses downward on hips.	1	2	-	1	1	1
4. When rising from sitting position, protective unit feels insecure.	-	1	1	-	-	-
5. When standing, crotch protector presses against crotch.	-	-	-	-	-	1
6. When sitting, seat surface feels too hard.	-	-	-	-	1	-
7. When sitting, crotch protector too long, interferes with movement.	1	-	-	-	-	-

larger sample is required to determine which combinations of protective unit and suspension system (if any) are the more preferred.

5. CONCLUSIONS:

a. Subjects rated the buttocks and crotch protective units with long and short crotch protectors as equally satisfactory for fit, comfort, estimated length of time the system could be worn, and adequacy of the following dimensions: width and depth of sitting surface, firmness of cushion and angle between sitting surface and crotch protector.

b. Subjects considered both lengths of crotch protector to be 1.15 inches too wide.

c. Subjects considered the longer (11 inch) crotch protector to have been 0.33 inches too long and the shorter (9 inch) crotch protector to have been 1.30 inches too short.

d. The optimum crotch protector height appeared to be between 10.30 and 10.67 inches.

e. Subjects rated the three suspension systems (waist band, pistol belt and hip strap) as equally satisfactory for fit, comfort and estimated length of time system could be worn. There appeared to be no significant interactions between suspension systems and protective units.

f. Subjects rated the hip strap suspension system significantly easier to use than either the waist band or pistol belt. The hip strap was rated close to "Quite easy to use", while the other two suspensions, although differing significantly, were both between "Somewhat difficult to use" and "Reasonably easy to use".

g. The majority of subjects reported discomfort due to the edges of the sitting surface and crotch protector pressing against or chafing the thighs.

Appendix I

**Memorandum Report For:
Chief, Clothing & Equipment Development Branch
Clothing & Organic Materials Division**

**PRELIMINARY HUMAN FACTORS ANALYSIS OF A BODY
SUPPORTED AIRCREWMAN'S BUTTOCKS AND CROTCH ARMORED
PROTECTIVE UNIT**

by

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October 1966

**Pioneering Research Division
U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts 01760**

Memorandum Report:
Preliminary Human Factors Evaluation of a Body-Supported
Aircrewman's Buttocks and Crotch Armored Protective Unit

1. Introduction

On 3 October 1966, the AMC Project Officer for Personnel Armor requested NLABS to develop a buttocks and crotch protective unit for aircrewmembers which could be attached to, and worn on the body in standing, crouching and sitting positions. The unit was required to defeat .30 caliber armor piercing projectiles at 100 meters. Prior to this request, a seat/groin protective unit to be mounted on a helicopter troop seat had been developed by NLABS to provide buttocks and crotch protection to the aircrewman in the sitting position only. In order that the quickest possible response be made to the AMC requirement, the NLABS developing elements requested the Anthropology Laboratory, Psychology Laboratories, PRD, to determine if the seat portion of the seat/groin protective unit, less its supporting structure, could be modified for wearing on the body. If such an interim approach was found to be feasible, the developers also desired to know the necessary modifications to the seat unit for fit and compatibility and the most comfortable means of attaching the unit to the aircrewman's body. Accordingly, the Anthropology Laboratory developed and implemented a brief study of the seat/groin unit and three suspension systems.

2. Objectives:

- a. To determine if any method of attaching the seat/groin protective unit to the aircrewman appeared feasible.
- b. To determine the preferred method of attachment, if more than one method appeared feasible.
- c. To determine the changes in dimension and contour of the seat/groin protective unit to better accommodate the wearer.

3. Methodology

- a. The model of the armored sitting surface was dismantled from its supporting structure and was attached to three different suspension systems: an over-the-shoulder suspender system; an around-the-waist fabric belt with straps, and a standard pistol belt with straps. The rear attaching straps of each suspension system contained an elasticized portion to keep the protective unit snug against the buttocks when the wearer was standing.
- b. Each of four subjects was clothed in a prototype Nomex flight suit and size Regular front and back torso armor. On successive days, as the suspension systems were fabricated and became available, each subject tried on the protective units with a different suspension system. The order of presentation was: suspenders, waist band and pistol belt. A more lengthy design would, of course, counter-balance order of presentation.

c. The experimenter (E) questioned each subject (S) verbally concerning the comfort, fit and restriction of each item. Any comments S chose to volunteer were recorded along with his answers to E's questions. E also asked each S which of each pair of attachment systems he preferred, the one he then had on or that of the previous day. On the final day, after all three suspension systems were evaluated, E recorded S's final preference among all three.

d. For each suspension system, E measured and recorded:

(1) The distance the crotch protector needed to be extended to provide protection when S is standing.

(2) The amount that the seat pan could be reduced in dimension and still provide the wearer with buttocks protection.

(3) The amount the rearmost edge of the seat pan could be rolled upwards to better conform to S's anatomy when he was standing, yet permit a comfortable sitting position.

4. Subjects:

Four enlisted scientists and engineers were used as test subjects. All subjects were in the height range of men properly fitted by size Regular torso armor, but one was at the bottom of the size category and would have been better accommodated by a size Short.

5. Results:

a. All subjects agreed that, in combat, they would use the seat/groin unit when attached to the body. Their preferences among the attachment systems were as shown in Table I. The over-the-shoulder suspender system was not preferred by any subject when compared with the waist-band system alone or compared with both the waist-band system and the pistol belt system together. Although not statistically significant at the 5% level, such a result tends to indicate that the around-the-waist systems are the more preferred.

Table I: Preferences of Subjects for suspender (S), waist band (W) and pistol belt (B) suspender systems for seat/groin protective unit.

<u>Choice</u>	<u>Subj. 1</u>	<u>Subj. 2</u>	<u>Subj. 3</u>	<u>Subj. 4</u>
S vs W	W	W	W	W
W vs B	B	B	W	W
S vs W vs B	B	B	W	W

b. The means of the dimension changes of the seat unit as measured by E are shown in Table II.

Table II: Dimension changes to seat/groin protective seat unit (N⁴).

<u>Dimension</u>	<u>Mean (inches)</u>	<u>S.D. (inches)</u>
Add to height of crotch protector	3.75	1.33
Reduce seat pan width	0.38	1.11
Reduce seat pan depth	1.62	0.63
Roll up rear edge of seat pan	1.40	0.20

c. The comments of the test subjects were as follows:

(1) Over-the-shoulder suspender system:

- (a) shoulder straps slip (2 men)
- (b) seat presses into back of thigh when standing (2 men)
- (c) neck hurts (after 20 minutes) (1 man)
- (d) crotch protector too wide (1 man)
- (e) crotch protector all right (1 man)

(2) Waist-band system:

- (a) armor feels unsteady (3 men)
- (b) seat presses into back of thigh when standing (1 man)
- (c) decreased weight on chest from that of suspenders (1 man)
- (d) not as snug fit to body, feels cooler than suspenders (1 man)

(3) Pistol belt system:

- (a) armor feels unsteady (2 men)
- (b) seat presses into back of thigh when standing (1 man)
- (c) feels better than waist band (1 man)
- (d) belt presses on hip bone (1 man)

5. Recommendations:

a. A model of the new seat unit with both waist attachment systems be made for evaluation by aircrewmembers flying simulated missions.

b. The dimensions of the existing seat/groin unit be used for the model except that:

- (1) the crotch protector should be lengthened four inches.
- (2) the seat pan depth should be reduced one inch.
- (3) the rear edge of seat pan should be rolled upward one inch.

Appendix II

Rating Scales Used To Evaluate Buttocks And Crotch Protective Units

CARD 1: COMFORT SCALE

Which one of the following phrases best expresses your feelings about the comfort of the buttocks and crotch protective unit you are now wearing?

1. quite uncomfortable.
2. reasonably uncomfortable.
3. slightly uncomfortable.
4. reasonably comfortable.
5. quite comfortable.

CARD 2: FIT SCALE

Which one of the following phrases best expresses your feelings about the fit of the buttocks and crotch protective unit you are now wearing?

1. the fit is quite poor.
2. the fit is reasonably poor.
3. the fit is somewhat poor.
4. the fit is reasonably good.
5. the fit is quite good.

CARD 3: EASE OF USE SCALE

Which one of the following phrases best expresses your feelings about using the attachment system of the buttocks and crotch protective unit you are now wearing?

1. quite difficult to use.
2. reasonably difficult to use.
3. somewhat difficult to use.
4. reasonably easy to use.
5. quite easy to use.

CARDS 4 & 5: ADEQUACY OF DIMENSIONS SCALES

For the buttocks and crotch protective unit you now have on:

1. the length of the crotch protector should be:
 - a. longer.*
 - b. left alone.
 - c. shorter.*

*if a. or c., how many inches change?

2. the width of the crotch protector should be:
 - a. wider.*
 - b. left alone.
 - c. narrower.*

*if a. or c., how many inches change?

3. the seat breadth (side-to-side) should be:
 - a. wider.*
 - b. left alone.
 - c. narrower.*

*if a. or c., how many inches change?

4. the seat depth (front-to-rear) should be:
 - a. larger.*
 - b. left alone.
 - c. smaller.*

*if a. or c., how many inches change?

5. the seat cushion should be:
 - a. firmer.
 - b. left alone
 - c. softer.

CARD 6: ESTIMATED LENGTH OF TIME SCALE

If you were in combat, how long do you think you could fly in a helicopter with this buttocks and crotch protective unit on?

1. at least one hour, but not two.
2. at least two hours, but not three.
3. at least three hours, but not four.
4. at least four hours, but not five.
5. at least five hours, but not six.
6. at least six hours, but not seven.
7. at least seven hours, but not eight.
8. at least eight hours, but not nine.
9. at least nine hours, but not ten.
10. at least ten hours.

CARD 7: FINAL CHOICE

Of all the protective systems you have worn:

1. which type of armored protective unit do you prefer?
 - a. long crotch protector.
 - b. short crotch protector.
2. which type of suspension system do you prefer?
 - a. waist strap.
 - b. pistol belt.
 - c. hip strap.

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DOCUMENT CONTROL DATA - R&D		
<i>(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)</i>		
1. ORIGINATING ACTIVITY (Corporate author) U.S. ARMY NATICK LABORATORIES Natick, Massachusetts		2a. REPORT SECURITY CLASSIFICATION Unclassified
		2b. GROUP
3. REPORT TITLE Human Factors Evaluation of Body Supported Aircrewman's Buttocks and Crotch Protective Units: Comparisons of two heights of crotch protector and three suspension systems.		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Research Study Report		
5. AUTHOR(S) (Last name, first name, initial) BURSE, Richard L.		
6. REPORT DATE July 1967	7a. TOTAL NO. OF PAGES 20	7b. NO. OF REFS 1
8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S) 68-4-PR	
b. PROJECT NO. 1C024701A121-02	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) EPR-14	
c.		
d.		
10. AVAILABILITY/LIMITATION NOTICES Distribution of this report is unlimited. Release to CFSTI is authorized		
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY U.S. Army Natick Laboratories Natick, Massachusetts 01760	
13. ABSTRACT The research described was an evaluation of body-supported aircrewmen's buttocks and crotch protective units in which two heights of crotch protector and three different suspension systems were compared with respect to fit, comfort, ease of use, estimated length of time the system could be used and the adequacy of several dimensions of the protective units. In general, both types of protective units and all three suspension systems were equally satisfactory. One type of suspension system and one height of crotch protector were significantly easier to use, however, while both crotch protectors were too wide. Subjects desired that the longer crotch protector be shortened and the shorter crotch protector be lengthened to approximately the same length. This desired change apparently was based on factors other than physical discomfort.		

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Human factors	8					
Design	8					
Testing	8					
Evaluation	8					
Acceptability	8					
Body armor	8,9					
Man-equipment compatibility	4					
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