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SHIPBOARD EVALUATION OF EXPERIMENTAL MODEL BUOYANT INSULATED COLD WEATHER JACKETS

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SHIPBOARD EVALUATION OF EXPERIMENTAL MODEL I BUOYANT INSULATED COLD WEATHER CLOTHING

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TABLE OF CONTENTS

	Page
LIST OF TABLES	v
LIST OF ILLUSTRATIONS	vii
ABSTRACT	ix
SUMMARY	xi
PROBLEM	xi
CONCLUSIONS	xi
INTRODUCTION	1
PROCEDURE	2
DISCUSSION OF FINDINGS	13
APPENDIX A - REFERENCES	A1

LIST OF TABLES

TABLE		PAGE
I	DISTRIBUTION OF EXPERIMENTAL CLOTHING	6
II	EXPERIMENTAL IMPERMEABLE COLD WEATHER JACKET SUMMARY OF DATA FROM QUESTIONNAIRES, PHASE I	7
III	EXPERIMENTAL PERMEABLE COLD WEATHER JACKET SUMMARY OF DATA FROM QUESTIONNAIRES, PHASE I	8
IV	EXPERIMENTAL IMPERMEABLE COLD WEATHER JACKET SUMMARY OF DATA FROM QUESTIONNAIRES, PHASE II	10
V	EXPERIMENTAL PERMEABLE COLD WEATHER JACKET SUMMARY OF DATA FROM QUESTIONNAIRES, PHASE II	11

LIST OF ILLUSTRATIONS

Figure		Page
1	Experimental Permeable Cold Weather Jacket (Model I)	3
2	Cross-section of Permeable Jacket showing Perforated Polyvinyl Chloride Foam Insulation	3
3	Experimental Impermeable Cold Weather Jacket (Model I)	4
4	Cross-section of Impermeable Jacket showing Solid PVC Foam Insulation	4

ABSTRACT

A service evaluation of experimental buoyant permeable and impermeable cold weather jackets was conducted during two consecutive winters aboard aircraft carriers and destroyers. The extended evaluation was conducted to assess the protective properties, fit, and durability (especially of the buoyant insulation) of the garments. The jackets were insulated with unicellular polyvinyl chloride foam (PVC) which provided sustained emergency buoyancy as an integral component of the jackets. This feature is not provided by the standard Navy A-2 Intermediate Cold Weather Jacket and A-1 Extreme Cold Weather Jacket when the liner is removed. Test results indicated that the new jackets furnished satisfactory, functional utility and environmental protection and that the PVC foam was suitable for use as an insulating material. The tests also revealed certain design shortcomings of the impermeable jacket which will require correction.

SUMMARY

PROBLEM

To conduct a service evaluation of experimental cold weather jackets (permeable and impermeable types) designed to provide sustained positive buoyancy. To determine: adequacy of fit, protective properties, and serviceability of the garments; also, to assess the suitability of the buoyant unicellular foam as an insulating medium.

CONCLUSIONS

The experimental permeable jacket was found to be very satisfactory and provided added protection as compared to the standard A-2 permeable jacket. The new item was preferred over the standard because of its superior protective properties, especially when worn in windy, wet/cold conditions.

The experimental impermeable jacket was considered generally satisfactory but requires design changes to improve fit and protective properties. Except for the attached hood, the general design of the new garment was preferred to the standard impermeable A-1 jacket.

The unicellular polyvinyl chloride foam (PVC) used in the experimental jackets presented no unusual problems. No tearing, breakdown, or loss of thickness of the material was observed as a result of the wear and renovations to which the garments were subjected. This buoyant plastic foam material appears satisfactory for use as insulation in cold weather jackets.

The perforated PVC foam used in the experimental permeable jacket provided ample ventilation for dissipation of moisture vapor. In addition, this material furnished superior protective properties as compared to the nylon fleece used in the A-2 jacket.

SHIPBOARD EVALUATION OF EXPERIMENTAL MODEL I
BUOYANT INSULATED COLD WEATHER JACKETS

INTRODUCTION

The present Navy Intermediate and Extreme Cold Weather Outfits, first adopted in 1951, have had numerous design and material changes which have increased functional utility, comfort and environmental protection.* One additional necessary improvement, however, is providing sustained positive buoyancy as an integral part of the jacket components of both these outfits.

The incorporation of this feature was requested by the Chief of Naval Operations as one means of reducing "lost-at-sea" accidents.[1] Wearing a life preserver is prescribed during periods of emergencies and when performing hazardous duties; however, accidents have occurred where a man falls overboard during normal routine topside duties when a life preserver is not worn. The Naval Aviation Safety Center, Norfolk, has documented the number of men lost at sea from carrier shipboard operations.[2] These cases are further increased when other type ships are included. Many of the accidents occur in winter when environmental and sea conditions are more hazardous and the men are wearing winter clothing. Once the clothing wets out, the immersed man struggles and quickly becomes exhausted from trying to stay afloat.

As an expedient for incorporating positive buoyancy in cold weather clothing, the removable quilted batt liner of the A-1 jacket was replaced with one made from 2 layers of 1/8" thick unicellular polyvinyl chloride foam which provided satisfactory buoyancy.[3] It did not entirely solve the problem, however. The A-1 jacket, when worn without the liner, and the A-2 jacket (which is used more extensively than A-1) do not provide buoyancy. The garments wet out quickly when immersed, and become negatively buoyant within a few minutes. To correct this, a development program was initiated for the redesign of both jackets to incorporate a buoyant insulating material. The objective was to provide inherent positive buoyancy without reducing the required environmental protection or serviceability of the items.

*JACKET, INSULATED, EXTREME COLD WEATHER (A-1) W/Polyvinyl Chloride foam removable liner	8415-753-5617 (series)
TROUSERS, INSULATED, EXTREME COLD WEATHER (A-1)	8415-743-5627 (series)
HOOD, EXTREME COLD WEATHER (A-1) (Shipboard)	8415-753-5600 (series)
JACKET, INTERMEDIATE COLD WEATHER (A-2)	8415-753-5612 (series)
TROUSERS, INTERMEDIATE COLD WEATHER (A-2)	8415-753-5622 (series)
CAP, INTERMEDIATE COLD WEATHER (A-2)	8415-270-1991 (series)

Upon completion of initial development work, thirty impermeable and permeable jackets, designated Model I, were manufactured. The purpose was to test their buoyancy characteristics and to assess the garments with regard to adequacy of protection, fit, and durability (especially of the polyvinyl chloride foam insulating material). The buoyancy testing, before and after wear and renovation, was undertaken as a separate evaluation phase and was reported on previously.[4] The second phase, the evaluation of wear and use characteristics, is the subject matter for this report.

PROCEDURE

Description of Test Items

Two types of experimental jackets were tested during this evaluation: (1) a permeable jacket intended as a general cold weather work item for use by deck force personnel performing at a high activity level, and considered the experimental counterpart of the present permeable A-2 jacket; and (2) an impermeable jacket intended for use by shipboard personnel exposed for long periods under sedentary conditions such as when performing ship's lookout duties, and considered the experimental counterpart of the present impermeable A-1 jacket.

The experimental permeable cold weather jacket was designed in a hip-length style with a slide fastener front closure having a protective over-flap. The upper half of the garment was insulated with two layers of 1/8-inch thick perforated polyvinyl chloride foam - the inner layer being quilted to a nylon tafetta lining fabric. The sleeves were insulated with one layer of the quilted perforated PVC foam and the bottom half of the garment was lined with nylon fleece. The outer shell was constructed of a water repellent treated cotton sateen fabric. As with the standard A-2 jacket, this garment was made permeable to permit dissipation of moisture vapor. This was accomplished by perforating the unicellular non-porous polyvinyl chloride foam insulation with 1/8-inch diameter holes spaced approximately 3/8-inch between centers. The jacket and perforated PVC interliner are shown in Figs. 1 and 2.

The impermeable cold weather jacket was designed in a below-the-hip length style, with a combination slide fastener and protective flap front closure and an attached hood. The hood had a visor and adjustable protective chin and nose flaps which were secured by means of a "Velcro" nylon tape fastener. The hood and sleeves were both lined with a single layer of quilted, non-perforated (solid) 1/8-inch thick PVC foam. The body of the garment was insulated with two layers of similar 1/8 PVC foam, with only the layer closest to the body being quilted. This jacket and the solid PVC foam insulation are illustrated in Figs. 3 and 4.

Fig. 1 - Experimental Permeable Cold Weather Jacket (Model I). NAVSUPRANDFAC Photo RT 83-1

Fig. 2 - Cross-Section of Permeable Jacket showing Perforated Polyvinyl Chloride Foam Insulation. NAVSUPRANDFAC Photo 96-1

Fig. 3 - Experimental Impermeable Cold Weather Jacket (Model I). NAVSUPRANDFAC Photo 83-2

Fig. 4 - Cross Section of Impermeable Jacket Showing Solid PVC Foam Insulation. NAVSUPRANDFAC Photo 96-2

The outer fabric used for both the hood and jacket was a 3-1/2 oz per square yard high tear resistant nylon twill neoprene coated on the back side. This material was similar to that used on the standard A-1 garment.

The waterproof and windproof characteristics of this jacket was required to protect topside personnel against the high wind and wet conditions encountered during shipboard cold weather operations.

The experimental jackets were designed to be worn together in extreme cold temperature, such as found in the Arctic or the Antarctic regions, where additional insulation would be required. The impermeable jacket was, therefore, sized larger than the permeable jacket so that it could be worn over it, when necessary.

Test Procedure

The wear evaluation was conducted by utilizing shipboard personnel performing a variety of duties aboard carrier and destroyer type vessels. So that sufficient wear data might be accumulated on the items the evaluation was extended over two-years, using the four-month winter periods of each year. During both test periods, the ships cruised most frequently off the New England Coast encountering typical New England winter temperatures with a low down to $0^{\circ}F$. Heavy seas and high velocity winds were frequently encountered.

Prior to issue of the experimental clothing, the test subjects were briefed by technical personnel of the U. S. Naval Supply Research and Development Facility, Bayonne, New Jersey who visited the ships. Each test subject was issued one garment, either an impermeable or a permeable jacket, depending on his assigned duties. The subjects were requested to wear their experimental jacket intermittently with respective A-1 and A-2 standard cold weather clothing, if available, to obtain comparative information. Individual questionnaires prepared specifically for each jacket, were furnished to and completed by the subjects and returned at the completion of each test phase.

During the period between the first and second phases of the evaluation, the experimental jackets were laundered by standard methods and examined for failures and damages, especially to the PVC foam lining materials. A second laundering and/or a dry cleaning was made at the completion of the second phase, and the garments were re-examined.

The ships used in both evaluation phases and the quantity of experimental clothing distributed to each ship are shown in Table I. A combined total of eighty-four test subjects participated in the two phases of the evaluation.

TABLE I - DISTRIBUTION OF EXPERIMENTAL CLOTHING

	Test Vessel	Number of Impermeable Cold Weather Jackets	Number of Permeable Cold Weather Jackets
Phase I	USS WASP (CVS-18)	10	10
	USS HISSEM (DER-400)	8	8
	USS KEPPLER (DD-760)	7	7
Phase II	USS LAKE CHAMPLAIN (CVS-39)	10	10
	USS DECATUR (DD-936)	7	7
	Total	42	42

Evaluation Results

The results of the completed questionnaires are summarized in Tables II through V. In general, the findings and comments obtained during Phase I testing were confirmed by results of Phase II tests. Use of the same worn garments for Phase II did not appear to detract from the favorable comments of the test subjects, nor did it result in any additional adverse comments. Unfortunately, not all of the test subjects had the A-1 or A-2 jackets to compare to the respective experimental garment. Only 20 subjects (on carriers) had the standard A-1 jacket and 27 (on carriers and on destroyers) the A-2 jacket. The remainder were still wearing the older Winter N-1 cold weather outfit, an obsolete item.

TABLE II - EXPERIMENTAL IMPERMEABLE COLD WEATHER JACKET
SUMMARY OF DATA FROM QUESTIONNAIRES; PHASE I
USS HISSEM (DER-400), USS WASP (CVS-18),
USS KEPPLER (DD-765)

	Yes	No	No Difference
1. Warmth and Protection			
a. Did the jacket and hood provide warmth at temperatures ranging from 20°F. to 35°F.?	25	0	
b. Did jacket and hood provide warmth at temperatures below 20°F.?	23	2	
c. Were the jacket and hood too warm above 40°F.?	18	7	
d. Did the experimental jacket and hood seem warmer than the standard A-1 items you have been wearing using the same combination of clothing accessories? (15 subjects did not have A-1 items.)	3	6	1
e. Did the jacket and hood provide you good protection under wet/cold conditions?	24	1	
2. Fit			
a. How did the jacket fit?			
(1) Good	5		
(2) Fair	8		
(3) Unsatisfactory	12		
b. How did the hood fit when worn over accessory items? (10 subjects did not wear it in this manner.)			
(1) Too large	1		
(2) Too small	11		
(3) Just right	3		
3. Comfort and Ability to Work			
a. Was the jacket and hood comfortable to wear when performing your duties?	23	2	
b. Did you have any difficulty performing routine duties?	4	21	

TABLE II (Cont'd)

	Yes	No	No Difference
4. Durability			
a. Were there any signs of wear and/or breakdown of any components?	0	25	
5. General Comments			
a. Do you like an attached hood better than a separate hood?	7	13	5
b. If you had a choice, which jacket would you choose? (10 subjects wore A-1 Jacket and 15 subjects wore N-1 jacket as standards.)			
(1) Experimental	20		
(2) Standard	3		
(3) No preference	2		

TABLE III - EXPERIMENTAL PERMEABLE COLD WEATHER JACKET
SUMMARY OF DATA FROM QUESTIONNAIRES, PHASE I
USS HISSEM (DER-400), USS WASP (CVS-18),
USS KEPPLER (DD-765)

	Yes	No
1. Warmth and Protection		
a. Did the jacket provide sufficient warmth at temperatures above 32°F?	25	0
b. Did the jacket provide sufficient warmth at temperatures below 32°F?	19	6
c. Which jacket provided better protection against high winds?		
(1) Experimental	18	
* (2) Standard	4	
(3) No difference	3	
d. Which jacket provided better protection against wet/cold exposure?		
(1) Experimental	22	
* (2) Standard	2	
(3) No difference	1	

TABLE III (Cont'd)

	Yes	No
2. Fit		
a. How did the jacket fit?		
(1) Good 19		
(2) Fair 4		
(3) Unsatisfactory 2		
3. Comfort and Ability to Work		
a. Was the jacket comfortable to wear when performing your duties?	25	0
b. Did you have any difficulties in performing duties?	0	25
c. Which jacket caused more sweating?		
(1) Experimental 11		
* (2) Standard 8		
(3) No difference 6		
4. Durability		
a. Were there any signs of wear and/or breakdown of any components?	0	25
5. General Comments		
a. Which jacket provided better protection?		
(1) Experimental 16		
* (2) Standard 6		
(3) No difference 3		
b. If you had a choice, which jacket would you select?		
(1) Experimental 20		
* (2) Standard 4		
(3) No preference 1		

*10 subjects wore A-2 jackets and 15 subjects wore N-1 jackets as standards

TABLE IV - EXPERIMENTAL IMPERMEABLE COLD WEATHER JACKET
SUMMARY OF DATA FROM QUESTIONNAIRES, PHASE II
USS DECATUR (DD-936), USS LAKE CHAMPLAIN (CVS-39)

	Yes	No	No Difference
1. Warmth and Protection			
a. Did the jacket and hood provide warmth at temperatures ranging from 20° to 35°F.?	17	0	
b. Did jacket and hood provide warmth at temperatues below 20°F.?	17	0	
c. Were the jacket and hood too warm above 40°F.?	14	3	
d. Did the experimental jacket and hood seem warmer than the standard A-1 items you have been wearing using the same combination of clothing accessories? (7 subjects did not have A-1 items.)	2	7	1
e. Did the jacket and hood provide you good protection under wet/cold conditions?	16	1	
2. Fit			
a. How did the jacket fit?			
(1) Good	3		
(2) Fair	6		
(3) Unsatisfactory	8		
b. How did the hood fit when worn over accessory items? (9 test subjects did not wear it in this manner.)			
(1) Too large	0		
(2) Too small	6		
(3) Just right	2		
3. Comfort and Ability to Work			
a. Was the jacket and hood comfortable to wear when performing your duties?	16	1	
b. Did you have any difficulty performing duties?	3	14	

TABLE IV (Cont'd)

	Yes	No	No Difference
4. Durability			
a. Were there any signs of wear and/or breakdown to any components?	0	17	
5. General Comments			
a. Do you like an attached hood better than a separate hood?	4	11	2
b. If you had a choice which jacket would you choose? (10 subjects wore A-1 jacket, and 7 wore N-1 jacket as standards.)			
(1) Experimental	12		
(2) Standard	3		
(3) No preference	2		

TABLE V - EXPERIMENTAL PERMEABLE COLD WEATHER JACKET
SUMMARY OF DATA FROM QUESTIONNAIRES, PHASE II
USS DECATUR (DD-936), USS LAKE CHAMPLAIN (CVS-39)

	Yes	No
1. Warmth and Protection		
a. Did the jacket provide sufficient warmth at temperatures above 32°F.?	17	0
b. Did the jacket provide sufficient warmth below 32°F.?	13	4
c. Which jacket provided better protection against high winds?		
(1) Experimental	13	
* (2) Standard	2	
(3) No difference	2	
d. Which jacket provided better protection against wet/cold conditions?		
(1) Experimental	15	
* (2) Standard	0	
(3) No difference	2	

TABLE V (Cont'd)

	Yes	No
2. Fit		
a. How did the jacket fit?		
(1) Good 11		
(2) Fair 4		
(3) Unsatisfactory 2		
3. Comfort and Ability to Work		
a. Was the jacket comfortable to wear when performing your duties?	17	0
b. Did you have any difficulties in performing duties?	0	17
c. Which jacket caused more sweating?		
(1) Experimental 9		
* (2) Standard 4		
(3) No difference 4		
4. Durability		
a. Were there any signs of wear and/or breakdown of any components?	0	17
5. General Comments		
a. Which jacket provided better protection?		
(1) Experimental 12		
* (2) Standard 2		
(3) No difference 3		
b. If you had a choice, which jacket would you select?		
(1) Experimental 12		
* (2) Standard 3		
(3) No preference 2		

*All subjects wore standard A-2 jacket for comparison.

DISCUSSION OF FINDINGS

Analysis of the questionnaires, interviews with test subjects, and examinations of test garments before and after renovation revealed the following:

Polyvinyl Chloride Foam Interlining

Evaluation and examination of the foam interlining during and after both phases of the evaluation were made to determine: (1) the effect of wear and renovation on thickness, flexibility and durability; (2) the ability of the perforations to adequately ventilate the permeable type jacket; and (3) the possible stiffening of the material during wear at low temperature.

Examination of the test garments revealed no evidence of loss of thickness or of excessive stiffening resulting from two winters of use and after being subjected to two renovations (2 launderings or 1 laundering and 1 dry cleaning with standard solvent). Some permanent creasing in the foam was noted where the jackets were folded during storage and shipment, but the creases had no apparent effect on the functioning of the material. Durability of the foam was also excellent with no major tears or breakdown noted during examination of the test jackets.

The purpose of the perforations in the PVC used in the experimental permeable jacket was to allow for dissipation of moisture vapor and prevent overheating. Information from the questionnaires and comments from users indicated that the foam perforations functioned as intended. In fact, a few of the test subjects who wore the standard permeable A-2 jackets indicated greater perspiration build-up in the standard jacket as compared to the perforated foam lined jacket. Several of the subjects who wore the Winter N-1 jacket, which is heavier than the A-2 item, also expressed this comment.

No adverse stiffening of the PVC foam was noted by subjects wearing both experimental items. The lowest temperature reached was approximately 0°F. While 0°F. condition was only briefly encountered, it does not appear the stiffening of the material will present any significant problems in wear. In addition, laboratory tests confirmed that objectionable stiffening does not occur until temperatures below -20°F. are encountered.

Warmth and Insulation

Responses from test subjects during both phases of the evaluation revealed that the insulation provided by both experimental cold weather jackets was excellent and suitable for the purposes intended. In fact, in instances where comparisons were made between the standard and experimental jackets, subjects reported that the experimental permeable jacket provided more warmth than the A-2 jacket. This was especially noticeable in high winds and under wet condition when subjects were not wearing protective rain clothing. The PVC insulation provided better wind protection and also retained its warmth properties since it did not wet-out like the nylon fleece of the standard A-2 jacket. During the entire evaluation no serious complaints were noted concerning problems of excessive chill or cold on the part of test subjects. The experimental impermeable jacket was not considered as warm as the standard A-1 jacket but it provided ample insulation. Some comments were made about wind entry through sleeve openings and the bottom area of the impermeable jackets, which reduced the effective warmth. This did not occur with the permeable jacket since knitted sleeve cuffs and side waist adjustments were provided.

Durability

No problems were noted during the evaluation with the durability of the materials, seams, and accessories used in the clothing. No component wore out, nor was there any evidence of premature failures even though some of the subjects were performing flight deck duties which subjected the test items to rigorous wear. The fact that both types of experimental jackets remained entirely usable after two winters' use and two renovations indicated the reliability of this gear as concerns it serviceability.

Comfort, Fit and Design

The use of PVC foam insulation did not appear to affect the fit or comfort of the experimental permeable jacket as compared to the standard A-2 item. The foam made the jacket somewhat bulkier, but none of the subjects (during both phases of the evaluation) found this to be a problem.. They reported that the permeable jacket fit well and permitted sufficient mobility and freedom of movement to perform their duties without difficulty. Although the present A-2 jacket was well liked, the new jacket was preferred, especially, because of its greater versatility under all use conditions.

The experimental impermeable cold weather jacket was judged to be oversized and somewhat clumsy by many test subjects. This was mainly because the jacket was designed and sized as the outer garment to be worn over, and in combination with, the permeable jacket in extreme cold weather (sub-zero). However, the jackets were not used in combination since the temperatures did not require it. Since the new buoyant jackets are primarily being designed for use aboard ships where the frequency of use of the two items together is extremely low, it would appear to be more advantageous to size the impermeable garment as an independent unit to fit the body and to utilize a next larger size when use of the combination is required.

In addition to the sizing problem of the impermeable jacket, the following additional design shortcomings were noted:

(1) the lack of knit cuffs or other suitable closure at sleeve bottoms, and the lack of a means for drawing up the bottom of the jacket, permitted cold wind to blow into the jacket and caused chilling.

(2) Having the hood permanently attached to the jacket proved unsatisfactory. Most test subjects reported that the hood restricted head movement. In addition, when the hood was thrown back on the shoulder while not in use the wind blew it against the head. Interferences of this sort were felt to be a safety hazard in many operations, particularly those encountered in flight deck operations.

(3) The hood could not be used adequately with the types of sound powered telephone equipment being used or with sound attenuators used during carrier flight operations. Most subjects who wore accessory head items indicated a preference for a separate hood which would be compatible with sound powered phone equipment and/or attenuators. Since both types of equipment must be worn directly over the ears, it appears difficult to provide complete compatibility and still have a hood which would be functional when the various head pieces are not used. Meeting the requirement for head set compatibility may, therefore, require the development of a separate hood to be used by phone talkers and flight deck personnel.

APPENDIX A

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13. ABSTRACT

A service evaluation of experimental buoyant permeable and impermeable cold weather jackets was conducted during two consecutive winters aboard aircraft carriers and destroyers. The extended evaluation was conducted to assess the protective properties, fit, and durability (especially of the buoyant insulation) of the garments. The jackets were insulated with unicellular polyvinyl chloride foam (PVC) which provided sustained emergency buoyancy as an integral component of the jackets. This feature is not provided by the standard Navy A-2 Intermediate Cold Weather Jacket and A-1 Extreme Cold Weather Jacket when the liner is removed. Test results indicated that the new jackets furnished satisfactory, functional utility and environmental protection and that the PVC foam was suitable for use as an insulating material. The tests also revealed certain design shortcomings of the impermeable jacket which will require correction.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT

INSTRUCTIONS

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