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REPORT NO. NADC-82122-60



DEVELOPMENT OF THE HELICOPTER CREWMAN JACKET

Jules Z. Lewyckyji
Aircraft and Crew Systems Technology Directorate
NAVAL AIR DEVELOPMENT CENTER
Warminster, Pennsylvania 18974

JANUARY 1982

FINAL REPORT

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NAVAL AIR SYSTEMS COMMAND
Department of the Navy
Washington, DC 20361

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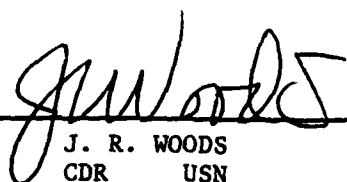
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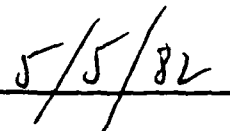
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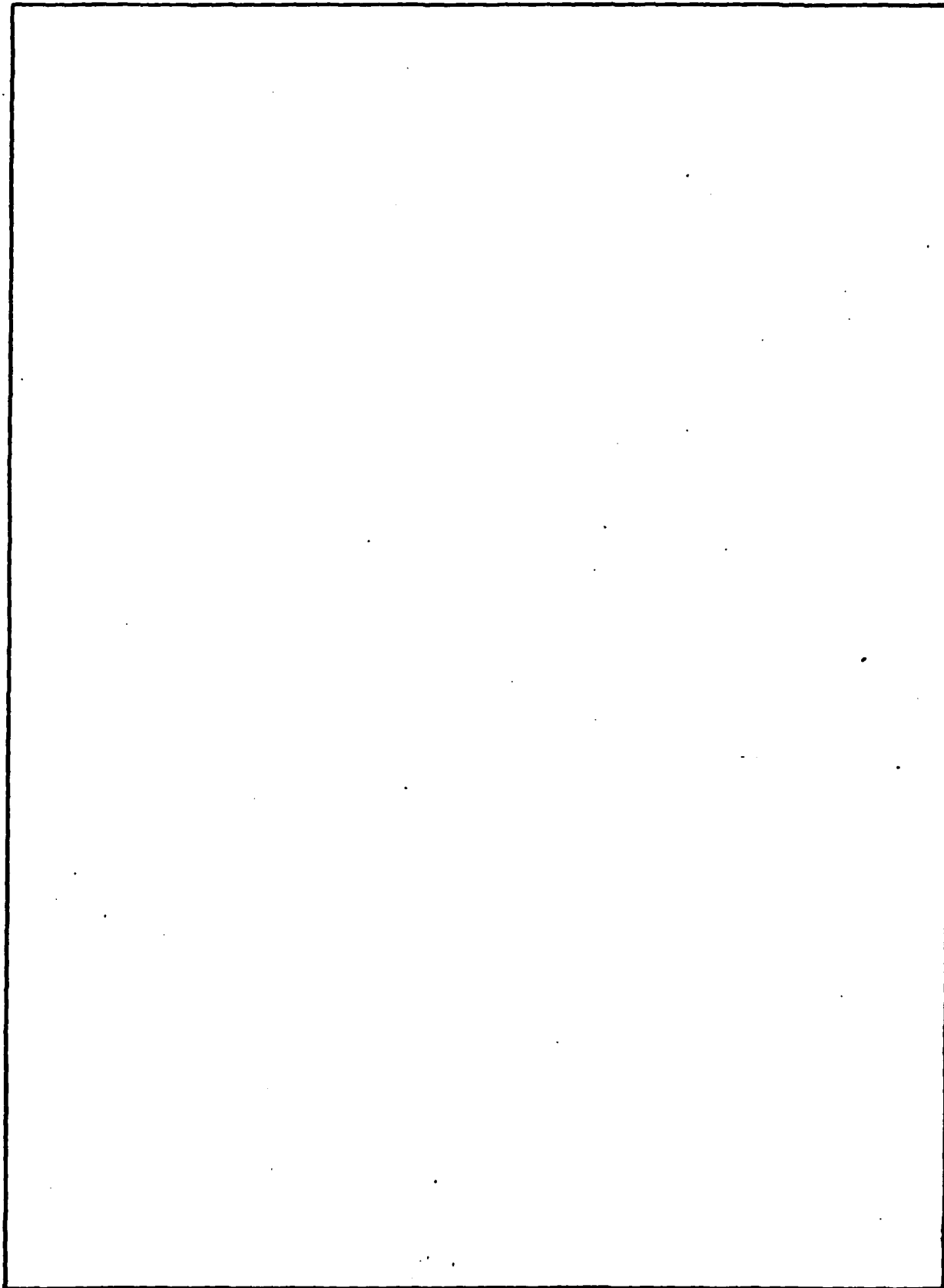
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4. TITLE (and Subtitle) DEVELOPMENT OF THE HELICOPTER MOBILE CREWMAN JACKET		5. TYPE OF REPORT & PERIOD COVERED Final Report
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7. AUTHOR(s) Jules Z. Lewyckyj		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Helicopter Mobile Crewman Jacket Passenger, Helicopter, Jacket Jacket, Helicopter Mobile Crewman or Passenger Flotation Jacket CO ₂ Inflation Device Crewman, Helicopter, Jacket		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This jacket, to be worn by Helicopter Mobile Crewmen or Helicopter passengers, provides for insulation and flotation to a wearer forced into cold water. It consists of an outer fire resistant aramid shell, a vest- like bladder attached to the shell and a layer of insulation. This bladder can be inflated thru a CO ₂ inflation device by a pull on a beaded handle. It can also be inflated orally. When inflated, the jacket will keep the wearer face-up in the water.		

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ATTACHMENT

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- (2) NAVAIRDEVCON ltr to NAVAIRSYSCOM dated 13 Aug 1980 "test & Evaluation Master Plan, Constant Wear Flotation Jacket; forwarding of." B-5
- (3) Test and evaluation Master Plan No. 109-7 Rev. A dated 27 April 1981 "Constant Wear Anti-Exposure Flotation Jacket." B-7

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INTRODUCTION

Mobile helicopter crewmen or helicopter passengers, escaping from a downed helicopter, require a flotation device which will keep them afloat and have enough insulation properties to allow for comfortable 20 minute stay in 32°F water with 20 mph winds. The helicopter mobile crewman jacket, designed for this purpose, permits the crewman or passenger to enter a life raft easily, and is compatible with other equipment worn by him and should not interfere with his normal duties when worn regularly. The jacket should not impede egress from a submerged helicopter during an emergency in-water situation. The jacket design should be such that the crewmen will elect to wear it on a regular basis whenever they board a helicopter for an overwater mission during cold weather operations requiring use of anti-exposure protection equipment.

The jacket consists of an outer fire-resistant aramid twill shell with aramid front zipper. Inside the outer shell and attached to it is a removable vest-like nylon/urethane inflatable liner. At various points in this vest, there are seal points connecting the liner so that when inflated, the inflated vest is patterned in such a way as to keep the jacket wearer afloat, face up. A CO₂ inflation device, with CO₂ bottle, is actuated by a beaded inflation handle extending through the side of the outer jacket. An oral inflation tube is attached, to be used to top off the CO₂ inflation jacket or to be used in the event the CO₂ system does not operate. In addition to the jacket, the aircrewman will wear thermal aramid underwear, aramid flight coverall, winter weight socks, safety boots, and his standard helicopter helmet. The jacket will also have stowage pockets to carry anti-exposure type mittens in case of emergencies.

In case of immersion, the jacket when worn with other prescribed cold weather clothing will keep the wearer afloat (face up) and protected for 2 hours in 45°F cold water, or for 20 minutes in 32°F water with 20 mph winds.

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DEVELOPMENT OF HELICOPTER MOBILE CREWMAN JACKET

Development of a jacket to provide thermal protection and flotation to a wearer was initiated by the Naval Air Development Center in 1974. The U.S. Coast Guard, Washington, DC requested that NAVAIRDEVCEEN establish procedures and provide life saving equipment for deck crewmen on commercial vessels operating in the Great Lakes during the winter. The problem was that of crewmen inadvertently falling into frigid water and drowning or hypothermia setting in quickly with inevitable death unless some means was provided to protect the crewmen until rescue.

In March 1974, NAVAIRDEVCEEN issued a solicited proposal to the Coast Guard titled "Integrated Escape, Survival and Rescue Detection System for Great Lakes Winter Shipboard Operations." This proposal outlined the procedures to be followed in providing for saving personnel exposed to the frigid waters of the Great Lakes during winter operations. In June 1974, the Coast Guard issued a purchase request to NAVAIRDEVCEEN to develop a constant wear module and encapsulating flotation insulating module in accordance with CG-D14-73 "Evaluation of Survival Suits for Use on the Great Lakes."

In 1974-1975, some Jackets were made of nylon cloth with nylon inflatable liners. They had an elastic waist band, patch pockets, and a metal zipper. The test subjects wore Nomex winter underwear, athletic socks, denim work trousers, denim work shirt, wool sweater and high work shoes. In addition, at end, inflatable gloves were worn. About 30 Jackets were tested under various conditions: 32° - 35°F water, 20 knot wind, 20°F air; fire pit tests; cold chamber tests. Tests subjects could withstand cold water/air tests without too low temperatures drops in extremities or too low a rectal temperature drop. Flame tests permitted a 1½ minute exposure to flame before skin discomfort was felt (Reference (a)). After in-water tests at NAVAIRDEVCEEN, the Coast Guard Constant Wear Jacket did not self-right the wearer under all conditions.

This concluded the formal NAVAIRDEVCEEN involvement with the U.S. Coast Guard in the development of the Constant Wear Jacket.

In Oct. 1978, NAVAIRDEVCEEN proposed (Attachment 1) a program to develop a constant wear inflatable garment that would provide insulation and thermal protection and could be quickly inflated in cold water.

In Fiscal 1979, the U.S. Navy determined that a jacket was required for helicopter mobile crewmen and helicopter passengers which would protect the wearer from hypothermia during water immersion and would keep him afloat, face-up. An investigation was begun by NAVAIRDEVCEEN on commercially available jackets and the U.S. Navy developed jacket for the U.S. Coast Guard. This program studied insulating materials as well as jacket design and construction.

The 3M Company (St. Paul, MN) published data on their "Thinsulate" Thermal Insulation (reference b). This data showed the use of infrared thermography to compare effectiveness of clothing insulation and design and discussed the mechanism of heat transfer in fibrous materials. "Thinsulate" is a non-woven batting of fine polyolefin fibers which provides thermal resistance to heat flow. The "Thinsulate" can provide thermal insulation that is better than provided by down, wool, or polyester fiberfill for equal thickness of insulating material.

A request for information was prepared by NAVAIRDEVCON for commercial anti-exposure jackets. In mid 1979, several companies were answering NAVAIRDEVCON requests for information. Winel of America, Inc. (Grafton, OH) proposed their "Norwester Flotation Jacket" "with warmth and flotation qualities" at \$126.00 each. Offshore Products, Inc. (El Cajon, CA) offered their "Blue Water Inflatable Boating Vest" at \$64.95 each. This had a CO₂ inflatable inner bladder. East/West Industries (Farmingdale, NY) proposed a "Quick Donning Anti-Exposure Flotation Jacket" at \$830.00 each. This was to be self-buoyant, quick donning with thermal protection. ILC-Dover (Frederica, DE) proposed their Model 58 Hypothermia Jacket.

In Aug. 1980, NAVAIRDEVCON forwarded (Attachment 2) a Test and Evaluation Master Plan (TEMP) for the "Constant Wear Flotation Jacket" to NAVAIRSYSCOM.

By Oct. 1980, East/West Industries (Farmingdale, NY) had delivered 12 anti-exposure jackets. ILC Dover delivered 10 hypothermia jackets by Dec. 1980.

In Jan. 1981, a NAVAIRDEVCON Program Review presented both ILC Dover and East/West garments and it was stated that in-house testing would start late in Jan. 1981. Funding delays had made the program milestones slip.

In Jan. 1981, both Jacket designs were tested. One type (East/West) contained a heat sealed bladder with additional neoprene foam insulation and an aramid knit outershell fabric. The other (ILC Dover) used Thinsulate insulation in addition to a heat sealed bladder and had an aramid woven twill outershell fabric. Eight (8) of each type jacket were tested. Pool and cold chamber tests were run with subjects from the 3rd, 50th and 98th percentile. The following tests were also conducted: CO₂ inflation times, oral inflation times, pressure tests, permeability test, abrasion and flame tests, aircraft fluid contamination test, laundry resistance tests and face-up flotation tests.

The ILC Dover Jacket was comfortable, the groin insulating protector was easily secured and the Jacket brought the wearer face up in the water.

The East/West Jacket was bulkier, less comfortable and would not bring the wearer face up in the water with or without the groin protector.

In March 1981, NAVAIRDEVCON issued a work request for the TECHEVAL at NATC, Patuxent River, MD. Chaps were to be included during the testing. (The chaps are composed of two pouch-like containers, strapped on to each leg and held up by a belt around the waist. They are used to store survival items, as required by the mission).

In March 1981, a synopsis for procurement of 60 Jackets was placed in the Commerce Business Daily. A Request for Proposal for 60 Jackets went to the NAVAIRDEVCON Supply Department, using open competitive bidding. The RFP also requested the following data: a short report on all work done, knowledge gained, results achieved; test methods and test equipment used; drawings and lists for limited production.

East/West Industries replied that they would only submit costs and pricing if they were selected with no technical proposal since they had previously furnished Jackets.

ILC Dover proposed a 17 week schedule for 60 Jackets with a total cost of \$53,576 (\$15,465 for the development and fabrication of the prototype, \$38,111 for 60 jackets). The outer fabric would be fire resistant aramid 2/2 twill/expanded PTFE, the comfort liner of fire resistant cotton and the Jacket would include a bladder of urethane coated nylon and a black oxide brass zipper (two way nylon zippers are flammable and melt).

In May 1981, NAVAIRDEVCON sent a revised TEMP to NAVAIRSYSCOM (Attachment 3).

In July 1981, a contract was awarded to ILC Dover for 60 Jackets at a cost of \$53,321. Design Review meetings were held on dates indicated with information presented, as follows:

1 Sept. 1981: The bladder was tested at ILC; the cuff and neck were to be neoprene; the raft pocket would be changed to incorporate breakaway capability; one inside zipper would be used.

29 Sept. 1981: 60 Jackets were due in December; face of Jacket would be Nomex/Gore laminate; face-up flotation was guaranteed.

6 Oct. 1981: Pool tests at NATC, Patuxent River, MD, with chaps and gunners belt; flotation face-up was adequate even with zipper partly or full open; heads up flotation was achieved in 1-2 seconds.

15 Oct. 1981: The pocket for Mini-Boat was sewn with break-away thread.

3 Nov. 1981: The latest Jacket was examined: The outer shell is 2/2 Nomex/expanded PTFE; integrated webbing withstood winch test with and without groin protector; Mini-Raft pocket is sewn with breakaway thread; Jacket comes in four sizes; final delivery to be by 25 November.

The Helicopter Mobile Crewman Jacket is shown in a series of pictures (Figures 1 to 16). Figure 1 is a front view, Figure 2 is a back view and Figure 3 is a side view of the Jacket. Figure 4 shows the Groin Insulating Protector, in dropped position. Figure 5 shows the Groin Insulating Protector being secured. Figure 6 shows the beaded handle which releases CO₂ from cartridge to inflate internal vest. Figure 7 shows the oral inflation tube (used to top off CO₂ inflation or to be used if CO₂ inflator device does not operate). Figure 8 shows the inside slide fastener open, exposing the internal vest (bladder). Figure 9 shows the bladder removed from the Jacket. Figure 10 shows the pocket in the back of the Jacket, in which the LRU-18 Mini-Raft is shown. Figure 11 shows the LRU-18 partly exposed and the beaded handle which releases CO₂ to inflate the Mini-Raft. Figure 12 shows the hoisting sling in its stowed position and Figure 13 shows the hoisting sling pulled out and ready-for-use. Figure 14 shows the instruction label, sewed to the inside of the Jacket. Figure 15 shows a wearer afloat in the Jacket and Figure 16 shows the wearer inflating Jacket with air while afloat.

Figure 17 shows the Jacket which did not turn the wearer face-up in the water and it was not chosen for further evaluation.

A formal Technical Evaluation (TECHEVAL) was conducted at NATC Patuxent River, MD. No major problems were encountered and the TECHEVAL was completed successfully. All personnel who wore the Jacket were satisfied with the garment and considered it a very useful article of wear.

At this time, NAVAIRDEVCON is preparing to support the Operational Evaluation (OPEVAL) to be conducted by the Commander Operation Test and Evaluation Force (COMOPTEVFOR), Norfolk, VA.

ACKNOWLEDGEMENT

The author acknowledges the contributions and participation of the following (and the activities they were associated with):

CAPT J. Wildman	Naval Air Systems Command
CDR J. Brady	Naval Air Systems Command
L. I. Weinstock	Naval Air Systems Command
CDR H. Gregoire	Naval Air Test Center, Patuxent River, MD
LCDR B. Slobodnik	Naval Air Test Center, Patuxent River, MD
H. Bless	Sanders and Thomas, Inc. Horsham, PA
D. De Simone	Naval Air Development Center
J. S. Harding	Naval Air Development Center
E. Boscola	Naval Air Development Center
A. Hellman	Naval Air Development Center
R. Pursell	Naval Air Development Center
W. Schrandt	Naval Air Development Center
G. P. Gillespie	Naval Air Development Center

LIST OF REFERENCES

- (a) NADC Report 77070-40 dated 23 Nov 1976 "Ship Escape, Survival and Rescue Detection System for Great Lakes Winter Shipboard Operations"
- (b) "Thermographic Evaluation and Heat Flow Analysis of Clothing Insulation and Garment Design" E.R. Hauser, D. D. Kane, G. D. Nelson

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APPENDIX A -
FIGURES

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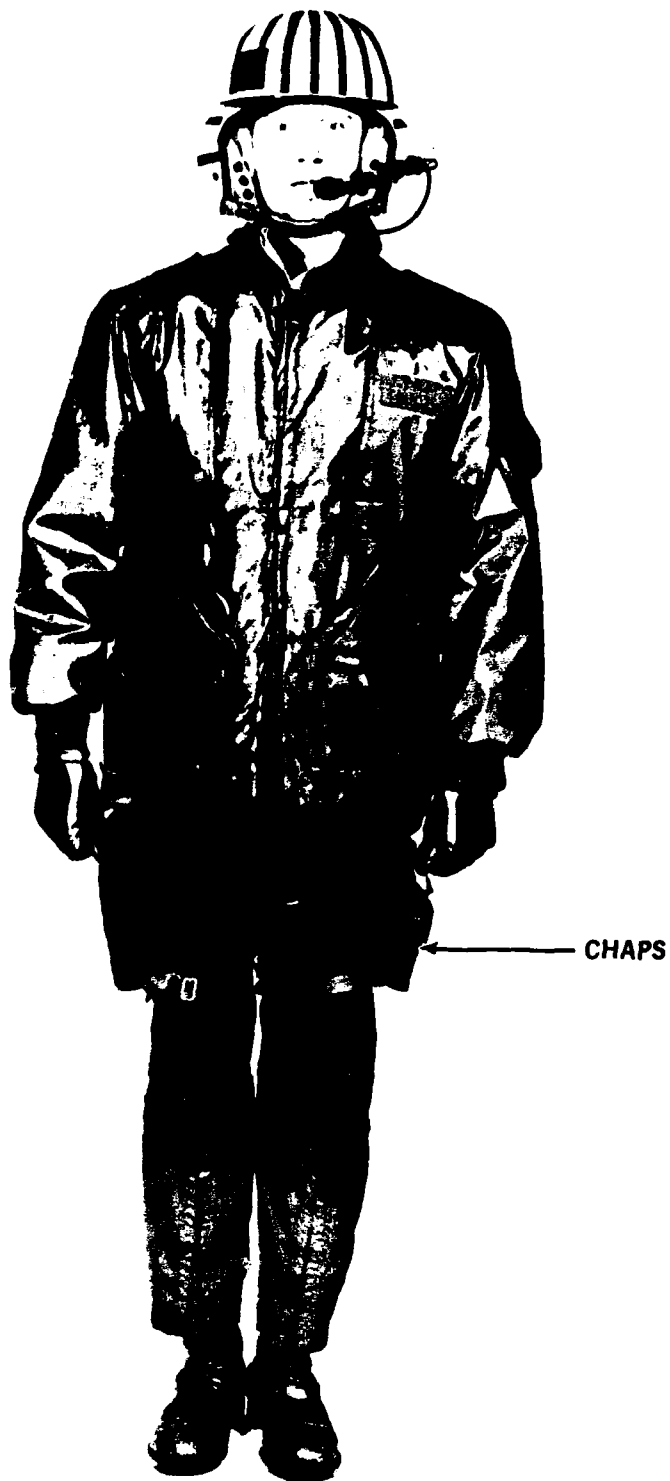


Figure A-1. Helicopter Mobile Crewman Jacket
Front View (Showing Chaps)

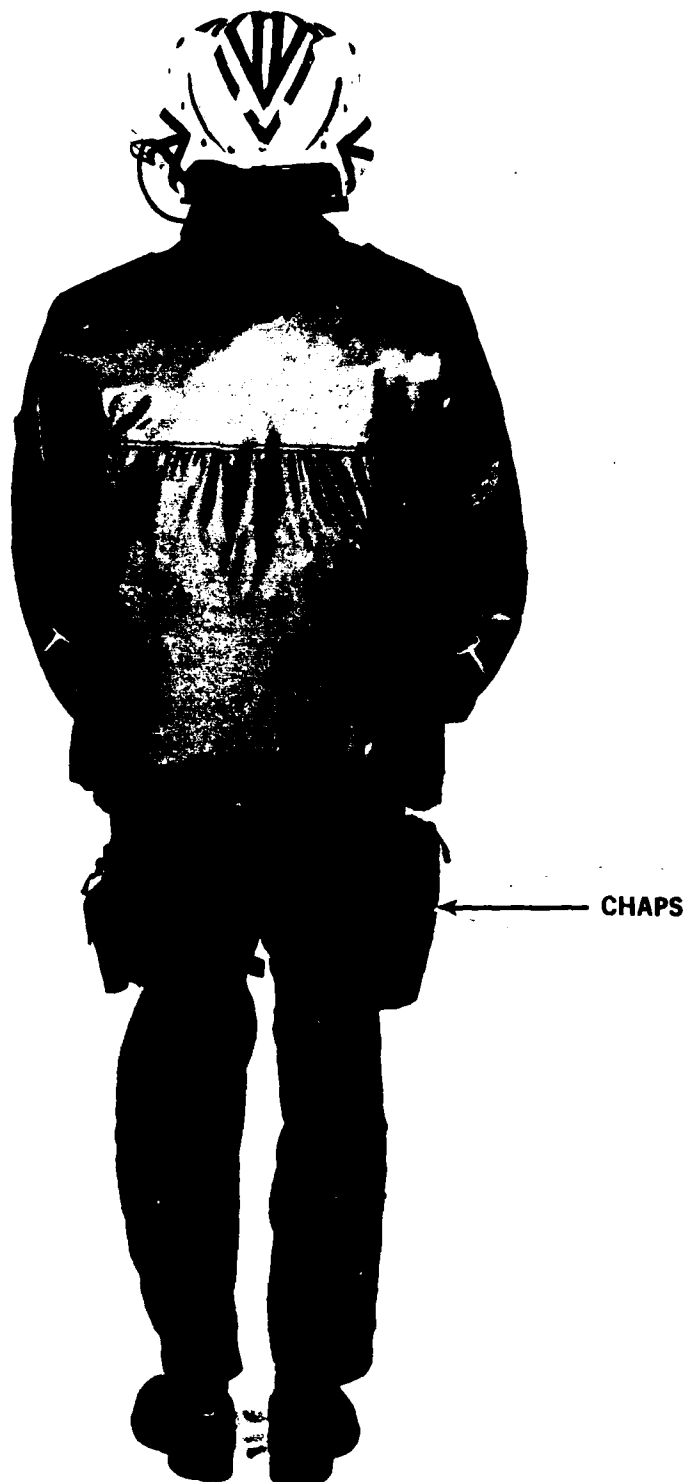


Figure A-2. Helicopter Mobile Crewman Jacket
Rear View



Figure A-3. Helicopter Mobile Crewman Jacket
Side View

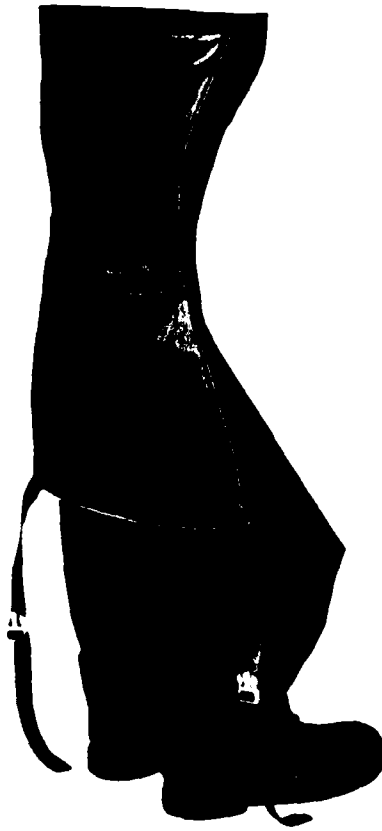


Figure A-4. Helicopter Mobile Crewman Jacket
Groin Insulating Protector, Dropped



Figure A-5. Helicopter Mobile Crewman Jacket
Groin Insulation Protector, Being Secured



Figure A-6. Helicopter Mobile Crewman Jacket
Beaded Handle Which Releases CO₂ Into Bladder

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Figure A-7. Helicopter Mobile Crewman Jacket
Oral Inflation Tube

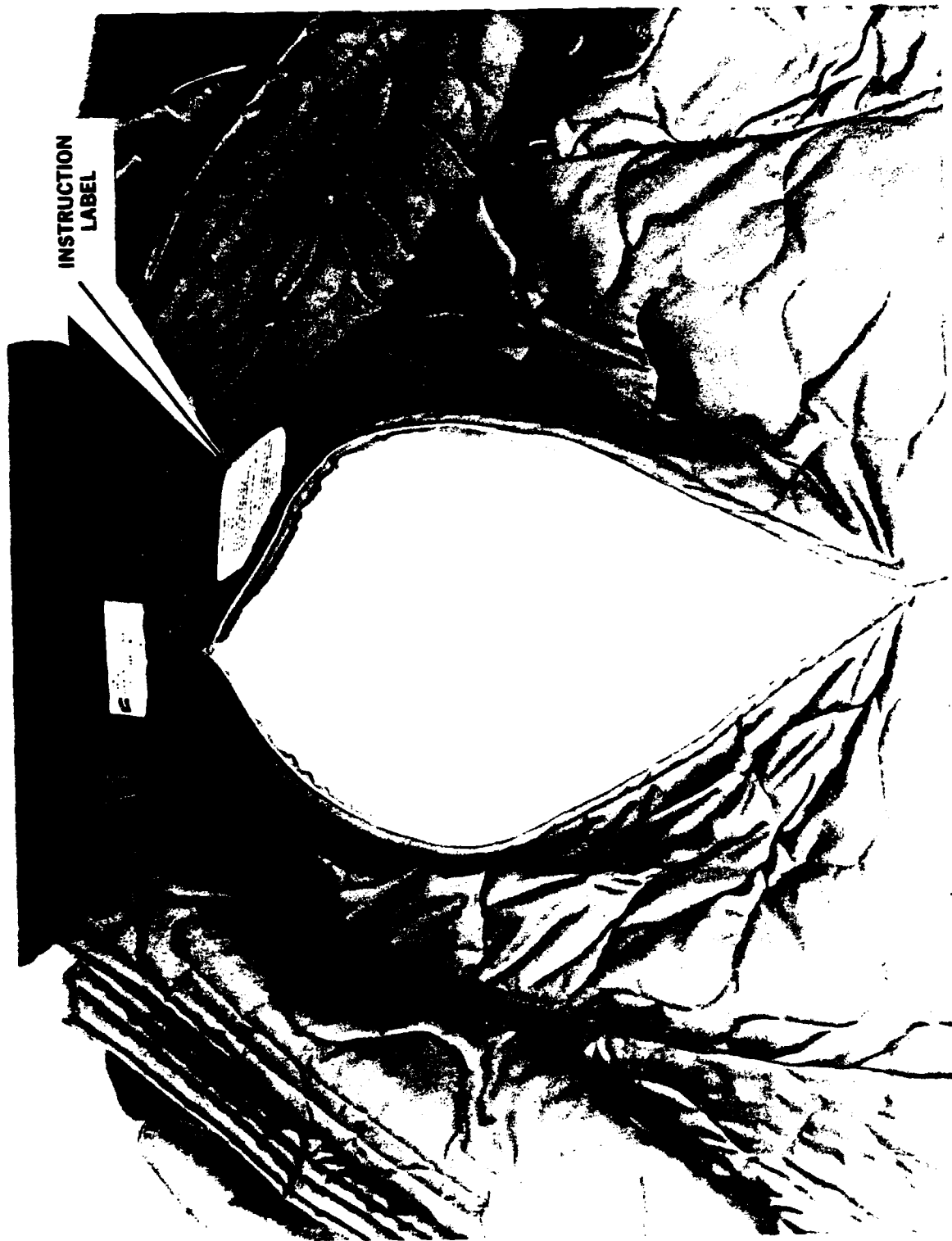


Figure A-8. Helicopter Mobile Crewman Jacket
Slide Fastener Opened to Show Bladder

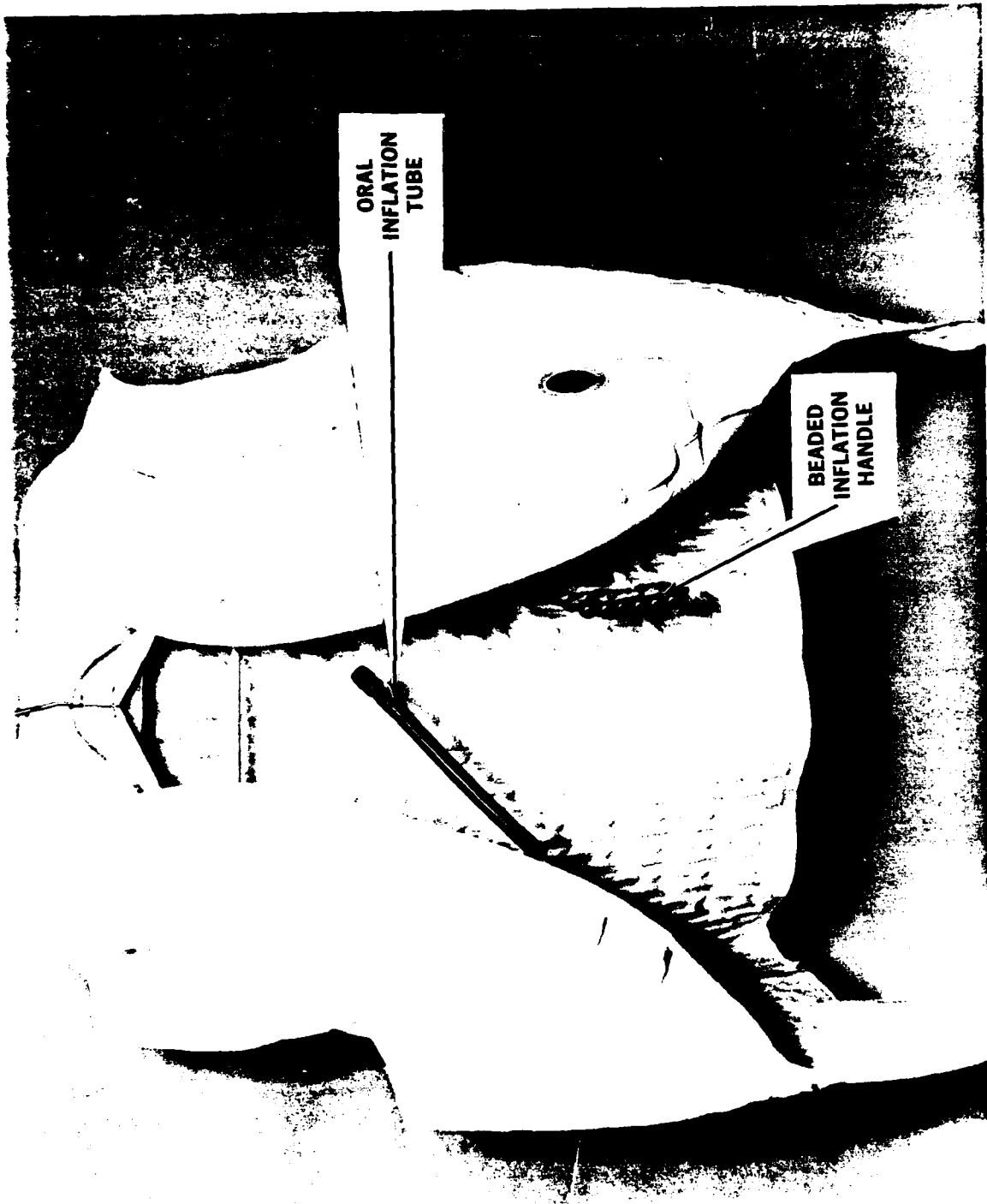


Figure A-9. Helicopter Mobile Crewman Jacket
Bladder Removed From Jacket



Figure A-10. Helicopter Mobile Crewman Jacket
Rear View Showing LRU-18, Mini-Raft, Pocket



Figure A-11. Helicopter Mobile Crewman Jacket
Rear View Showing LRU-18 Mini-Raft

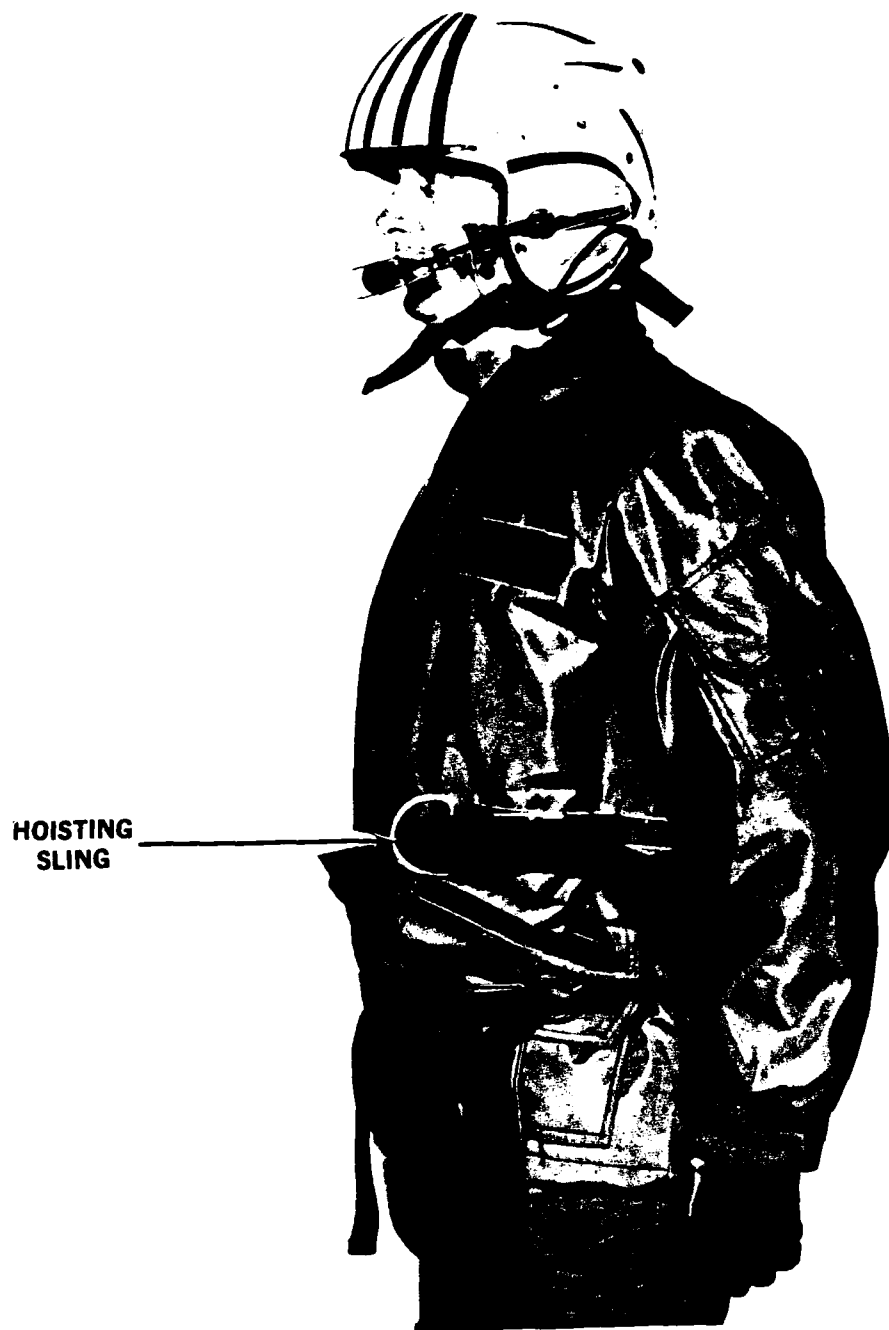


Figure A-12. Helicopter Mobile Crewman Jacket
Hoisting Sling in Stowed Position



Figure A-13. Helicopter Mobile Crewman Jacket
Hoisting Sling Ready-For-Use

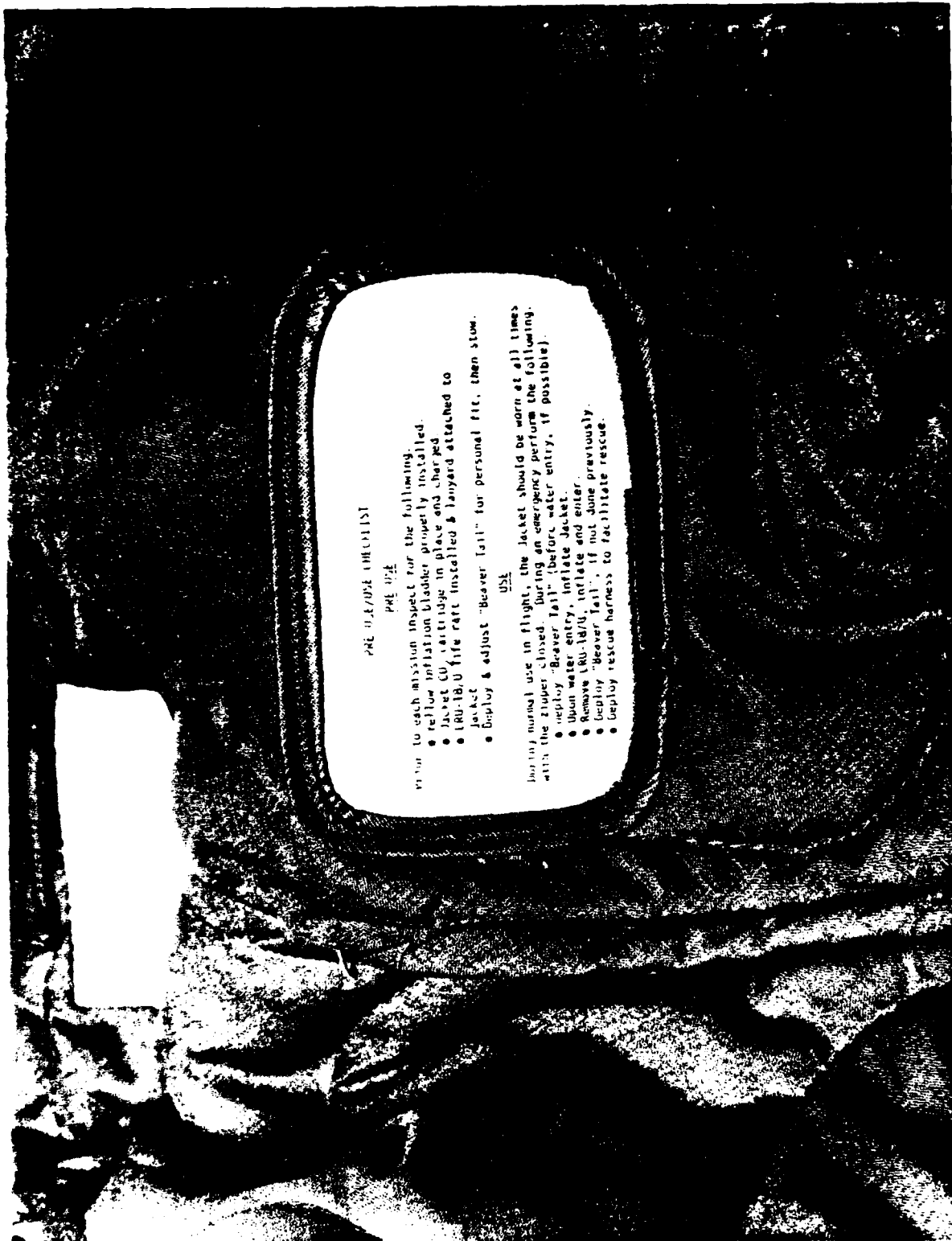


Figure A-14. Helicopter Mobile Crewman Jacket Instruction Label

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Figure A-15. Helicopter Mobile Crewman Jacket
Wearer Afloat

A-15

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Figure A-16. Helicopter Mobile Crewman Jacket
Wearer Inflating Vest With Air

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Figure A-17. Helicopter Mobile Crewman Jacket
Jacket Design Which Did Not Turn Wearer Face-Up

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ATTACHMENT (1) - NAVAIRDEVCON Program Management Summary of Research and Development "Protective Clothing and Devices (Jacket with Flotation)" dated 10 Oct 1978.

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PROGRAM MANAGEMENT SUMMARY OF RESEARCH & DEVELOPMENT EFFORTS

Program Element No. 63216N Task Area Title: Airborne Life Support Systems
Sub-Task Title: Protective Clothing and Devices (Jacket with Flotation)
Program Status: On-going ☐ Proposed ☐ Planned ☒ Date: 1 Oct 1978
Performing Laboratory/Center: NAVAIRDEVCEM/ACSTD
Technical Coordinator/Phone: D. DeSimone, DPN/441-2187
Project Engineer: N. Benson/R. Zaffiri
Contributing Laboratory/Center: _____
Cognizant SYSCOM Code: AIR-340B
CNM Product Area No./Title: 5/Crew Equipment & Life Support

1. Program Description

a. Objective

b. Technical Approach

c. Goals

Objective - To provide aircrewmembers, faced with the possibility of cold water exposure, protection by means of a constant wear inflatable garment which imposes a negligible degree of discomfort during the hours of inflight wear.

Technical Approach - Develop an abbreviated inflatable body garment that can be constantly worn, and quickly inflated by the wearer in a cold water immersion situation, and which will provide insulation and thermal protection.

Goals - To save the lives of aircrewmembers exposed to the hazards of cold water immersion.

2. Justification

a. Problem

b. Payoff

c. Risk

Problem - Insulation clothing for exposure protection of aircrewmembers is usually cumbersome to wear during the inflight mode and reduces inflight performance. Many crewmembers elect not to wear some of this required clothing with the risk of being insufficiently protected in the event of immersion in cold water.

Payoff - Increase chances of aircrewmembers survivability in cold water.

Risk - No technical risks anticipated.

ATTACHMENT (1) - 1

3. Program Coordination Other Navy ☐ USMC ☒ Army ☒ USAF ☒ TriService ☒ Other _____

The Army and USAF will be kept informed through the Tri-Service Life Support Steering Committee.

NADC-82122-60

Task Title:

Date:

Protective Clothing and Devices (Jacket with flotation)

1 Oct 1978

4. Performer Funding (SK)

a. Funding	To Date	FY 78	FY 79	FY 80	FY 81	FY 82	To Comp	Total
NADC	-	-	38.0	54.0	48.0	48.0	-	188.0
PFA(s)	-	-	-	-	-	-	-	-
Contracts(s)	-	-	70.0	-	-	-	-	70.0
Total	-	-	108.0	54.0	48.0	48.0	-	258.0
b. Contractors/PFA's	To Date	FY 78	FY 79	FY 80	FY 81	FY 82	To Comp	Total
TBD	-	-	70.0	-	-	-	-	70.0

5. Milestones

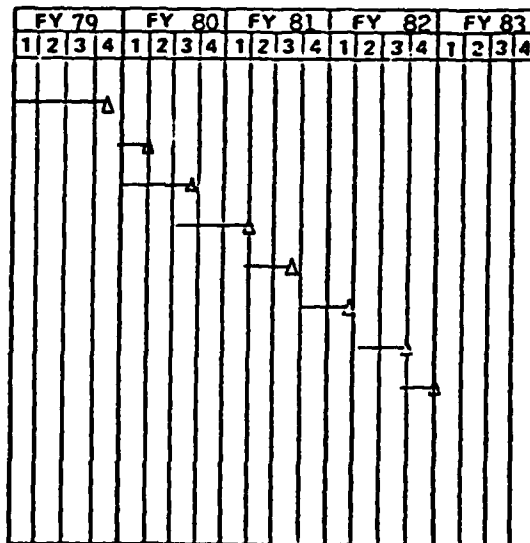
Start Date: 1 October 1978

Completion Date:

Projected IOC:

EVENTS

Develop functional breadboard model
 Complete technical T&E of System
 Interface with COMPTVEFOR
 Complete System definition
 Pilot Production Procurement
 OPEVAL
 Approval for Service Use
 Release for Production for Service Use



KEY: Δ Scheduled Event Δ Completed

6. Prepared by:

N. Benson

7. Approved by:

D. N. De Simone

Date:

1 Oct 1978

New Program

EVENTS

Establish TD?/DCP

Revise TDP/DCP

Establish Functional Breadboard Model Design

Develop Functional Breadboard Model

[illegible]

	CFY-1	CFY	CFY+1	CFY+2	CFY+3
a. Professional Man-Years		0.4	0.6	0.6	0.6
Military Man-Years		-	-	-	-
Technical Man-Years		-	-	-	-
Shop Man-Years		0.2	0.3	0.2	0.2
Total Direct Labor Man-Years		0.6	0.9	0.8	0.8
b. Total Labor & Overhead		35.0	50.0	45.0	45.0
Materials and Travel		3.0	4.0	3.0	3.0
Major Procurement/Contracts		70.0			
Planning Estimate		108.0	54.0	48.0	48.0
Funds Available					

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ATTACHMENT (2) - NAVAIRDEVCON ltr to NAVAIRSYSCOM dated 13 Aug 1980 "Test & Evaluation Master Plan, Constant Wear Flotation Jacket; forwarding of."

6033

6333

13 AUG 1980

From: Commander, Naval Air Development Center
To: Commander, Naval Air Systems Command (AIR-531)
Subj: Test and Evaluation Master Plan (TEMP), Constant Wear Flotation Jacket;
forwarding of
Ref: (a) DODDIR 5000.3 of 26 Dec 1979
(b) NAVAIR Conference Mr. L. Weinstock (AIR-5311) and NAVAIRDEVCEEN,
Mr. J. Z. Lewycky (603312) of 30 Jul 1980

Encl: (1) NAVAIRDEVCEEN TEMP, Constant Wear Flotation Jacket of 1 Aug 1980

1. Enclosure (1) has been prepared in accordance with reference (a) and is forwarded as discussed in reference (b) for review and approval.
2. Further information concerning this matter may be obtained from this Center, Mr. J. Lewycky, Autovon 441-2861/2092.

J. HARDING
By direction

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ATTACHMENT (2)

NADC-82122-60

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NADC-82122-60

Attachment (3) - Test and Evaluation Master Plan No. 109-7 Rev. A dated
27 April 1981 "Constant Wear Anti-Exposure Flotation Jacket."

Date Rev 27 Apr 1981

Test Evaluation Plan, No. 109-7

Anti-Exposure-Flotation Jacket

Administrative Information

1. Full Program Title: Constant Wear Anti-Exposure-Flotation Jacket.

CP/NDCP No. Waived (CNO Memo Ser 987/645098 dtd 15 Sept 80)

2. Program Element No: 64264N Project No. W0606-SL
3. Acquisition Category: ACAT III DA: Naval Air Systems Command
4. Points of Contact:

<u>Title</u>	<u>Name</u>	<u>Code</u>	<u>AV Phone No.</u>
Program Sponsor	VADM W. L. McDonald	OP-05B	225-2629
Program Coordinator	CDR E.P. Vollmer	OP-506N	224-2504
Development Coordinator	LCOL W.A. Allanson	OP-982E31	224-4840
Acquisition Manager	CAPT J.B. Wildman	NAIR-531	222-7548
Participating AM			
CHNAVMAT Coordinator	Mr. J. Sivy	MAT-08DC	222-2646
DA Test Director	CDR J.B. Brady	NAIR-5311	222-7482
Operational Test Director		VX-1	351-8796
Operational Test Coordinator	LCDR W.R. Brenner	COMOPTEVFOR	690-5080
DA Test Director	Mr. D. Wright	NAIR-6203A	222-7809
NAVAIR/ASU Coordinator	CDR P. Wiest	NAIR-101R	222-6168
NAVAIR Project Manager	Mr. W. Weinstock	NAIR-5311D	222-7480
NAVAIR Logistics Manager	Mr. C. Tanger	NAIR-4114A3	222-9193
NAVAIRDEVCON (CFA) Program Mgr.	Mr. E. Boscola	NADC-60302	441-2188
Program Engr.	Mr. J. Lewyckj	NADC-603312	441-2412

ATTACHMENT (3) - 2

5. Funding and Procurement

Funding (\$M)	1980 and prior	1981 (Note 1)	1982	1983	1984	1985
RDT&E						
Non-T&E	70	54	35			
DT&E		21	5			
OT&E				75		
PAT&E					10	
Procurement						
Non-T&E						
DT&E	20					
OT&E		63	35			
PAT&E					TBD	
O&M						
DT&E						
OT&E						
PAT&E						
Procurement Quantity						
Preproduction Prototypes	22	60				
Pilot Production						
Production					TBD	

Note 1 Current FY

6. Delivery and Installation

a. Delivery Schedule	1980 and prior	1981 (Note 1)	1982	1983	1984	1985
Preproduction Prototypes	22	60				
Pilot Production						
Production					TBD	
b. Programmed Testing						
FY-81 - DT-IIA at NAVAIRDEVGEN; DT-IIB at NATC, Patuxent River, MD						
FY-83 - OT-II at COMOPTEVFOR site						

7. Remarks

When the DA judges system ready for OPEVAL, he certifies readiness to CNO via CNM. Criteria: a. TEMP current and approved by CNO b. all DT-II completed c. all TEMP specified DT-II objectives are met d. there is a high probability that system will perform in OPEVAL and will meet criteria for ASU after OPEVAL.

ATTACHMENT (3) - 3

Date Rev 27 Apr 1981

TEST AND EVALUATION MASTER PLAN NO. 109-7

Anti-Exposure-Flotation Jacket

PART I Description

1. Mission. Mobile helicopter crewmen, escaping from a downed helicopter, require a flotation device which will keep them afloat and have enough insulation properties to allow for comfortable 20 minute stay in cold water with 20 mph winds. The constant wear anti-exposure flotation jacket, designed for this purpose, should permit the crewman to enter a life raft easily, should be compatible with other equipment worn by him and should not interfere with his normal duties when worn regularly. The jacket should not impede an aircrewman's egress from a submerged helicopter during an emergency in-water situation. The jacket design should be such that the crewmen will elect to wear it on a regular basis whenever they board a helicopter for an overwater mission during cold weather conditions requiring use of anti-exposure protection equipment.

2. System.

a. Key functions. The constant wear anti-exposure flotation jacket (hereafter referred to as the Jacket) has been developed to answer the needs described in the mission, above. It consists of an outer fire-resistant aramid twill jacket with aramid front zipper. Inside the outer jacket and attached to it is a removable vest-like nylon inflatable liner. At various points in this vest, there are seal points connecting the liner so that when inflated, the blown up vest is compartmented in such a way as to keep the jacket wearer afloat, head up. A CO₂ inflation device, with CO₂ bottle, is actuated by a beaded inflation handle extending through the side of the outer jacket. An oral inflation tube is attached, to be used to top off the CO₂ inflated jacket or to be used in the event the CO₂ system does not operate. In addition to the jacket, the aircrewman will wear thermal aramid underwear, aramid flight coverall, winter weight socks, safety boots, and his standard helicopter helmet. The jacket will also have stowage pockets to carry anti-exposure type mittens in case of emergencies.

In case of immersion, the jacket when worn with other prescribed cold weather clothing will keep the wearer afloat (heads-up) and protected for 2 hours in 45°F cold water.

b. Interfaces. The jacket can be worn with other required flight gear and will not hinder the performance of an aircrewman's regular duties when worn in the aircraft.

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c. Unique Characteristics. The jacket will replace the relatively bulky current anti-exposure assemblies and LPU life preservers worn by mobile helicopter crewmen. It will provide a more comfortable and practical system than the standard combination life preserver anti-exposure garment.

3. Required Operational Characteristics (DP for Cold Water Exposure Protection, OR# W1159-SL)

a. Operational Effectiveness

<u>Characteristics to be demonstrated</u>	<u>By Milestone II</u>		<u>By Milestone III</u>	
	<u>Threshold</u>	<u>Goal</u>	<u>Threshold</u>	<u>Goal</u>
(1) Attain complete flotation by using CO ₂ inflation system	15 sec.	8 sec.	10 sec.	8 sec.
(2) Flotation, heads up	Always	Always	Always	Always
(3) Survival * in water at 40°F, Air 30°F, Wind 10 mph	15 min.	30 min.	20 min.	30 min.
(4) Survival * in water at 32-35°F, Air 20°F, Wind 20 mph	10 min.	20 min.	20 min.	30 min.
(5) Boarding of a life raft (LR-1 or Mini Raft)	30 sec. in sea state 2	30 sec. in sea state 3	20 sec. in sea state 2	20 sec. in sea state 3
(6) Compatible for use in following helicopters	H-1,H-2 H-46,H-53, H-60,LAMPS MK-3	Same	Same	Same

* Survival capability to be measured by average skin temperature no lower than 55°F, hand and leg temperatures no lower than 45°F, and rectal temperature not lowered by more than 2°F. Anti-exposure mittens must be worn during these tests.

b. Operational Suitability

- (1) Reliability - The Jacket must demonstrate that it will inflate completely with the CO₂ inflation system. To provide a greater margin of safety an oral inflation tube will be provided in the jacket as an auxiliary inflation system. The system must demonstrate a minimum 95% reliability and a goal of 98% reliability. With constant regular wear of the jacket, the MTBF threshold must be 60 days with a goal of 90 days by Milestone II and a threshold of 90 days and a goal of 120 days by Milestone III.

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Failure shall be determined by failure to hold CO₂ for a period of 4 hours or by wear out of outer jacket so that it is unsuitable for wear.

(2) Maintainability

(a) No organizational maintenance shall be required except for visual inspection. Test, checkout, and maintenance will be performed at the intermediate level. The MTTR threshold must be 1 hour with a goal of 1/2 hour by Milestone II and a threshold of 1/2 hour with a goal of 1/4 hour by Milestone III.

(b) For use on LAMPS helicopters stationed on destroyers, one helicopter crewman will be trained in the minimal maintenance required. Jackets which are in service will have a 91 day inspection period.

(3) Logistic Supportability

(a) When the Jacket is introduced to the fleet, spare parts and repair parts required for maintenance actions will be allotted. The CO₂ and oral inflation devices will be the same as those used in current non-ejection seat A/C life preservers: thus, shorebased spare requirements will be minimized. Also, all maintenance tasks will be within scope of duties and training of current PR's.

(b) On destroyers carrying LAMPS helicopters, items will be stocked on shipboard which are required to perform the few needed maintenance tasks (i.e., CO₂ bottles, inflators, gaskets, replacement inflatable liners, etc.).

(4) Compatibility - The Jacket must be compatible with all aircrew clothing and life support equipment.

(5) Interoperability - The Jacket must not interfere with the helo aircrewman performing his mission duties. These duties include various tasks such as: moving helicopters and cargo; working as mine countermeasure and VERTREP crewmen; directing hoisting operations, sometimes in prone position; and other physically demanding duties.

(6) Training (user) - It must not require more than 1 hour of training. It would be preferable if an untrained survivor could use the jacket successfully. (Training requirements will be supplied by NADC).

(7) Safety - The Jacket must not pose any safety of flight problems to the aircrewman or helo. It must not inadvertently activate while in the aircraft. (If it does activate, it will not create any major in-flight problems).

- (8) Human Factors - The Jacket must fit the 3rd to 98th percentile sizes. It also must be sufficiently comfortable and functionally suitable so that it will not interfere with cold weather helo operations when worn on a continuous basis.

4. Required Technical Characteristics (DP for Cold Water Exposure Protection, OR# W1159-SL)

<u>Characteristics to be demonstrated</u>	<u>By Milestone II</u>		<u>By Milestone III</u>	
	<u>Threshold</u>	<u>Goal</u>	<u>Threshold</u>	<u>Goal</u>
a. Weight	7 lbs.	6 1/2 lbs.	6 1/2 lbs.	4 lbs.
b. Time to inflate with CO ₂	7 sec.	5 sec.	5 sec.	3 sec.
c. Time to inflate orally	2 minutes	1 1/2 min.	1 1/2 min.	1 min.
d. Integrity - CO ₂ pressure test	2 psi	5 psi	2 psi	5 psi
e. Permeability - CO ₂ test	2 psi for 2 hrs	2 psi for 3 hrs	2 psi for 3 hrs	2 psi for 4 hrs
f. Flame test; skin pain threshold time	5 sec.	8 sec.	5 sec.	10 sec.
g. Minimum buoyancy (inflated Jacket)	15 lbs.	20 lbs.	20 lbs.	25 lbs.

5. Critical T.& E Issues

a. Technical Issues

The critical issues to be addressed during testing are vest seam integrity, vest cloth permeability, time to inflate with CO₂ and abrasion resistance of aramid fabric.

b. Operational Issues

The primary factor to be considered is ability of the Jacket to be inflated after immersion and provide a heads - up floating attitude of survivor. It must also provide adequate thermal protection in cold water and cold air. Additionally, it must permit easy boarding of a life raft. The Jacket must be sufficiently durable and tear resistant to be used as a constant wear garment and allow wearer to perform mission specific functions without undue hinderance or premature wear out.

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Date Rev 27 Apr 1981

TEST AND EVALUATION MASTER PLAN NO. 109-7

Anti-Exposure-Flotation Jacket

PART II Program Summary

1. Management

a. NAVAIR Responsibilities

- (1) Resolve any T&E difference with COMOPTEVFOR
- (2) Provide necessary documentation for test item readiness for OPEVAL
- (3) Provide necessary ASU documentation

b. NADC Program Manager's Responsibilities

- (1) Provide TECHEVAL test plan in conjunction with NATC and be responsible for DT-IIA testing.
- (2) Provide test articles for TECHEVAL and OPEVAL
- (3) Provide necessary spares, training syllabus (operating and maintenance), maintenance and operating manuals and necessary special support equipment to COMOPTEVFOR
- (4) Provide deficiency progress and final TECHEVAL reports to NAVAIR and COMOPTEVFOR
- (5) Implement necessary changes as a result of any COMOPTEVFOR deficiency report to permit tests to continue as planned
- (6) Prepare PAT&E procedures and institute ECP's as required to correct fleet discovered deficiencies after production.

c. NATC (Naval Air Test Center, Patuxent River, Md) Test Director's Responsibilities

- (1) Be responsible for DT-IIB Testing
- (2) Insure that helicopter support complies with test plan
- (3) Provide progress and deficiency reports to NADC Program Manager.
- (4) Provide a final TECHEVAL evaluation report (DT-IIB) to NADC, NAVAIR, and COMOPTEVFOR.

d. COMOPTEVFOR Test Director Responsibilities

- (1) Be responsible for OT&E and for preparation of the OT&E test plan.
- (2) During OT-II (OPEVAL), provide for operational support for the testing.
- (3) Provide progress and deficiency reports to NADC program manager.
- (4) Provide a final evaluation OT&E report to NADC and NAVAIR.

2. Integrated Schedule See foldout, II-2

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Date Rev 27 Apr 1981

TEST AND EVALUATION MASTER PLAN NO. 109-7

Anti-Exposure-Flotation Jacket

PART III DT & E Outline

1. DT&E to Date

a. DT-I (1974-1975)

- (1) Equipment Description: Jacket made of Nomex cloth with nylon inflatable liner. It had an elastic waist band, a crotch strap, patch pockets, a metal zipper. The test subjects wore Nomex winter underwear, athletic socks, denim work trousers, denim work shirt, wool sweater and high work shoes. In addition, at end, inflatable gloves were worn.
- (2) Events: Approximately 30 Jackets were tested under various conditions: 32° - 35°F water, 20 knot wind, 20°F air, fire pit tests; cold chamber tests.
- (3) Test Results: Tests subjects could withstand cold water/air tests without too low temperature drops in extremities or too low a rectal temperature drop. Flame tests permitted a 1 1/2 minute exposure to flame before skin discomfort was felt. The crotch strap was removed and the metal zipper replaced with a plastic zipper.
- (4) Management Decision: Obtain a new design which did not require a pop-out of inflatable bladder in the upper chest area for proper flotation.

b. DT-IIA

- (1) Equipment Description: Two Jacket designs were tested. One type contained a heat sealed bladder with additional neoprene foam insulation and an aramid knit outershell fabric. The other used a polypropylene/polyester fiber batt insulation in addition to a heat sealed bladder and had an aramid woven twill outershell fabric. Eight (8) of each type jacket were tested.
- (2) Events:
 - (a) Pool and cold chamber tests were run with subjects from the 3rd, 50th and 98th percentile.
 - (b) Water temperature were first at 45°F, air at 30°F and 10 MPH winds. Then tests were run at 32°F - 35°F water, 20° air and 20 MPH wind.

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- (c) Measurements were made of extremity temperatures, and rectal temperature during above conditions.
 - (d) Subjects wore, in addition to Jacket, winter aramid underwear, athletic socks, aramid overalls, high work boots, inflatable gloves and helicopter helmet.
 - (e) The following tests were also conducted: CO₂ inflation times, oral inflation times, pressure tests, permeability test, abrasion and flame tests, aircraft fluid contamination test, and laundry resistance tests.
- (3) Results: One of the types of Jacket (the polypropylene/polyester fiber batt insulated type) passed the various test phases. The other type (with neoprene foam insulation) was not successful in the testing.
 - (4) Management Decision: Continue testing into the DT-IIB (TECHEVAL) phase with the successful Jacket candidate.

2. Future DT&E

a. DT-IIB (TECHEVAL) (Apr 1981 - July 1981)

- (1) Equipment Description: 10 Jackets which passed DT-IIA successfully will be tested. These will incorporate all improvements required by DT-IIA. They will be the Engineering Development Model.
- (2) Objective: One objective is to support the Management Decision as to first Major Production. The primary objective is the validity of the Constant Wear Flotation Jacket system. In addition, it will evaluate the adequacy of the training and maintenance procedures.
- (3) Events Scope of Testing/Basic Scenarios
 - (a) Subjects from the 3rd, 50th and 98th percentile will test the Jacket in the pool.
 - (b) Inflation capability will be tested. Flotation characteristics will be evaluated. Insulation properties will be checked.
 - (c) On board the helicopter, comfort and mobility of the subjects will be the subject of close scrutiny. The ability of the mobile crewmen to conduct their usual tasks will be evaluated.
 - (d) A standard training curriculum will be provided to test subjects.

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- (e) The Intermediate Maintenance Activity (Parachute Loft) will be instructed in maintenance procedures.
- (f) NATC will report to NADC after each series of tests as noted in the test program to be prepared by NADC. Results will be analyzed by NADC.
- (g) NATC will conduct tests in open sea with several helicopter drops of subjects.
- (h) Training curriculum will be evaluated by NATC management as well as by test subjects.
- (i) Maintenance procedures and maintainability will be evaluated by Parachute Loft, before, during and after testing.
- (j) Analysis and evaluation will be conducted by NATC, NADC and finally by COMOPTEVFOR.

3. Critical Items

- a. Training manuals and materials must be available prior to tests.
- b. Maintenance procedures must be available.
- c. Jackets must be available together with proper number of CO2 bottles and spares to conduct tests.

Date Rev 27 Apr 1981

TEST AND EVALUATION MASTER PLAN NO. 109-7

Anti-Exposure-Flotation Jacket

PART IV OT & E Outline

1. OT&E to Date

- a. No OT&E has been accomplished to date.

2. Future OT&E

- a. OT-II (OPEVAL) (Jan. 1982 - May 1982)

- (1) Equipment Description. This will consist of 60 (4 sizes) pre-production prototype Constant Wear Flotation Jackets. This will be the Jacket tested in DT-IIB with any improvements required as determined by the test results.
- (2) OT&E Objectives: The objective will be to determine whether the operational requirements (as listed under "Operational Effectiveness and Suitability") can be met in an operational environment.
- (3) OT&E Events/Scope of Testing/Basic Scenarios (To be determined by OPTEVFOR).

3. Critical Items

- a. DT-IIB must conclude satisfactorily before OT-II starts.
- b. During OT-II, a failure reporting system will be developed by COMOPTEVFOR and NADC. NADC will analyze any possible failures so that corrective measures may be taken to continue tests.
- c. Operating and Maintenance documents must be available
- d. Integrated Logistics Support Plan (including FMEA) must be available
- e. Logistic Support, including spares and repair parts, must be available
- f. Personnel training for OPEVAL personnel must be completed
- g. System Safety Program is completed

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Date Rev 27 Apr 1981

TEST AND EVALUATION MASTER PLAN NO. 109-7

Anti-Exposure-Flotation Jacket

PART V PAT&E Outline

1. Scope of Testing

- a. A new MILSPEC will be issued for the Jacket. Its quality assurance provisions will insure that materials and workmanship meet required acceptance levels. They will include, at a minimum, examination of fabric, examination of workmanship on seams and attachments and triggering of CO2 bottle to insure proper inflation. Also, each jacket will be inflated with 2 psi air to check seams and fabric for integrity and permeability.
- b. A production lot test quantity of a full range of Jacket sizes will be procured to determine specification validity and commercial producibility using RDT&E 6.6 funds.
- c. A failure reporting system will be established by NADC to monitor problem areas which surface during operational use of the system. The data collected will be used to provide corrective action where required and ECP's for modification to the production of new Constant Wear Flotation Jackets.

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TEST AND EVALUATION MASTER PLAN NO. 109-7 DATE REV 27 April 1981

ANTI-EXPOSURE-FLOTATION JACKET

Part VI-Special Resource Summary

Resource	DT&E	FY 81				FY 82				FY 83				FY 84			
		1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1	2	3	4	1	2	3	4
Test Articles	DT&E		16 ADM	10 EDM													
	OT&E																
ADT&E Support	DT&E				30 AVE HOURS												
	OT&E																
Test Sites	DT&E				NADS, NATC												
	OT&E																
Support Equipment	DT&E				Pod/ FOL/DUBART COLD CHAMBER												
	OT&E																
Logistics Support	DT&E		JACKET SPARES	JACKET SPARES													
	OT&E													JACKET SPARES			
Personnel	DT&E				15 CREW 2-0' LEVEL NATC												
	OT&E				1-1' LEVEL									60 CREW 5-0' LEVEL OPTVFOR			
Personnel Training	DT&E				NATC PERSONNEL									2-1' LEVEL			
	OT&E													OPTVFOR PERSONNEL			
Planned Travel	DT&E				3K												
	OT&E													5K			

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