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INTEGRATION OF PERSONAL EQUIPMENT

TECHNICAL DOCUMENTARY REPORT ASD-TDR-62-601

September 1962

Directorate of Operational Support Engineering
Aeronautical Systems Division
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio

Project No. 6336, Task No. 63619

20061016185

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David Clark Co. Inc., Worcester, Massachusetts;
Author: A. J. Kenneway, III)

NOTICES

8-182N, 300, 10-23-62

FOREWORD

This report was prepared by the David Clark Company Incorporated, Worcester, Massachusetts, on Air Force Contract AF 33(616)-8250, "Integration of Personal Equipment". The work was administered under the direction of the Directorate of Operational Support Engineering, Aeronautical Systems Division, with Technical Monitoring being performed by Mr. William Benson of the Personal Equipment Branch. The studies began in April 1961 and were concluded in June 1962 and represent a joint effort of the Analysis and Evaluation Group at the Laboratory and the Research and Development Group of the David Clark Company Incorporated.

The report was prepared under the direction of Mr. A. J. Kenneway - Project Monitor. The cooperation of the following development and administrative personnel made this report possible: Mr. Joseph A. Ruseckas - Projects Director, Mr. Richard S. Murdock - Photography, Messrs. J. Garrepy, F. P. Carr and C. W. Nadreau - Design Technicians, Mrs. Margaret Plante and Mr. Norman Osborne - Editing and Preparation for Reproduction.

This is the final report on this contract.

* * * * * *

ABSTRACT

Due to the extremely variable environments to which United States Air Force personnel are subjected, survival equipment reliability is becoming an urgent critical requirement. Work continues in design and fabrication of items which will fulfill the requirements, are lightweight, capable of being integrated with other flight equipment, and easily operable by one man. This report describes the approach methods, problem areas and progress made in fabricating a one-man cold water survival raft, several underarm life preservers with and without parachute harness integration, and re-design approaches to the standard one-man life raft (PK-2 and MB-4). These items would provide an aircrew member with survival capabilities if he were subjected to bailout over water. The main problems of designing and integrating these items with others without compromising individual specifications are discussed. Practical solutions were achieved in most areas.

This report has been reviewed and is approved.

W. P. Shepardson

W. P. SHEPARDSON
Chief, Crew Equipment Division
Directorate of Operational Support Engineering

CONTENTS

CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS

ILLUSTRATIONS

I. INTRODUCTION

The particular aircraft mission dictates the personal equipment protection configuration required. Emphasis is placed on the integration of the various assemblies in order that maximum life saving protection, comfort and mobility may be afforded. Only through the best possible compatability of individually required items is the aircrew member given optimum survival capability. Present and future mission requirements dictate the need for continued miniaturization, consolidation and reduction of weight and bulk in personal equipment assemblies. Some results of the overall integration problems are presented in this report.

II. DEVELOPMENT OF A COLD WATER SURVIVAL RAFT

Efforts were made to develop and/or improve a one-man cold water survival life raft. A single ply of fabric, coated on one side only was used. It was the same length as previous models but the circumference was decreased in the main cell. This raft had no insulation and the floor area was inflatable in the buttocks area only, by means of a removable bladder. Figures 1 and 2.

The inflatable floor, fabricated of the basic cell fabric, was constructed in a baffle configuration. The top and bottom layers were joined together by means of baffles.

The canopy was constructed of reduced diameter tubes, or struts, to which a layer of flare cloth was cemented, inside and out, creating a dead air space of approximately two inches. Figure 3. Hook and pile nylon tape (Velcro) was used for the closure of this model. Figure 4. The struts were automatically inflated by means of a life preserver inflator with a 28 gram CO_2 cylinder. Figure 5.

The stabilizers were detachable so the user could, at his discretion, employ them or not under various survival conditions. Figure 6.

A flared tube bailer was used on this model, Figure 7.

The oral inflation tubes were 1/8 inch ID on the struts and 3/8 inch ID on the main cell.

Manuscript released by the author 20 July 62 for publication as an ASD Technical Documentary Report.

Figure 1
One-Man Life Raft Water Survival Only

Figure 2
One-Man Life Raft, Removable Bladder

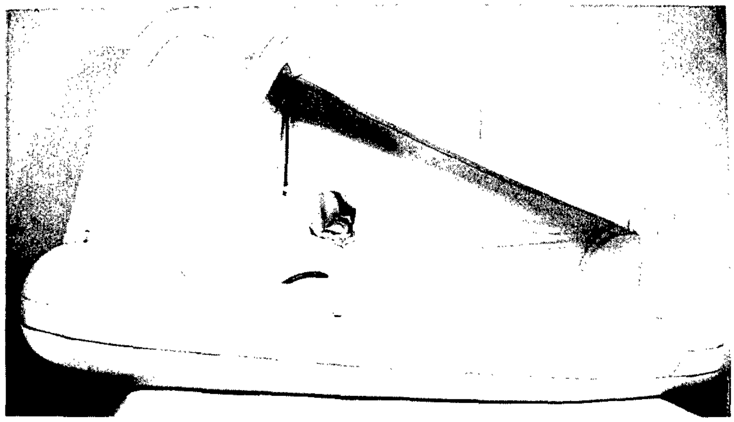


Figure 3
One-Man Life Raft - Canopy

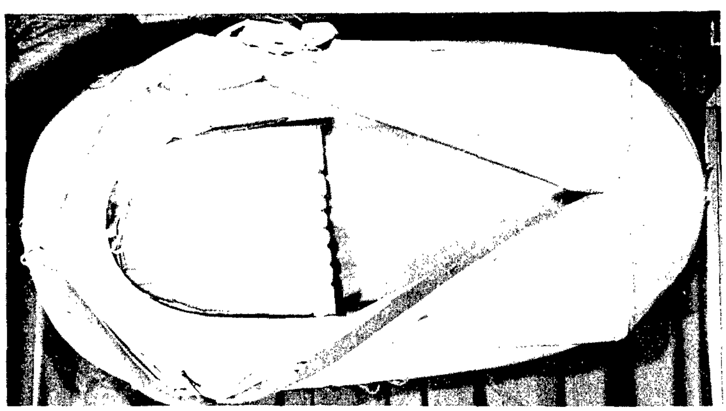


Figure 4
One Man-Life Raft, Hook and Pile Closure

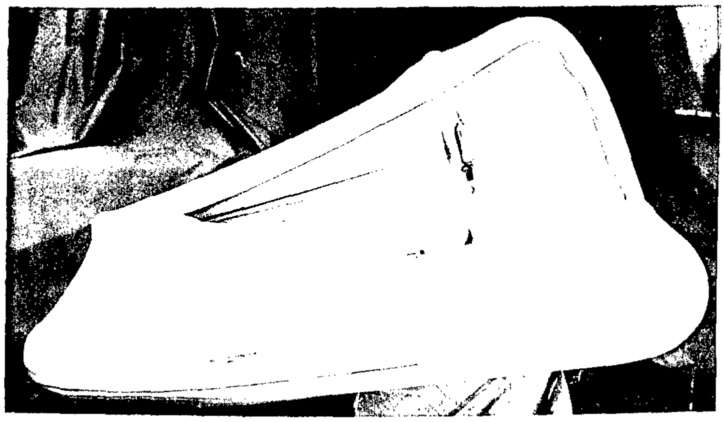


Figure 5
Life Preserver Inflator Cylinder

Figure 6
Mounting for Detachable Stabilizers

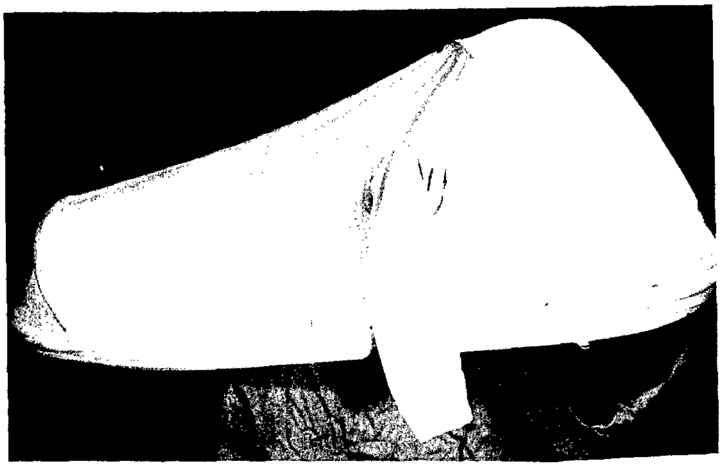


Figure 7
Flared Tube Bailer

A weight reduction was realized due to the type of fabric used, as well as construction re-design. The raft was capable of withstanding the required pressures and the normal treatment required during survival use. This raft was Model #3, P/N S904B.

III. DEVELOPMENT OF UNDERARM LIFE PRESERVERS

Four (4) each underarm life preservers were fabricated, incorporating the following requirements:

1. Inflation System

Each cell was inflated by means of an 18-gram threaded CO_2 cylinder and an inflator 1-9/16 inch in length and 11/16 inch diameter, Figure 8. The inflator has a vent whereby the air in the cell, when subjected to altitude changes, passes through the inflator stem and through the piercing pin cylinder. The inflator lanyard has a 5/8 inch diameter yellow ball attached to the end and is permanently installed to the pack opening lanyard so it is impossible for the actuating lanyard to become wrapped around the inflator lever.

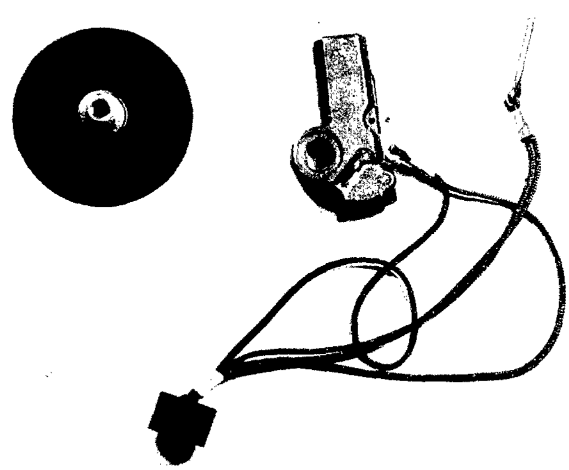


Figure 8
CO_2 Cylinder Inflator

2. Flotation Cells

The shells were made of the flat pattern design, Figure 9, with the cell fabric neoprene coated nylon. A baffle was installed in the area of the inflator attachment within the cell, to prevent cold cracking of the fabric coating. Figure 10. The area where the cell attaches to the pack was reinforced to withstand at least five (5) jumps into a pool from a height of ten (10) feet. Cell color is molten orange.

3. Oral Inflation

The cell oral inflation tube is 1/8 inch ID, with a positive locking oral valve, Figure 11.

4. Pack

A quiltor cord and pin was utilized to close the pack. The cells were attached to the pack by means of nylon cord and the pack was attached to an adjustable harness. A snap and ring was used on the chest strap, Figures 12 and 13.

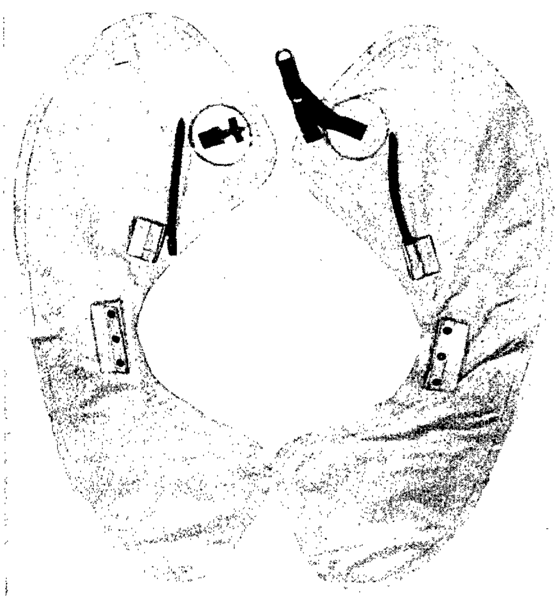


Figure 9
Flat Design Flotation Cells

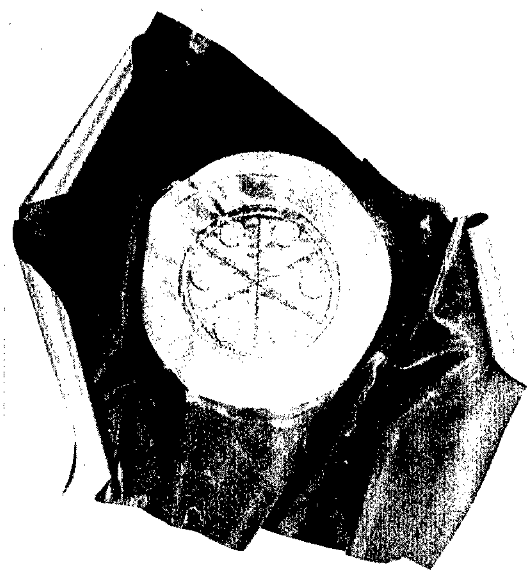


Figure 10
Cold Gas Deflector

Figure 11
Oral Inflation Tube

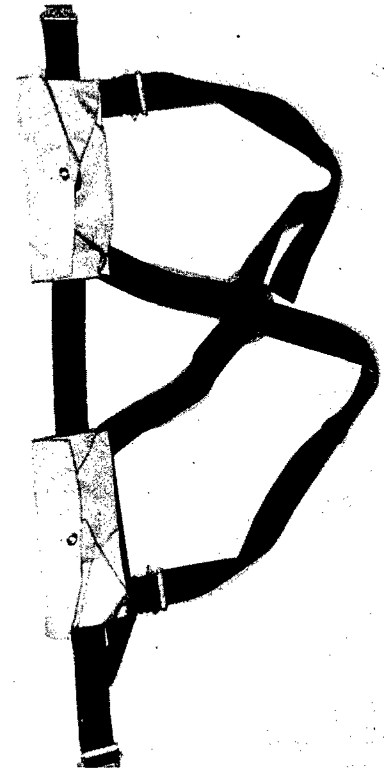


Figure 12
Experimental Life Preserver, With Adjustable Harness

Figure 13
Experimental Life Preserver, With Snap and Ring

Model #1 Life Preserver

This model, with harness, was completed incorporating all the above requirement features, Figures 14, 15 and 16.

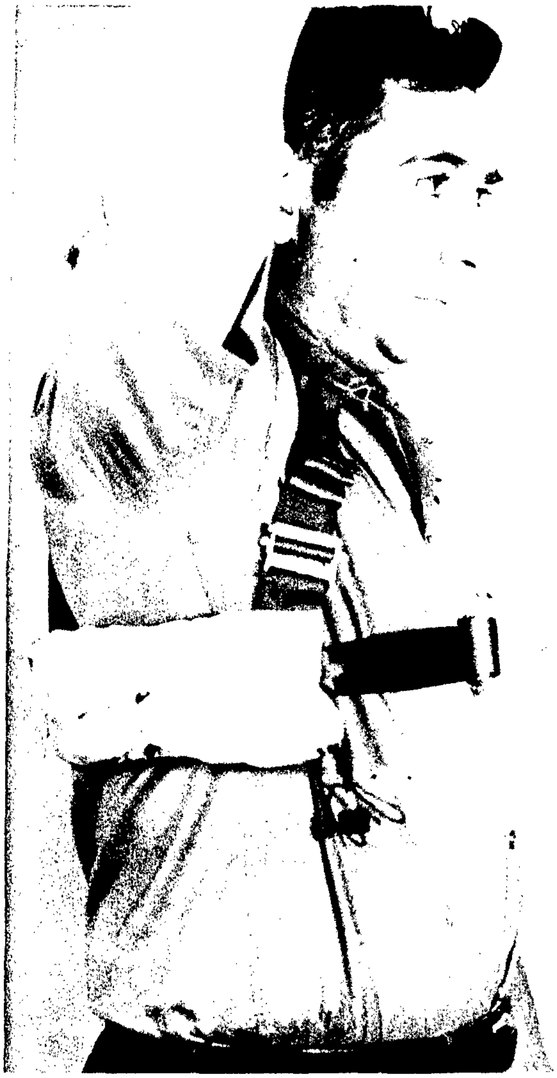


Figure 14

Model #1 Life Preserver, Side View

Figure 15
Model #1 Life Preserver, Front View

Figure 16
Experimental Life Preserver, Inflated, Cell Attached To Container

Model #2 Life Preserver

This model was similar to Model #1, except the cells were inflated by means of a dual inflator (with two (2) each 8-gram CO_2 cylinders). Figures 17, 18 and 19.

Figure 17
Model #2 Life Preserver, Inflated, With Dual Inflation System

Figure 18
Model #2 Life Preserver, Dual Inflators, Front View

Figure 19
Model #2 Life Preserver, Dual Inflators, Rear View

Model #3 Life Preserver

This model, without harness, was fabricated similar to Model #1, except the preserver was capable of being attached to a B-5 parachute harness by adjustable nylon cord lacing and slide fasteners. Each cell was inflated with an 18-gram CO_2 cylinder. Figures 20 and 21.

Model #4 Life Preserver

This model was integrated with the parachute harness designed for the F-106B seat. This was similar to Model #3, except that the slide fasteners were positioned for compatability with the F-106B chute harness. Figures 22, 23, 24, 25, 26.

The above described life preservers were forwarded to Aeronautical Systems Division for evaluation.

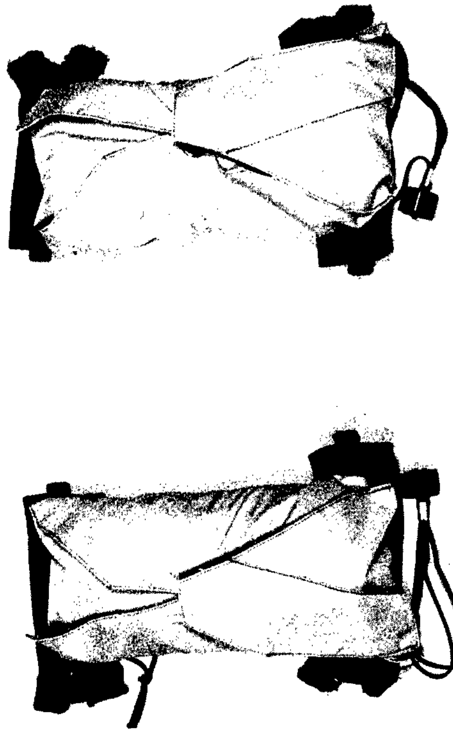


Figure 20
Model #3 Life Preserver, Packaged, Without Harness

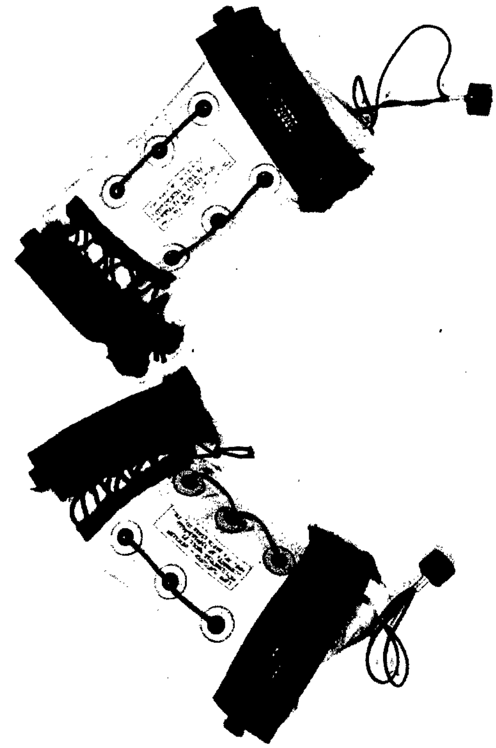
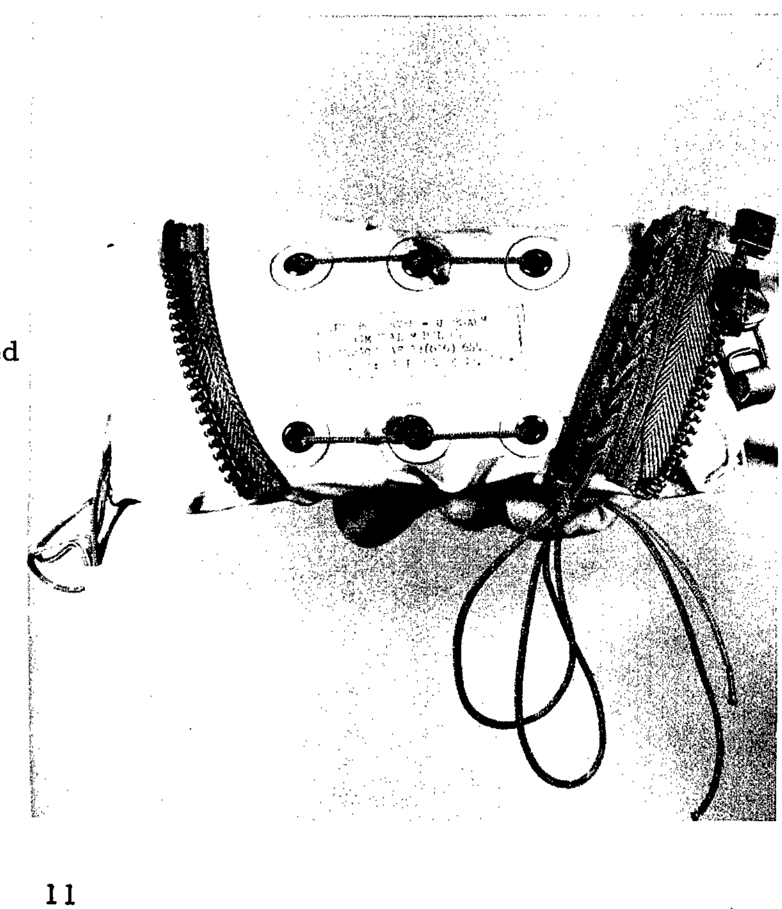


Figure 21
Model #3 Life Preserver Showing Zipper attachment

Figure 22
Model #4 Life Preserver, Packaged



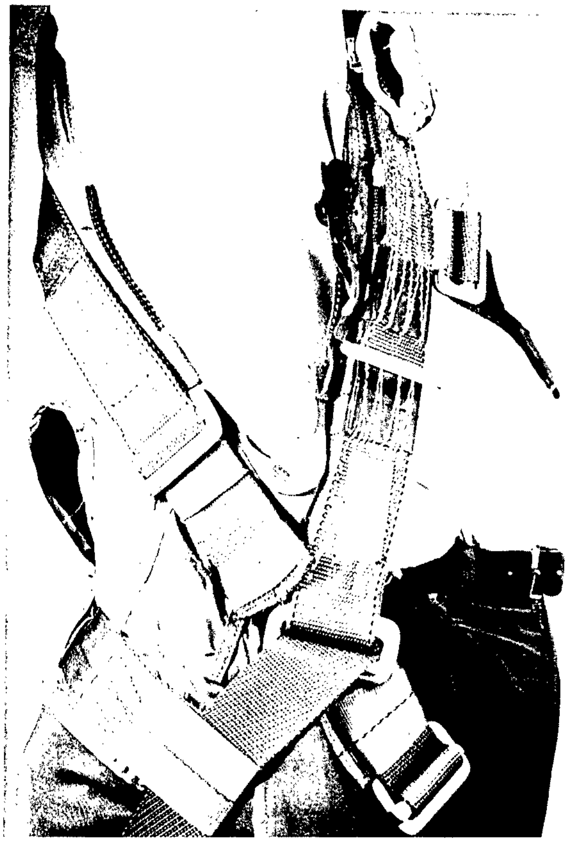


Figure 23
Model #4 Life Preserver, Harness Attaching Feature, Side View

Figure 24
Model #4 Life Preserver, Harness Attaching Feature, Front View

Figure 25
Model #4 Life Preserver, Harness Attaching Feature, Rear View

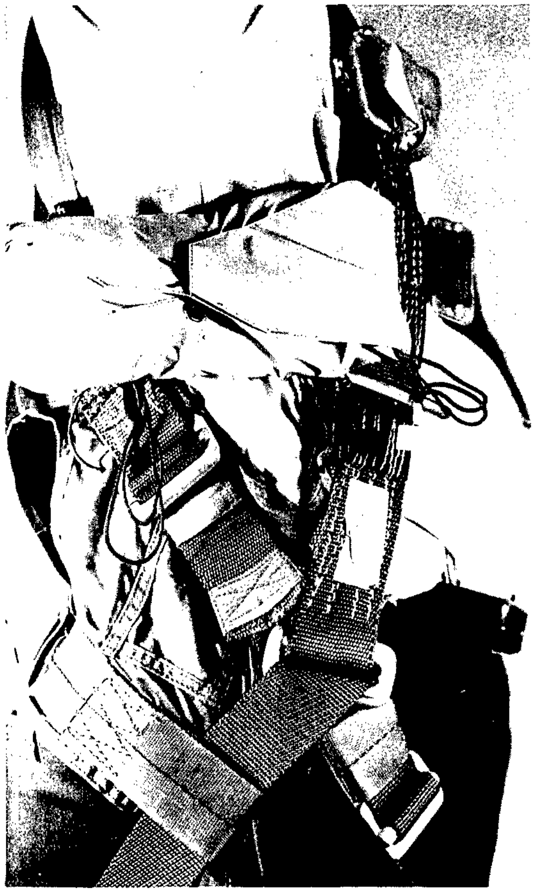


Figure 26
Model #4 Life Preserver, Harness Attaching Feature, Side View

IV. DEVELOPMENT OF STABILIZATION AND BOARDING FEATURES ONE-MAN LIFE RAFTS

Eight (8) each one-man life rafts were re-designed and refurbished in accordance with requirements described in the following paragraphs. These experimental life rafts are similar to MB-4 and PK-2 life rafts and include new stabilization and boarding features of various configurations. For convenience, the experimental rafts are designated Number One through Eight.

Experimental Raft #1

This raft was fabricated having two (2) ballast pockets added to the underside of the life raft floor, along each side, under the water line. The pockets were approximately cylindrical in shape, 18 inches long, 5 inch diameter. Three (3) ports were incorporated near the top of the ballast pockets, large enough to readily admit water into the pockets. Figure 27.

Experimental Raft #2

This raft was identical to Raft #1, except an additional pocket was added at the bow of the raft. The additional pocket was approximately 7 inches wide, 4-1/2

Figure 27
Experimental Raft

inches long, 9 inches deep, containing a port 5 inches long by 1-3/4 inches deep, located at the top of the bow side of the ballast pocket. A loop affixed to the bottom interior was provided with a lanyard to the top of the raft in order to collapse the pocket. Figure 27.

Experimental Raft #3

This raft had two (2) internal vertical bulkheads installed in the raft tube, secured so it could swing in either direction normal to the points of attachment. Figure 28. These bulkheads were installed in the small end of the flotation cell, adequately spaced to facilitate entry of personnel into the raft. An equalizer tube, with valve, was installed to permit inflation of the entry section after boarding the raft. Figures 29 and 30

Experimental Raft #4

This raft had the bulkheads installed as in experimental Raft #3 and the water ballast pockets are the same as experimental Raft #2. Figure 31.

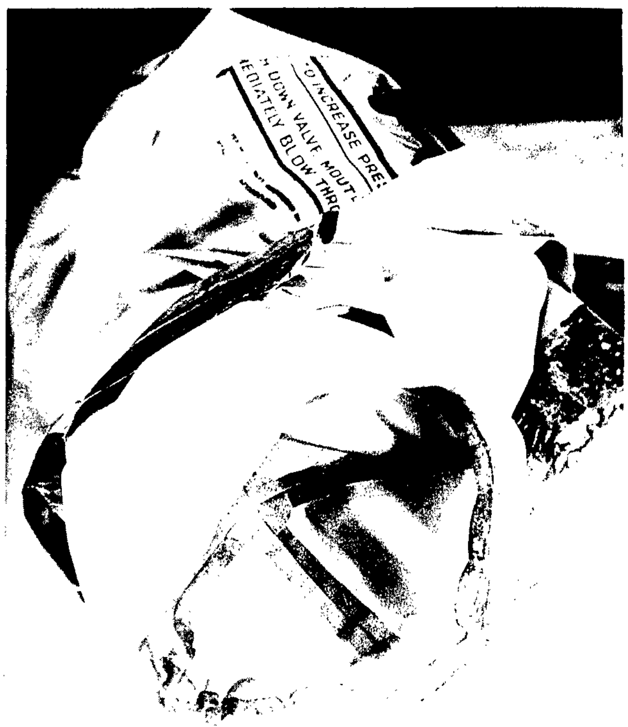


Figure 28
Experimental Raft #3

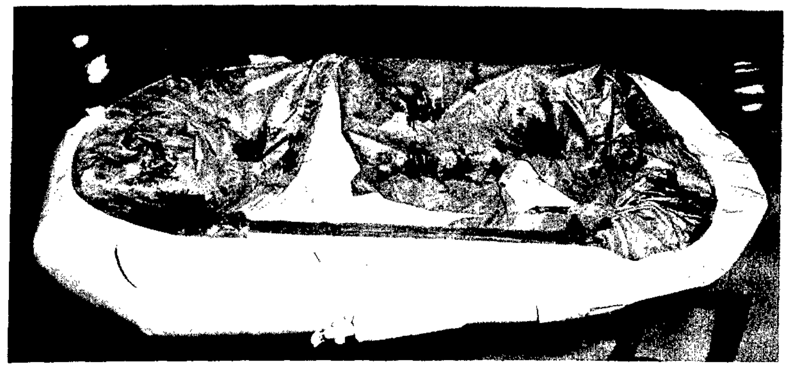


Figure 29
Experimental Raft #3

Figure 30
Experimental Raft #3

Figure 31
Experimental Raft #4

Experimental Raft #5

This raft provided approximately 10 inches of slack material in the floor of the raft, with three (3) water ballast pockets attached, similar to the pockets in experimental Raft #2. The vertical bulkheads, Figure 32, were eliminated.

Figure 32
Experimental Raft #5

Experimental Raft #6

This raft was constructed identical to Raft #3, except 10 inches of slack material was added to the floor. Figures 27, 33 and 34.

Experimental Raft #7

This raft was identical to Raft #6 with the addition of three (3) ballast pockets as in Raft #2, Figure 35.

Figure 33
Experimental Raft #6

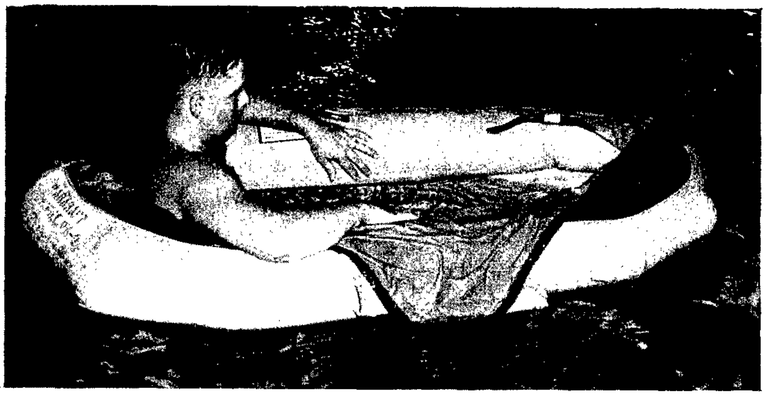


Figure 34
Experimental Raft #6

Figure 35
Experimental Raft #7

Experimental Raft #8

This raft was identical to Raft #7, except the slack material in the floor was reduced from 10 to 5 inches. Figures 36 and 37.

The material used for the life raft floors and ballast pockets was vest cloth, (weighing 8 ounces per square yard). This fabric was used to expedite delivery for scheduled tests. The bulkhead material used in the flotation cell is Type N, Specification MIL-C-6819. The equalizer tubes are the same as the oral inflation tube on the rafts. The valve is the male and female bayonet, with the male portion self sealing and attached to the main cell while the female (non-self sealing) is attached to the boarding area. The valve assembly may be operated manually. Upon completion, these rafts were forwarded to the procuring activity for evaluation.

Figure 36
Experimental Raft #8

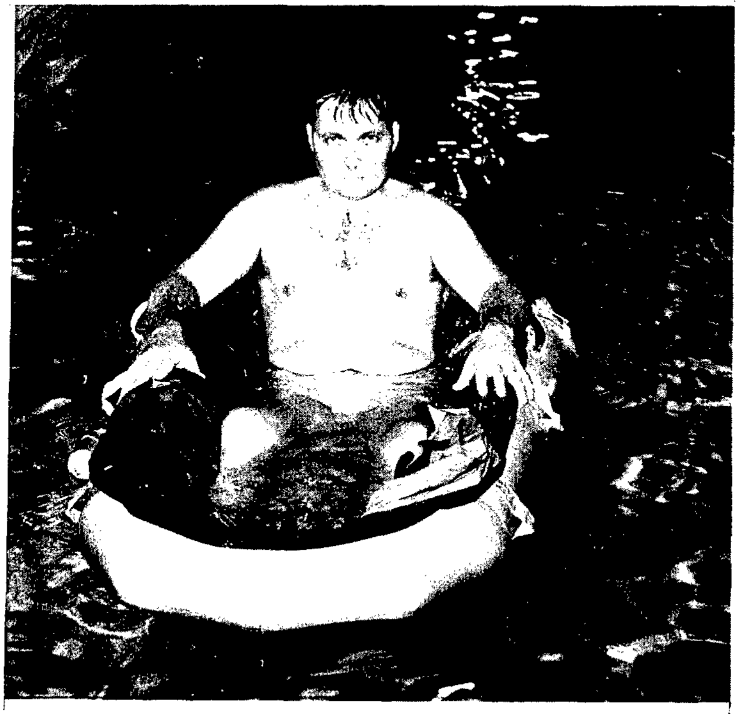


Figure 37
Experimental Raft #8

V. MODIFICATION OF A/P 22S-2 FULL PRESSURE SUIT AND INTEGRATION OF PARACHUTE HARNESS WITH A/P 22S-2 FULL PRESSURE SUIT

1. A request was received to fabricate a parachute harness assembly to be integrated with the A/P 22S-2 Full Pressure Suit. The suit was forwarded to our company and the following work was accomplished:

   a. The vent system in the suit was modified to the most current configuration.

   b. New neck ring was installed, P/N ACS-263.

   c. The parachute harness assembly was integrated with this Full Pressure Suit and returned to the Project Officer for evaluation. Figures 38 and 39.

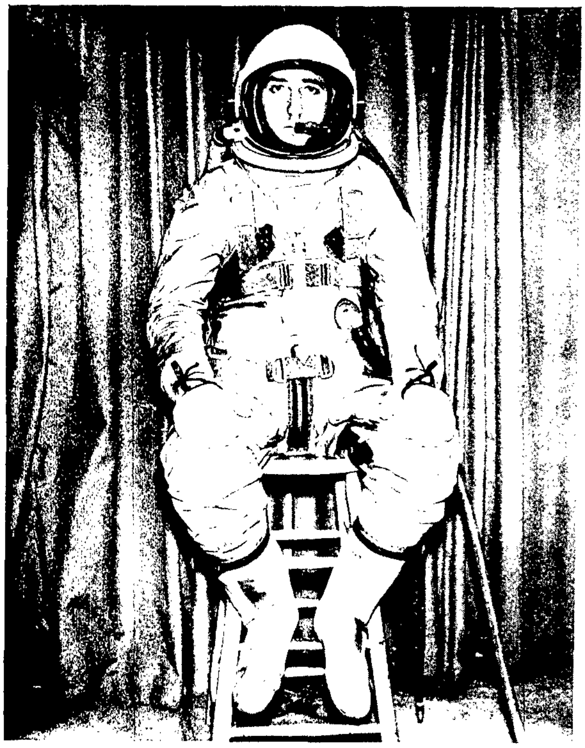


Figure 38
Integration Of Parachute Harness With F/P Suit, Front View

Figure 39
Integration Of Parachute Harness With F/P Suit, Side View

VI. STUDY IN AUTOMATIC ACTUATION AND INFLATION OF SURVIVAL EQUIPMENT

1. SURVIVAL COMPONENT EQUIPMENT CONSIDERATIONS:

The considerations for automatic actuation of survival component equipment upon parachute opening were:

a. Inflation of the underarm life preservers.

b. Deployment of seat kit and the inflation of the life raft.

c. A built-in safety factor in the form of a manual over-ride for actuation (in the event of the failure of the automatic system). An investigation of the possibilities of integrating the Air Force standard flotation equipment, LPU-2/P or LPU-3/P life preservers and MB-4 life raft, to provide means of automatic inflation of life preservers and life rafts immediately after parachute opening, appeared feasible.

The principle in general is as follows:

> When the parachute risers were extended during the parachute opening, the lanyards, attached to the risers, would actuate the inflators of the underarm preservers and pull the actuator handle on the survival kit. The survival kit would drop away from the crewman and inflate the life raft. The CO_2 cylinders and inflator heads would be integrated into the parachute pack, and the preserver pack would be re-designed to eliminate the bulk.

2. DIRECT APPROACHES

a. Approach #1, Figure 40, shows a pin shearing device with a shear pin capacity of approximately 110 pounds attached to the riser midway between the riser buckle and the shoulder strap. A cable with a breaking strength of approximately 200 pounds, anchored to the side of the riser, would pull away on chute deployment. This cable in turn would pass through an eyelet in the lower right side of the parachute cover and tie into the kit release system lever. This cantilever would push a rod forward on the two internal bars, taking the place of the action of the handle release. Basically this system is external, except where it enters into the lever mechanism box and into the parachute pack. Upon parachute opening, the riser strap would start its outward swing and draw the cable attached to the kit release. The opening force of the chute would pull the lever (that drives the rod) in a forward direction approximately 3/4 of an inch, thereby, actuating the various mechanisms in the seat in one motion. There would be a time lapse in each sequence, but not considered in this phase.

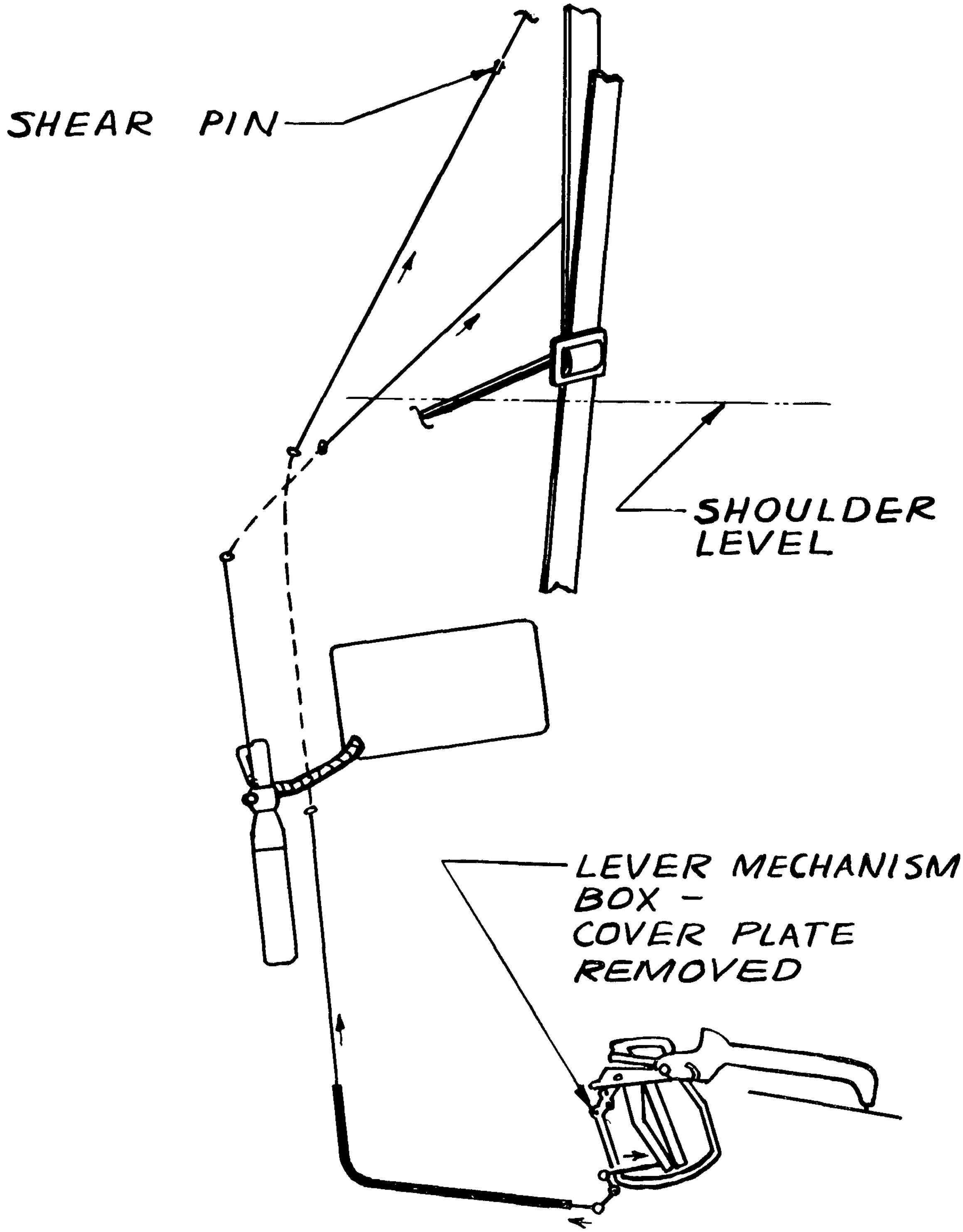
The sequence of operation is described below:

(1) The personal leads would be disconnected and fired by one cable.

(2) The release of the lap belt which would deploy the seat kit.

(3) Following seat kit deployment the life raft CO_2 bottle would be actuated. Following this action a breakaway would take place in which the parted cable would follow the seat kit when it falls away.

(4) The life preservers would inflate, actuated in approximately the same manner as the seat kit. The break-away principle was not applied to these since there appeared to be no requirement for it.



APPROACH № 1

ASD-TDR-62-601 Figure 40

The CO_2 cartridges were in their own pocket, mounted on the parachute cover. There is webbing and a directional snap which restrains the cylinder and prevents any gross movement. The lever on the inflator valve travels approximately 2-1/2 inches to actuate the CO_2 cylinder and approximately a 5-pound pull is required to actuate this cylinder.

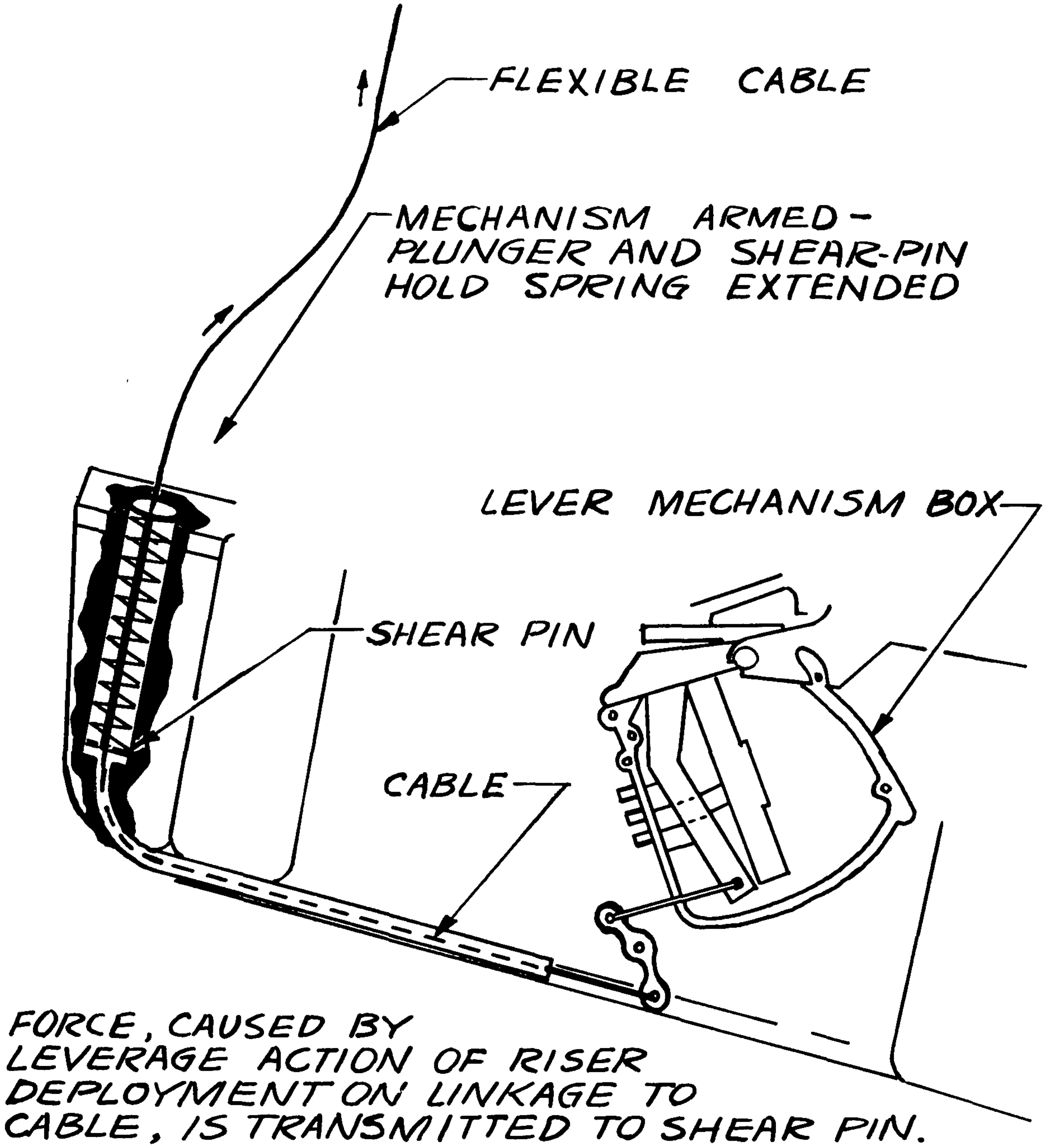
The inflation hose leading from the CO_2 cartridge to the life preserver can be disconnected (1/2 turn bayonet disconnect) along with the parachute harness upon water entry. The life preservers have a self-sealing disconnect installed on them. It is possible to retain the present kit handle providing the safety catch was removed, and a shear pin or safety wire installed. This would act as the manual over-ride in the event the automatic system failed. The safety wire would keep the handle in the closed position so that it would not accidently be fired during aircraft entry or in any gross movement situation.

b. Approach #2 - This approach dealt with channeling the cable through the personal leads block, Figure 41, but employing the cantilever and rod mechanism as in approach #1. The firing cable would pass through the personal leads block and the personal leads bundle, then up the parachute harness and over the risers to the inside of the parachute pack. The use of a compression spring was considered for the triggering device. In order to arm this device, the plunger, a component part of the personal leads bundle, would be inserted into the block as on all other lead connections. As the plunger was inserted it would put the spring under tension and relieve any stresses in the linkage. Upon actuation, when the risers pay out, the plunger (retained by the shear pin) attached to the cable through the personal leads bundle and to the riser, would be drawn from within the center of the spring, shearing the pin, causing the springs to compress, firing the mechanism.

Another version of the above approach is outlined in Figure 42. This spring would be the tension variety and when loaded would go into compression. The loaded mechanism would be retained by a release hook, triggered by the extending risers. In the event of a failure in the automatic system, this mechanism could be released manually.

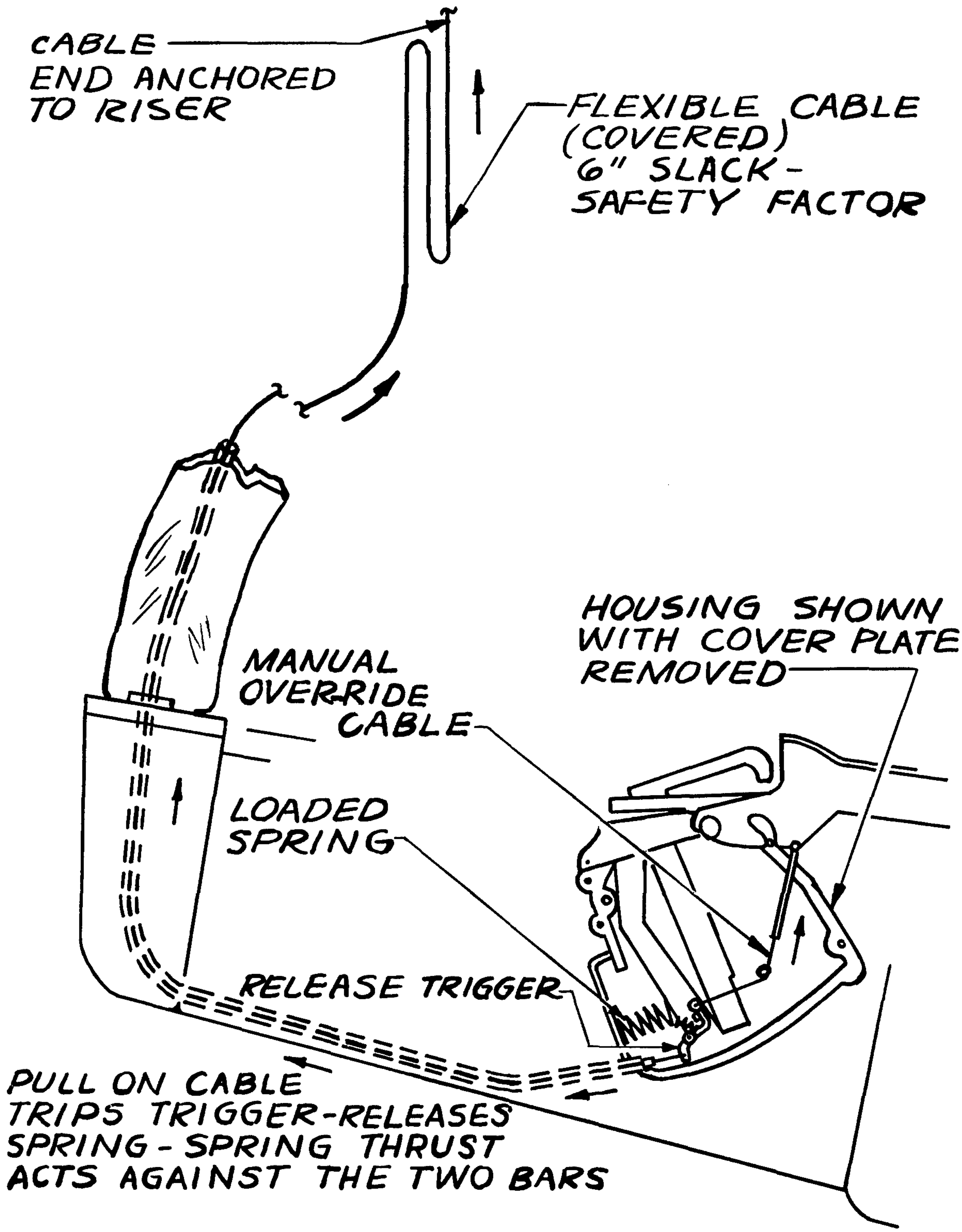
3. In conclusion, automatic seat-kit deployment upon parachute opening remains in the problematical stage.

Another possible approach to this problem may be seat-kit deployment at a given altitude before touchdown. This is obviously complex and would doubtlessly involve electronic components.



ASD-TDR-62-601

Figure 41



APPROACH № 2 (VARIATION)

ASD-TDR-62-601 Figure 42

VII. INTEGRATED COMPENSATED EXHALATION VALVE

Efforts were made to integrate an improved compensated exhalation valve with the HGU-8/P helmet.

A procedure for checking out the valves was pursued with the new valve currently mounted in the helmet, being the base line. This type valve No. 196-75, indicated chugging and leakage. A temporary installation of an MA-2 valve indicated an absence of the same degree of chugging and leakage. Several of the GFE MA-2 valves were checked out and one was found to have a high rate of leakage.

An additional effort to reduce some of the problem areas was to insert a screen mesh on the internal side of the valve adaptor and to observe its behavior. There was no indicated difference although it was believed that possibly contaminants could be prevented from entering the valve seat if this screen were maintained in position.

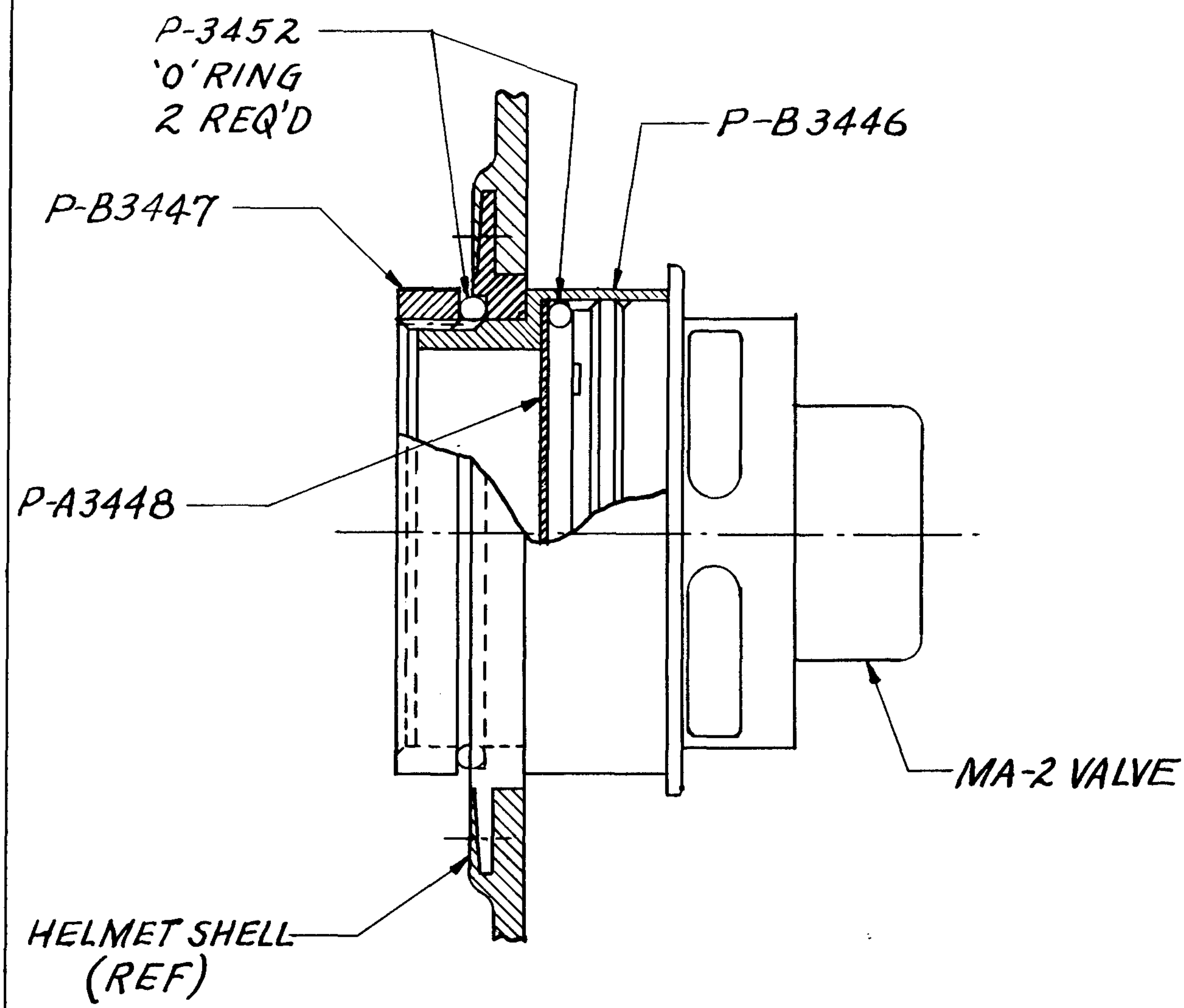
There was a noticeable difference in the behavior of the valves in that the MA-2 valve indicated dumping during a long inhalation while at pressure, whereas, this situation was not evident with the 196-75 valve.

Based on the above observations and due to the fact that the MA-2 valve indicated considerably less chugging and leakage than the present new valve, it was decided to adapt the MA-2 valve to the existing mounting flange.

Without altering the present mounting flange for the No. 196-75 valve, an adaptor was designed that would accept the MA-2 valve. This adaptor passed through the flange on the helmet shell and accepted an "O" ring and locking nut on the internal side of the shell. The external side of the adaptor received a section of stainless steel screen mesh to prevent contaminating particles from obstructing the valve seat. It further accepted an "O" ring which serves as a seal between the valve assembly and adaptor. The MA-2 Valve Adaptor Assembly is P/N ACS-B709, (Figure 43).

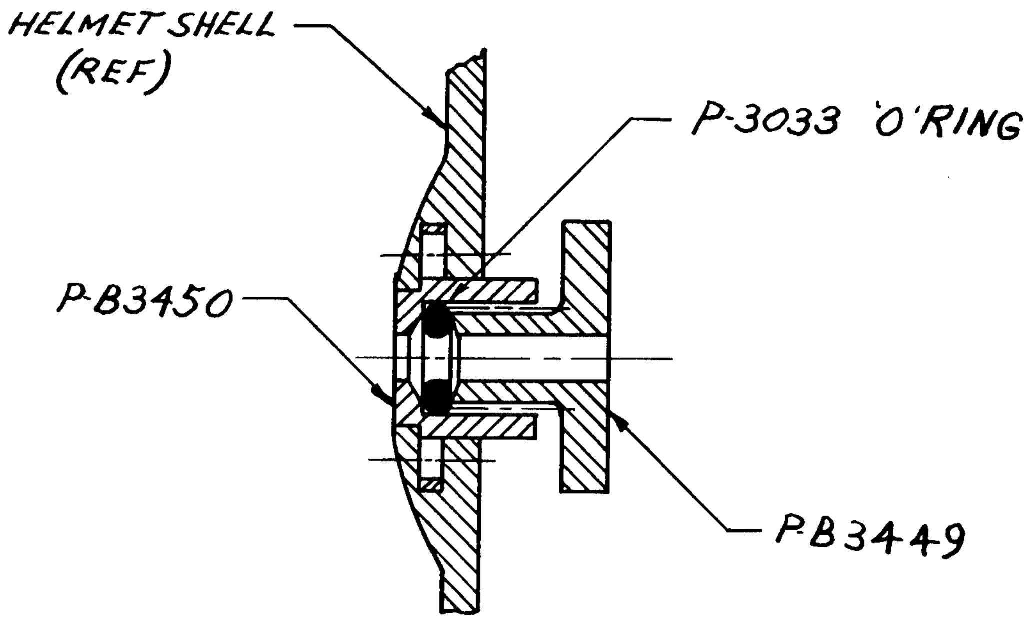
The compensating pressure tube was passed through a hole drilled approximately 1-1/4 inch on center from the valve opening, toward the frontal area. This hole accepts the pass-thru adaptor. One half of the pass-thru adaptor, the flange, was embedded in the internal side of the shell, while the other half, the locking collar, was slipped over the compensating tube. The tube was then passed through the tube flange and the collar tightened down to seat on an "O" ring. The Compensating Tube Pass-Thru Assembly is P/N ACS-A710 (Figure 44). A sealing screw was furnished (P-A3451) to seal the pass-thru in the event the MA-2 valve is removed from the helmet (Figure 45).

If it were found to be desirous to reduce the protruberances of the valve, a simple



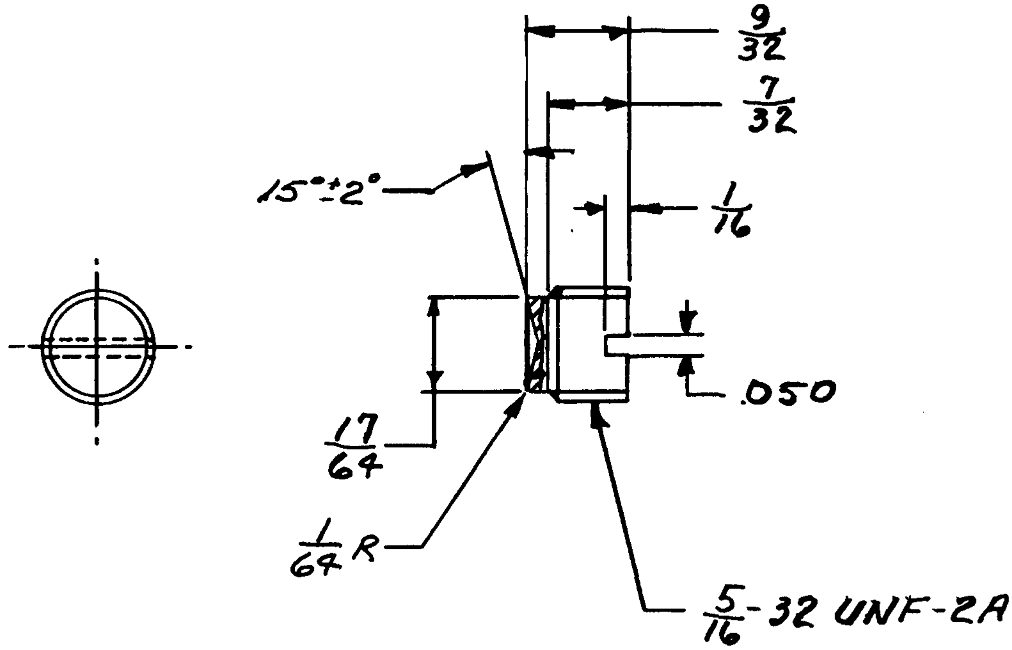
ADAPTER ASSEMBLY
MA-2 VALVE

ASD-TDR-62-601 Figure 43



PASS-THRU ASSY
MA-2 VALVE COMPENSATING TUBE

Figure 44



SCREW-
SEALING, PASS-THRU
ASSEMBLY

ASD-TDR-62-601 Figure 45

machining operation could be accomplished to enlarge the ID of the present valve flange and insert the MA-2 valve to seat on its shoulder. The MA-2 locking nut could be used, but an "O" ring should be employed for sealing. This would be a simple retrofit and it was felt that it did not warrant modifying the standard helmet any further at this time, until acceptability of a valve had been determined.

Aeronautical Systems Division, Dir/Operational Support Engineering, Crew Equipment Division, Wright-Patterson AFB, Ohio
Rpt No. ASD-TDR-62-601. INTEGRATION OF PERSONAL EQUIPMENT. Final report, Sep 62, 30pp. incl illus.

Unclassified Report

Due to the variable environments United States Air Force personnel are subjected to, survival equipment reliability is becoming an urgent critical requirement. Work continues in design and fabrication of items which fulfill the requirements, are lightweight and will integrate easily with other flight equipment.

(over)

1. Integration of personal equipment
I. AFSC Project 6336, Task 63619
II. Contract AF 33(616)-8250
III. David Clark Co. Inc., Worcester, Massachusetts
IV. A. J. Kenneway, III
V. Aval fr OTS
VI. In ASTIA collection

This report describes approach methods, problem areas and progress made in fabricating a one-man cold water survival raft, several underarm life preservers with and without parachute harness integration, and redesign approaches to the standard one-man life raft (PK-2 and MB-4). The problem of designing and integrating one item with another without compromising individual characteristics are discussed. Practical solutions were achieved in most areas.

Aeronautical Systems Division, Dir/Operational Support Engineering, Crew Equipment Division, Wright-Patterson AFB, Ohio
Rpt No. ASD-TDR-62-601. INTEGRATION OF PERSONAL EQUIPMENT. Final report, Sep 62, 30pp. incl illus.

Unclassified Report

Due to the variable environments United States Air Force personnel are subjected to, survival equipment reliability is becoming an urgent critical requirement. Work continues in design and fabrication of items which fulfill the requirements, are lightweight and will integrate easily with other flight equipment.

(over)

1. Integration of personal equipment
I. AFSC Project 6336, Task 63619
II. Contract AF 33(616)-8250
III. David Clark Co. Inc., Worcester, Massachusetts
IV. A. J. Kenneway, III
V. Aval fr OTS
VI. In ASTIA collection

This report describes approach methods, problem areas and progress made in fabricating a one-man cold water survival raft, several underarm life preservers with and without parachute harness integration, and redesign approaches to the standard one-man life raft (PK-2 and MB-4). The problem of designing and integrating one item with another without compromising individual characteristics are discussed. Practical solutions were achieved in most areas.