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DEVELOPMENT OF AN INTEGRATED LIFE-PRESERVER / SURVIVAL VEST FOR CANADIAN FORCES AIRCREW

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ABSTRACT

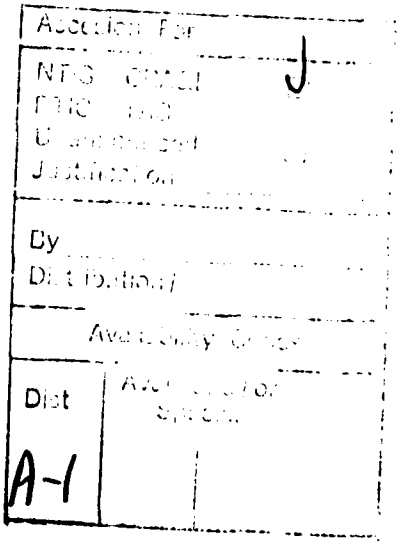
Canadian Forces (CF) aircrew are using life-preservers that were developed in the 1950's. Years of use and testing have shown that these units have many deficiencies. The Medical Life Support Division (MLSD) of the Defence and Civil Institute of Environmental Medicine (DCIEM) tested numerous types of life-preserver units to identify a suitable replacement.

With the introduction of Arctic operations for the CF188 a need arose for more Life Support Equipment (LSE) for the aircrew than is carried in the seat-pack survival kit. Therefore, the CF188 pilots wear the CF survival vest that has several pockets to carry additional survival equipment and protective clothing.

Because no entirely satisfactory life-preserver could be identified and to meet the concurrent need for a survival vest for CF aircrew DCIEM/MLSD developed an integrated life-preserver/survival vest (LP/SV). The design criteria were based on the requirements listed in the Air Standardization Coordinating Committee Air Std 61/4, recommendations outlined in previous DCIEM reports, and ideas put forth by aircrew who tested prototype models in the field.

The early prototypes were developed at DCIEM/MLSD. Mustang Industries Inc. of Richmond, B.C. produced 42 units of advance prototype LP/SV's for field trials. They were also awarded contracts to complete the initial data and drawing packages for the CF.

The LP/SV will enter service in the near future, and will meet or exceed the Air Standardization Coordinating Committee (ASCC) specifications required of a modern life-preserver.



INTRODUCTION

Canadian Forces aircrew have been using one of three basic life-preservers. Ejection seat aircrew wear the Irvin high performance life-preserver that incorporates an automatic inflation device (AID); helicopter/transport aircrew wear the same life-preserver with a manual inflation device; maritime aircrew, fixed-wing and rotary-wing, wear a Bauer life-preserver that incorporates three independent buoyancy compartments. These life-preservers were designed in the early 1950's and have changed little during the years.

At the 1980 meeting of Working Party 61 of the Air Standardization Coordinating Committee (ASCC) , all member nations* were directed to evaluate their aircrew life-preservers to determine compliance with their standard (1). Tests (2) revealed that none of the three CF life-preservers could meet all the criteria specified in the Air Standard (AIR STD).

During the early 1980's, the CF was receiving the CF188 aircraft and the aircrew found the Irvin high-performance life-preserver to be incompatible with the Martin-Baker ejection seat harness system. In addition, a requirement for a survival vest for use on deployment to the Arctic was identified. As a consequence, the Medical Life Support Division (MLSD) of DCIEM began development of an integrated life-preserver and survival vest (LP/SV) in the Fall of 1985. In 1986 DAR issued a Statement of Requirement (SOR) (4) outlining the shortcomings of CF life-preservers and establishing the design requirements of a replacement life-preserver.

AIM

The purpose of this report is to describe the LP/SV and its development.

* ASCC member nations are: Australia, Canada, New Zealand, United Kingdom, and United States

DESIGN RATIONALE

The design rationale for the integrated life-preserver/survival vest (LP/SV) is based on the specifications in the ratified standard (1) and recommendations contained within two previous DCIEM reports (2, 3). The AIR STD is detailed at Tables 1, 2, & 3, and Annex A.

In addition, it was recommended (3) that any new CF life-preserver have a large volume bladder that is:

a. sealed using radio frequency energy rather than glue; and

b. anchored snugly utilizing a low waist strap.

Also, the method of stowage and attachment should be simple, slim-line, and compatible with seat harnesses.

Using the above specifications and recommendations as guidelines for a design, MLSD produced a prototype LP/SV (Figure 1). The goal was for the new design to meet or exceed all the specifications, remain simple in design and operation, be of reasonable cost, and gain the universal acceptance of CF aircrew.

GENERAL DESCRIPTION

The integrated LP/SV consists of an inflatable life-preserver (LP) contained in a flame resistant stole (protective cover) and a flame resistant Nomex mesh survival vest (SV) that acts as a mounting platform for the LP. The survival vest has two plastic patches sewn to it, on the chest and at the side of the waist (Figure 2), for the mounting of the chemical defence respirator manifold and filter blower (Figure 10). To allow the chemical defence equipment to be mounted on the LP/SV and not interfere with aircraft structures and controls, the LP/SV system has two variants: the Right Sided patch version (Figure 2) for use in all aircraft, and the Left Sided patch version (Figure 3) for use in all those non-ejection seat aircraft positions where the Right Sided version is incompatible. These two versions are mirror images of each other. For ejection seat aircraft, the Right Sided version is fitted with an automatic inflation device (AID) with manual capabilities. Non-ejection seat aircraft use both the right and left sided patch versions fitted with a manual inflation device or an AID. In both versions inflation is achieved through the release of compressed gas

from an expendable cartridge (Figures 4 to 9).

The bladder system has two compartments divided by a floating baffle that is free to move between the front and rear chambers depending on the gas volume in each. The rear chamber is inflated by the compressed gas and, if required, deflation can be achieved by venting gas through the rear chamber oral inflation valve on the left side. If this chamber is punctured, the front chamber can be orally inflated through the oral inflation valve on the right side.

The flotation angle can be adjusted by grasping the webbing loops at the base of the cell lobes and pulling the ends of the cell closer to the waist (Figures 7, 8). This will pull the user's waist closer to the surface of the water and help to put the face farther out of the water.

The NOMEX survival vest is similar to the current CF survival vest except for a modification to the neck area for the attachment of the LP. It also incorporates "Plastiglide" patches (Figures 2 & 3) to allow the attachment of the chemical defence respirator manifold and the ACDVS (Figure 10). The pockets included on the LP/SV can provide up to 220 cubic inches of storage space. They are arranged to be compatible with seat restraint systems and associated harnesses and can easily be changed to fit operational needs.

PROTOTYPES - DESIGN, OPERATION, AND TESTING

The prototype and final models of the integrated LP/SV are waistcoat type life-preservers that incorporate a single point inflation device (manual/automatic). The LP/SV uses one 35 gram CO_2 cylinder to achieve full inflation. The bladder material is yellow polyurethane coated nylon while the baffle material is a clear urethane film.

Donning/Doffing

The LP/SV is simple to don. The front closure is achieved with a nylon zipper. The first prototype vest was adjusted at the sides by lacing similar to that used in anti-G suits. Once set up and adjusted, the lacing did not need to be changed unless a different configuration of clothing were adopted (in later development this lacing was replaced by a belt). Day to day adjustment was achieved by use of the waist belt. The first prototype vests were produced in three sizes: small (chest 36 to 40 inches), medium (40 to 44), and large (44 to 48).

Compatibility With Aircraft Restraint Systems and Parachute Harnesses

The design of the LP stole allows all shoulder straps to be routed under the stole to ensure comfort and compatibility. Some interference between the parachute harness and first prototype stole was identified and an interim solution was incorporated during the field trials. The remedy involved undoing three loops of the speed lacing to allow the parachute harness to pass under the stole area (Figure 11). The stole did not interfere with the simplified combined harness of the CF188.

Inflation, Buoyancy, and Flotation Characteristics

At room temperature the LP/SV achieved full inflation within three seconds, produced buoyancy of 18.2 kg, and could provide a flotation angle approximately 40 degrees from vertical. There was difficulty achieving rapid full inflation at low temperatures; this problem will be discussed in greater detail later.

Self-Righting Characteristics

When placed face down in calm water, subjects not wearing an immersion suit were self-righted in 2.2 to 3.8 seconds with an average time of 2.7 seconds. No subject was self-righted while wearing an immersion suit because of the suit's inherent buoyancy, but it was easy for the subjects to actively right themselves and maintain this position.

Lifting Straps

The lifting straps on the LP/SV are centrally located (Figures 12, 13) and accessible to both hands. However, arm injury could preclude the wearer from attaching himself to a hoist.

Wind Blast

The prototype LP/SV's were subjected to a series of short-duration uni-directional blasts ranging from 250 knots to 600 knots with no resultant damage. In a later 600 knot ejection test some damage was sustained; the results of that test and the corrective actions taken are discussed later in this report.

Chemical Defence

The LP/SV was designed for use with Individual Protective Equipment (IPE) and the Aircrew Chemical Defence Ventilator System (ACDVS). This

required a specific configuration for wear in different aircraft types resulting in two versions as previously mentioned: the Right Sided patch version for use in all aircraft (Figure 2), and the Left Sided patch version for use in all non-ejection seat aircraft (Figure 3). The principle difference between the two is that they are mirror images of each other so the Aircrew Chemical Defence Ventilator System (ACDVS) can be mounted on opposite sides to prevent interference with aircraft structures and controls. The position of the manifold patch on the chest dictates the position of the front zipper being slightly off-centre (Figures 2 & 3).

Field Trials

Following complete testing of the prototype units produced at MLSD, a contract was let to have 35 LP/SV's produced for evaluation during extensive trials at selected flying units. Mustang Industries Inc. of Richmond, B.C. was awarded the contract and delivered 35 units to MLSD in February 1988. The field trials were undertaken to determine the suitability of the LP/SV as a replacement for the current Canadian Forces life-preservers. In addition, product improvement suggestions were encouraged. The participating units and vest distribution (as directed by National Defence Headquarters [Directorate of Air Requirements] and Air Command) (5) were as follows:

a. CFB Comox - Left Sided patch version (four units) for trial on the CP121 (Tracker), CP140 (Aurora), CH113 (Labrador), and CC115 (Buffalo);

b. CFB Edmonton - Left Sided patch version (five units) for trial on the CH135 (Twin Huey), CH136 (Kiowa), CH147 (Chinook), CC130 (Hercules), and CC138 (Twin Otter);

c. CFB Cold Lake - Right Sided patch version (four units) for trial on the CF188 (Hornet), CF5 (Freedom Fighter), and the CT133 (Silver Star);

   - Left Sided patch version (one unit) for trial on the CH118 (Single Huey);

d. CFB Winnipeg - Right Sided patch version (two units) for trial on the CT114 (Tutor) and the CT133 (Silver Star);

   - Left Sided patch version (two units) for trial on the CH139 (Jet Ranger), CT134 (Muskateer), and the CC129 (Dakota);

e. CFB Bagotville - Right Sided patch version (four units) for trial on the CF188 (Hornet);

f. CFB Shearwater -Left Sided patch version (four units) for trial on the CH124 (Sea King) and the CH135 (Twin Huey);

g. CFB Baden - Right Sided patch version (four units) for trial on the CF188 (Hornet) and the CT133 (Silver Star); and

h. CFB Lahr -Left Sided patch version (three units) for trial on the CH136 (Kiowa).

The life-preserver performed well during the swimming pool trials that were done before flying evaluations. However, during flying operations a few problems were identified:

a. ejection seat aircrew, especially the CF5 and CF118 operators, were concerned with the bulk and length of the LP and stole. The CF5 operators modified the speed lacing on the stole (Figure 11) to ensure that the parachute harness passed under the stole to achieve the proper positioning of the quick release box. The CF118 pilots found that the bulk and length obstructed their vision downwards;

b. sizing of the vest did not seem to be adequate for some trial bases;

c. a large percentage of users questioned the system of lacing adjustments on the sides. The consensus was that an easier and less time consuming method would be preferable;

d. during the trials, several problems were encountered when an individual tried to tighten the waist belt while in the water. If the belt was not fitted snugly when it was donned, it was difficult to adjust once the wearer was in the water; and

e. heat stress was reported by some users; any method to reduce the heat build-up was to be considered.

Besides these five main points, minor comments were made regarding pocket placement and suggested contents. Although the LP/SV was given a user trial by many operators who were not accustomed to wearing survival vests, the general consensus was one of acceptance.

FURTHER DEVELOPMENT

Representatives of DCIEM/MLSD and the Directorate of Aerospace Engineering met with Mustang Industries Inc. personnel to evaluate alterations to resolve the problems identified during the Phase I field trial. This resulted in the following modifications:

a. the neoprene coating inside the stole and pockets was removed to reduce bulk, stiffness, and heat build-up;

b. Nomex rather than nylon lacing was used to attach the stole to the survival vest enabling the manufacturer to expose the lacing and move the bulk of the stole 3.2 cm aft to eliminate helmet/stole chaffing;

c. the stole length was shortened 8.3 cm to allow proper parachute harness interface and to eliminate vision restrictions;

d. the system of side lacing to adjust sizing was replaced by a single strap and buckle on each side. This modification facilitates fitting and tightening of the vest around the chest while in the water. It also permits an increase in the waist dimensions thereby ameliorating the sizing problems reported during Phase I;

e. the waist belt and buckle were redesigned to facilitate better sizing and adjustment of the waist belt while in the water. The adjustment system used during Phase I could be altered only at the back of the waist belt and proved to be unacceptable; and

f. pull tabs were attached to the lifting straps and secured to the vest by velcro to assist deployment.

These modifications, although minor, greatly enhanced the LP/SV's operational compatibility. To address the concerns of those aircrew who do not require a survival vest in their operations a life-preserver unit without a survival vest (LP) was produced (Figures 14, 15). The life-preserver portion is unchanged; however, all the survival vest material on the sides and back has been removed. This item is a one-size-fits-all design and can serve as a life-preserver for aircraft passengers and for aircrew not requiring a survival vest.

Phase II Trial

Following the design changes to the LP/SV as a result of phase I, the modified LP/SV's were trialled in phase II. Seven prototype systems were taken to the Phase I trial bases by the Project Officer. Cockpit compatibility tests, aircrew briefings and surveys, and flying evaluations were carried out to the extent that operational schedules allowed.

A unanimous acceptance of the LP/SV and LP was expressed at all trial bases.

During the Phase II trial it was discovered that an extra-large size is needed for a fully kitted Para-Rescue Specialist and for some of our larger aircrew.

The Phase II trial showed that the shortcomings identified by the aircrew community had been successfully overcome.

Cold Water Test

In an effort to duplicate the worst-likely operational conditions (Arctic Operations) the LP/SV was cold-soaked at -2° C. for 18 hours, cooled to -20° C for 20 - 30 minutes, then immersed and immediately inflated in salt water (-2° C.). The LP/SV developed 15 kg buoyancy in five seconds (ASCC maximum time) and 16 kg buoyancy (ASCC minimum buoyancy) in eight seconds.

The ASCC Air Std 61/4 (1) calls for the production of 16 kg buoyancy within 5 seconds of activation of the inflation device throughout the entire range of environmental conditions in which the preserver may be used. DCIEM will be repeating the Cold Water Test with CO_2 and other gases to determine if methods and/or mixtures of gases can be found to enable the LP/SV to meet this stringent criterion. This has been a difficult problem to overcome. Other nations have had difficulty developing inflation devices that will produce the necessary buoyancy in the required time in very cold water without using an inflation gas other than CO_2. The containers required for the necessary volumes of other gases tend to be too bulky.

600 Knot Ejection Test

On 19 April 1990 the LP/SV was mounted on the dummy that was part of the A.E.A. test of the Canadian Forces CF188 Martin-Baker AIM parachute harness in the MK SJU-9 ejection seat (6). The test was carried out on the rocket test track at Pendine, Ireland. The Mk SJU-9 seat with a 98 percentile dummy occupant was ejected at a speed of 600 knots. The LP/SV suffered damage that earlier versions had not in the DCIEM wind blast tests discussed previously. The ejection test conditions were a more realistic test of the design of the LP/SV than the DCIEM wind blast tests because the dummy was subjected to tumbling and multi-directional wind vectors. Upon ejection and entry into the 600 knot windstream the LP stole collar was blown open. The bladder then flailed in the wind pulling the manual inflation cord resulting in the inflation head being activated. Also, the front central closure zipper on the SV was pulled open from the top down to the buckle assembly on the waist section. Post trial inspection at DCIEM revealed torn speed lacing and grommet strips.

To correct these deficiencies the following modifications to the LP/SV are required:

a. sew the end of the LP protective container zipper cover flap to the front of the protective container at the bottom inside corner to make a tighter cover (Figure 16);

b. add velcro closures to the life preserver adjustment straps where they exit the protective cover (Figure 17);

c. make the openings for the adjustment straps as narrow as possible (Figure 18);

d. place two grommets at each of the lower ends of the Life Preserver protective container with matching grommets on the Survival Vest and tie the protective container to the vest (Figure 19);

e. place the first loop of the speed lacing below the first grommet on the left side of the life preserver protective container to hold the bottom of the container tighter to the vest (similar to the right side) (Figure 20);

f. sew a pull-dot fastener to the vest at the top of the zipper closure to hold the vest closed and prevent the zipper from running down (Figure 20);

g. insert reinforcing material into the cell anchor strips to provide additional strength for the grommets (Figure 21); and

h. construct the speed lacing loops from a continuous lace for the entire length of each speed lacing strip; the lacing should first be sewn to the strap along its entire length then sewn again when the strap is folded (Figure 22).

Waist Belt and Adjustment Buckle

Because the buckle used on the second prototype LP/SV was awkward to use it was replaced with the buckle that has been used on CF life-preservers for many years. Also, the waist strap was modified to allow in-water adjustment with this buckle (Figure 23).

Speed Lacing Replacement

The NOMEX speed lacing used to fasten the LP to the SV is susceptible to disintegration when exposed to fire. It disintegrates within 3 seconds on exposure to the flame of a match. Because of the design of speed lacing, if any of the loops in the chain become unfastened for any reason (eg. fire or trauma) the remaining loops to the beginning of the chain will quickly come undone leaving the LP only partly attached to the SV. This was dramatically apparent during the 600 Kt ejection test. In an immersion situation with an unconscious aircrew the LP will float above the head allowing the wearer to drown.

To decrease the probability of the above situation from occurring it is strongly recommended that the LP stole be sewn to the SV. Recognizing that there is a desire/requirement to have the LP stole quickly interchangeable a method of sewing the LP to the SV has been designed to allow Safety Systems Technicians in the field to easily remove the stitching and sew on a replacement stole. It should be noted that the LP/SV is not designed to be worn without the LP attached - the bladder pull-down straps are permanently affixed to the SV and require storage in the stole. Even with the speed lacing feature the LP/SV cannot be worn as a LP/SV one day and a SV the next.

It is recommended that the speed lacing strips on the SV be replaced with lengths of webbing (Figures 24 to 28). This webbing marks the proper position on the SV for the mounting of the LP stole and allows for the relatively easy

removal of the stitching should it be necessary to replace the LP stole. At the front bottom ends of the stole the webbing has been folded back up over the end of the stole to provide a stronger attachment to prevent tearing and flailing in high speed ejections.

The above recommended changes do not create any production problems and in fact with the decrease in the manufacture of the speed lacing are time savers.

Because sewing the LP stole to the SV will greatly improve the robustness to damage of the LP/SV it is strongly recommended that the changes suggested above be implemented.

PHASE III PREPRODUCTION

A detailed data, specifications, and drawing package was produced by Mustang Industries Inc. in 1990.

CONCLUSIONS

The performance of the final model of the LP and LP/SV and compliance with the Air Standardization Co-ordinating Committee's Air Std 61/4, 5 September 1975 are summarized at Tables 1, 2, and 3. The life-preserver portion of the LP and LP/SV meets or exceeds all the specifications of the Air Standard with the exception of the rate of inflation and buoyancy provided in very cold Arctic conditions. The buoyancy achieved in 5 seconds is only seven percent short of the ASCC standards (15 kg vs. 16 kg) and the added bulk of an alternate inflation gas should be assessed in this light.

The LP/SV and LP are simple in design and easy to use.

The LP/SV and LP have gained the universal acceptance of CF aircrew.

RECOMMENDATIONS

It is recommended that the LP and LP/SV be designated as the replacements for the aircraft passenger life-preserver and three aircrew life-preservers currently in use in the Canadian Forces.

It is strongly recommended that the LP stole be sewn to the SV rather than be attached by speed lacing.

It is recommended that the LP/SV be subjected to wind-blast trials and another ejection test to ensure that the modifications made after the 600 Knot ejection test done on 19 April 1990 will indeed correct the deficiencies discovered.

It is recommended that further testing be done to evaluate alternate inflation devices and/or gases to meet ASCC criterion in Arctic conditions.

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1. **Air Standardization Coordinating Committee**: Air Standard 61/4, Flotation and Sea Survival, Test Methods and Requirements, 5 September 1975.

2. **FIRTH, J.A., R.W. SMITH, J.C. STEFFLER.** Evaluation of Canadian Forces Life-Preservers To Determine Compliance With Air Standardization Coordinating Committee - Air Standard 61/4, DCIEM Report No. 83-C-38, July 1983.

3. **MARTIN, N.A.** Performance Of Several Aircrew Life-Preservers With Various Clothing Ensembles, DCIEM Report No. 86-R-24, May 1986.

4. **Directorate of Air Requirements:** Statement of Requirement - Aircrew Life Preserver, 14220-100 (DAR 3-2), May 1986.

5. **Directorate of Air Requirements:** User Trial Directive, 14240-120-81 (DAR 3-2) 10 February 1988.

6. **A.E.A. TEST REPORT NO. 881**, April 1990.

Table 1. LPU/SV Compliance With General and Material Requirements of ASCC AIR STD 61/4 - 5 September 1975

P = Pass / F = Fail / NA = Not Applicable

Distinctive colour	P - bright yellow
Maximum visibility when wet or dry after inflation	P
One or two sizes	P - one size LP fits 4 sizes of SV
Accommodate 3rd - 98th percentile	P
Adjustable for comfort	P
Does not interfere with breathing, hearing, or vision	P
Survival aids are accessible when preserver inflated	P
Hoisting mechanism is conspicuous, readily available	P
Fire retardant	P
Suitable for world-wide use	P
Not irritating to skin, no offensive odour	P
Uses corrosive-resistant metal that is free of burrs and sharp edges	P
Dissimilar metals are suitably protected against electrolytic corrosion	P
Nutrients for fungi are absent or are suitably treated	P
Designed for minimum deterioration by abrasion, sunlight, moisture, micro-organisms, heat, fuel, hydraulic lub oil and grease, salt spray	P

Table 2. LPU/SV Compliance with Inflation Devices, Methods and Performance Requirements of ASCC Air Std 61/4 5 September 1975

P = Pass / F = Fail / NA = Not Applicable

Inflation Method - Gas - Manual or Automatic	P - CO_2 (35 grams) or other for cold weather
Mean Inflation Time (under five seconds)	P - 3 sec at 20° C air and water to 18.2 kg buoyancy - 5 sec. at -2° C salt water and -20° C air to 15 kg buoyancy - 8 sec. at -2° C salt water and -20° C air to 16 kg buoyancy
CO_2 Charge - Chamber 1 - Chamber 2	35 grams oral
Manual Inflator Pull Force (15 +/- 10 pounds)	P
Inflation Devices	
Single Point Inflation Device for Full Buoyancy	P
Manual Operation - readily recognizable to sight - readily recognizable to touch	 P P
Automatic Inflation	
Activated in salt and fresh water of 90 (+10/-0) microhms resistivity	P

Table 2. (cont'd)

Immune to inadvertent inflation in cockpit	P
Manual inflation capable of overriding automatic inflation	P
Protected against premature activation due to rain or other moisture	P
Full inflation within five seconds throughout entire range of environmental conditions in which the preserver may be utilized (ie; +30° C water & +65° C air to -2° C salt water & -20° C air)	- 3 sec at 20° C air and water to 18.2 kg buoyancy - 5 sec in -2° C salt water and -20° C air to 15 kg buoyancy - 8 sec at -2° C salt water and -20° C air to 16 kg buoyancy (alternate inflation gas can be used for cold weather ops)
<u>Oral Inflation</u>	
Readily accessible to hand and mouth	P - separate chambers for gas inflation and oral inflation
Incorporates check valve and means of deflation	P

Table 3. LPU/SV Compliance With Inflation, Floatation and Buoyancy Requirements of ASCC Air Std 61/4 - 5 September 1975

P = Pass / F = Fail / NA = Not Applicable

Mean Self-Righting Time (max. five seconds)	P - < 3 sec at 20° C at 18.2 kg buoyancy
Floatation angle in degrees (45 +/- 20) with adequate support for back of head	P - approx. 40 degrees - adjustable
Mean Buoyancy In Kilograms Chamber 1 (16 kg minimum)	P - 18.2 kg in 3 sec at 20° C air and water - 15 kg in 5 seconds and 16 kg in 8 seconds at -2° C salt water and -20° C air
Inflation Characteristics	
Full inflation within 5 seconds	P - 3 seconds at 20° C - at -2° C salt water, after cold soaking in air at -20° C achieved 93.75% inflation (15 kg buoyancy) in 5 sec
No evidence of construction or material failure	P
Flow of gas in/out not hindered	P
Seams, flange and oral inflation tube and valve not separated by inflation	P

Table 3. (cont'd)

Seams and attachment not puckered by inflation or deflation	P
Withstands twice normal pressure	P
Less than 0.5 psig lost after 10 minutes inflation at 2 psig	P
Withstands 600 KIAS windblast	not tested since final modification
Floatation Characteristics	
Prevents downward facing	P
Positions unconscious subject facing upwards within five seconds	P
Positions head up with mouth and head clear of water	P

Figure 1: DCIEM Prototype LP/SV

Figure 2: Mustang Prototype - Phase I
Right-Sided Patch Version of LP/SV

- for use in all CF ejection aircraft
- for use in non-ejection aircraft when chemical defence (CD) equipment must be worn on right side
- on later models the length of the LP and the system of sizing changed

Figure 3: Mustang Prototype - Phase I
Left-Sided Patch Version of LP/SV

- for use in non-ejection aircraft when chemical defence (CD) equipment must be worn on left side

Figure 4: Mustang Prototype - Phase I

Manual Inflation Tab

Figure 5: Mustang Prototype - Phase I

Manual Inflation Tab - Inflation Initiated

Figure 6: Mustang Prototype - Phase I

Front View of Inflated LP/SV

Figure 7: Mustang Prototype - Phase I

Side View of Inflated LP/SV
with Automatic Inflation Device (AID)
- showing floatation adjustment straps being pulled down

Figure 8: Mustang Prototype - Phase I

LP/SV With Floatation Angle Adjustment Straps Pulled Down

Figure 9: Mustang Prototype - Phase I

Rear View of Inflated LP/SV

Figure 10: LP/SV with Aircrew Chemical Defence Ventilation System (ACDVS) and associated CD Equipment

Figure 11: Mustang Prototype - Phase I

Interim solution to Stole/Parachute Harness Interface

Figure 12: Mustang Prototype - Phase I

LP/SV Lifting Straps

Figure 13: Mustang Prototype - Phase I

LP/SV Lifting Straps

Figure 14: Side View of Inflated LP

With Manual Inflation Device

Figure 15: Rear View of Inflated LP

Figure 16: End Of LP Protective Container Zipper Cover Flap Sewn

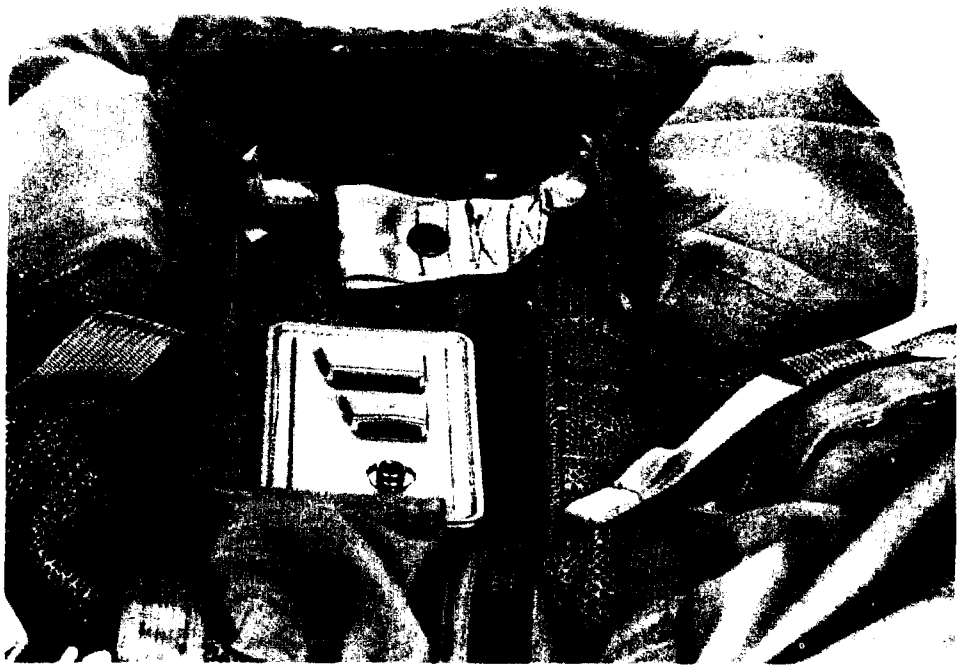


Figure 17: Velcro Closures On Adjustment Straps

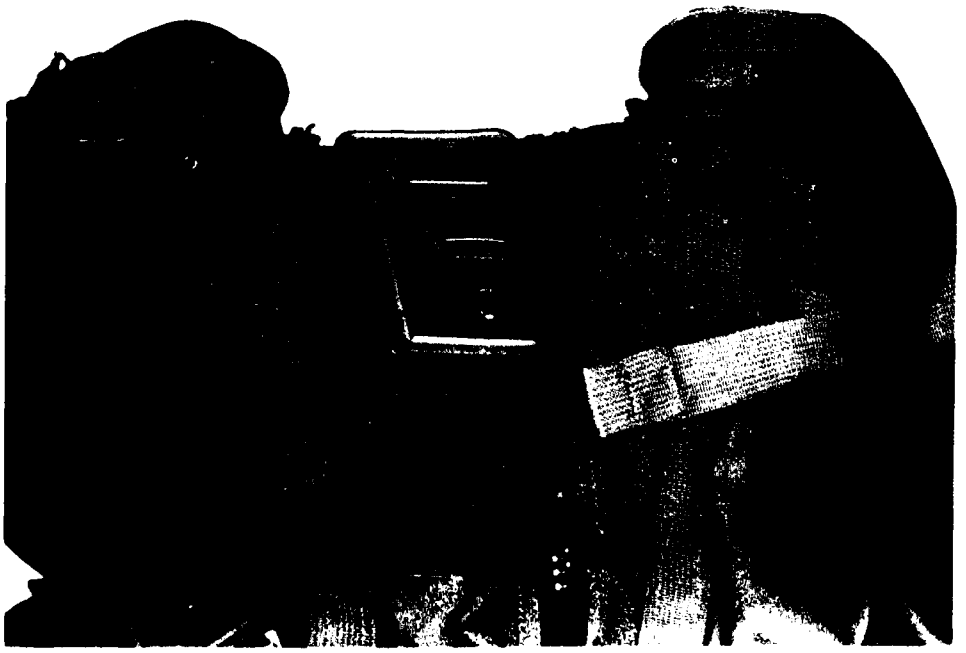


Figure 18: Smaller Openings For Adjustment Straps

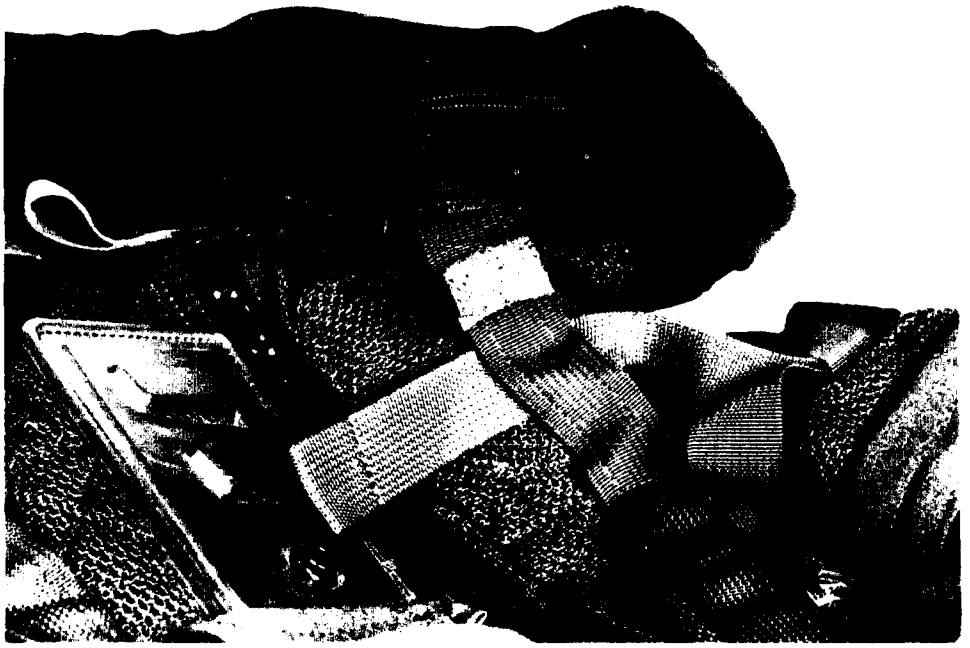


Figure 19: Grommets

Figure 20: First Loop Of Speed Lacing and Pull-Dot Fastener

Figure 21: Cell Anchor Strip

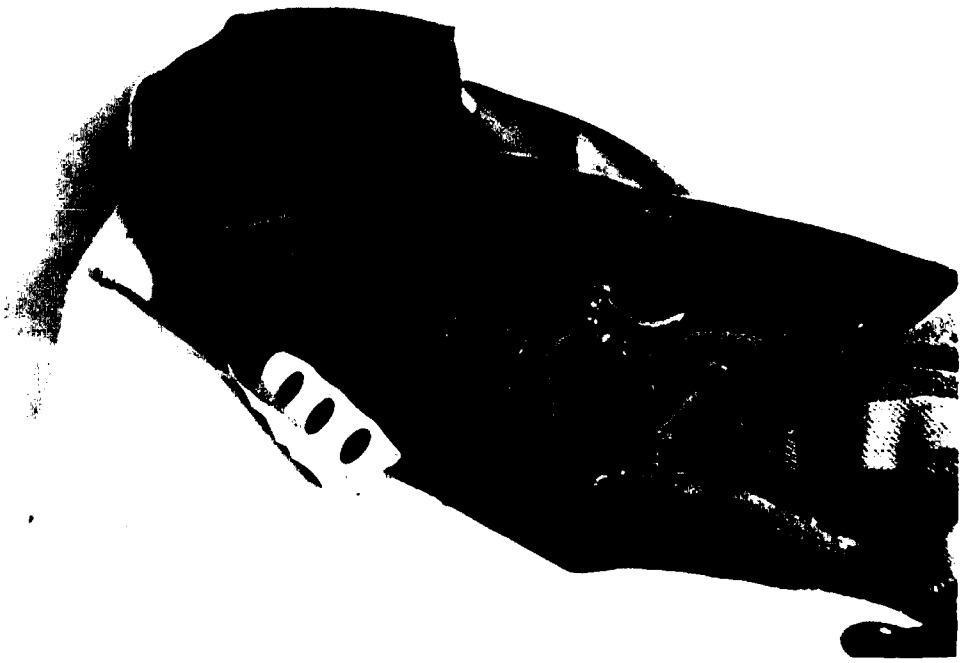


Figure 22: Speed Lacing

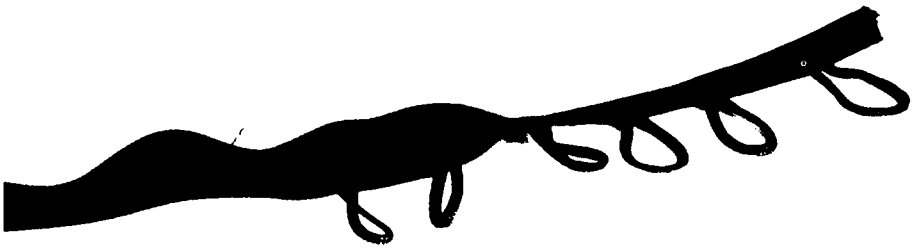


Figure 23: Waist Strap Buckle And Adjustment System

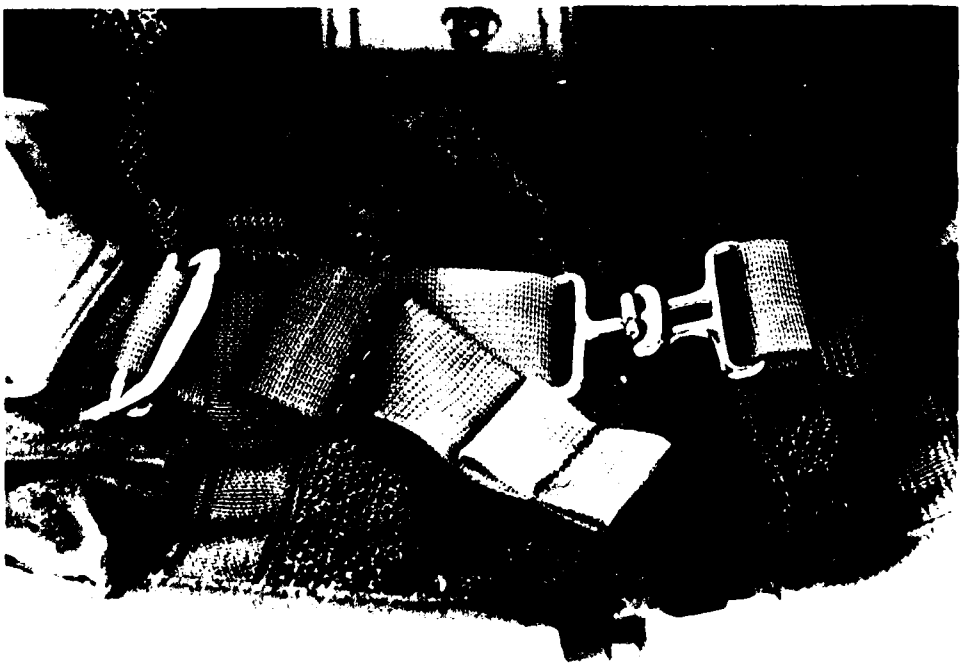


Figure 24 - LP sewn to SV

Note ends of webbing folded over

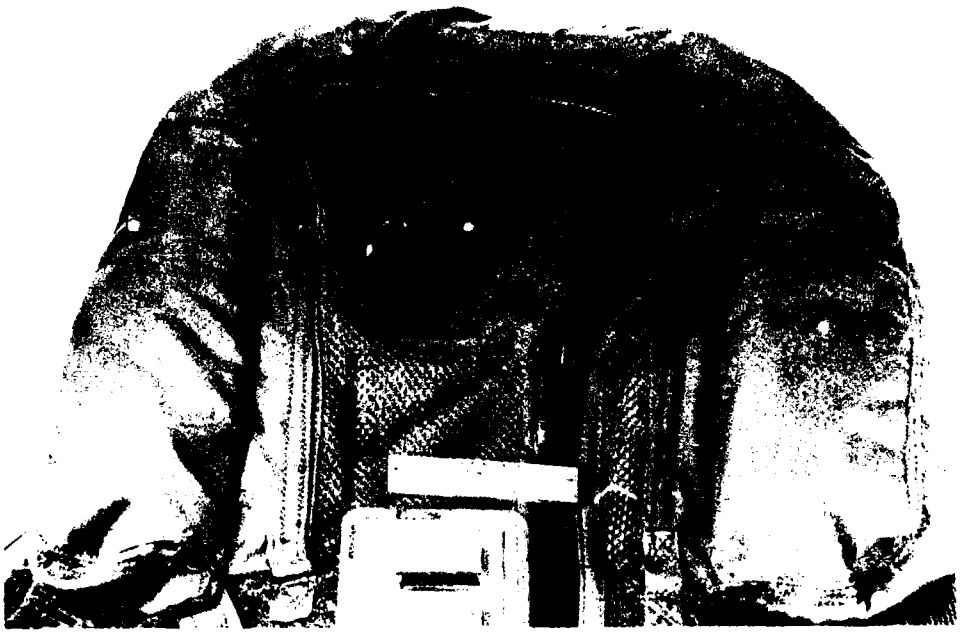


Figure 25 - LP sewn to SV

Note ends of webbing folded over

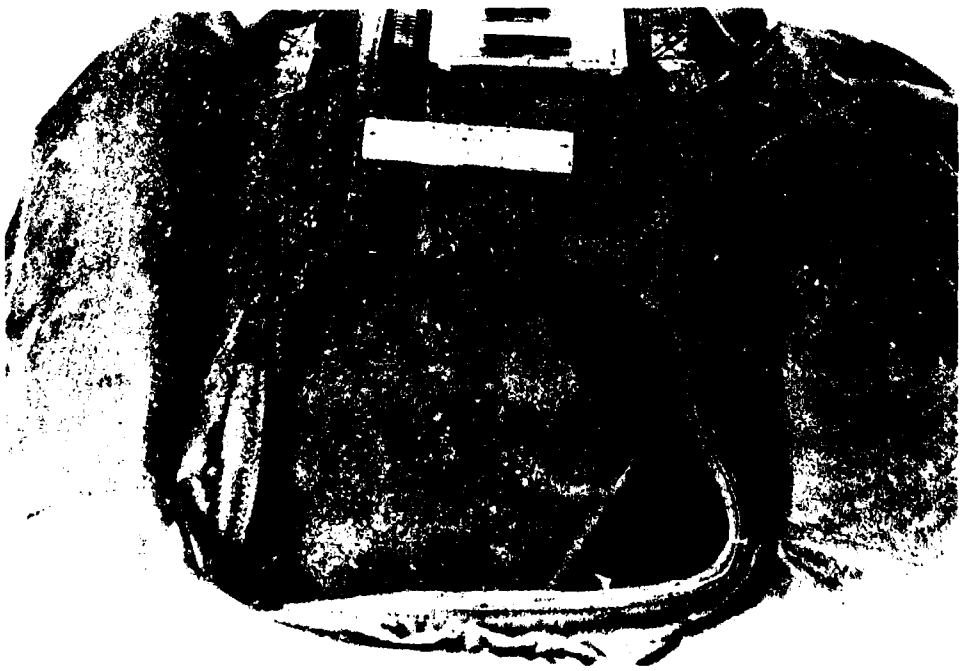


Figure 26 - LP sewn to SV

Note ends of webbing folded over

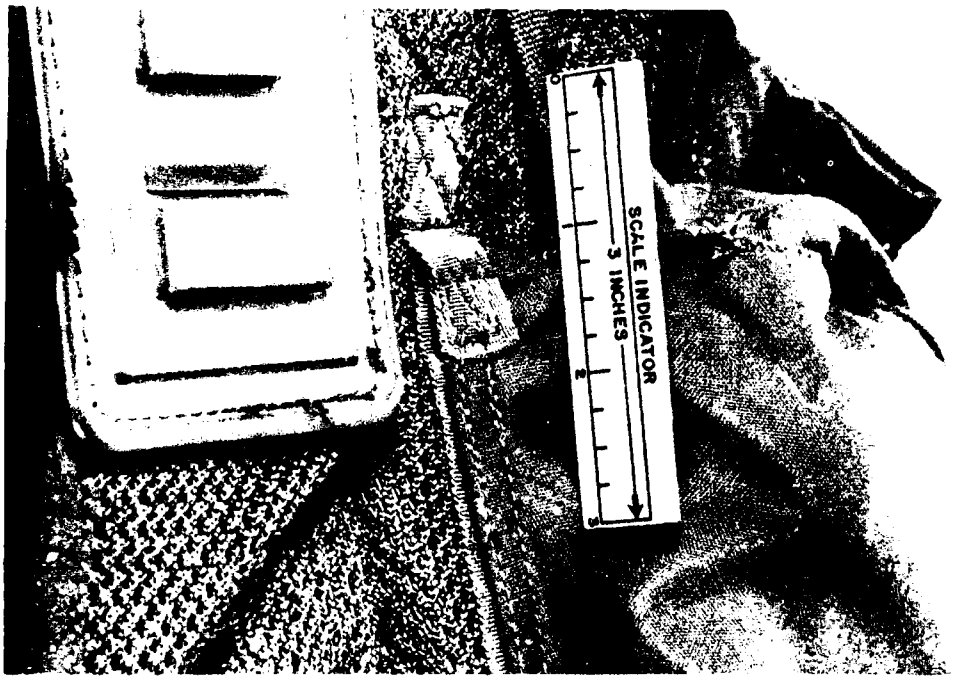


Figure 27 - LP sewn to SV

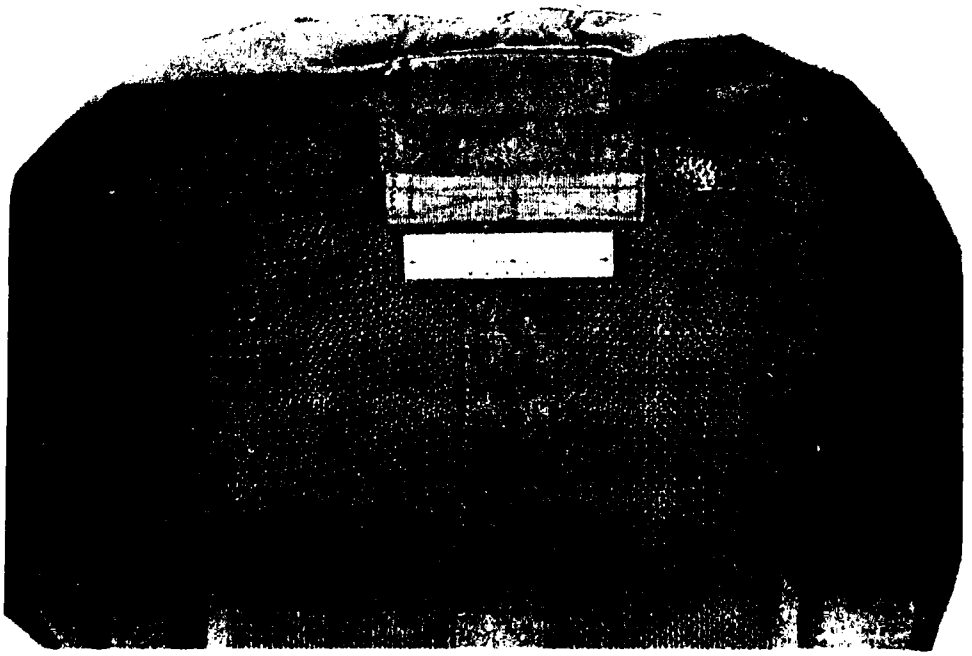
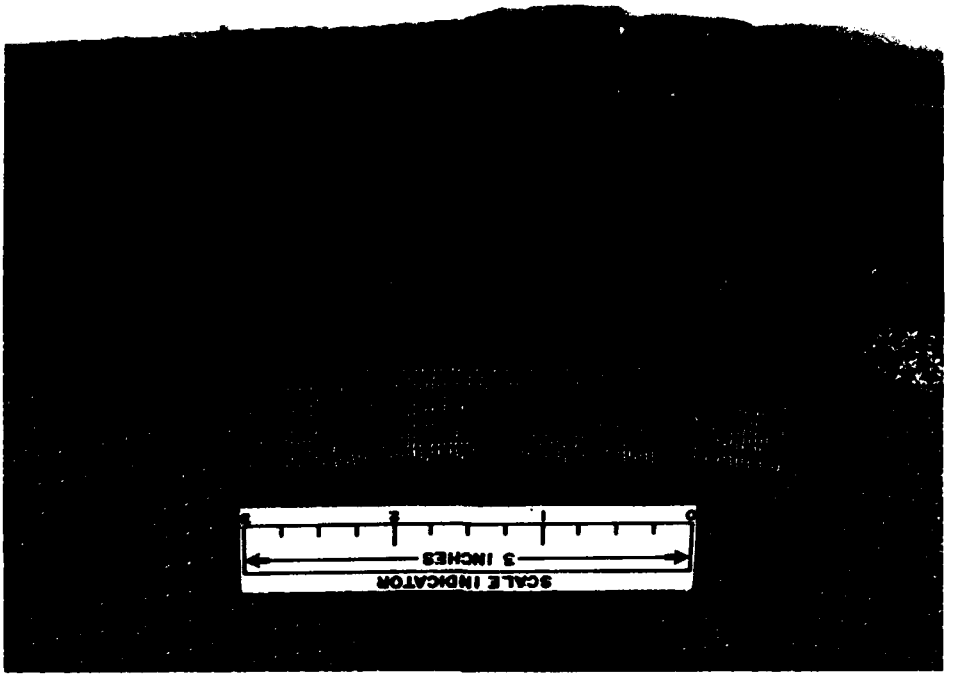


Figure 28 - LP sewn to SV



Annex A: ASCC Air Std 61/4, 5 September 1975, Flotation and Sea Survival, Test Methods and Requirements

UNCLASSIFIED

ASCC

AIR STD 61/4
5 SEPTEMBER 1975

AIR STANDARDIZATION AGREEMENT

FLOTATION AND SEA SURVIVAL, TEST METHODS AND REQUIREMENTS

Air Standardization Co-ordinating Committee

UNCLASSIFIED

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AMENDMENT LIST

AL No.	AL Date	By Whom Amended	Date	Signature

TERMS OF AGREEMENT

1. Object. To standardize the requirements for inflatable life preservers.

2. References. Part I, para 105; Part III, para 317 and Appendix "E" of the Report of the Fifteenth Meeting of Working Party 61 - Aerospace Medical and Life Support Systems and para 3 e of the MC Review and para 1 d of the ASCC Coordinating Statement dated 25 July 1975 on the above Meeting and UK AVP 24, BS 2 F100, BS 3595 and US Fed SPEC CCC-T-191.

3. Related Air Standards. The following are ASCC AIR STDS which have a direct bearing on or contain essential details for full understanding of this AIR STD and on which implementation of this AIR STD may depend: ASCC AIR STDS (Latest Editions) 51/1 and 51/5.

4. Release. This Standard may be released in accordance with National Security Policies.

5. Agreement. This agreement constitutes declaration of intent to conform to the provisions expressed herein. No departure therefrom will be made by any participant without prior consultation with the others, except that if unavoidable circumstances make it essential for any nation to take immediate action without prior consultation, the other ASCC nations will be advised as soon as possible.

6. Subscription by Other Services. The US Navy, the US Army, the Royal Navy, the British Army, the Royal Australian Navy, the Australian Army, the Royal New Zealand Navy and the New Zealand Army subscribe to this Standard.

7. Reservations. Nil.

BY AUTHORITY OF:

Chief of Staff, USAF
Chief of Naval Operations, USN
Chief of the Defence Staff, CF
Chief of the Air Staff, RAF
Chief of the Air Staff, RAAF
Chief of the Air Staff, RNZAF

For The Air Standardization Coordinating Committee

B.J. CASTLEDINE, Lt. Colonel
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ASCC Monitoring Committee

J.V. RADICE, Wing Commander
RAF Member
ASCC Monitoring Committee

F.W. LAWLER, Captain
USN Member
ASCC Monitoring Committee

R.J. HIGH, Lt. Colonel
USAF Member
ASCC Monitoring Committee

M.D. PEACOCK, Wing Commander
RNZAF Member
ASCC Monitoring Committee

P. DRAKE, Wing Commander
RAAF Member
ASCC Monitoring Committee

DETAILS OF AGREEMENT

8. Agreement. The participants agree that the following characteristics and requirements shall be incorporated in inflatable life preservers.

9. General Requirements. The life preserver, both in the uninflated and inflated state shall provide comfort with a minimum of bulk and restriction. It shall also offer no interference with breathing, vision or hearing. The life preserver shall provide sufficient space to accommodate the survival aids specified for the life preserver and ensure their ready accessibility when the life preserver is inflated. The life preserver may incorporate a standard snap link to provide for hoisting during helicopter rescue operations and some conspicuous and readily accessible means, e.g. lifting beckets, to permit withdrawal of the wearer from the water. For use in high speed ejection seat aircraft, the life preserver shall be capable of withstanding a 600 knot wind blast with subsequent retention of its operational performance and that of its associated survival aids.

a. Materials. The life preserver may be constructed of a fire retardant material or encased in a fire retardant casing, such that all external materials shall be flame resistant. The inflatable material of the life preserver shall have sufficient tear strength in accordance with performance requirements. Additionally, all materials and components shall be suitable for world-wide use and storage and shall be free of any ingredient likely to cause irritation of the skin, having an offensive odour or any other property objectionable in a garment.

(1) Metal Parts. All metal parts shall be of a corrosion-resistant material or treated in a manner to render them adequately resistant to corrosion. All metal parts shall be free from burrs or sharp edges, and neither the assembly nor any part of it, inflated or deflated, shall be capable of damaging an inflatable life raft or the wearer.

(2) Dissimilar Metals. Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other.

(3) Fungus-proof Materials. Materials which are not nutrients for fungi shall be used to the greatest extent practicable. In cases where materials that are nutrients for fungi must be used, such materials shall be treated with a fungicidal agent.

(4) Non-metallic Components. Non-metallic components shall be designed to minimize deterioration caused by abrasion and/or exposure to sunlight, micro-organisms, moisture, heat, fuel, hydraulic and lubricating oil and grease, and salt spray. Protection shall be provided for those non-metallic components, particularly nylon lines, for which strength degradation association with abrasion or exposure-induced deterioration can endanger the preserver user.

b. Inflation Characteristics. The preserver shall be wholly gas inflated upon either manual or automatic operation, providing the specified buoyancy is attained within five seconds, and is achieved over the entire range of environmental conditions in which the preserver may be utilized such as:

	Minimum Degrees Centigrade	Maximum Degrees Centigrade
Water Temperature	0	30
Air Temperature	-10	65

(1) Single Point Inflation. The preserver shall incorporate a single point of inflation, a manually operated device, which shall be readily recognizable to both sight and touch and located to be readily operated by either hand, when gloved, wet and cold. The operation shall require a pull of

$$68\ ^{+45}_{-22}\text{N}\ (15\ ^{+10}_{-\ 5}\ \text{lb}).$$

Manual inflation shall be capable of overriding automatic inflation.

(2) Automatic Inflation. The preserver may incorporate automatic inflation which shall operate and be activated by immersion in both salt water and in fresh water having a level of resistivity of $90\ ^{+10}_{-\ 0}$ microhms at standard conditions. The automatic device must also be totally immune to inadvertent inflation in the cockpit and protected against premature inflation during escape and descent through precipitation. The life preserver should fully inflate within five seconds, regardless of mode of operation. Full inflation is defined as the ability of the life preserver to support a 98th percentile aircrew member, as defined in the applicable anthropometric standard, with flight clothing and applicable personal/survival equipment, in the water, within five seconds after life preserver actuation.

(3) Oral Inflation. The preserver shall be equipped with a means of oral inflation which shall be readily accessible to the mouth and to either hand. The oral inflation provision shall incorporate a check valve and a means of deflating the life preserver. The oral inflation system must not leak.

c. Self-righting Characteristics. The preserver shall have the following capabilities in righting the aircrew member:

(1) Maximum righting time of five seconds;

(2) Inability of the wearer to float face downwards; and

(3) Ability to maintain the wearer floating on his back with his face out of the water while unconscious.

d. Operation (Gas Generated). When the preserver is inflated for operation, there shall be no evidence of hindrance to the flow of the gas. All the seams, sealed areas, and cemented attachments shall remain intact and shall show no indication of separation. There shall be no evidence of construction or material failure. The attachment of the flange and of the oral inflation tube to the compartment and the bond between the oral inflation valve and tube shall remain intact. There shall be no evidence that the gas being discharged from the compartment is obstructed or that the oral inflation tube and valve is blocked. The seams or attachments shall not pucker when the compartments are inflated or deflated.

e. Flotation Characteristics. The life preservers shall provide head-up flotation with mouth and face clear of the water while maintaining the optimum body flotation angle of 45 ± 20 degrees from the vertical with adequate support for the back of the head. The life preserver shall provide a minimum buoyancy, throughout the range of water temperature specified, of 16 kg (35 lbs.). Additional buoyancy shall be provided to support a heavily loaded aircrew member or other aircraft occupants.

f. Pressure Requirement. The life preserver shall be sufficiently strong to withstand twice the normal inflation pressure without damage.

g. Leakage Requirement. Following full inflation to a pressure of 14 KPA (2 psig) the pressure drop in the flotation chamber after 10 minutes shall be less than 3 KPA (0.5 psig).

h. Colour A distinctive colour should be used except where combat conditions exclude it. The colour when used may be restricted to the flotation compartment when inflated but should be of maximum visibility by day both when saturated with water and when dry.

j. Sizing. One size of life preserver is desired but two sizes are permitted. The life preserver shall accommodate the 3rd through 98th percentile range of the user population wearing standard flight clothing and applicable personal survival equipment. Adjustment shall be provided to give a secure but comfortable fit.

SECURITY CLASSIFICATION OF FORM
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Development of an Integrated Life-Preserver/Survival Vest for Canadian Forces Aircrew

4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

Graham, Peter G. Captain
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Canadian Forces (CF) aircrew have been using life-preservers that were developed in the 1950's. Years of use and testing have shown that these units have many deficiencies. The Medical Life Support Division (MLSD) of the Defence and Civil Institute of Environmental Medicine (DCIEM) tested numerous types of life-preserver units to identify a suitable replacement.

Because no entirely satisfactory life-preserver could be identified and to meet the concurrent need for a survival vest for CF aircrew DCIEM/MLSD developed an integrated life-preserver/survival vest (LP/SV). The design criteria were based on the requirements listed in the Air Standardization Coordinating Committee Air Std 61/4, recommendations outlined in previous DCIEM reports, and ideas put forth by aircrew who tested prototype models in the field.

The LP/SV will enter service in the near future, and will meet or exceed the Air Standardization Coordinating Committee (ASCC) specifications required of a modern life-preserver.

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Life-Preserver

Survival Vest