EAST/WEST INDUSTRIES, INC. FARMINGDALE, NEW YORK

11

REPORT NO. 208-2-101

FINAL REPORT FOR PROJECT 208-2

VACUUM PACKED MINI-RAFT

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (14) 208-2-101	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) VACUUM PACKED MINI-RAFT.		5. TYPE OF REPORT & PERIOD COVERED (9) FINAL REPORT
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (11) 16 Dec 74		8. CONTRACT OR GRANT NUMBER(s) (15) N62269-74-R-Ø612 NEW
9. PERFORMING ORGANIZATION NAME AND ADDRESS EAST/WEST INDUSTRIES, INC. 22 Central Drive Farmingdale, NY 11735		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DD1664 Identification Number UDI-E-40103
11. CONTROLLING OFFICE NAME AND ADDRESS CREW SYSTEMS DEPT. NAVAL AIR DEVELOPMENT CENTER		12. REPORT DATE December 16, 1974
		13. NUMBER OF PAGES 41
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 44 p.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

MINI-RAFT, ONE-MAN LIFE RAFT, INFLATABLES,

VACUUM PACKAGING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This technical report culminates the development and design effort of a one-man Mini-Raft and two types of vacuum packaging. Type I is designed for insertion into a flight suit leg pocket. Type II is mountable as a back pack on an aircrewman's vest. Contents include reference to drawings, and give the results of trade-off studies.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

391649

VACUUM PACKED MINI-RAFT

TABLE OF CONTENTS

FINAL REPORT FOR PROJECT 208-2

VACUUM PACKED MINI-RAFT

SECTION I

INTRODUCTION & SUMMARY

This technical report has been prepared for the Life Support Engineering Division of the NADC Crew Systems Department as the Final Report required by Contract N62269-74-R-0612. It culminates the development and design effort, at East/West Industries, of a one-man Mini-Raft and two types of vacuum packaging.

Six Mini-Rafts per East/West P/N 208J100-1 have been fabricated. Three of these have been vacuum packed into Type I Packets per P/N 208D200-1, designed for insertion into a flight suit leg pocket. The other three Mini-Rafts have been vacuum packed into Type II Packets per P/N 208D300-1, designed for mounting as a back pack on the crewman's vest. Drawings for the Mini-Raft and the Packets are being submitted together with this report.

The Mini-Rafts were constructed from a pattern furnished to East/West by NADC at the outset. This pattern was similar to a previously furnished pattern from which two Mini-Rafts had been manufactured on Contract N62269-74-M-8476. Mini-Rafts delivered on the current contract utilized the same 4 oz./sq. yd. sea-blue taffeta nylon (urethane coated) as had been accepted by the Navy on the former contract. The new pattern differed slightly from the old pattern, in that the seat area was somewhat reduced and the handles were deleted.

The engineering and manufacturing effort during this program involved preliminary physical tests, as well as optimizing trade-off studies. Experimental prototype raft sections were constructed where necessary for test and evaluation of heat-sealed joints and for preliminary vacuum packing method investigations. These studies and investigations led to the design of tools suitable for the manufacture of 6 rafts and 3 packs of each type, and to the preparation of the EWI drawings. Informal liaison between East/West and NADC personnel was conducted as necessary to ensure adequate coordination.

The primary goal of this program was to develop techniques needed for production of the Mini-Raft and its vacuum packs. This goal was achieved as follows:

- East/West's RF Heat Sealing facility and a suitable set of sealing dies were manufactured and calibrated for optimum heat-sealed joints using the coated fabric selected for this program.
- An experimental raft, configured exactly to the Government-furnished pattern, was built, and its packageability into acceptably-shaped vacuum packs verified. Design features, not originally a part of the pattern, were added as follows:
    - Nylon strings inserted into all channels to guide air flow during evacuation and folding of the raft.
    - Anti-chill/chafing boot added to CO_2 cylinder to protect fabric; uses hook-and-pile attachment to facilitate easy replacement of cylinders.
    - Proper positioning of CO_2 inflation valve to permit optimum location of inflation mechanism for packaging and operation.

- Type I (leg pack) and Type II (back pack) vacuum packs, having appropriate shapes, were designed to have pull handle, tear seal and internal lanyard configurations that guarantee highly reliable inflation within seconds after manual actuation is started. Feasibility of manufacture and ability to retain vacuum were demonstrated.

Some of the objectives of East/West's original proposal for this program were not satisfied. The work done on this program demonstrated the degree of feasibility for these objectives. The following key conclusions were obtained as a result of studies and investigations:

- An overall volume of 96 cu. in. was obtained for the Type I Pack using 7 mil thick fabric. An alternate fabric, only 5.5 mils thick can provide a reduction to approximately 82 cu. in. Both volumes exceed the 70 cu. in. goal originally planned. It may be necessary to increase the size of the crewman's leg pocket and, perhaps to use hook-and-pile fabric for this pocket to facilitate installation and removal of the Mini-Raft.

- A packaging efficiency of 70.8% was obtained in the Type I Pack. Packaging efficiency was found to be unrelated to the hand feel of raft fabric, and is limited essentially by the geometrical shapes of components such as valves and CO_2 cylinders.

- For both the Type I and Type II configurations, the smallest overall dimension has slightly exceeded goals (2" max. and 1" max., respectively) that were originally planned. Basically, this is because the 1.5" dia. CO_2 cylinder is the only available size for the required 2 oz. capacity.

- An overall volume of 105 cu. in. was obtained for the Type II Pack using 7 mil thick fabric. An alternate fabric only 5.5 mil thick, can provide a reduction to approximately 88 cu. in. As expected, this exceeds the volume of 60 cu. in. originally set for a ½" thick pack, but easily meets the 120 cu. in. volume resulting from the proposed 1" thick packet. It is recommended that consideration be given to the omission of vacuum from the Type II back pack. Such a pack would be somewhat larger but would provide greater crewman's comfort by virtue of its softness.

SECTION II

TECHNICAL DISCUSSION

A. Fabric Selection

There had already been some prior experience in the design and fabrication of the "Deep-Sit High Freeboard" Mini-Raft at the outset of this program. Crew Systems Department personnel had designed the basic raft and provided East/West with pattern information, from which 2 Mini-Rafts were constructed and delivered on Contract N62269-74-M-8476.

The selection of fabric for the aforementioned first two rafts was based on the desire for a sea-blue color, 4 oz./sq. yd. urethane-coated taffeta which would have strength and sealability properties needed. Test results showed that the selected fabric was the strongest of several candidate fabrics considered. Thus it was jointly the opinion of NADC and East/West personnel that this fabric be selected for the current program.

During the course of construction and design of the Mini-Rafts and vacuum-packs, it was discovered that early hopes for high packaging efficiency had been overly optimistic, and that a 70 cubic inch leg packet is not feasible with the selected fabric. Nevertheless, this fabric was still considered to be the most suitable, from a strength and safety viewpoint, and it was decided to complete the manufacturing as started. In this way, the primary goals of the project would be achieved with a minimum of delay. Manufacturing techniques and vacuum package concepts were indeed developed and successfully demonstrated with the original fabric.

Trade-off studies subsequently led to indications that a thinner gage fabric may be suitable for this application. The fabric in current use has a 7 mil thickness and a weight of 4.50 oz./sq. yd. of which 1.8 oz./sq. yd. is base nylon taffeta. In considering other fabrics, it was found that samples of a 5.5 mil thick, 1.8 oz./sq. yd. base nylon taffeta, coated with 2.0 oz./sq. yd. urethane, exhibited sufficient strength and sealability even though its weight is only 3.8 oz./sq. yd. Calculations show that this fabric is 21 percent thinner than the presently used fabric, and should reduce the overall vacuum-packed volume of the leg packet from 96 to about 80 cubic inches. This 17 percent decrease will not meet the original 70 cubic inch goal, but may be worth attaining in order to provide a practical leg packet acceptable to crew personnel, even though the seal strength margin of safety is somewhat decreased.

B. Design and Construction

With regard to manufacturability of seals and joints, the Mini-Raft's design had been proven satisfactory in prior efforts. The two rafts delivered on the previous program were used by the Navy to demonstrate feasibility from the viewpoint of both manufacturability and functionality, using a dark-colored fabric.

In considering the additional requirements for folding and vacuum packing, it has been found necessary to make a few minor design changes. Anticipating some of these needs, NADC engineers have modified the pattern to eliminate the handle and to reduce the amount of fabric employed in the seat area. These changes have provided a reduction in overall bulk, and therefore, serve to reduce overall pack volume. Further changes were found to be necessary. One of these was the insertion of nylon strings into all internal channels within the raft. The strings are so arranged that, upon application of suction to the inlet valves, air is guided along the strings for complete evacuation, thus preventing the formation of pockets into which air might be entrapped as the fabric collapses.

Drawing 208J100, provided with this report, gives the details of string locations and attachments. The small additional bulk of the added string was found to be more than offset by the resulting decrease in overall volume due to entrapped air.

Another design change has consisted of the addition of an anti-chill/anti-chafing boot to the CO_2 cylinder and valve assembly. This serves to protect the raft's fabric when folded and inserted into the vacuum pack. It also protects against vacuum-pack fabric chafing. In addition, the boot provides an anti-chill feature that limits any stiffening of raft fabric during inflation as the expanding gas cools the cylinder walls. This boot has been designed with a hook-and-pile attachment to facilitate easy replacement of cylinders.

To further refine the technology of Mini-Raft manufacture, shop effort during this program was directed mainly toward the development and design of improved tooling. Whereas the first two rafts had been manufactured with relatively few special tools, the current program produced a set of versatile tools which provide more efficient operation of the RF heat sealing facility. Considerably less trial and error is now needed for the small quantity manufacture of Mini-Rafts. Preliminary knowledge was gained toward ultimate production techniques for larger quantities of manufactured rafts. A preliminary manufacturing specification was prepared, and served as a goal during the fabrication of the 6 rafts produced for this program. A copy of Specification 208MS100 is included in the Appendix of this report.

The primary objective of this program was successfully met with the manufacture and demonstration of leg-packet and back-packet vacuum packs. Drawings 208D200 and 208D300 show, respectively, the design features of these packs. Tests have shown that the pull-handle, tear seal and internal lanyard configurations function well, and that highly reliable inflation occurs within seconds after manual actuation is started. In the limited time during which finished packs have remained on hand, it appears that retention of vacuum is excellent.

Although the primary goals of this program have been met, a relatively low packaging efficiency was achieved.

The actual packaging efficiency of the leg packet was measured and found to be 70.8 percent. Careful investigation showed that little can be done to increase this efficiency factor. It is limited essentially by the geometrical shapes of components such as valves and CO_2 cylinders. It is unrelated to the hand feel of the raft fabric for 4 oz. taffeta materials whose range of softness to boardiness is relatively narrow. These fabrics are so pliable that voids or pockets cannot be created by fabric stiffness; the fabric must yield completely to atmospheric pressure on the exterior surface unless restrained by bridge-like supports. The reason for low packaging efficiency lies, no doubt, in the irregularities of component shapes that provide such bridge-like supports and prevent intimate, skinlike contact between the interior surface of the package envelope and every point on every interior component.

The overall volume of the leg packet is 96 cubic inches, which exceeds the initial goal of 70 cubic inches (7" x 5" x 2"). As previously discussed, some improvement may be feasible if a thinner gage fabric is used. The overall volume of the back packet is 105 cubic inches, which easily meets the 132 cubic inch goal (12" x 11" x 1") that was considered feasible (although it fails to meet the 12" x 11" x ½" goal originally desired). Owing to the 1.5" diameter CO_2 cylinder (the only available size for the required 2 oz. capacity), it was not possible to maintain the package depth dimension goal of 1" for the entire back-packet.

The size limitations described above are not of serious consequence, but do require some reconsideration of initial concepts. Although the leg packet may be reduced by about 17 percent in volume through the use of thinner gage fabric, the crewman's leg pocket should be increased in size over that originally thought necessary. It would also be of great advantage to make the leg pocket peelable by using hook-and-pile fabric, in order to facilitate both installation and quick removal of the vacuum packet for emergency use and in the event that the vacuum is accidentally lost. In considering the crewman's comfort while wearing the back-packet, there appears to be no need for even a 1" maximum thickness limitation, and it would be desirable to omit the evacuation of the package. The evacuated and folded raft in an unevacuated packet would provide a degree of softness on the crewman's back and would not excessively increase the size of his back pack.

C. <u>Trade-off Studies</u>

In order to facilitate the selection of optimum fabric for the application, the parameters of importance were considered, and their relationship to properties of available fabrics established. These relationships are itemized below:

1. <u>Peel and Shear Strength</u> - For nylon taffeta base cloth and uniform quality surface application of a thin urethane coating, the adhesive strength of a heat-sealed joint will increase with coating thickness, because the

cross-section area of the bonded zone will increase as the amount of available heat-softened urethane increases. Pigmentation of the urethane weakens the chemical bond of urethane coat to nylon, and will therefore weaken the peel and shear strength.

2. Tear Resistance - Depends mainly on the base cloth weave and weight for a given yarn denier and fabric weave density. For nylon taffeta, the urethane coating has the effect of decreasing tear resistance. This is because the urethane binds the yarn threads together and prevents a relative gathering motion among them. Freedom of mesh motion tends to protect against initial fracture under tension because gathering of the threads produces greater combined strength.

3. Bulk Volume - Depends entirely on total thickness of the coated fabric, and is therefore proportional to the weight per square yard.

4. Hand Feel - Depends fundamentally on the stiffness properties of the adhesive tie-coat used to create a strong chemical bond between the urethane and nylon surfaces. However, the presence of pigment in the urethane will soften the finished

fabric's hand while lowering the strength of this chemical bond. It follows, therefore, that lightly colored fabrics are more likely to have a soft hand because they would consist of natural nylon coated with pigmented urethane. Conversely, deep colors require dyeing of the nylon base cloth and would normally preclude the need for pigmenting the urethane coat; hence deeply colored fabrics often exhibit more "boardiness" than do lightly colored fabrics. It is now understood that an advancement in the state-of-the-art now permits the attainment of a somewhat softer hand feel for deeply colored fabrics through the use of improved adhesive tie-coat materials.

5. Color - Natural nylon base cloth that has been scoured and heat set has a whitish appearance. When coated with clear urethane, the peel and shear strengths are maximized. Dyed nylon negligibly weakens adhesion of the urethane coating and minimally affects the hand feel. Pigmenting the urethane slightly weakens the adhesion to the nylon and softens the hand feel. If a deep color is desired, the nylon fabric should be dyed. Deeply colored urethane pigmentation results in a light color on the nylon side as seen through the translucency of the whitish base cloth.

6. Abrasion Resistance - Resistance to internal damage by abrasion is known to be best for clear urethane. There does not appear to be a known relation between abrasion resistance of the nylon and the presence of dye. However, it is reasonable to anticipate the possibility that some dyes and pigments may have more of an effect than others.

Four candidate fabrics which were previously used in inflatable products for the Navy were investigated for the Mini-Raft application. Measurements were made and tests run on available samples of these materials. The results are tabulated in Table I. An inspection of Table I reveals that the data obtained verify the above considerations.

<u>TABLE I</u>

<u>PROPERTIES OF CANDIDATE FABRICS</u>

Property \ Fabric Candidate Identification	BLUE (E/W Mini-Rafts)	GRAY (Mittens)	GREEN ("G" Suit)	WHITE (E/W encapsulating rafts)
Yarn denier	70	70	70	70
Approx. yarns/in. warp	108	108	108	108
Approx. yarns/in. fill	80	80	80	80
Average measured weight oz./sq. yd.	4.50	5.46	3.81	4.06
Total thickness	.007	.007	.0055	.006
Strength #/in. peel	62	30	40	52
Strength #/in. shear	85	63	72	75
Nylon color status	Dyed	Natural	Dyed	Natural
Urethane color status	Clear	Pigmented	Clear	Clear
Relative hand description	Boardy	Soft	Boardy	Boardy

In summary, the trade-off studies on this program have led to the following general conclusions:

- Overall packaging volume of a vacuum-packed inflatable depends primarily on the thickness of the coated fabric and on maintaining close tolerances for that thickness. It does not depend on the hand feel of the fabric.
- There are trade-offs among color, adhesion strength and hand feel of urethane-coated nylon fabrics. Deep colors are obtained by dyeing the nylon and using clear urethane. Pigmented urethane creates a soft hand and weakens adhesive qualities.
- Peel and shear strengths of all 4 candidate fabrics exceed minimum requirements for a Miniraft application.
- The candidate having the thinnest gage can provide up to not more than 17% reduction in vacuum-pack overall volume with respect to the thickest gage investigated, provided close tolerances are maintained on the urethane coat thickness.

D. <u>Test Data</u>

As previously mentioned, Specification 208MS100 (see Appendix) was prepared as a guide for the evaluation of the 6 rafts produced in this program and as a preliminary manufacturing specification, ultimately to apply to large scale production of the Mini-Raft. Table II, below, is a summary of the performance test data obtained on the manufactured rafts when inspected in accordance with the performance requirements of the specification.

TABLE II

PERFORMANCE TEST DATA

Test \ Raft Serial Number	1	3	4	5	6	7
CO_2 Operation						
60 sec.	OK	OK	OK	OK	OK	OK
60 min.	OK	OK	OK	OK	OK	OK
Deflation	OK	OK	OK	OK	OK	OK
Pressure Test						
First 10 min.	No Adj.	Slight Adj.	No Adj.	Slight Adj.	No Adj.	No Adj.
Second 10 min.	4.0psi	3.9psi	4.0psi	4.0psi	3.9psi	4.0psi
Leakage Test						
Upper Section	2.0psi	2.0psi	2.0psi	2.0psi	1.9psi	2.0psi
Lower Section	1.9psi	1.9psi	2.0psi	2.0psi	2.0psi	2.0psi
Visual Inspection						
Performed	OK	OK	OK	OK	OK	OK

SECTION III

CONCLUSIONS AND RECOMMENDATIONS

A. General

This Final Report is being submitted as Item A001 of DD1423 in Contract N62269-74-R-0612, and is associated with East/West Drawings 208J100, 208D200 and 208D300 that are appended hereto. These drawings are being submitted as Item A002 of DD1423 of the same contract.

Six (6) Mini-Rafts, P/N 208J100-1, have been fabricated. Three (3) of these have been vacuum packed into Type I Packets, P/N 208D200-1, designed for insertion into a leg pocket of an aircrewman's flight suit. Three (3) have been vacuum packed into Type II Packets, P/N 208D300-1, designed for back-pack mounting on an aircrewman's vest.

The Mini-Rafts were constructed from a Government-furnished pattern which was modified somewhat in order to accommodate the needs of vacuum packing. The modifications, consisting of the addition of internal nylon strings and of an anti-chill/chafing boot for the CO_2 cylinder, and the positioning of the CO_2 inflation valve are included in the information on the drawings being furnished.

The vacuum packets were designed to accommodate the raft. Tests showed that all performance objectives for the vacuum packs were met, and verified feasibility of manufacture.

The design and construction effort led to some improved tooling and shop fabrication techniques. Also, trade-off studies were conducted in a search for optimization of fabric parameters. The design, construction and study efforts provided valuable experience from which the following conclusions were reached.

B. Conclusions

1. Selection of Fabrics - The sea-blue colored, 4 oz./sq. yd. taffeta fabric, of which the rafts and the vacuum packets were made, is the best choice when strength is of utmost importance. However, it was not possible to meet original goals for overall packet volume owing to the combination of fabric bulk and relatively low achievable packaging efficiency (70.8%).

2. Packaged Volumes - The packaged volumes were 96 cu. in. for the Type I and 105 cu. in. for the Type II packets. Study results have indicated that overall packaged volume depends essentially on the thickness of the coated fabric and not on its hand feel. A thinner gage material is available that could theoretically provide about 17 percent reduction in packaged volume.

3. Color - There are trade-offs among color, adhesion strength and hand feel of urethane-coated nylon fabrics. Deep colors are obtained by dyeing the nylon and using clear urethane. Pigmented urethane creates a soft hand and weakens adhesive qualities.

4. Manufacturing Techniques - East/West Industries has developed successful manufacturing techniques that facilitate the production of good quality Mini-Rafts and vacuum packages. Preliminary knowledge has been acquired toward the techniques for larger scale production, and a preliminary manufacturing specification prepared (see Appendix).

C. Recommendations

It is recommended that the manufacture of additional Mini-Rafts be authorized for further evaluation by the Navy. This should include, initially, a small quantity to be made of a thinner gage material in order to determine, by actual test, whether sufficient strength exists to ensure the desired reliability and whether an adequate volume savings can be effected. Following this, it is recommended that a pilot production run be authorized in order to finalize the techniques for manufacture of larger quantities.

It is also recommended that consideration be given to the omission of vacuum from the Type II back pack in order to soften the packet and thereby improve on the aircrewman's comfort.

EAST/WEST INDUSTRIES

MANUFACTURING SPECIFICATION

LIFE RAFT, INFLATABLE,

ONE-MAN MINI

East/West P/N 208D100-1

1. SCOPE

1.1 This Specification covers the manufacture and inspection requirements for one type of a mini, one-man, inflatable life raft, when produced in substantial quantities. It shall serve as a guide for the requirements to be met when small quantities are manufactured using preproduction methods. It is mandatory that this document shall apply to all Mini-Rafts manufactured by East/West except as may otherwise be specified on the work order authorization form.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect form a part of this Specification to the extent specified herein:

SPECIFICATIONS:

Federal

BB-C-101	Carbon Dioxide (CO_2), Technical and U.S.P.

Military

MIL-I-6903	Ink, Marking (For Parachutes and Other Textile Items)

STANDARDS:

Federal

FAA-TSO-C13c	Inflation Valves
FED-STD-595	Colors

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection By Attributes
MIL-STD-129	Marking for Shipment and Storage
MS26545	Cylinders - Compressed Gas, Nonshatterable

Industrial

Reeves, Inc.	Adhesive #DP402

DRAWINGS:

East/West Industries, Inc.	208J100

3. REQUIREMENTS

3.1 First article - Unless otherwise specified, the mini, one-man, inflatable life raft tested under this Specification shall be a product which has been inspected and has passed the first article inspection specified in 4.3 through 4.3.2.

3.2 Materials and components - The materials and components shall conform to the applicable specifications, standards, and drawings as listed or required herein. Unless otherwise specified, the materials and components, except for the metallic parts, used in the construction of the mini, one-man inflatable life raft, shall have been manufactured not more than 12 months prior to the date of delivery of the mini, one-man, inflatable life raft (see 6.2 (g)).

3.2.1 Cloth -

3.2.1.1 Main and lower tubes, anti-chill boot and abrasion, attaching, and reinforcing patches - The main and lower tubes anti-chill boot, and abrasion, attaching, and reinforcing patches shall be fabricated from #70 denier nylon, coated one side with urethane, WT4-4.5OZ, color #35042, blue, of Fed. Std. 595.

3.2.6 Oral inflation assembly - The oral inflation assembly of upper section shall face bottom of raft, and the oral inflation assembly of lower section shall face top of raft. Both units shall contain valves conforming to FAA-TSO-C13c.

3.2.11 Adhesive - The adhesive shall be the adhesive, DP402, manufactured by Reeves Incorporated, or equivalent. The adhesive shall be neutral in color or colorless.

3.3 Design - The shape and arrangement of the life raft and the components shall conform to East/West Drawing No. 208J100-1.

3.4 Construction - The life raft shall be constructed in accordance with East/West Drawing No. 208J100-1.

3.4.1 Cutting - The life raft and the components shall be cut in strict accordance with the patterns, developed by the Engineering Department, which show seam allowance, size, shape and location of the components, and notches or markings for the proper assembly of all the parts. The developed patterns shall not be altered in any manner except by engineering change authorization and shall be used for making the working patterns.

The coated side of the cloth shall be on the innerside of the main and lower tubes. The uncoated side of the cloth for the floor shall be the side that will be in contact with the water.

3.4.2 Use of adhesive - In all the cementing operations, the surface to which the adhesive shall be applied, shall be thoroughly cleaned with a suitable solvent so that the dusting materials (zinc stearate or talc) and any other surface contaminant are removed. The surface shall be clean prior to cementing. Care shall be exercised to insure that the coating and the base undercloth shall not be damaged and the adhesion between both shall not be impaired in any manner by prolonged exposure to the solvent. The solvent used shall evaporate completely, prior to the application of the adhesive, and shall leave no residue. The cemented areas shall not contain any trapped air, channel, or wrinkle. The adhesive shall be controlled to insure that old adhesive or adhesive that has partly or completely polymerized shall not be used. The containers for the adhesive shall be free from congealed adhesive before being refilled.

3.4.2.1 Cementing of the patches, and attachments - The cementing of the patches and attachments shall be undertaken utilizing the technique outlined in 3.4.2 so that, prior to the inspection of the assembled life raft, the adhesive shall have developed its optimum bonding properties. The anti-chafing liner shall be cemented to the life raft without tension. The adhesive, when dry or cured, shall present a neat and uniform appearance. The adhesive shall not be allowed to remain in clots, and upon drying or curing shall not cause the cloth, seam tapes, and attachments to shrink or pucker at any point on the life raft.

The life raft shall be free from any congealed mass of the adhesive and spots or stains resulting from excessive adhesive. All the applicable parts of the life raft shall be covered with a minimum amount of zinc stearate or talc to prevent adherence of unrelated surfaces.

3.5 Markings - The markings shall be legible and durable and of contrasting color, one-half inch high letters and numerals, which shall be thoroughly dry, prior to packaging. The marking ink shall conform to MIL-I-6903. The outboard side of the main tubes, at the bow, shall contain the following information:

P/N MINIRAFT
NAME OF MANUFACTURER
CONTRACT NUMBER
DATE OF MANUFACTURE (Month and Year)
SERIAL NUMBER

3.6 Performance - After completing visual examination specified by paragraph 4.6.1, the following requirements shall be met when following the inspection procedures under paragraph 4.6.

3.6.1 Carbon dioxide operation - Each life raft, when inspected for operation as specified in 4.6.2, shall inflate to its design shape, as shown in 208J100-1, in not more than 60 seconds without any evidence of impediment or blockage to the flow of the carbon dioxide gas or by restriction by any component. The carbon dioxide shall enter the main tubes only. All the seams, patches, and cemented attachments shall remain perfectly intact and shall show no indication of separation. There shall be no evidence of constructional or material failure in any respect. The main or lower tubes shall not be twisted or distorted greater than 6°. The oral inflation valve shall operate without difficulty and shall shut off the flow of the carbon dioxide gas completely. The attachment of the flange end of the oral inflation tube to the main tube and the attachment of the oral inflation tube to the valve shall remain perfectly intact. This examination and test shall be performed in sequence with the pressure and leakage inspections. The operation inspection shall be performed first followed by the pressure inspection and the leakage inspection, respectively. After each inspection, the main and upper tubes shall be completely deflated.

3.6.2 Pressure - The pressure in the main and lower tubes shall be not less than 3.75 pounds per square inch gage (psig), after inspected as specified in 4.6.3. All the seams, patches, and cemented attachments shall remain perfectly intact and shall show no indication of separation. There shall be no evidence of constructional or material failure in any respect. The floor or the main or lower tubes shall not be twisted or distorted greater than 6°.

3.6.3 Leakage - The pressure in the main and lower tubes shall be not less than 1.75 psig, after inspected as specified in 4.6.4. There shall be no passage of air from the main tubes to the lower tubes.

3.7 Workmanship -After completion of the final assembly, the life rafts shall be thoroughly cleaned and all loose thread, lint, and foreign matter shall be removed. The metal components shall not be misaligned nor contain any sharp edge, crack, dent, nick, burr, or sliver. The life rafts shall not contain any spot, stain, non-specified hole, abraded area, tear, or cut. Because of the emergency and life support use of this equipment, the importance of providing a product of uniform excellent quality cannot be overemphasized. The life rafts shall be uniform in quality and shall be free from irregularities or defects which could adversely affect performance, reliability, or durability. The life rafts shall conform to the quality and grade of product established by this test procedure. The occurrence of defects shall not exceed the acceptance criteria established herein.

4. QUALITY ASSURANCE PROVISIONS

4.1 <u>Responsibility for inspection</u> - Unless otherwise specified by this procedure, the Quality Control Department (QC) is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified by this procedure, QC may use their own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Engineering Department. Engineering reserves the right to perform any of the inspections set forth in this Specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Classification of inspection - The examination and testing of the mini, one-man, inflatable life rafts shall be classified as follows:

(a) First article inspection - First article inspection consists of examinations and tests performed on samples which are representative of the production item(after authorization of a work order)to determine that the production item meets the requirements of this Specification (see 3.1 and 4.3 through 4.3.2).

(b) Quality conformance inspection - Quality conformance inspection consists of examinations and tests performed on individual products or lots to determine conformance of the products or lots with the requirements set forth in this Specification (see 4.4 through 4.4.1.2).

4.3 First article inspection - The first article inspection of the mini, one-man, inflatable life rafts shall consist of examinations and tests for all of the requirements of this Specification.

4.3.1 First article samples - Unless otherwise specified by the work order as soon as practicable after authorization, the Manufacturing Department shall submit two life rafts for first article inspection. The samples shall be representative of the construction, workmanship, components, and materials to be used during production. When Manufacturing is in continuous production of these life rafts, from work order to work order, submission of further first article inspection samples on the new work order may be waived, at the discretion of Engineering (see 6.2(c)). Approval of the first article inspection samples, or the waiving of the first article inspection, does not preclude the requirements for performing the quality conformance inspection. The first article inspection samples shall be forwarded as specified in the work order. (see 6.2(d)).

4.3.2 Upon completion of the first article inspection, all the applicable inspection reports, recommendations and comments pertinent for use in monitoring production will be forwarded to the cognizant project engineer. One of the approved first article inspection samples of the life rafts will be held by QC for use in monitoring production. The remaining life raft will be destroyed in the first article inspection and shall not be considered as part of the quantity to be delivered under the work order.

4.4 Quality conformance inspection - The sampling and inspection levels shall conform to MIL-STD-105. The quality conformance inspection shall consist of the following:

Visual examination
Carbon dioxide operation
Pressure
Leakage

4.4.1 Sampling -

4.4.1.1 Inspection lot -

4.4.1.1.1 Life Rafts - An inspection lot size shall be expressed in units of one life raft made essentially under the same conditions and from the same materials and components. The sample unit shall be one life raft.

4.4.1.2 Sampling for examinations and tests of the life rafts - The sample size, acceptance criteria, examinations and tests required, for the life rafts, shall be as specified in Table I.

TABLE I

SAMPLE SIZE, ACCEPTANCE CRITERIA, EXAMINATIONS, AND TESTS OF THE LIFE RAFTS

Inspection	Paragraph Requirement	Paragraph Method	Sample Size	Acceptance Criteria
Visual examination	3.3 thru 3.5, 3.7 and Figs. 1 thru 14	4.6.1.1	Every life raft for major defects. Inspection Level II for minor defects.	Reject all units with any major defect and an acceptable quality level of 6.5 defects per unit for minor defects.
Carbon Dioxide Operation 1/	3.6.1	4.6.2	Every life raft.	Reject all defective units.
Pressure 1/	3.6.2	4.6.3	Every life raft.	Reject all defective units.
Leakage 1/	3.6.3	4.6.4	Every life raft.	Reject all defective units.

1/ These inspections shall be performed in sequence. The carbon dioxide operation inspection shall be performed first, then the pressure inspection, and then the leakage inspection. The results of the operation, pressure, and leakage inspections shall be identifiable by the assigned serial number (see 6.2(d)) which shall be marked on the life raft as specified in 3.5.

4.5 Inspection conditions -

4.5.1 Atmospheric conditions - Unless otherwise specified, all the inspections required by this test procedure shall be conducted at an atmospheric pressure of 28 to 32 inches of mercury and at a temperature of 70±18 degrees Fahrenheit (25±10 degrees Centigrade). If the final conditions of the ambient temperature or barometric pressure, at the end of the 4 hour waiting period of the leakage inspection, 4.6.4, are different from the initial conditions recorded at the start of the inspection, the following corrections shall be made to the final pressure readings in psig.

4.5.1.1 Temperature correction - For each degree Fahrenheit rise in temperature, 0.031 psig shall be subtracted from the final pressure reading. For each degree Fahrenheit drop in temperature, 0.031 psig shall be added to the final pressure reading. The corresponding correction per degree Centigrade is 0.056 psig.

4.5.1.2 Barometric pressure correction - For each 0.1 inch of mercury rise in barometric pressure, 0.049 psig shall be added to the final temperature-corrected pressure reading. For each 0.1 inch of mercury drop in barometric pressure, 0.049 psig shall be subtracted from the final temperature-corrected pressure reading.

4.5.2 Pressure measurement - The pressure shall be measured by means of a Bourdin Gage or a mercury manometer calibrated in psig or inches of mercury and having an accuracy of at least ± 0.5 inches of mercury. To convert inches of mercury to psig, multiply the inches of mercury by 0.49.

4.5.3 Inspection area and equipment - The area in which the rafts are inspected shall be adequately protected to preclude damage to the units. The area and inspection equipment shall be free of sharp or rough edges, burrs, protrusions, and anything else which will cut, tear, or damage the life raft or the components.

4.5.4 Air - When use of air is specified in an inspection, the air used shall not contain any oil or liquid water.

4.6 Inspection procedures -

4.6.1 Visual examination -

4.6.1.1 Life rafts - Every life raft shall be examined visually for major defects to determine conformance to this Specification. Each life raft, selected as a sample unit from the lot, shall be examined visually for minor defects. The classification of defects, Table II, shall be used to classify the defects found.

TABLE II

CLASSIFICATION OF DEFECTS FOR THE VISUAL EXAMINATION OF THE LIFE RAFTS

Defect	Major	Minor
GENERAL		
a. Any non-specified hole, scissors or knife cut, tear, burn, or weakening defect such as smash, multiple float, loose slub, or abraded area	X	
b. Any portion of the cloth stiffened, hardened, or scorched by any process of manufacturing	X	
c. Cloth side of the tube cloth not on the outerside of the main or lower tubes	X	
d. One to three mends and/or patches less than $1\frac{1}{2}$ inches in any straight line		X
e. More than three mends and/or patches less than $1\frac{1}{2}$ inches in any straight line	X	
f. Upper oral inflation assembly which does face the occupant and/or lower oral inflation assembly which does not face the occupant, misplaced, bent, distorted, or not serving the intended purpose	X	
g. Oral inflation tube not secured to the oral inflation valve	X	
METALLIC COMPONENTS		
a. Any surface rough, misaligned, distorted, or containing any corrosion, scale, pit, nick, sliver, burr, sharp edge, dent,or crack	X	
b. Any surface unclean or containing embedded foreign matter	1/	

TABLE II (Continued)

Defect	Major	Minor
c. Any loose, detached, or not securely retained component	1/	
d. Any inlet valve threads, missing, stripped, torn, or broken	X	
e. Any finish missing or not uniformly finished		X
CLEANNESS		
a. Any unsightly slub or discoloration of the cloth		X
b. More than 3 spots or stains, on the exterior of the life raft, greater than one inch in any straight line dimension		X
c. More than 3 spots or stains, on the inside of the life raft, greater than one inch in any straight line dimension		X
d. One to 3 congealed masses of the adhesive, on the surface of the raft or anti-chafing liner, greater than 1/4 inch in diameter		X
e. More than 3 congealed masses, of the adhesive, on the surface of the raft or anti-chafing liner greater than 1/4 inch in diameter	X	
f. Any cement on the inlet valve opening	X	
CEMENTING		
a. Cement on the cloth surface in excess of 1/2 inch		X
b. Any evidence of adhesion of unrelated surfaces	X	
c. Color of the adhesive not neutral or colorless	X	

TABLE II (Continued)

Defect	Major	Minor
d. Any cemented area that has more than 3 wrinkles per inch	X	
e. Any wrinkle, as a result of cementing, raised more than 1/8 inch in height	X	
MARKINGS		
a. Any information missing, incorrect, incomplete, or illegible		X
COMPONENTS AND ASSEMBLY		
a. Any component not as specified or any defect of a component or defect of assembly, not herein classified	1/	
b. Any component, component part, or required operation omitted, or any operation improperly performed, not herein classified	1/	
c. Any component part not cut in accordance with the patterns (see 3.4.1), not herein classified	1/	
d. Any dimension not as specified, not herein classified	1/	

1/ The defect shall be classified as major, when it seriously affects the serviceability or appearance, otherwise it shall be classified as a minor defect.

4.6.2 Carbon dioxide operation - The raft shall be spread out and placed in a horizontal position on the floor of the inspection area (see 4.5.3). One inflation assembly, consisting of a compatible one-man life raft valve and MS26545B2C0020 or MS26545B4C0020 carbon dioxide cylinder, charged with 2.0±0.01 ounces of carbon dioxide conforming to BB-C-101, Grade B, Type I, shall be installed on the life raft. The main tubes shall be inflated by pulling the pull cable of the inflation valve with an abrupt quick motion, actuating the inflation valve. The inflation system shall meet the requirements of paragraph 3.6.1 for a period of 60±5 minutes after the raft has been inflated.

Upon completion of the examination, the main tubes shall be completely deflated by unlocking the oral inflation valve and allowing the carbon dioxide gas to exhaust through the oral inflation assembly. The mouthpiece of the oral inflation valve shall be depressed to allow the carbon dioxide gas to flow through the valve to determine whether there is any difficulty in depressing the mouthpiece, whether the flow of the carbon dioxide gas is restricted by excess adhesive, talc, zinc stearate, other foreign matter, by damage due to the securing of the oral inflation valve, or whether the flow of carbon dioxide gas is impeded or blocked by the misplacement of the oral inflation tube base reinforcing patch (see 3.6.1). Upon completion of the examination for the flow of the carbon dioxide gas through the mouthpiece, the mouthpiece shall be released to its original position to determine whether the valve operates without difficulty and that the flow of the carbon dioxide gas is shut off completely (see 3.6.1). Upon completion of the testing and examination, the main and lower tubes shall be completely deflated and the raft shall then be subjected to the pressure inspection, 4.6.3.

4.6.3 Pressure - The completely deflated life raft shall be placed on the floor of the inspection area (see 4.5.3). All the pressure readings shall be taken with the raft in this position. The main and lower tubes shall be inflated, with air (see 4.5.4), to a pressure of 4.0 psig in not less than 60 seconds. The air supply shall be securely shut off and after a minimum of 10 minutes, the pressure in the main and lower tubes shall be checked and readjusted, if necessary, to the original pressure of 4.0 psig. At the end of a minimum of 10 minutes after the readjustment period, the pressure in the tubes shall meet the pressure requirement of paragraph 3.6.2. While inflated, the raft shall be examined for material and construction failure, separating of the seams, patches, and attachments, twisting or distortion of the floor or the main or lower tubes (see 3.6.2). Upon completion of the testing and examination, the main and lower tubes shall be completely deflated and the raft shall then be subjected to the leakage inspection, 4.6.4.

4.6.4 Leakage - The completely deflated raft shall be placed on the floor of the inspection area (see 4.5.3). The temperature and pressure readings shall be taken with the raft in this position and in the vicinity of the raft. The main tubes only shall be inflated with air (see 4.5.4) to a pressure of 2.0 psig. The air supply shall be securely shut off and after a minimum of 15 minutes, the pressure in the main tubes shall be checked and readjusted, if necessary, to the original pressure of 2.0 psig. The temperature and barometric pressure shall be recorded at this time. At the end of a minimum of 4 hours after the readjustment period, the pressure shall be measured and corrected for any change in the temperature or barometric pressure (see 4.5.1 through 4.5.1.2). The corrected pressure in the main tubes shall meet the pressure requirement of paragraph 3.6.3. While the main tubes are inflated, the lower tubes shall be examined to determine if any air passed from the main tubes into the lower tubes (see 3.6.3). Upon completion of the testing and examination of the main tubes, and while inflated, the lower tubes shall be inflated with air (see 4.5.4) until there shall be a pressure of 2.0 psig in the main and lower tubes. The air supply shall be securely shut off and after a minimum of 15 minutes, the pressure in the main and lower tubes shall be checked and readjusted, if necessary, to the original pressure of 2.0 psig. The temperature and barometric pressure shall be recorded at this time. At the end of a minimum of 4 hours, after the readjustment period, the pressure in the main and lower tubes shall be measured and corrected for any change in the temperature or barometric pressure (see 4.5.1 through 4.5.1.2). The corrected pressure in the main and lower tubes shall meet the pressure requirement of paragraph 3.6.3. The life rafts may be stacked one upon another during the 4-hour waiting period of the leakage inspection, provided the following shall be adhered to:

(a) The temperature shall be recorded at a level comparable to the height at which the raft being inspected was stowed during the 4-hour waiting period.

(b) At the end of a minimum of 4 hours from the readjustment period, the raft to be checked for pressure shall be removed from the stacking and placed in a horizontal position on the floor of the inspection area. The barometric pressure of the inspection area shall be recorded. The pressure in the main and lower tubes, as applicable, shall be measured and corrected for any change in the temperature or barometric pressure (see 4.5.1 through 4.5.1.2). In no event shall the pressure in the main and lower tubes, as applicable, be determined with another raft stacked upon it. Upon completion of the testing and examination, the main and lower tubes shall be completely deflated.

5. PREPARATION FOR DELIVERY

5.1 Packaging - Packaging shall be Level C.

5.1.1 Level C - The life rafts shall be packaged to afford the minimum degree of protection necessary to prevent deterioration or damage during shipment under normal environmental conditions and commercial modes of transportation.

5.2 Packing - Packing shall be Level C.

5.2.1 Level C - The packaged life rafts which require packing for acceptance by the carrier, shall be packed within exterior type shipping containers in a manner that shall insure safe transportation, at the lowest rate, to the point of delivery. The containers shall conform to the minimum requirements of the rules and regulations applicable to the mode of transportation selected.

5.3 Marking - In addition to any special marking required by the work order (see 6.2(f)), the interior and exterior fiberboard containers shall be marked in accordance with MIL-STD-129 and shall include the date of manufacture (month and year).

6. NOTES

6.1 Intended use - The life raft covered by this test procedure is intended for use as emergency equipment by aircraft personnel forced down at sea.

6.2 Ordering data - Work orders shall specify the following:

(a) Title, number, and date of this test procedure.

(b) Quantity desired.

(c) Whether first article inspection is waived (see 4.3.1).

(d) Issuance of a block of serial numbers to cover the individual serialization of the life rafts for the quantity to be manufactured.

(e) Unless otherwise specified, the applicable levels of packaging and packing (see 5.1 and 5.2) shall be Level C.

(f) Whether any special markings are required (see 5.3).

(g) Certificate of compliance for the age of the materials and components (see 3.2).

6.3 Patterns - The patterns, for one life raft, will be furnished by Engineering to Manufacturing for use in cutting working patterns (see 3.4.1).

6.4 Data - For the information of Engineering and Manufacturing: Any of the data specified in applicable documents listed in Section 2 of this Specification or referenced lower-tier documents need not be prepared or furnished to Engineering, unless specified in the work order. The data to be furnished shall be listed on EW Form 208-10, which shall be attached to and made a part of the work order.