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EVALUATION OF 'AQUA-PAK'.(U)
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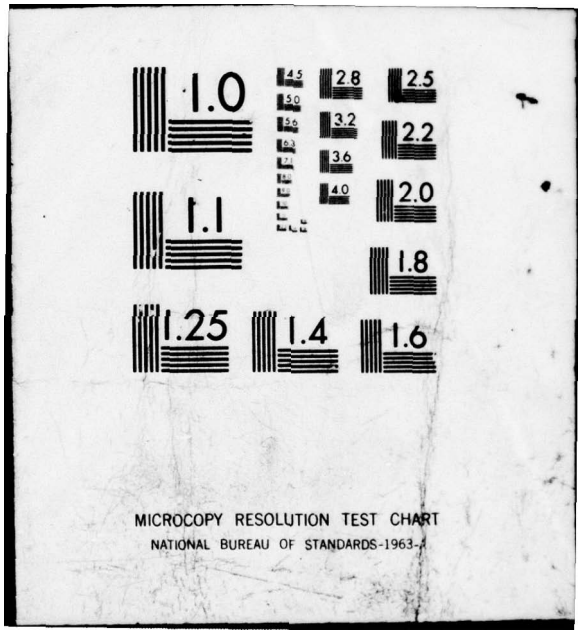
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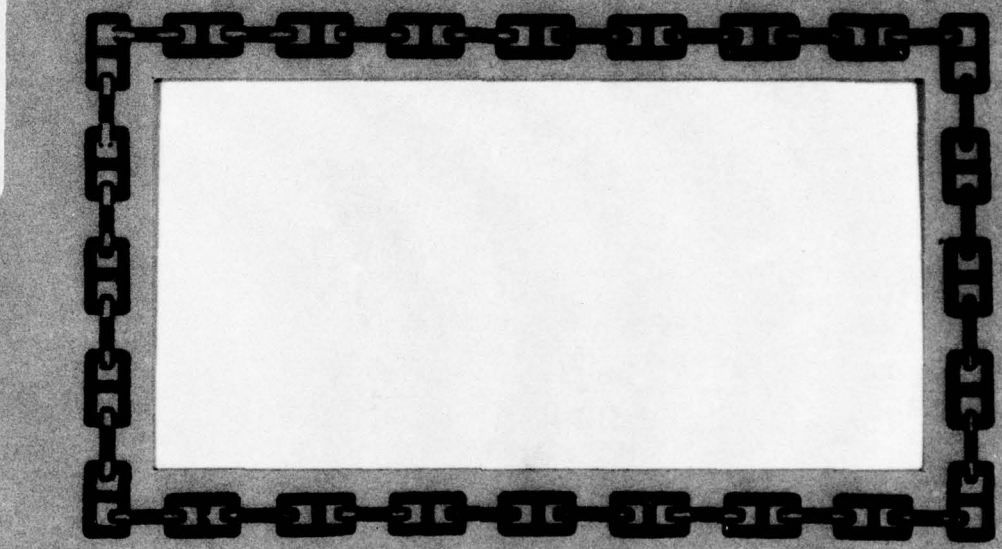


NAVY EXPERIMENTAL DIVING UNIT

U.S. NAVY EXPERIMENTAL DIVING UNIT
U.S. NGF, WASHINGTON 25, D.C.

EVALUATION REPORT 11-57

EVALUATION OF "AQUA-PAK"

PROJECT NS 185-005 SUBTASK 4 TEST 38

5 DECEMBER 1956

AD #

CONDUCTED & PREPARED	SUBMITTED	APPROVED
GEORGE HASLIP GM1(DV) USN	W. F. SEARLE, Jr. LT. USN PROJECT OFFICER	M. des GRANGES CDR USN OFFICER IN CHARGE

ABSTRACT

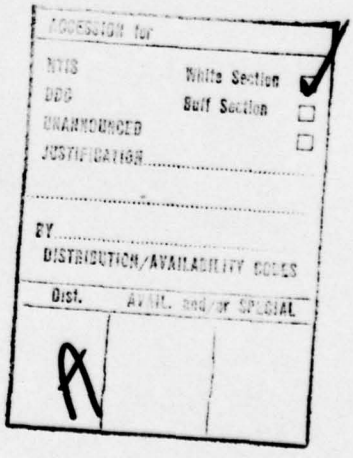
This evaluation was made to determine the suitability for naval service of the commercially designed and produced SCUBA bottle carrier and harness, "AQUA-PAK". Interest has been indicated in the AQUA-PAK" as a carrier-harness for use with the yet-to-be-developed Standard U.S. Navy SCUBA (including standard bottles).

The "AQUA-PAK" was evaluated subjectively by swimming pool runs and the subjects' comments are given verbatim. The results are discussed and lead to recommendations concerning modifications required prior to certification as recommended for naval service.

The mechanical workmanship of the "AQUA-PAK" is quite good, the design is simple and maintenance is easy.

The carrier is not, in its present form, certified as recommended for naval service though the basic design is very good and in most features the subjects felt that the "AQUA-PAK" was superior to other methods of securing SCUBA to the swimmer's back. The most serious deficiency is the unreliability of the emergency ditching release. It was also found that the bottles were held too far off the swimmer's back by the support plate, causing discomfort when walking out of the water. The harness jockstrap was not considered necessary and the release lanyard pull-ball is recommended for replacement.

The "AQUA-PAK" is a positive step toward a standard bottle carrier and, with minor mechanical modifications, gives promise of being acceptable.



SUMMARY

PROBLEM

Is the "AQUA-PAK" bottle carrier suitable for use in the naval service?

FINDINGS

The "AQUA-PAK" bottle harness is well built and smoothly finished. It is easy to dismantle and reassemble for repairs and cleaning. It provides a sturdy, comfortable method for properly securing and carrying scuba bottles while swimming. The scuba bottles cannot, however, be carried close enough to the swimmer's back. The bottle spacer is not adaptable to all scuba bottles. The jockstrap is unnecessary. The wooden emergency release ball provides a poor grasp. The emergency release mechanism fails to operate with consistency. The Scott "HYDRO-PAK" rigs are not adaptable to the "AQUA-PAK".

CONCLUSION

The "AQUA-PAK" scuba bottle carrier is not suitable for naval service at this time. It is recommended that the carrier be modified to bring the bottles closer to the swimmer's back and to improve the emergency release pull device.

ADMINISTRATIVE INFORMATION

References: (a) BuShips LTR Ser 538-2273 of 28 August 1956
(b) NRC, Pacific Science Board LTR of 19 September 1956

Reference (a) authorized the Himalayan Pak Company, Inc. to submit the "AQUA-PAK" for evaluation to Experimental Diving Unit.

Reference (b) advised that a sample was being sent to the Experimental Diving Unit.

On 26 September 1956, the "AQUA-PAK" was received by the Experimental Diving Unit.

On 26 September 1956, the Bureau of Ships verbally directed the Experimental Diving Unit to evaluate the "AQUA-PAK" and assigned the project number NS 185-005, Subtask 4, Test 38.

George HASLIP, GM1(DV), USN was designated project engineer.

Work commenced on 8 October and was completed on 23 November 1956.

The following breakdown indicates the man-hours expended for this evaluation:

Description	Manhours
Preliminary set-ups	8
Subjective runs	100
Photography	4
Report preparation	32
Report typing and duplication	16
TOTAL	160

This manuscript was submitted for review on 3 December and was accepted on 5 December 1956.

This report is issued in the evaluation report series, distributed only by the Bureau of Ships. It is the first and final report for the project.

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LIST OF ILLUSTRATIONS

1. OBJECT

1.1 Introduction

1.1.1 For several years, the Navy has been working towards a standardized open circuit scuba for general use by the fleet. In line with the program of standardization, a need exists for a standardized harness or carrier harness arrangement for carrying the bottles on the swimmer's back.

1.2 Objective

1.2.1 This report has one objective, namely; to determine if the subject "Aqua-Pak" is a possible means to meet the requirements of a standardized carrier-harness.

1.3 Scope

1.3.1 The scope of this project, though including an evaluation of the Aqua-Pak for both single and double bottle scuba, is directed primarily at a study of the Navy's needs, and therefore, emphasis has been given to the two bottle scuba. No attempt has been made to redesign the Aqua-Pak to correct deficiencies noted.

2. DESCRIPTION

2.1 General

2.1.1 The Aqua-Pak is a carrier harness which may be used with either single or double bottle scuba rigs. The Aqua-Pak has a rectangular shape and the following overall dimensions:

(1) Length ----------15 1/2 inches
(2) Width ----------12 1/2 inches
(3) Thickness ---------- 1/8 inch
(4) Weight ---------- 4 lbs 15 oz

2.1.2 The Aqua-Pak is shown in figures 1 and 2 and is composed of the following parts (corresponding pieces are numbered on figures 1 and 2):

(1) Backplate
(2) Shoulder straps
(3) Waist strap
(4) Jockstrap
(5) Emergency releasing rip cord
(6) Tank support bracket
(7) Single tank clamp
(8) Dual tank extension clamp
(9) Back support webbing
(10) Tank spacer
(11) Weight pockets

2.2 Specific Features

2.2.1 The back plate (piece 1) is made of lightweight, anodized aluminum. On the upper corners, slots have been cut to accomodate the shoulder straps (piece 2) and in the center of the top edges of the back plate, a hand space has been cut to facilitate carrying. On the left and right sides of the backplate, two holes have been cut to reduce water drag.

2.2.2 The shoulder straps (piece 2) are made of cotton webbing treated to resist mildew. They are 27 inches long and 2 1/8 inches wide. Incorporated on the straps are release rings and cones made of nickel plated brass.

2.2.3 The waist strap (piece 3) is made of cotton webbing treated to resist mildew. It is 25 inches long and 2 1/8 inches wide. Incorporated on the waist strap are emergency release rings and cones made of nickel plated brass, fully corrosion resistant.

2.2.4 The jockstrap (piece 4) is made of cotton webbing treated to resist mildew. It is 28 inches long and 1 inch wide.

2.2.5 The emergency releasing mechanism, or rip cord (piece 5) consists of a wooden ball type handle, a 16 inch long nylon pull cord and 2 releasing pins inserted in the releasing cones.

2.2.6 The tank support bracket (piece 6) is an aluminum bracket 12 inches long and 1 3/4 inches wide. It is indented to retain bottles in a steady, upright position. Four holes have been cut to eliminate water drag as much as possible. This bracket is designed to take either single or double bottles.

2.2.7 The single tank clamp (piece 7) is a stainless steel strap 29 inches long. A "Tee" bolt 3 1/4 inches long is used to secure the single bottle rig to the backplate.

2.2.8 The double tank extension clamp (piece 8) is a stainless steel strap 11 1/2 inches long. It is used in conjunction with and as an extension to the single tank clamp to secure the double bottle rig to the backplate.

2.2.9 The back support webbing (piece 9) is made of nylon webbing 14 inches long and 2 inches wide and is located near the bottom of the backplate. It is used to keep the Aqua-Pak from hitting the swimmer on the lower back. It also aids in the comfort of the swimmer when out of the water.

2.2.10 The tank spacer (piece 10) is 3 3/4 inches long by 3/4 inch wide. It is made of aluminum, and designed to keep the bottles evenly spaced when tightening the tank clamps.

2.2.11 The weight pockets (piece 11) are inverted nylon pockets holding one-pound weights. A "Murphy Button" fastener permits instant release of weights. The pocket fits smoothly over the waist strap,

preventing the weights from twisting or digging into the swimmer's body.

2.3 Manufacturer's Instruction Sheet

2.3.1 The Himalayan Pak Company, manufacturer of the Aqua-Pak, supplied a short four page instruction sheet with the equipment. These instructions pictured the various parts of the Aqua-Pak and give instructions on its rigging, use, maintenance, and care.

3. PROCEDURE

3.1 Pool Tests

3.1.1 The pool tests were made in a swimming pool, using the Aqua-Pak with the following types of scuba rigs:

(1) Aqua-Lung, 1 bottle
(2) Aqua-Lung, 2 bottles
(3) Northill Air-Lung, 2 bottles
(4) Scott Hydro-Pak, 2 bottles

The bottles were charged to 2100 p.s.i. Two subjects were used for each subjective run; one subject wearing a conventional scuba harness and one subject wearing the Aqua-Pak. Upon completion of initial runs with each rig, the subjects exchanged harnesses to facilitate a comparison of the Aqua-Pak to that of the conventional harness. For the four rigs, a total of eight runs were made and each run to a distance of 1/4 mile.

3.1.2 Each subject was instructed to check for the following:

(1) The accuracy of "rigging instructions."
(2) The accuracy of "Tips on Maintenance, Care, and General Use."
(3) The accuracy of the manufacturer's pamphlet, "Mounting of Tanks."
(4) The facility with which the weight pockets are used.
(5) The ease with which the rig was donned and adjusted.
(6) The general comfort prior to entry into the water; and the ability to move about and walk, as when coming up onto a beach.
(7) The ease and comfort of the rig, when entering the water.
(8) The general fit of the rig in the water.
(9) The ability to adjust the rig for comfort after entering the water.
(10) The general swimability of the rig.
(11) The additional resistance to fast spurts (as compared to regular harness).
(12) Restriction to free body movements such as rolling, head up and down, arm motion, etc.
(13) The increase or decrease of drag resistance as compared to a conventional harness.
(14) Any specific torque characteristics.
(15) Any obstruction to movement or any torque experienced when working or bounding off the bottom, feet up.

(16) Obstructions to general fit, or interference when working, such as lifting weights or pulling lines.
(17) Unusual obstruction to rolling movements in confined spaces.
(18) Unusual torque when lying face down, face up, standing up, and vertical-head down.
(19) Difficulty in reaching reserve air valves or pulls.
(20) Success in ditching and reliability of emergency release mechanism.

4. RESULTS

4.1 Accuracy of Manufacturer's Pamphlet

4.1.1 The two subjects wrote the following comments in response to the instructions or questions indicated in each article. The comments are made in the following order: (1) Haslip, (2) Suglia.

4.1.2 Check and comment on accuracy of "Rigging Instructions."

(1) The instructions are concise and easily followed.
(2) The instructions are accurate and easily followed.

4.1.3 Comment on "Tips, Care, Maintenance, and General Use."

(1) The instructions are complete and in good order.
(2) It covers all desired subjects and is complete.

4.1.4 Comment on instructions "Mounting on Tanks."

(1) The instructions cover mounting of tanks very satisfactorily.
(2) The instructions cover in detail the mounting of the tanks.

4.2 Pool Tests (Aqua Lung - single bottle - Figures 3a, 3b, 3c)

4.2.1 The two subjects wrote the following comments in response to the instructions or questions indicated in each article. The comments are made in the following order (1) Haslip, (2) Suglia.

4.2.2 Comment on the ease or difficulties with which the Aqua-Pak was donned and adjusted.

(1) There is absolutely no difficulty in donning and adjusting the Aqua-Pak, even when only one subject is used without assistance from another.
(2) It is easier to don and adjust the Aqua-Pak with assistance from another subject; however, one subject, alone, experiences no difficulty.

4.2.3 Comment on the general comfort prior to entry into the water and the ability to move about and walk, as when coming up onto a beach.

(1) The weight of the bottles, being at some distance from the subject's back, tends to pull and cause undue strain on

the subject's shoulders and back. However, it is much more comfortable than a conventional harness.

(2) The Aqua-Pak is much more comfortable than a standard Aqua Lung harness. One major advantage is the back support webbing, which eliminates the tendency of the bottles to strike the subject's buttocks, as in a standard harness.

4.2.4 Comment on the ease and comfort of the Aqua-Pak when entering the water.

(1) Since the bottles are secured to the subject much better than the conventional harness, there is less tendency of the bottles shifting position on entry into the water.
(2) The bottles, being secured to the subject so much better than with a standard harness, will not shift position when entering the water, either by jumping or walking down a ladder.

4.2.5 Describe the general fit of the Aqua-Pak in the water.

(1) The fit of the Aqua-Pak in the water was very good, with or without jockstrap.
(2) Excellent fit, even without the jockstrap.

4.2.6 Comment on the ability to adjust the Aqua-Pak for comfort after entering the water.

(1) There is not any difficulty in adjusting the Aqua-Pak for comfort.
(2) The Aqua-Pak can be adjusted for comfort in the water, with comparative ease.

4.2.7 Describe the general swimability of the Aqua-Pak.

(1) The Aqua-Pak does not offer any unusual interference while swimming. It is actually a decided improvement over the conventional harness as it keeps the bottles straight on the subject's back, thus eliminating the tendency of the bottles to shift.
(2) The Aqua-Pak does not interfere with the subject's swimming any more than a standard harness would, and due to the fact that the bottles are secured so much better with the Aqua-Pak, the tendency of the bottles to shift position is eliminated.

4.2.8 Does the Aqua-Pak offer additional resistance to fast spurts, as compared to a regular harness?

(1) The Aqua-Pak does not offer any noticeable additional resistance to fast spurts.
(2) The Aqua-Pak does not offer any additional resistance to fast spurts.

4.2.9 Comment on any restriction to free body movements, such as rolling, moving head up and down, arm motion, etc.

(1) Free body movements are more easily performed, because the bottles are more securely fastened to the swimmer's body.
(2) There is no restriction to body movements with the Aqua-Pak.

4.2.10 Compared to the regular harness, is there any significant increase or decrease in drag or resistance when swimming with the carrier? Describe any planing effect.

(1) Compared to the conventional harness, the Aqua-Pak does not have any increase in drag or resistance. There is a definite decrease in drag due to the bottles being more securely fastened to the swimmer's body. There was no planing effect at all.
(2) There was no increase or decrease in drag or resistance nor was there any increased planing effect while using the Aqua-Pak, as compared to the regular harness.

4.2.11 In swimming and turning, describe any specific torque characteristics. If torque characteristics were noted, describe efforts and success of readjusting harness to eliminate.

(1) With the Aqua-Pak adjusted on shore, there was no further need to adjust the rig to eliminate torque. The tendency toward torque was not noticeable.
(2) Torque characteristics were not noticeable while swimming and turning. There wasn't any need to adjust the Aqua-Pak harness.

4.2.12 Comment on any obstruction to movement or torque experienced when simulating work and bouncing off the bottom, feet up.

(1) When simulating work or bouncing off the bottom, feet up, there was neither restriction to movement nor torque, because the bottles are securely fastened to the swimmer.
(2) There wasn't any obstruction to movement or any noticeable torque when simulating working conditions and bouncing off the bottom, feet up.

4.2.13 Simulating work such as heaving a line and lifting weights, comment on the general fit and obstructions as compared to the regular harness.

(1) The Aqua-Pak fits very well and offers no obstruction to general tasks a diver may be called upon to perform.
(2) The Aqua-Pak fits very comfortably and does not offer any unusual obstruction while working on the bottom.

4.2.14 Is there any unusual obstruction to rolling or movement in a confined space?

(1) There isn't any more obstruction to working or rolling movements in a confined area while wearing the Aqua-Pak, than while wearing a conventional harness.

(2) The bottles rigged in an Aqua-Pak do not present any unusual torque in any position, because they are so securely fastened to the wearer.

4.2.16 Comment on any difficulty in reaching or manipulating the reserve air valve or pulls when wearing the carrier.

(1) Since the bottles are placed farther away from the swimmer, when wearing the Aqua-Pak, it is a little more difficult to pull the reserve air mechanism. However, it can be reached without excessive effort.
(2) It is a little harder to reach the reserve air, because the bottles are placed farther back on the swimmer. It can be reached without undue difficulty, however.

4.2.17 Describe the facility with which the emergency release is operated and the success in ditching the equipment as compared to ditching the same rig with standard harness.

(1) The emergency release mechanism worked only 50% of the time. The release line tends to bind very easily. However, the release mechanism is easily reached, and when working properly, ditching is actually faster than when ditching with a conventional harness.
(2) The Aqua-Pak can very easily be ditched and the release mechanism is easily reached. However, the release mechanism binds and as a result, it does not always release.

4.3 Pool Tests (Aqua Lung, Figures 4a, 4b, 4c and Northill Air Lung - Double Bottle, Figures 5a, 5b, 5c)

4.3.1 After each subjective run with the Aqua Lung rigged with two bottles and with the Northill Lung rigged with two bottles, the divers carefully completed their questionnaires. Since there were many instances wherein the comments were similar, the results are combined. In all cases, there was no difference between the comments on the Aqua-Lung and the Northill Lung. The comments are made in the following order: (1) Haslip, (2) Suglia.

4.3.2 Comment on the ease or difficulties with which the Aqua-Pak was donned and adjusted.

(1) There is aboslutely no difficulty in donning and adjusting the Aqua-Pak, even when only one subject is used, without assistance from another.
(2) It is easier to don and adjust the Aqua-Pak with assistance from another subject; however, one subject alone experiences no difficulty.

4.3.3 Comment of the general comfort prior to entry into water and the ability to move about and work, as when coming up onto a beach.

(1) The weight of the bottles, being at some distance from the subject's back, tends to pull and cause undue strain on the subject's shoulders and back. However, it is much more comfortable than a conventional harness.
(2) The Aqua-Pak is much more comfortable than a standard harness. One major advantage is the back support webbing which eliminates the tendency of the bottles to strike the subject's buttocks, as in a standard harness.

4.3.4 Comment on the ease and comfort of the Aqua-Pak, when entering the water.

(1) Since the bottles are secured to the subject much better than the conventional harness, there is less tendency of the bottles shifting position on entry into the water.
(2) The bottles being secured to the subject so much better than with a standard harness, they will not shift position when entering the water, either by jumping or walking down a ladder.

4.3.5 Describe the general fit of the Aqua-Pak in the water.

(1) The fit of the Aqua-Pak in the water was very good, with or without the jockstrap.
(2) Excellent fit, even without the jockstrap.

4.3.6 Comment on the ability to adjust the Aqua-Pak for comfort after entering the water.

(1) There is not any difficulty in adjusting the Aqua-Pak for comfort.
(2) The Aqua-Pak can be adjusted for comfort in the water, with comparative ease.

4.3.7 Describe the general swimability of the Aqua-Pak.

(1) The Aqua-Pak does not offer any unusual interference while swimming; actually, it is a decided improvement over the conventional harness, as it keeps the bottles straight on the subject's back, thus eliminating the tendency of the bottles to shift position.
(2) The Aqua-Pak does not interfere with the subject's swimming, any more than a standard harness would, and due to the fact that the bottles are secured so much better with the Aqua-Pak, the tendency of the bottles to shift position is eliminated.

4.3.8 Does the Aqua-Pak offer additional resistance to fast spurts as compared to a regular harness?

(1) The Aqua-Pak does not offer any noticeable additional resistance to fast spurts.
(2) The Aqua-Pak does not offer any additional resistance to fast spurts.

4.3.9 Comment on any restriction to free body movements, such as rolling, moving head up and down, arm motion, etc.

(1) Free body movements are more easily performed, because the bottles are more securely fastened to the swimmer's body.
(2) There isn't any restriction of body movement with the Aqua-Pak.

4.3.10 Compared to the regular harness, is there any significant increase or decrease in drag or resistance when swimming with the carrier?

(1) Compared to the conventional harness, the Aqua-Pak hasn't any increase in drag or resistance. There is a definite decrease in drag, due to the bottles being more securely fastened to the swimmer's body. There was not any planing effect at all.
(2) There was no increase or decrease in drag or resistance, nor was there any increased planing effect while using the Aqua-Pak as compared to the regular harness.

4.3.11 In swimming and turning, describe any specific torque characteristics. If torque characteristics were noted, describe efforts and success of readjusting harness to eliminate.

(1) With the Aqua-Pak adjusted on shore, there wasn't any further need to adjust the rig to eliminate torque. The tendency toward torque was not noticeable.
(2) Torque characteristics were not noticeable while swimming and turning. There wasn't any need to adjust the Aqua-Pak harness after entry into the water.

4.3.12 Comment on any obstruction to movement or torque experienced when simulating work and bouncing off the bottom, feet up.

(1) When simulating work or bouncing off the bottom, feet up, there was neither restriction to movement nor torque, because the bottles are securely fastened to the swimmer.
(2) There wasn't any obstruction to movement of any noticeable torque, when simulating working conditions and bouncing off the bottom, feet up.

4.3.13 Simulating work such as heaving in a line and lifting weights, comment on the general fit and obstructions as compared to regular harness.

(1) The Aqua-Pak fits very well and offers no obstructions to general tasks a diver may be called upon to perform.
(2) The Aqua-Pak fits very comfortably and does not offer any unusual obstruction while working on the bottom.

4.3.14 Is there any unusual obstruction to rolling or movement in a confined space?

(1) There is no more obstruction to working or rolling in a confined space while wearing the Aqua-Pak than while wearing a conventional harness.
(2) The Aqua-Pak does not offer any unusual obstruction while working or rolling in a confined space.

4.3.15 Do the bottles as rigged in the Aqua-Pak present any unusual torque when lying face down, face up, standing up, or vertical - head down?

(1) In any and all positions the Aqua-Pak has much less torque than the conventional harness, because the bottles do not shift on the swimmer.
(2) The bottles rigged in an Aqua-Pak do not present any unusual torque in any position, because they are so securely fastened to the wearer.

4.3.16 Comment on any difficulty in reaching or manipulating the reserve air supply valves or pulls when wearing the carrier.

(1) Since the bottles are placed farther away from the swimmer, when wearing the Aqua-Pak, it is a little more difficult to pull the reserve air mechanism. However, it can be reached without undue strain.
(2) It is a little harder to reach the reserve air, because the bottles are placed farther back on the swimmer. It can be reached without undue difficulty, however.

4.3.17 Describe the facility with which the emergency release is operated and the success in ditching the equipment as compared to ditching the same rig with standard harness.

(1) The emergency release mechanism worked only 50% of the time. The release line tends to bind very easily. However, the release mechanism is easily reached and when working properly, ditching is actually faster than when ditching with a conventional harness.
(2) The Aqua-Pak can very easily be ditched, and the release mechanism is easily reached. However, the release mechanism binds and as a result, it does not always release.

4.4 Pool Tests (Aqua-Pak rigged with Scott Hydro-Pak bottles - Figures 6a and 7a).

4.4.1 Evaluation of the Aqua-Pak rigged with Scott Hydro-Pak bottles was impossible, due to the fact that the Scott bottles could not be satisfactorily rigged to enable a swimming test. There were two main reasons why this was impossible.

4.4.2 When the Scott bottles were rigged with the control valves in the down position (Figure 6) the leader hose, running from the bottles to the face mask, was not long enough to enable free head movement. Each swimmer's head was pulled at a considerable angle to the right, thus eliminating any possibility of moving the head so as to face forward. (Figures 6a and 6b).

4.4.3 When the Scott bottles were rigged with the control valves in an upright position (Figures 6, 6a, 6b), it was impossible for the swimmer to reach any of the valves (Figure 7).

4.5 Weight Belt and Pockets

4.5.1 The weight pockets offer no resistance to ditching of weights. The weighted pockets should be carried on the harness belt if weights are needed rather than on a separate belt to facilitate ditching all gear in a minimum amount of time. No adverse effects are noted in comfort of the Aqua-Pak when worn with weights attached.

4.5.2 The weight pockets would not hold up under the strain of weights over a period of time; however, weights are easily dislodged from pockets when they are not desired. A separate weight belt should not be used as this extra equipment would take longer to ditch. The weights, if desired, should be a part of the Aqua-Pak as the manufacturer intended. Carrier harness was not affected by the use of weights.

5. DISCUSSION

5.1 General

5.1.1 The general design and mechanical workmanship and finish of the Aqua-Pak is quite satisfactory. Both subjects were agreed that the Aqua-Pak method of securing the scuba to their back was far superior to the standard commercial harnesses supplied with either the Aqua-Lung, Northill Air-Lung, or the Scott Hydro-Pak. It appeared that the bottles were more positively secured to the swimmer's back and yet having little or no tendency to float up or shift sideways. Yet, there was no discomfort indicated. The deficiencies discussed individually in 5.2 below, are all functional and correctable without modification to the basic design. The most serious deficiency, and the one which prevents even a qualified recommendation for service, is the unreliability of the emergency release (ditching) mechanism. No harness arrangement can be accepted without this provision being 100% reliable.

5.1.2 The basic design of the Aqua-Pak is considered good and worthy of consideration for use in a standard U.S. Navy scuba. The fact that the bottle spacer does not fit all rigs tested is of little consequence since the spacer's size would be designed to suit standard bottles. The fact that the Scott Hydro-Pak was not useable on the Aqua-Pak is also not serious since the Scott supply hose could easily be lengthened to suit the carrier. In short, minor design modifications to the Aqua-Pak would make it adaptable to a standard U.S. Navy scuba.

5.2 Specific Deficiencies

5.2.1 As noted above, the most serious deficiency noted was the unreliability of the emergency release mechanism. This feature failed to operate approximately 50% of the time. Repeated inspection both out of and under the water failed to turn up the cause of the malfunctioning. The lanyards were free and there appeared to be a binding at the release cover. One-hundred percent reliabilityof this feature is essential in an acceptable carrier-harness.

5.2.2 The design of the carrier is in itself simple, making maintenance easy. All parts can readily be disassembled for cleaning or replacement. The only tool required is a three-eighth inch socket wrench.

5.2.3 The subjects were agreed in their observation that when walking on land with the scuba and carrier on, there was somewhat more backwards torque on their shoulders than with the conventional commercial harness. It appears that this is as a result of the bottles (center of gravity) being held further away from the back by the carrier's tank support bracket. This deficiency is correctable by reducing the depth of the bracket, thus bringing the bottles closer to the swimmer's back.

5.2.4 The Aqua-Pak appears to have been designed for use with the commercial model Aqua-Lung. The curved seats in the tank support bracket and the bottle spacer (for two bottle use) best fit the Aqua-Lung. With other commercial models wherein the bottle spacing is different as a result of different manifold dimensions, the tank spacer does not fit. If the Aqua-Pak is to be used with commercial models, different size spacers will be required for different models. The spacer supplied was nothing more than a short piece of extruded aluminum "H" beam. In the naval service, field units would undoubtedly supply their own spacers of wood or aluminum. If the carrier were used with a standard U.S. Navy scuba, the spacer would be designed to fit the standard bottles and standard manifold and this problem would no longer exist.

5.2.5 An alternate solution to the requirement for different sized spacers would be to substitute an "X" shaped extrusion for the "H" extrusion. If the two axes of the "X" were made different dimensions, the same spacer piece could be designed to fit two scuba's and it might be possible, through compromise, to satisfy more than two models.

5.2.6 The jockstrap part of the harness has no functional value in the use of the carrier and in no way aids in the swimability. It is an actual hinderance to rapid ditching of the rig.

5.2.7 The emergency release lanyard has a small wooden ball at its end to facilitate both location and pulling. The ball seems to be too small and slippery. In line with recent comments from the field concerning the difficulty of manipulating the emergency release, particularly in cold water when the hands are numb, it is doubtful that the ball could be grasped by a cold, exhausted

diver. It is recommended that a ring of relatively large cross section to facilitate location and of at least 3 inches in diameter, to facilitate pushing or pulling by stiff, frozen fingers, be substituted for the wooden ball.

6. CONCLUSIONS

6.1 Findings

6.1.1 The Aqua-Pak carrier harness is found to be a well built, reasonably well engineered, smoothly finished apparatus which adequately fulfills its purpose of carrying open-circuit scuba bottles securely attached to a swimmer's back. The apparatus contains several minor design deficiencies which are readily correctable.

6.1.2 The emergency release (ditching) feature of the Aqua-Pak was found to be unreliable and it was primarily this fact which prevented a recommendation for service use provided the operating forces felt a need for such a carrier.

6.1.3 Contrary to preliminary expectations, no unusual torque or drag characteristics were found in the use of the Aqua-Pak. The subjects generally found that comfort and swimability was improved over that experienced with standard commercial harnesses.

6.2 Conclusions

6.2.1 It is concluded that the Aqua-Pak in its present form is not suitable for recommendation for service use, primarily because of the unreliability of the emergency release features.

6.2.2 It is further concluded that the basic design of the Aqua-Pak carrier harness gives promise as a step in the right direction towards the design of a carrying rig for the proposed U.S. Navy standard scuba.

6.3 Recommendations

6.3.1 It is recommended that the emergency release (ditching) system be restudied and, if necessary, redesigned to ensure 100% reliability.

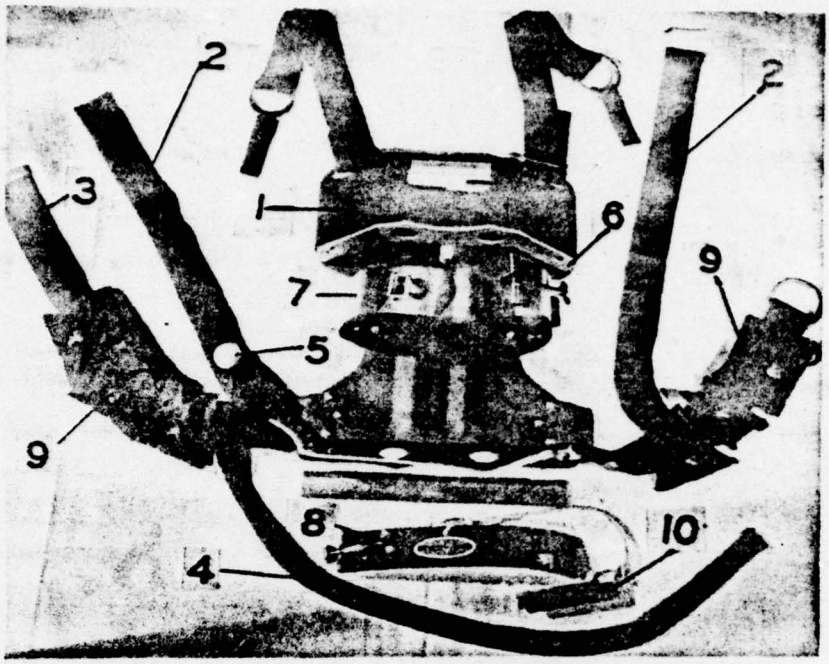
6.3.2 Minor design recommendations, explained fully in the text of the report, are as follows:

(a) Replace emergency release lanyard ball with a large ring.

(b) Reduce the depth of the back support plate.

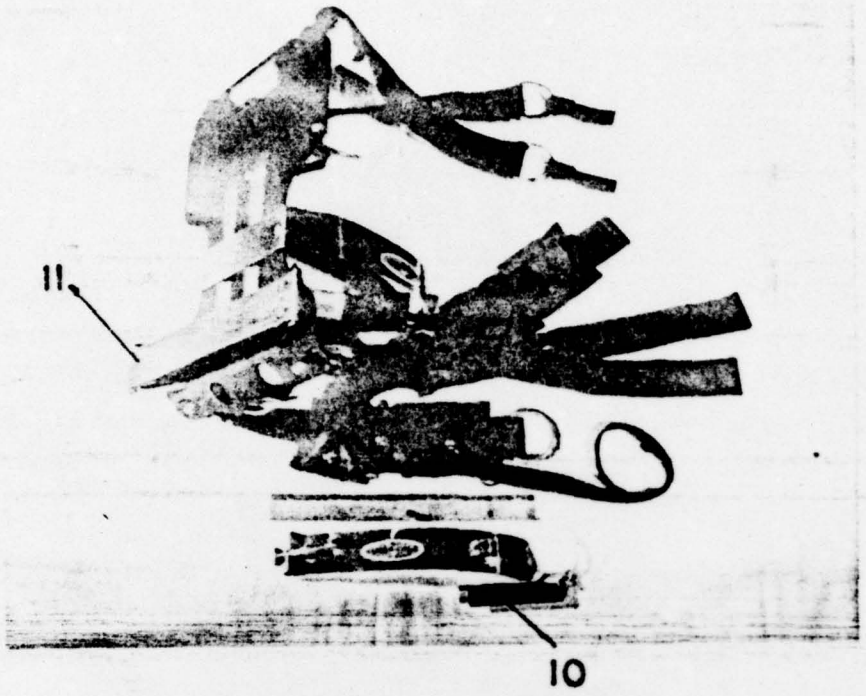
(c) Delete the jockstrap portion of the harness.

(d) Replace the present "H" shaped bottle spacer with an "X" shaped spacer of rectangular (rather than square) cross-sectional outline, of such dimensions



1 BACKPLATE
2 SHOULDER STRAPS
3 WAIST STRAPS
4 JOCK STRAPS
5 EMERGENCY RELEASING RIP CORD
6 TANK SUPPORT BRACKET
7 SINGLE TANK CLAMP
8 DUEL TANK EXTENSION CLAMP
9 WEIGHT POCKETS
10 TANK SPACER

FIG. 1



10 TANK SPACER

11 BACK SUPPORT WEBBING

FIG. 2

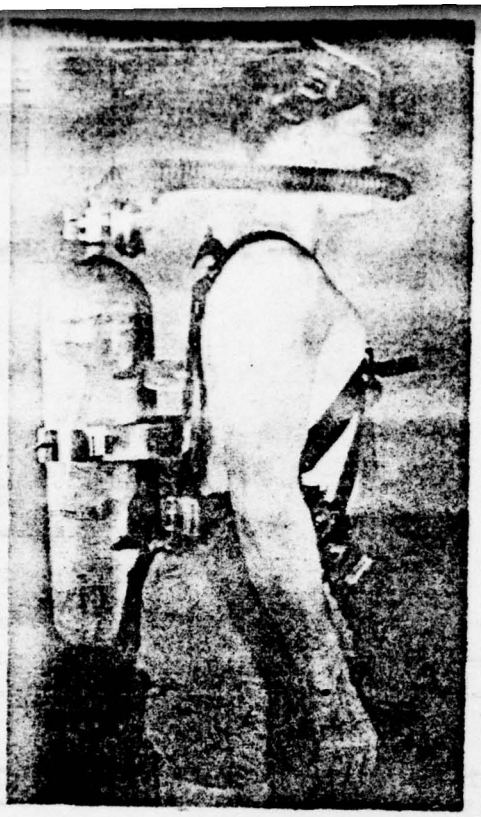


FIG 3-A

FIG. 3B

FIG. 3-C

FIG. 4-A

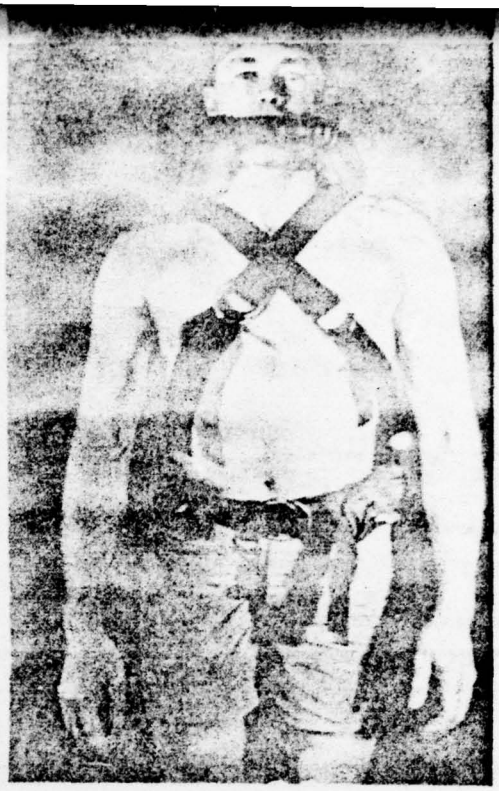


FIG. 4B

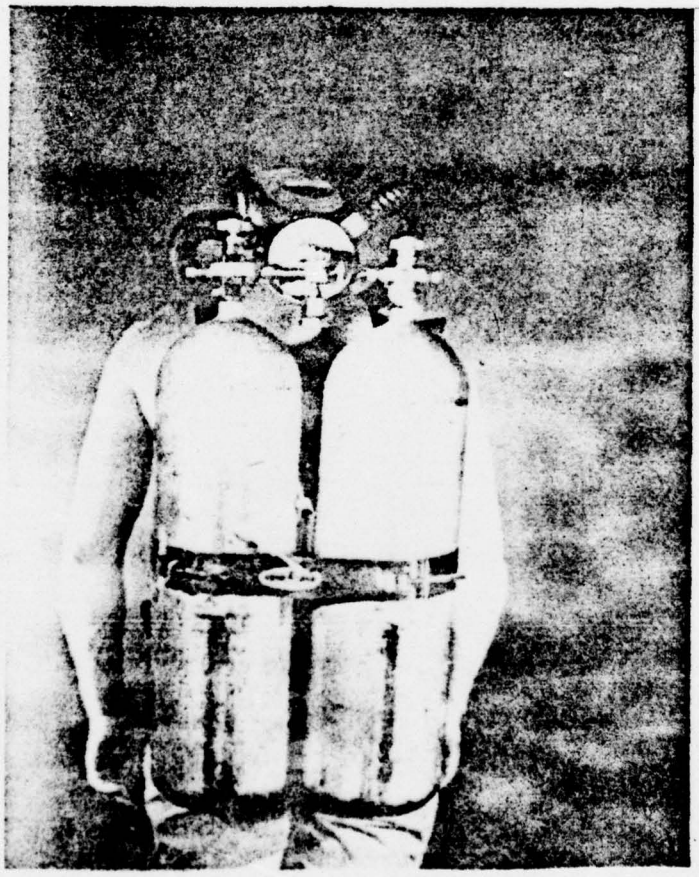


FIG. 4C

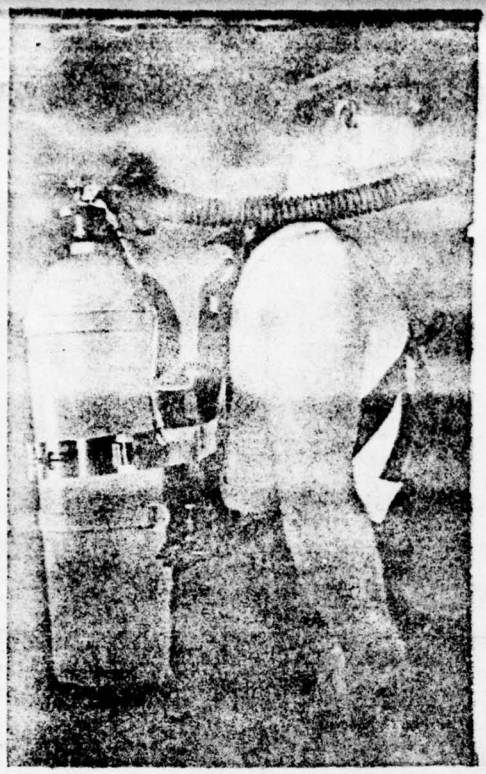


FIG. 5-A

FIG. 5-B

FIG. 5-C

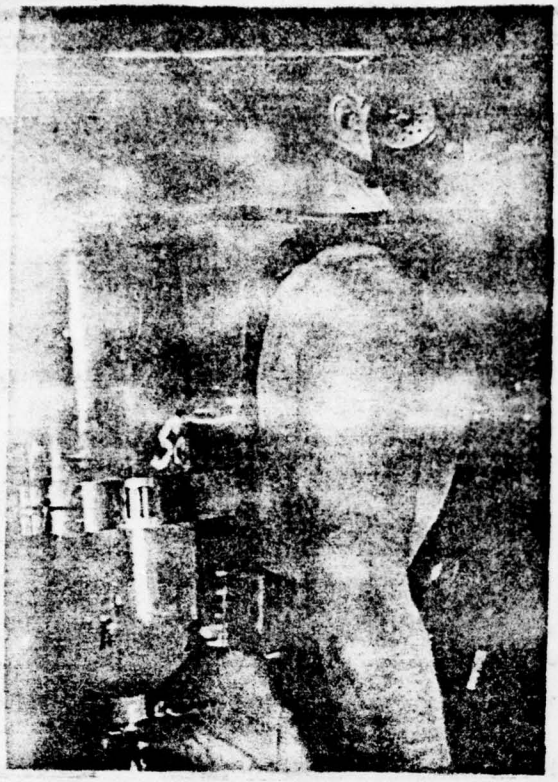


FIG.6-A

FIG.6-B

FIG. 6-C

FIG. 7-A

FIG. 7-B

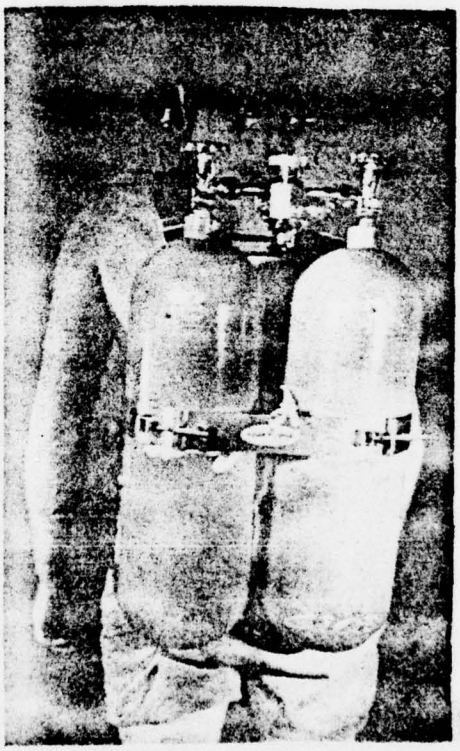


FIG. 7-C

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

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

This evaluation was made to determine the suitability for Naval service of the commercially designed and produced SCUBA bottle carrier and harness, "AQUA-PAK". Interest has been indicated in the AQUA-PAK as a carrier-harness for use with the yet-to-be-developed Standard U. S. Navy SCUBA (including standard bottles).

(CONT.)

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20. The "AQUA-PAK" was evaluated subjectively by swimming pool runs and the subjects' comments are given verbatim. The results are discussed and lead to recommendations concerning modifications required prior to certification as recommended for Naval service.

The mechanical workmanship of the "AQUA-PAK" is quite good, the design is simple and maintenance is easy.

The carrier is not, in its present form, certified as recommended for Naval service though the basic design is very good and in most features the subjects felt that the "AQUA-PAK" was superior to other methods of securing SCUBA to the swimmer's back. The most serious deficiency is the unreliability of the emergency ditching release. It was also found that the bottles were held too far off the swimmer's back by the support plate, causing discomfort when walking out of the water. The harness jockstrap was not considered necessary and the release lanyard pull-ball is recommended for replacement.

The "AQUA-PAK" is a positive step toward a standard bottle carrier and, with minor mechanical modifications, gives promise of being acceptable.