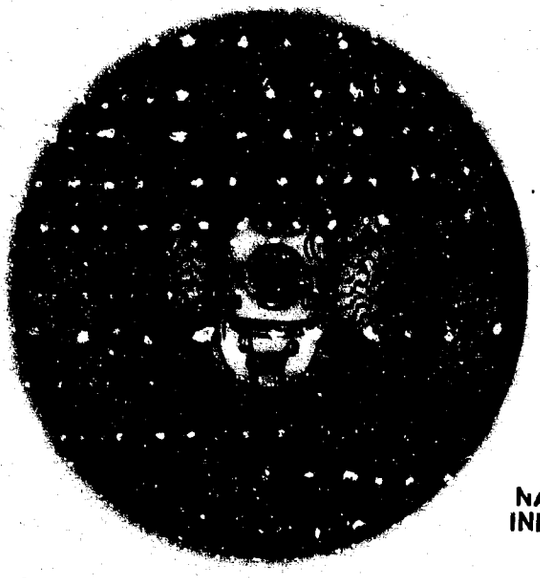
AD 729657

THE DETERMINATION OF THE BASIC CONDITION OF LIGHTNESS THAT CAN BE ATTAINED BY THE PRESENT LIGHTWEIGHT DIVING OUTFIT AND THE UNDERWATER SWIM SUIT AND THE EVALUATION OF THEIR OPERATING CHARACTERISTICS

REPORT NO. 2-50

NAVY EXPERIMENTAL DIVING UNIT



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14

NAVY EXPERIMENTAL DIVING UNIT
WASHINGTON NAVY YARD
WASHINGTON, D.C. 20390

21 March 1950

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REFER TO: S94-(3)-(2) 694D of 28 Sept 49

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
OFFICER IN CHARGE
NAVY EXPERIMENTAL DIVING UNIT
WASH. NAVY YARD, WASHINGTON, D.C. 20390

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
THE DETERMINATION OF THE BASIC CONDITION OF LIGHTNESS THAT CAN BE ATTAINED BY THE PRESENT LIGHTWEIGHT DIVING OUTFIT AND THE UNDERWATER SWIM SUIT AND THE EVALUATION OF THEIR OPERATING CHARACTERISTICS

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final

5. AUTHOR(S) (First name, middle initial, last name)
LT THOMAS N. BLOCKWICK, USN

6. REPORT DATE
21 March 1950

7a. TOTAL NO. OF PAGES
11

7b. NO. OF REFS

8a. CONTRACT OR GRANT NO.

b. PROJECT NO. NS 186-052

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
REPORT 2-50

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT
U.S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through Office of Technical Services, Department of Commerce, Washington, D.C.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY
Navy Experimental Diving Unit
Washington Navy Yard
Washington, D.C. 20390

13. ABSTRACT

To determine the basic condition of lightness that can be attained by the present lightweight diving outfit and the underwater swim suit under various dress conditions and to determine the operating characteristics of them so that these results can be used as a basis for future improvements.

DD FORM 1 NOV 1473 (PAGE 1)
S/N 0101-807-6801

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
EDU Diving Divers Equipment						

TABLE OF CONTENTS

TABLES

OBJECT

To determine the basic condition of lightness that can be attained by the present lightweight diving outfit and the underwater swim suit under various dress conditions and to determine the operating characteristics of them so that these results can be used as a basis for future improvements.

METHOD

The buoyancy of the average naked man with a full inspired breath was first determined. This was accomplished by placing a weighed belt on the subject and then weighing him submerged with a full breath.

The buoyancy of ten subjects was determined in an open tank using the existing lightweight diving outfit under the following dress conditions:

(a) Man wearing working clothes - dungarees, shirt, socks and underclothing.
(b) With one suit of standard divers underwear, drawers, shirt and socks.
(c) With working clothes and one set of divers underwear.

This procedure was repeated using an underwater demolition swim suit.

The buoyancy in both cases was obtained by the subject wearing a weighed belt, and then being weighed after he took a full breath and was fully submerged, with the head approximately 2 feet below the surface of the water. The subject was seated on a cross bar that was supported by a line that was attached to the scales. The Browne mask was used, with air being the breathing media. No shoes were used. Care was taken that the suit was completely free of pocketed air before submerging. Ten runs were made under each set of conditions by different subjects.

To determine the effect of dress and underclothing while walking, swimming and working, runs were made in the swimming pool under these same three conditions with both dresses. Five or six runs were made under each condition. No special work was done in the swimming pool. The subject walked, swam and did what he chose.

In all tests the suits were alternated so that a preferential inclination would not be developed for a certain type of a suit.

DISCUSSION OF RESULTS

The following positive average buoyancies were obtained with the lightweight diving outfit:

Under condition (a), man wearing working clothes-dungarees, shirt, socks and underclothing: 5 pounds - 3 ounces.
Under condition (b), with one suit of standard divers underwear, drawers, shirt and socks: 9 pounds - 7 ounces.
Under condition (c), with working clothes and one set of divers underwear: 11 pounds - 13 ounces.

When the underwater swim suit was used, the following positive buoyancies were obtained:

Under condition (a): 6 pounds - 1 ounce
Under condition (b): 10 pounds - 10 ounces
Under condition (c): 12 pounds - 12 ounces

The above results were obtained with the lungs filled with air, and thus is a higher value than would normally be obtained. However, in all cases, the positive buoyancy is not excessive and could be easily compensated for by the addition of weights.

The results given are the results of ten runs made by different subjects. The deviation from the average for different individuals varied plus or minus 3 pounds. This is not excessive. See data sheets.

The positive buoyancy depends somewhat on the elimination of air in the suits, prior to the dive. It was rather easy to get all the air out of the swimming suit as the material is very pliable and shapes itself about the subject with little difficulty. It required more work to get rid of the air pockets in the lightweight diving suit because the material is less pliable and had a tendency to crease.

The underwater swim suit has about a pound greater positive buoyancy than the lightweight diving outfit, but this is not significant. It may be of interest to note that the positive buoyancy was greater with the use of divers underwear than with ordinary working clothes.

When these outfits were tried out in the swimming pool, it was found that weights equivalent to the positive buoyancy were desirable for swimming. To do light work, about 20 pounds was necessary. For heavier work, more weights would be required.

In general, the swimming suit was preferred. It is more comfortable, easier to don and air pockets are easily eliminated. However, it is not as rugged as the lightweight diving suit. The creases in the latter tended to chafe the diver, especially in the crotch. The mask required more strap pressure when used with the lightweight suit to make it watertight. The lightweight suit also had a greater tendency to leak around the mask and through the closure in the back.

The mask attachment is unsatisfactory in both suits. It should be attached permanently to the headpiece. This would eliminate the headstrap discomfort and leakage.

The type of mask used was satisfactory. It offered a large field of vision and is simple and rugged in construction. As stated before, it had to be secured very tightly to the face to prevent leakage, but this is not due to mask, but rather to the manner of attachment.

With a suit that had the mask attached to a suit, coming up in an emergency should the airline become fouled, could be effected by cutting the air line, dropping the weights and swimming to the surface. It is felt that this is safer than removing the mask

and swimming topside since there is enough residual air in the mask for the time interval required for the ascent. Moveover, mask displacement with the present outfit is quite possible. This would require an emergency ascent with its attendant dangers.

CONCLUSIONS

The underwater swim suit was preferred to the lightweight diving suit in that it was more comfortable and air could be gotten out of it quite easily. However, it is not as rugged as the lightweight diving suit.

The Browne type of mask was satisfactory, but the method of securing the mask is unsatisfactory because excessive strap pressure is required to make it watertight.

From 6 to 12 pounds of positive buoyancy is produced by the underwater swim suit, depending on the subject and the amount of clothes he wore. The lightweight diving suit averaged about a pound less under identical conditions.

The buoyancy of the average naked man was 2 pounds and 11 ounces.

Swimming is possible with both suits upon the addition of weights equal to the positive buoyancy.

At least 20 pounds of weights are required by the diver if he is to perform any work.

Leakage around the mask and the back closure was more pronounced in the lightweight diving suit than with the underwater swim suit, and greater strap pressure on the mask was required in the former.

The weights required by these suits are not excessive for either swimming or working.

It is felt that an emergency ascent would be safer with an outfit that had the mask attached permenently to the suit.

A good lightweight suit is feasible on the basis of these tests since only 20 to 30 pounds of weights are required for working conditions. This is somewhat less than the half belt and shoes required in the present lightweight diving suit.

RECOMMENDATIONS

It is recommended that a swim suit similar to the underwater swim suit be adopted as a basis for the construction of a lightweight diving outfit.

It is recommended that a face mask similar to the Browne be used in the construction of this suit.

It is recommended that the face mask be integral with the diving suit.

LIGHTWEIGHT DIVING SUIT WITH - DUNGAREES, SHIRT, SOCKS AND UNDERCLOTHING-
SUBJECT WITH LUNGS FILLED (BROWNE MASK)

SUBJECT	WEIGHT	BELT	BUOYANCY
PRICKETT, C.M.	4 lbs	9 lbs 11 oz	5 lbs 11 oz
HESLOP, W. R.	2 lbs 8 oz	9 lbs 11 oz	7 lbs 3 oz
SINGLETON, W.G.	3 lbs 14 oz	9 lbs 11 oz	5 lbs 13 oz
WEISBROD, H.	6 lbs 14 oz	9 lbs 11 oz	2 lbs 13 oz
ANDERSON, L. R.	5 lbs 13 oz	9 lbs 11 oz	3 lbs 14 oz
BARBARY, H. J.	4 lbs 12 oz	5 lbs 11 oz	4 lbs 15 oz
KRASIC, F.	2 lbs 4 oz	9 lbs 11 oz	7 lbs 7 oz
FERGUSON, C. P.	7 lbs 8 oz	9 lbs 11 oz	2 lbs 3 oz
PAROLA, M. P.	3 lbs 12 oz	9 lbs 11 oz	5 lbs 15 oz
CARR, D. L.	3 lbs 14 oz	9 lbs 11 oz	5 lbs 13 oz

AVERAGE 5 lbs - 3 oz

LIGHTWEIGHT DIVING SUIT WITH - ONE SUIT OF STANDARD DIVERS UNDERWEAR-DRAWERS, SHIRT, SOCKS-SUBJECT WITH LUNGS FILLED (BROWNE MASK)

SUBJECT	WEIGHT	BELT	BUOYANCY
PRICKETT, C. M.	3 lbs 9 oz	14 lbs 3 oz	10 lbs 10 oz
HESLOP, W. R.	3 lbs 6 oz	14 lbs 3 oz	10 lbs 13 oz
SINGLETON, W. G.	5 lbs 12 oz	14 lbs 3 oz	8 lbs 7 oz
ANDERSON, L. R.	5 lbs 13 oz	14 lbs 3 oz	8 lbs 6 oz
BARBARY, H. J.	5 lbs 1 oz	14 lbs 3 oz	9 lbs 2 oz
KRASIG, F.	3 lbs 12 oz	14 lbs 3 oz	10 lbs 7 oz
FERGUSON, C. P.	8 lbs	14 lbs 3 oz	6 lbs 3 oz
PAROLA, M. P.	2 lbs 4 oz	14 lbs 3 oz	11 lbs 15 oz
CARR, D. L.	4 lbs	14 lbs 3 oz	10 lbs 3 oz

AVERAGE 9 lbs - 7 oz

LIGHTWEIGHT DIVING SUIT WITH - ONE SUIT OF STANDARD DIVERS UNDERWEAR-DRAWERS, SHIRT, SOCKS - SUBJECT WITH LUNGS FILLED (BROWNE MASK)

SUBJECT	WEIGHT	BELT	BUOYANCY
PRICKETT, C. M.	8 lbs 4 oz	18 lbs 14 oz	10 lbs 10 oz
HESLOP, W. R.	6 lbs 5 oz	18 lbs 14 oz	12 lbs 9 oz
SINGLETON, W. G.	6 lbs 5 oz	18 lbs 14 oz	12 lbs 9 oz
WEISBROD, H.	7 lbs	18 lbs 14 oz	11 lbs 14 oz
ANDERSON, J. R.	8 lbs 8 oz	18 lbs 14 oz	10 lbs 6 oz
BARBARY, H. J.	7 lbs 4 oz	18 lbs 14 oz	11 lbs 10 oz
KRASIC, F.	5 lbs 12 oz	18 lbs 14 oz	13 lbs 2 oz
FERGUSON, C. P.	8 lbs 6 oz	18 lbs 14 oz	10 lbs 8 oz
PAROLA, M. P.	5 lbs 6 oz	18 lbs 14 oz	13 lbs 8 oz
CARR, D. L.	7 lbs 4 oz	18 lbs 14 oz	11 lbs 10 oz

AVERAGE 11 lbs - 13 oz

SWIM SUIT (RUBBER) WORKING CLOTHES - DUNGAREES, SHIRT, SOCKS AND UNDERCLOTHING SUBJECT WITH LUNGS FILLED (BROWNE MASK)

SUBJECT	WEIGHT	BELT	BUOYANCY
PRICKETT, C.M.	11 lbs 15 oz	18 lbs 14 oz	6 lbs 15 oz
HESLOP, W. R.	13 lbs 2 oz	18 lbs 14 oz	5 lbs 12 oz
SINGLETON, W. G.	12 lbs 3 oz	18 lbs 14 oz	6 lbs 11 oz
WEISBROD, H.	15 lbs 5 oz	18 lbs 14 oz	3 lbs 9 oz
ANDERSON, L. R.	13 lbs 14 oz	18 lbs 14 oz	5 lbs
BARBARY, H. J.	13 lbs 2 oz	18 lbs 14 oz	5 lbs 12 oz
KRASIC, F.	12 lbs 8 oz	18 lbs 14 oz	6 lbs 6 oz
FERGUSON, C. P.	15 lbs	18 lbs 14 oz	3 lbs 14 oz
PAROLA, M. P.	9 lbs 14 oz	18 lbs 14 oz	9 lbs
CARR, D. L.	12 lbs 8 oz	18 lbs 14 oz	6 lbs 6 oz

AVERAGE 6 lbs - 1 oz

SWIM SUIT (RUBBER) - ONE SUIT OF STANDARD DIVERS UNDERWEAR - DRAWERS, SHIRTS, SOCKS, SUBJECT WITH LUNGS FILLED (BROWNE MASK)

SUBJECT	WEIGHT	BELT	BUOYANCY
PRICKETT, C. M.	6 lbs 1 oz	18 lbs 14 oz	12 lbs 13 oz
HESLOP, W. R.	7 lbs 7 oz	18 lbs 14 oz	11 lbs 7 oz
SINGLETON, W. G.	5 lbs 8 oz	18 lbs 14 oz	13 lbs 6 oz
WEISBROD, H.	10 lbs 2 oz	18 lbs 14 oz	8 lbs 12 oz
ANDERSON, L. R.	9 lbs 5 oz	18 lbs 14 oz	9 lbs 9 oz
BARBARY, H. J.	8 lbs 4 oz	18 lbs 14 oz	10 lbs 10 oz
KRASIC, F.	7 lbs 5 oz	18 lbs 14 oz	11 lbs 9 oz
FERGUSON, C. P.	10 lbs 11 oz	18 lbs 14 oz	8 lbs 3 oz
PAROLA, M. P.	10 lbs	18 lbs 14 oz	8 lbs 14 oz
CARR, D. L.	6 lbs 11 oz	18 lbs 14 oz	12 lbs 3 oz

AVERAGE 10 lbs - 10 oz

SWIM SUIT (RUBBER) - WORKING CLOTHES AND ONE SET OF DIVERS UNDERWEAR - SUBJECT WITH LUNGS FILLED.

SUBJECT	WEIGHT	BELT	BUOYANCY
PRICKETT, C. M.	4 lbs 11 oz	18 lbs 14 oz	14 lbs 3 oz
HESLOP, W. R.	4 lbs 1 oz	18 lbs 14 oz	14 lbs 13 oz
SINGLETON, W. S.	8 lbs 12 oz	18 lbs 14 oz	10 lbs 2 oz
WEISBROD, H.	8 lbs	18 lbs 14 oz	10 lbs 14 oz
ANDERSON, L. R.	6 lbs 4 oz	18 lbs 14 oz	12 lbs 10 oz
BARBARY, H. J.	5 lbs 13 oz	18 lbs 14 oz	13 lbs 1 oz
KRASIC, F.	7 lbs 2 oz	18 lbs 14 oz	11 lbs 12 oz
FERGUSON, C. P.	8 lbs 12 oz	18 lbs 14 oz	10 lbs 2 oz
PAROLA, M. P.	3 lbs 8 oz	18 lbs 14 oz	15 lbs 6 oz
CARR, D. L.	4 lbs 10 oz	18 lbs 14 oz	14 lbs 4 oz

AVERAGE 12 lbs - 12 oz