FIELD EVALUATION OF MODIFIED SUBMARINE RESCUE AND ESCAPE SUITS

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SUMMARY PAGE

The Problem

To evaluate models of the two-piece submarine rescue and escape suits which have incorporated seven alterations recommended on the basis of previous field trials.

Findings

For submarine rescue and escape, the garment considered more satisfactory is the two-piece suit of two-way stretch material dyed International Orange, fitted with a neck gasket, head straps and two relief valves, one at the back of the head and one between the shoulders.

Indications

Further investigation is needed to determine preferred operational characteristics such as: Diaphragm relief valve compared with flutter valve; cotton waffle weave underwear compared with wool diver's underwear; and rubber gasket at the face opening compared with fabric gasket.

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ADMINISTRATIVE INFORMATION

This investigation was conducted under Project NM 00 in cooperation with the Naval Clothing Supply Office, Brooki which had requested an evaluation of improved models of exp submarine rescue and escape suits by letter from Commandin Clothing Supply Office, USNSA, N.Y., 1D42-1:mb of 8 Decem

REPORT OF INVESTIGATION

INTRODUCTION

The purpose of this study was to evaluate seven variabl recommended as a result of a previous field evaluation (1) fo to the two-piece submarine rescue and escape suits furnis Naval Clothing Supply Office, Brooklyn, N.Y.

MATERIALS RECEIVED FOR TESTING

The garments were of a single basic type consisting piece suit of double laminated stretchable cotton with a layer between. The seven features recommended for incorporation garments, included: (1) Built-in rubber neck gasket; (2) rubbe face opening; (3) attached or detachable rubber gloves; (4) bu preserver; (5) draw-string or strap adjustment at the back of (6) variously located flutter valves; and (7) elbow and knee r ments.

Twelve suits were supplied; however, each incorporate ent combination of the above features.

METHOD AND RESULTS

The suits were tested by the instructor personnel an officers attached to the Submarine Escape Training Tank unde lowing conditions: (1) Simulated submarine escapes from th lock using the Submarine Escape Appliance, the free or the technique, with the standard submarine life jacket; (2) swimmi distances with and without the life jacket, either with or withou

lung; (3) simulated rescue of a drowning man; and (4) skin diving an aqua lung diving to various depths.

These various tests were performed in three situations: (1) in the Training Tank in warm water (82-92°F); (2) in the Base swimmin pool in cool water (76-82°F); and (3) in the Thames River in cold wate (34-38°F).

After the cold water tests the length of time in the water and the water and air temperatures were recorded. Each individual was instructed to come out of the water whenever he began to feel uncomfortable. Oral temperature for each subject was recorded pre-and-post test, a physical examination was made for any evidence of hypothermia and each subject was asked the reason for his discontinuing the test. He was then asked to fill out an evaluation sheet.

Each man made a test using each suit and his opinion regarding the best features of each was determined. These evaluations were based primarily upon subjective responses and personal opinions of the individual. However, all personnel used in these tests have had considerable background of experience in underwater swimming and/or underwater physiology. Also, all the individuals used as subjects in these tests had had some experience with the prototype suits used in the previous evaluations.

The results of the tests and the consensus of opinion regarding each feature evaluated are included as Appendix A.

DISCUSSION

Basically, these suits are the same as the two-piece suits used in previous evaluations with the additions of the seven modifications

The material has been dyed International Orange to increase i
ability at sea, (see reference 2).

Leakage: Although the previous tests reported a minim
and number of leaks, considerable difficulty was encountered o
because of leakage in the seams. This caused wetting and chil
body and resulted in the termination of most cold water trial
to 12 minutes.

Face Opening: The rubber face opening was consid
comfortable than the fabric type and caused less leakage of
the face mask. Slight alterations in the fabric opening propo
observers from the Clothing Supply Office may eliminate these
and thus replace the rubber face opening which deteriorates mo
on stowage.

Relief Valves: Relief valves were located in the back
and in suits having a neck gasket in either the chest or the back
lief valves reduced or eliminated the leakage around the fa
even on rapid venting of the suit. It was found that the relief
low the neck gasket worked best when located high on the bac
the scapulae. All relief valves were of the flutter valve type
casion did not vent properly when the life jacket or aqua lung
It was suggested that the diaphragm type of relief valve might
this problem.

Neck Gasket: The neck gasket definitely reduces the
leakage reaching the chest and back even in the suits which h
lief valve in the head. The gasket was comfortable and caus
striction. It did not appreciably increase the difficulties in
removing the suit. A relief valve below the neck gasket is
vent off the air trapped in the body of the suit.

Buoyancy: On the suits with relief valves no excessive buoyancy was encountered. Free dives and aqua lung dives to 100 feet were made with no increased difficulty and no tendency toward squeeze in the arms or legs was noted. Escapes using the escape appliance or the free technique revealed no increased buoyancy. Buoyant escapes with a life jacket revealed that gas in the suit was rapidly vented off.

Gloves: The detachable gloves were objectionable in many trials because of leakage and also because of restriction to circulation. The attached gloves are cumbersome and reduce manual dexterity. For submarine escapes this is no factor, however. Admittedly, detachable gloves are preferable if these two objectionable features can be eliminated, especially if the suit is to be used for underwater work as well as submarine escapes.

Elbow and Knee Patches: The need for elbow and knee patches could not be ascertained on these trials since insufficient time was available for tests of climbing in and out of small boats and working on the bottom. It was found that elbow and knee patches did not interfere with maneuverability or cause any discomfort. It therefore seems advisable to incorporate them in all models of suits.

Built-in Life Jacket: The built-in life jacket provided adequate buoyancy on the surface. It was possible, however, for a man to float face down in the water with the life jacket inflated. There were no relief valves in the life jacket and, therefore, it could not be used in buoyancy escape. Since the floating characteristics of this jacket are not as good as the present submarine life jacket, and since submarine life jackets must be maintained, there is no good reason for incorporating one in the exposure suit.

Comfort and Maneuverability: No areas of excessive r
were noted in any of the suits. All were equally comfortable
euverable with either the submarine life jacket, the aqua lun

Ease of Dressing: At the beginning of the trial, it took a
of ten minutes to don a suit with the aid of another person.
peated attempts, however, the time was reduced to less than
utes. The detachable gloves reduce the amount of time nee
the suit as well as the need of an assistant.

Head Straps: The head straps were considered super
lacing in that the individual could adjust them more easily fo
comfort.

CONCLUSIONS

The addition of relief valves to vent off trapped air a
gasket are a definite improvement to the two-piece submari
and rescue suit. The use of International Orange colored fabr
increases detectability at sea (2). It is immaterial whether o
ber or fabric face openings, elbow and knee reinforcements a
able gloves are incorporated in the garment when used in subm
uations.

Since the requirements of a good submarine escape a
suit are essentially the same as those for a good underwater
suit, these additional features should be evaluated with this c
tion in mind so that a single type suit suitable to both purpo
obtained.

Further consideration is considered to be needed concerning t following items:

1. The development of a watertight, comfortable, detachab glove.
2. Further comparison of the fabric vs. rubber face openi
3. Comparison of the diaphragm and the flutter relief valv
4. Determining the necessity of elbow and knee reinforcement

It is felt that investigation should be made of the advantage this type of suit as a substitute for the foul weather clothing now suppli for use by personnel exposed to constant wetting. It is felt that this e capeand rescue suit might also prove valuable for personnel engaged any other work in which there is exposure to cold and wetting, for ex ample the torpedo retrievers.

REFERENCES

1. Field Evaluation of Submarine Rescue and Escape Suits, Memoran um Report No. 55-3, NM 002 013.01.02, 6 June 1955.

2. Field Study of Detectability of Colored Targets at Sea, Medical R search Laboratory Report No. 265, NM 002 014.09.03, May 195

APPENDIX A

A questionnaire was given each individual after each test This questionnaire contained the following 12 questions concer opinions. The findings on each feature evaluated appear in the opposite the questions.

Question	Answer
1. Did the neck gasket prevent water which may enter at the face opening from spreading down to the chest?	1. Unanimously yes exception of one in whose neck was than the opening.
2. Did you encounter any difficulty in passing your head through the neck gasket while donning and removing the suit?	2. Majority yes; appre ly 20% felt there w. increase in difficul
3. While wearing the suit was the neck gasket comfortable?	3. Majority yes; appro ly 20% felt slight fort.
4. Which face opening was better suited to keep out water? (a) Which was more comfortable? (b) Which would you recommend?	4. 60% preferred the face opening, 40% ric. (a) Rubber unanim preferred. (b) 60% recommen rubber; 40% recommer fabric opening.
5. Was there excessive restriction at the wrists while wearing cuffs and detachable gloves? (a) Degree of discomfort?	5. Majority yes; one t there was no res (a) Of those who fe was restricti half felt it was y jectionable, an half felt it slightly objecti
(b) Did water enter at the wrist junction?	(b) Unanimously ye

6. Did attached gloves allow sufficient manual dexterity? (a) Reasons? (b) Which style would you recommend at this time?	6. Unanimously no. (a) Too large; too clum (b) 60% preferred the d tachable gloves.
7. Which type of head adjustment did you prefer? (a) Which formed the tighter seal? (b) Which would you recommend for adoption?	7. Majority preferred strap; less than 20% pr ferred the drawstri (a) One-half felt they w equally effective; other half were equ divided as to which the better. (b) Almost unanimously favor of the straps.
8. Do you feel that flutter valves are necessary? (a) Number and location?	8. Over 90% felt they w necessary. (a) It was unanimou agreed by those favor flutter valves to ha one at the back of head and one betw the scapulae.
9. Do the reinforcements at the knees and elbows interfere with movement? (a) Do you recommend them?	9. Unanimously no. (a) Unanimously yes.
10. What was the maximum length of time required to don the suits? (a) The minimum length of time?	10. Average 11 minutes. (a) 4 minutes.
11. In cold water tests, what were the existing conditions? (a) How long did you remain in the water? (b) Why did you come out?	11. Water temperature 34-38 Air temperature 32-40° (a) Average 12 minute (b) Chilled from leakag water at the seams

12. **Physical findings resulting from cold exposure?**

12. (a) Oral temper
Average 1°F
imum of .4°F
imum of 1.6°
(b) Hyperemia o
of the body
through leak