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AEROSPACE CREW EQUIPMENT DEPARTMENT

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PHYSIOLOGICAL EVALUATION OF SUBJECTS EXPOSED TO A COLD WATER ENVIRONMENT WHILE WEARING DIFFERENT PROTECTIVE SUIT ASSEMBLIES

INTERIM REPORT

AIRTASK A3405311/202B/1F32-523-401, WORK UNIT 6

The physiological responses of two volunteer subjects exposed to an extreme cold water environment (0°C) while wearing the 3/16" Chloroprene Wet Suit, 1/8" Chloroprene Wet Suit, and the Polyvinyl Chloride Wet Suit were investigated under two conditions of use. constant immersion-flotation (COND I) and immersion-flotation for a two-minute period followed by raft occupancy (COND II). In view of exposure duration ranging from 0.5 to 1.0 hr and from 2.0 to 3.0 hr under CONDITIONS I and II, respectively, the results indicate that survival and tissue damage protection is afforded, within expected limits of time under both emergency conditions for search and recovery, by any of the clothing assemblies tested It is recommended, therefore, that the 1/8" Chloroprene Wet Suit be considered as the most acceptable on the basis of such physical characteristics as reduced weight and bulk.

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SUMMARY

Introduction

In determining the adequacy of thermal protective assemblies for aircrew personnel, subjects equipped with the 3/16" Chloroprene Wet Suit (WS), 1/8" Chloroprene WS, and the Polyvinyl Chloride Wet Suit (PVC) were exposed to severe water-air temperatures under two conditions of use: constant immersion-flotation (COND I) and a two-minute immersion-flotation period followed by raft boarding (COND II). In addition to the basic suit assembly, the subjects were equipped with an integrated torso harness and an LPA1 life vest. Conventional head, hand, and foot gear completed the protective suit assembly. Various body surface temperatures, used in the determination of mean weighted skin temperature (MWST), and rectal temperature (Tr) were measured by means of a multipoint thermistor indicator (YSI). Despite the fact that target time of exposure was preset at 1.5 hr in COND I and 2.5 hr in COND II, the subjects were informed prior to exposure that tests would be terminated upon reaching a rectal temperature of 35°C, extremity temperature of 8°-10°C, or upon an expressed unwillingness to continue in the stressful environment.

Results

Under COND I, exposure time was increased to slightly beyond one hour when the 3/16" WS was worn; using the 1/8" WS and the PVC, exposure time varied between 20 and 35 min. Among the different suit assemblies, the average loss in MWST ranged between 12° and 14°C. Changes in Tr using the 3/16" WS and the 1/8" WS varied slightly between +0.1°C and 0.3°C; the greatest change in Tr (-0.8°C) was observed in one test using the PVC. Under COND II, exposure time was as follows: 1.50 to 2.25 hr using the 3/16" WS, 2-3 hr with the PVC, and 2.25 to 2.75 hr with the 1/8" WS. A decrease of about 4°-7°C in MWST was observed in tests using the 3/16" WS and the PVC; in the case of the 1/8" WS, MWST loss ranged between 5.2° and 6.2°C. The greatest change in Tr (-1.4°C) was noted using the PVC; with the 1/8" WS and 3/16" WS, Tr changes were within -0.9° and -0.7°C, respectively. Generally, tests were aborted because of the temperature state of the extremities (foot and toe).

Conclusions and Recommendations

Test exposures in any case were not extended in time sufficient to attain target objectives of 1.5 hr under COND I; exposure duration of 2.5 hr or more was reached in five of twelve tests conducted under COND II. It is considered, however, that extrapolation of time-temperature curves of critical body areas indicates that neither death nor tissue damage would ensue under the conditions of use of the protective suits, as described, for the projected time of search and rescue. On the basis of thickness,

weight, and general physical characteristics, it is recommended that the 1/8" WS be considered as the suit assembly of choice for limited thermal protection in extreme water temperature environments. It is further recommended, despite the fact that imminent tissue damage is not indicated as a result of this study, that more adequate insulation protection be developed for the lower extremities, especially the feet and toes, in order to attenuate further the effects of cold water immersion

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INTRODUCTION

The search for a wholly acceptable aircrew suit assembly affording adequate protection in a cold water environment has led to the development of different wet suit assemblies as potential configurations to replace the standard MK5A exposure suit. The latter suit has been characterized as bulky and burdensome and, therefore, unacceptable in a normal cockpit environment by some pilot groups, despite its cold protective capabilities in the dry cold and water immersion emergency conditions for extended periods of time. The protective assemblies used in this study represent a departure from the dry suit concept of the MK5A assembly in that an acceptable level of water influx is allowed, accompanied by the consequent physiological effects of such water intake. It is considered that the different suit types, fitted properly, are indicative of a high level of user acceptance by virtue of a diminished encumbrance under normal flight conditions. The composite protective system herein considered incorporates additionally a one-man life raft with an inflatable floor and canopy. The use of a raft subsystem is intended to afford a higher level of thermal protection during emergency exposures, where and when it is most required. The objective of this study, therefore, is to investigate the physiological responses of subjects exposed to extreme water-air temperature conditions while wearing different protective suit assemblies alone and in conjunction with a life raft subsystem with an inflatable floor and canopy.

METHODS

The tests were conducted in the Weather Room Facility of the laboratory wherein the ambient temperature conditions were established well in advance of the start of the individual test. In addition, the cold chamber facility incorporated an immersion pool (18' diameter x 4' deep) wherein water temperatures were established prior to the start of the test. The desired level of wind velocity was attained by the use of fans positioned at the edge of the pool and directed on the exposed subject. The environmental conditions for all tests were as follows: 0°C (32°F) water temperature (Tw); -6.7°C (20°F) air temperature (Ta) and a wind velocity (WV) of 20 MPH directed on the immersed subject or the subject enclosed in the canopied raft, depending on the conditions under which the tests were run.

Two volunteer subjects from the enlisted complement of the laboratory were used as test subjects. Each man was well indoctrinated in the test procedure and was familiar with the rigors of cold water exposure, having participated as subjects in programs previously conducted. Nevertheless, they were instructed prior to the commencement of the test program to abstain from alcoholic beverages for 12 hr prior to the scheduled test and to assure themselves of an adequate night's rest followed by their customary breakfast and lunch, between which time heavy work was to be avoided. The subjects were further instructed to tend to their personal needs in regard to urination and defecation prior to reporting for duty. In this fashion, it was anticipated that the subjects would report for test duty in the most acceptable physical condition as might be normally expected.

The protective suit assemblies used in the program were designated as follows: (1) the 3/16" Chloroprene Wet Suit (3/16" WS); (2) the 1/8" Chloroprene Wet Suit (1/8" WS); and (3) the 3/16" Polyvinyl Chloride Wet Suit (PVC). The polychloroprene and polyvinyl chloride material used in the construction of the protective suits are foams of closed-cell designed to provide a level of thermal insulation. The physiological advantages to be gained by the use of wet suit types have been investigated in experimental programs concerned with the effects of cold water immersion on exposed personnel (1, 2). In addition to the basic suit assembly, the subjects were equipped with Rhovyl underwear, an integrated torso harness, a life vest, and a survival vest. Conventional head, hand, and foot gear, represented by wool inserts and anti-exposure mittens, wool socks and flight boots, flight helmet, and anti-exposure inflatable hood, completed the personal protective suit assembly.

In tests involving the subjects in the non-immersed condition maintained for the duration of the run, the one-man life raft (LRU-8P), equipped with an inflatable floor and canopy providing a dead-air space barrier between the man and the frigid air-water environment, was used. In cases where loss of air in the inflatable floor and canopy was encountered, the subject supplied oral inflation to the specific area as required in the course of the run. Water taken into the raft during the boarding maneuver was bailed out by means of the conventional container and/or the flight helmet in cases of large volume intake. In any event, the constancy of the bailing out of water from the raft was maintained.

The schedule of testing for the cold water immersion program is shown in Table I. Two subjects, wearing the three different suit configurations under two sets of conditions, were exposed to a constant set of ambient conditions as follows: 0°C (32°F) Tw, -6.7°C (20°F) Ta, and 20 MPH WV. In COND I the subjects were in the immersed-flotation attitude for the duration of the test and in COND II the two-minute immersion period was followed by the raft occupancy for the duration of the run. The 24-run program was conducted over a period of six weeks on the basis of four runs/week, the first day of the week allowing for the establishment of air and water temperature conditions in preparation for the week's testing. In only two cases were runs postponed to the seventh week by reason of subject indisposition. It was predetermined that the immersion tests be conducted during the first half of the testing period and that the raft studies follow during the second half of the six-week period. Under either condition, the subject, suit type, and replicative test were randomized in order to reduce any biasing effect of the environmental stress and personal equipment on the subjects to a minimum.

The protocol of each test in the experimental program followed the same general pattern, except for the starting time of tests under CONDITIONS I and II. For the immersion condition (COND I), tests were begun in the afternoon in order to assure further the constancy of the environmental conditions; for the raft condition (COND II), tests were begun in the morning in anticipation of the extended duration of the particular test. Upon reporting for duty, the subjects were weighed nude and their rectal temperature (Tr) and pulse rate were noted in order to assure an acceptable physiological state in regard to these parameters. A series of thermistor temperature sensors was adhesed to different parts of the body, including the pads of the index finger and great toe, for the measure of skin temperature (Ts); an in-dwelling thermistor rectal probe was inserted to a depth of 6-8 cm for a measure of deep body temperature (Tr) Skin and body temperatures were read directly using a YSI-Tele-Thermometer. A measure of mean weighted skin temperature (MWST) was derived from the individual skin temperatures according to the weighting factors indicated in Table II.

Following the instrumentation of the subject with the various temperature sensors, the appropriate protective clothing was donned as shown in Figure 1. Upon completion of the dressing sequence and prior to the actual exposure, the subject was ventilated by means of a portable conditioning device (Figure 2) in order to dissipate any heat buildup generated in the course of dressing, thereby assuring to some degree a level of thermal equivalence for all subjects at the start of the actual exposure. The subject was then disconnected from the ventilating unit and was directed to the environmental chamber and the immersion pool. The run lasted until certain physiological endpoints were reached (extremity temperature = 8°-10°C, core temperature = 35°C) or until the subject indicated an unwillingness to continue in the stress environment (Figures 3, 4, 5). At the conclusion of the test, the subject was rewarmed in an immersion tank in which water was maintained at 40.6°-43.3°C (105°-110°F) temperature (Figure 6)

RESULTS

The results concerning exposure time and various body temperatures for tests under COND I are presented in Table III When the 3/16" WS was worn by the subjects, the order of exposure time ranged between 30 min and 1 hr 10 min; in the case of both the PVC and 1/8" WS, exposure time was of the general order of 30 min under the same environmental conditions While decreases in MWST from initial to final levels were of the same order of magnitude using the 3/16" WS and the PVC (11°-14°C and 11°-13°C, respectively), the greatest losses in MWST were observed in tests using the 1/8" WS 13°-16°C). Decrease in Tr using the 3/16" WS, the 1/8" WS, and in three of the four tests using the PVC, varied only slightly from 0.1°-0.3°C; in the remaining test using the PVC, a drop of 0.8°C in Tr was observed. Generally, in this phase of the program (COND I), the reason for the termination of tests was attributable to the temperature state of the great toe, foot, or both, as shown in the temperature data presented in Table III. In all tests conducted under COND I, except in one exposure when the 3/16" WS was worn, the temperature state of the index finger and hands did not contribute towards the delimiting of exposure time; the observed temperature values of the finger and hand at the end of exposure in each test of COND I are shown in the same table.

In Table IV, the results concerning exposure time and various body temperatures for COND II are presented. When the 3/16" WS was worn by the subjects, the order of exposure time ranged between 1 hr 30 min to 2 hr 15 min. In the case of the 1/8" WS tests, exposure time varied between 2 hr 20 min and 2 hr 40 min; the range of exposure time when the PVC was worn was of the order of 2-3 hr. The change in MWST from initial to final levels during the various exposures ranged from -4.1° to -6.7°C when the 3/16" WS was worn; in exposures using the 1/8" WS and the PVC, decreases in MWST of -5.2° to -6.4°C and -4.6° to -7.2°C, respectively, were observed. In three exposures using the 3/16" WS, decreases in Tr ranged between -0.1° and -0.7°C; the measure of Tr in the fourth test was invalid due to the retraction of the rectal catheter probe during the course of exposure. Rectal temperature changes using the 1/8" WS ranged between -0.3° and -0.9°C; when the PVC was worn, observed decreases in this parameter varied between -0.3° and -1.4°C. Under COND II, foot and toe temperatures reached levels (<10.0°C) which indicated the termination of the run in eight of twelve tests conducted in this phase of the program. In all runs using the PVC, toe temperatures attained levels indicative of abortion, while in the case of both the 1/8" WS and 3/16" WS, only in two of four tests each was this level of toe temperature observed. While the temperature of the hands and fingers dropped naturally to cold levels in all exposures, none was so severe as to dictate the termination of the run. In four of twelve tests in this phase of the program, wherein neither extremity (hand or foot) had attained temperature levels indicative of abortion of the trials, the runs were terminated because of extreme cold discomfort, as reported subjectively.

DISCUSSION AND CONCLUSION

The duration of each exposure in the experimental program was based on the attainment of critical body temperatures or on the subject's expressed unwillingness to continue in the stressful environment. In all except two tests using the 3/16" WS and two using the 1/8" WS under COND II, wherein the test was terminated at the request of the subject, tolerance time was dictated by the critical temperature of the extremities (-10 C). The measure of suit protection in terms of tolerance time, therefore, was limited in most cases by the more immediate and direct response of the uniformly-equipped extremities to the exposure conditions. It is suggested that suit protection may more validly have been assessed if the design of extremity insulation would have allowed for more extended exposures under the environmental conditions and attitudes of testing.

The determination of survival time and onset of tissue damage was based on the extrapolation of time-temperature curves, as employed in previous studies concerned with the physiological evaluation of submarine escape suit systems (3, 4). In none of the tests conducted was the core or rectal temperature so affected as to indicate a threat to survival within the projected time envelope of 1.5 hr for COND I and 2.5 hr for COND II. Likewise, the temperature level reached by the extremities at the end of each test did not indicate the onset of tissue damage within the time envelope required under CONDITIONS I and II. Under the experimental conditions of the program reported herein, both the 1/8" WS and the PVC effected an exposure time of 25-30 min in immersion-flotation tests and, under the same conditions, the 3/16" WS allowed for at least one exposure of slightly beyond 1.0 hr in duration, notwithstanding the greater losses observed in foot and hand temperatures. In any case, results indicated that the hazards to survival and tissue damage were well beyond the required limit of time (1.5 hr) under experimental conditions of immersion-flotation in the low temperature water environment. Under COND II, a two-minute immersion followed by raft occupancy, average exposure time for both the PVC and the 1/8" WS was of the order of 2.5 hr, under the same conditions, the 3/16" WS effected an average exposure time of slightly less than 2.0 hr. These differences in exposure duration are attributable to the limiting temperature condition of the extremities in most cases, as mentioned previously, and not to the protective characteristics of the different suit assemblies per se. In this regard, a lesser order of MWST decrease (av - 5.2 C) was observed when the 3/16" WS was worn than when either the PVC or the 1/8" WS was worn by the subjects during tests of immersion followed by raft occupancy. With average decreases in rectal temperature of less than 1.0 C in all tests under COND II, and with limiting extremity temperatures attained after 1.5-2.5 hr of exposure, it is considered that any question of survival or tissue damage is well beyond the required limit of time (2.5 hr) under conditions of raft occupancy, preceded by a two-minute immersion period, in the extreme cold water environment.

It has been established, therefore, that the different exposure suit assemblies considered in this program of study possess the thermal insulative qualities needed to protect aircrew personnel exposed to a frigid water environment. In a selection of the suit assembly most acceptable in all aspects, it would appear that factors other than those of concern in a physiological assessment must be considered. These characteristics may include such qualities as weight, bulk, and ease of repair. While observations concerning these physical characteristics in the different suit assemblies were not germane to the present study, it would appear, nevertheless, that the 1/8" WS is characterized by acceptable physical qualities and, at the same time, can supply adequate thermal protection, within the time constraints mentioned heretofore, under extreme cold water conditions of immersion-flotation and raft occupancy, preceded by a two-minute period of immersion-flotation.

An important factor in the determination of thermal protection in a cold water environment under COND II is the length of time spent in the water prior to raft entry. If the time of exposure in frigid waters were extended appreciably beyond two minutes, an interval of time considered sufficient for raft entry under anticipated emergency conditions, tests indicate that exposed individuals equipped with either the 1/8" WS or the PVC would be more seriously affected than those wearing the 3/16" WS, as evidenced by the results under COND I. Under these conditions, the thermal protection afforded by the inflatable life raft would be expected to overcome the more severe levels of cold stress resulting from extended immersion time. Emphasis is placed, therefore, on a two-minute immersion prior to raft entry in order to prevent an appreciable reduction of the protective capabilities of the suit assemblies in a cold water environment.

The removal of water taken into the raft in the boarding maneuver is likewise important in a consideration of the overall protective system. As mentioned in the approach to this investigation, the constancy of water removal was maintained in order to eliminate any biasing effects attributable to varying amounts of cold water taken in or retained in the life raft among all tests in the program. This removal of raft water was accomplished by the use of helmets, plastic buckets, and sponges. In the real emergency, even greater amounts of water than those under controlled laboratory conditions, and most probably at more frequent intervals than just at raft boarding, may be taken into the raft as a result of unfavorable sea-state conditions. Since unreported tests indicate that adverse thermal effects can occur in potential pooling areas in the raft, it is imperative that more efficient methods be devised to remove raft water in order to enhance the thermal protective capability of the entire system.

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TABLE I

SCHEDULE FOR COLD WATER IMMERSION PROGRAM

	DAY 2	DAY 3	DAY 4	DAY 5
Week 1 (PM run - 1230)	S1 Suit 1 COND I	S2 Suit 1 COND I	S1 Suit 1 COND I	S2 Suit 1 COND I
Week 2 (PM run - 1230)	S2 Suit 3 COND I	S1 Suit 2 COND I	S2 Suit 2 COND I	S1 Suit 3 COND I
Week 3 (PM run - 1230)	S1 Suit 2 COND I	S2 Suit 3 COND I	S1 Suit 3 COND I	S2 Suit 2 COND I
Week 4 (AM run - 0930)	S2 Suit 2 COND II	S1 Suit 1 COND II	S2 Suit 3 COND II	S1 Suit 2 COND II
Week 5 (AM run - 0930)	S2 Suit 1 COND II	S1 Suit 3 COND II	S2 Suit 3 COND II	S1 Suit 2 COND II
Week 6 (AM run - 0930)	S2 Suit 1 COND II	S1 Suit 3 COND II	S2 Suit 2 COND II	S1 Suit 1 COND II

SUBJECTS: S1, S2

SUITS: Suit 1 = 3/16" WS
Suit 2 = 1/8" WS
Suit 3 = PVC

CONDITIONS: COND I = immersion
COND II = immersion and raft

TABLE II

THERMISTOR LOCATION AND WEIGHTING FACTORS USED
IN DETERMINING MEAN WEIGHTED SKIN TEMPERATURE

LOCATION	WEIGHTING FACTOR
1. Rectal	--
2. Right great toe, pad	0.0350
3. Right foot, dorsum	0.0350
4. Right calf, lateral	0.1300
5. Right mid-thigh, lateral	0.0950
6. Right mid-thigh, medial	0.0950
7. Xiphoid area	0.0875
8. Right upper chest	0.0875
9. Right scapula	0.0875
10. Lower back, kidney level	0.0875
11. Right index finger, pad	0.0250
12. Right hand, dorsum	0.0250
13. Right mid-forearm, anterior	0.0700
14. Right upper arm, lateral	0.0700
15. Forehead	0.0700

TABLE III

EXPOSURE TIME AND BODY TEMPERATURES (°C) OF SUBJECTS WEARING DIFFERENT PROTECTIVE SUITS IN A COLD WATER ENVIRONMENT UNDER COND I (IMMERSION-FLOTATION)

SUIT	TEST	TIME (HR:MIN)	ΔMWST	ΔTr	TOE/FOOT	FINGER/HAND
PVC	1 - S1	0:30	-12.9	-0.8	12.2/7.2	17.0/25.1
	2 - S1	0:20	-10.8	+0.1	10.1/18.6	12.8/25.8
	3 - S2	0:33	-11.8	-0.2	18.2/10.1	18.5/26.6
	4 - S2	0:20	-11.0	0.0	21.4/10.2	19.3/27.6
1/8" WS	1 - S1	0:30	-15.3	+0.2	10.0/6.5	18.5/22.8
	2 - S1	0:34	-14.3	+0.1	11.0/8.4	11.0/24.9
	3 - S2	0:24	-16.3	-0.1	13.7/9.2	20.8/25.4
	4 - S2	0:28	-12.8	NV	17.9/8.4	18.6/26.8
3/16" WS	1 - S1	1:10	-10.7	0.0	8.7/9.8	9.3/NV
	2 - S1	0:30	-13.3	+0.1	7.6/7.2	14.8/22.4
	3 - S2	0:30	-13.2	-0.3	7.0/7.1	15.8/18.0
	4 - S2	0:40	-14.0	-0.2	7.2/9.8	18.0/24.2

PVC = Polyvinyl Chloride Suit
WS = Wet Suit
S1, S2 = Subjects
Tr = Rectal Temperature
MWST = Mean Weighted Skin Temperature
NV = No Value

TABLE IV

EXPOSURE TIME AND BODY TEMPERATURES (°C) OF SUBJECTS WEARING DIFFERENT PROTECTIVE SUITS IN A COLD WATER ENVIRONMENT UNDER COND II (IMMERSION AND RAFT BOARDING)

SUIT	TEST	TIME (HR:MIN)	ΔMWST	ΔTr	TOE/FOOT	FINGER/HAND
PVC	1 - S1	2:30	-7.2	-0.5	8.0/15.2	21.6/28.6
	2 - S1	3:00	-5.3	-1.4	10.7/13.7	24.5/25.0
	3 - S2	2:40	-7.2	-0.4	9.4/14.8	14.3/21.2
	4 - S2	2:06	-4.6	-0.3	10.2/14.1	16.1/23.1
1/8" WS	1 - S1	2:25	-6.2	-0.3	8.1/11.4	20.9/25.3
	2 - S1	2:40	-6.4	-0.3	8.6/14.0	21.1/25.9
	3 - S2	2:20	-6.4	-0.9	13.1/16.0	14.6/22.5
	4 - S2	2:34	-5.2	-0.4	12.3/14.9	15.1/26.8
3/16" WS	1 - S1	1:32	-5.1	NV	12.1/15.6	18.2/24.4
	2 - S1	2:13	-5.0	-0.1	9.0/13.1	19.6/29.5
	3 - S2	1:50	-6.7	-0.7	7.8/14.5	14.9/22.8
	4 - S2	1:40	-4.1	0.4	12.2/16.8	16.8/23.4

PVC = Polyvinyl Chloride Suit
WS = Wet Suit
S1, S2 = Subjects
MWST = Mean Weighted Skin Temperature
Tr = Rectal Temperature
NV = No Value

FIGURE 1 - Subject instrumented with thermistor sensor harness and wearing two-piece Rhovyl underwear.

PHOTO NO: CAN-394857(L)-7-69

FIGURE 2 - Fully-equipped subject being ventilated with a portable blower before immersion exposure.

PHOTO NO: CAN-394859(L)-7-69

FIGURE 3 - Subject during constant immersion-flotation (Cond. I) or for a fixed-time period prior to raft boarding (Cond. II).

PHOTO NO: CAN-394863(L)-7-69

FIGURE 4 - Subject boarding life raft after immersion period.

PHOTO NO: CAN-394855(L)-7-69

FIGURE 5 - Ballistic Water [illegible]

PHOTO NO: CAN-394864(L)-7-69

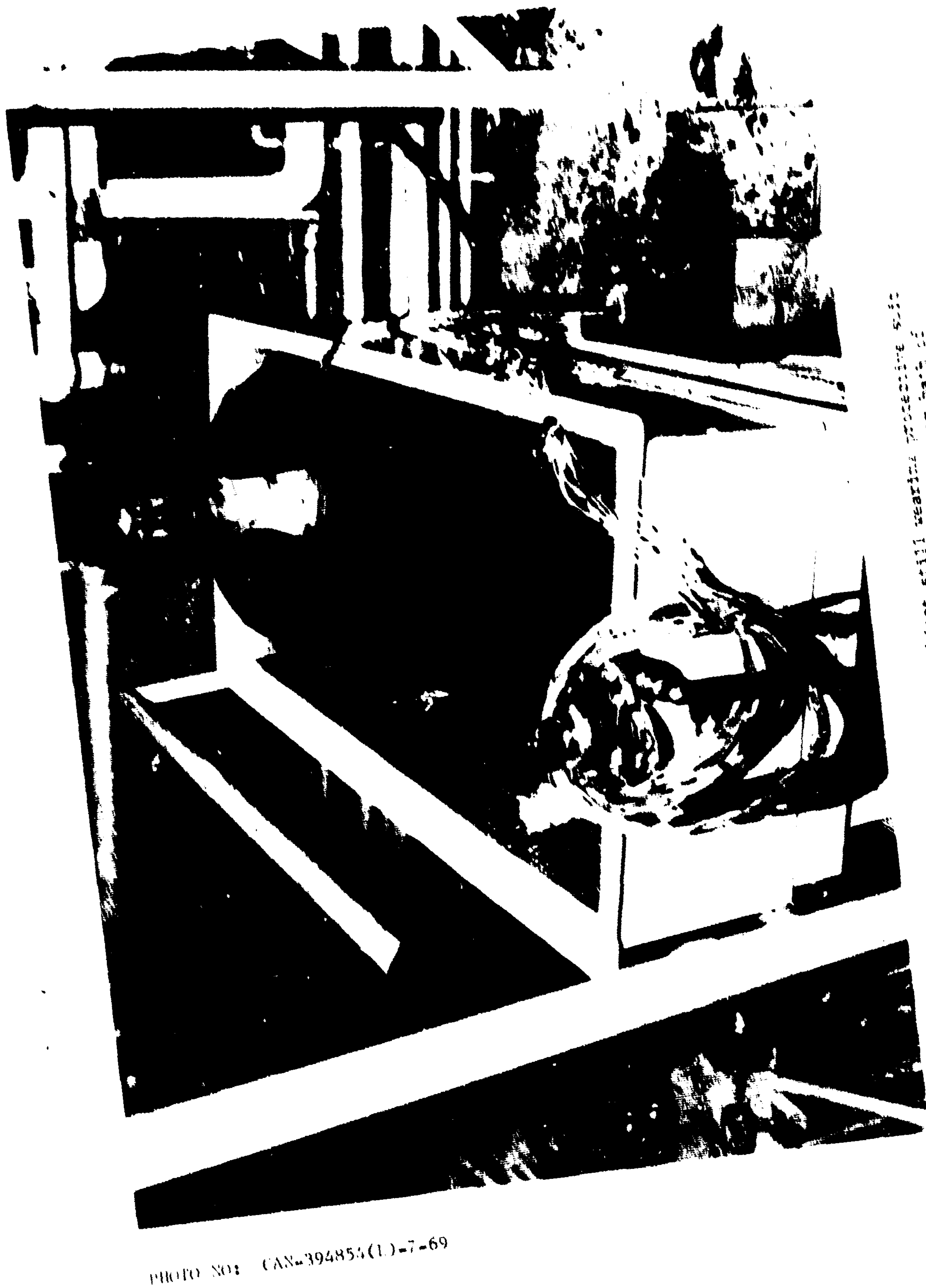

FIGURE 6 - Subject still wearing protective suit being rewarmed in a water bath of 105°-110°F (40.6°-43.3°C) temperature.

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13. ABSTRACT

The physiological responses of two volunteer subjects exposed to an extreme cold water environment (0°C) while wearing the 3/16" Chloroprene Wet Suit, 1/8" Chloroprene Wet Suit, and the Polyvinyl Chloride Wet Suit were investigated under two conditions of use: constant immersion-flotation (COND I) and immersion-flotation for a two-minute period followed by raft occupancy (COND II). In view of exposure duration ranging from 0.5-1 0 hr and from 2 0-3 0 hr under CONDITIONS I and II, respectively, the results indicate that survival and tissue damage protection is afforded, within expected limits of time under both emergency conditions for search and recovery, by any of the clothing assemblies tested. It is recommended, therefore, that the 1/8" Chloroprene Wet Suit be considered as the most acceptable on the basis of such physical characteristics as reduced weight and bulk.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
PROTECTIVE SUIT ASSEMBLIES						
COLD WATER IMMERSION						
BODY TEMPERATURE						

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