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PROJECT COLD CASE

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TECHNICAL DOCUMENTARY REPORT AAL-TDR-64-23

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ARCTIC AEROMEDICAL LABORATORY

AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
FORT WAINWRIGHT, ALASKA

Project 8238, Task 823801

NOTICES

FOREWORD

Tests in Project Cold Case were conducted by Maj Paul A. Albert, Capt John F. Lee, MSgt Walter W. Millard, MSgt John R. Schumann and TSgt James F. Williams, all from the Arctic Aeromedical Laboratory.

Special acknowledgement is extended to the following individuals who participated as subject survivors in Project Cold Case II: 1st Lt Robert L. Woodward, AAL; MSgt William G. Leighton, TAC Sea Survival School, Langley AFB, Virginia; TSgt Arlyn E. Rappe, HQ TAC, Langley AFB, Virginia; SSgt Curtis R. Hahn, AAL; A1C Warren G. Quade, TAC Sea Survival School, Langley AFB, Virginia; and A2C James C. Hammack, AAL.

In addition, the assistance of MSgt Olin E. Burkett, 4756th Test Sqdn, ADC, Tyndall AFB, Florida, was invaluable in dressing the subjects and in monitoring the subjects in the field.

ABSTRACT

The results of Project Cold Case, an investigation of the cold land survival capabilities of Air Force pilots wearing the Full Pressure High Altitude Flying Outfit (A/P22S-2 and A/P 22S-3) are presented in this report. In December 1963, six subjects wearing these garments were placed under simulated survival conditions in a wooded area of interior Alaska near Fairbanks. Ambient air temperatures reached -30° F and were below -27° F for at least 50% of the time. On the third day air temperatures rose and remained at -10° F until the conclusion of the test The test lasted for 72 hours. Two subjects wearing the Full Pressure Suit without additional clothing survived for 11 and 30 hours. At the end of this time they were fatigued and moderately hypothermic. Two subjects with the Full Pressure Suit plus a nine-piece down-filled survival outfit (Clothing Outfit, arctic survival) survived for 52 and 72 hours. The 52-hour survivor suffered a noncold injury which necessitated his removal. Two subjects with the Full Pressure Suit plus an experimental ADC Walk-Around Sleeping Bag survived for 72 hours each.

PUBLICATION REVIEW

HORACE F. DRURY
Director of Research

SECTION 1. INTRODUCTION

The Full Pressure Suit (FPS) was designed to serve as protective equipment for airmen who venture into the atmosphere to altitudes at or above 50,000 ft. The purpose of this equipment is twofold: first, to provide an artificial atmosphere of 35,000 ft for the aircrew member in the event of rapid cabin pressure loss and second, to provide protection against the environmental stresses of low oxygen tension, low temperatures and wind blast if the aircrew member must eject from a high performance aircraft at high altitudes. The outfit consists of high altitude coveralls, high altitude flying helmet, high altitude gloves, full pressure coverall pressure controller and full pressure helmet pressure demand oxygen regulator. This equipment is described in T.O. 14P3-6-81. In addition, the aircrew member wears an alert-type boot (Boot, flying, quick-donning insulated, Type FWU-3/P, made by the Addison Shoe Company). The coveralls themselves are constructed of four layers: a "slippery" inner layer, a layer containing distensible air bladders, a restraint layer to prevent overinflation of the bladders and a protective cover. Exposure mittens are provided with the suit and are normally carried in an outer pocket. This suit is impermeable to gas or moisture transfer and must be mechanically ventilated when it is worn by an aircrew member on alert status or in an aircraft.

The FPS does not provide a great deal of thermal insulation for protection against extreme low temperatures. This fact was immediately apparent to the Air Defense Command (ADC), even though the reports which presented the results of tests of the FPS in a cold chamber indicated that this garment was adequate for short-time survival. The length of exposure was too short, however, to be able to extrapolate from these cold chamber tests to actual field conditions. An ADC (ADOOP-WT) letter dated 23 January 1963 to Headquarters, U. S. Air Force requested that Air Force Systems Command (AFSC) be assigned responsibility for extensive cold land survival testing of the FPS. AFSC, in turn, directed Aerospace Medical Division (AMD) to conduct a valid field evaluation of the survival capabilities of pilots wearing the FPS in an arctic surrounding. The responsibility for conducting these tests was delegated to Arctic Aeromedical Laboratory (AAL), and a test program was drafted at a meeting attended by representatives from ADC and AAL at Ent AFB 6-7 February 1963. At the conclusion of this meeting, seven Full Pressure Suits, including the -2 and the -3 models, were hand-carried to AAL in Fairbanks, Alaska. The various items of survival gear, both mandatory and optional items, found in ADC fighter aircraft were procured for these tests. In addition, a Personal Equipment Technician who was familiar with the FPS was sent to AAL to assist with the fitting of the garments and to give advice about problems peculiar to them.

Cold Case I commenced on 11 February 1963 at Fairbanks. These tests were carried out during periods of low environmental temperature until the end of the winter season. The results were described by Capt J. H. Veghte in a typewritten report forwarded to ADC entitled An Interim Report on Cold Case.

To prepare for a second winter of testing, a mimeographed report, Project Cold Case: A Review, prepared by Dr. F. A. Milan, the new AAL Project Officer, was forwarded to ADC in October 1963. This report reviewed the work accomplished to date, set forth the plans for the second test season and provided interim guidance on the potential of the FPS for cold weather survival.

ADC(ADOOP-WT) agreed to the revised test plan in a letter dated 22 November 1963, and testing of the FPS in Cold Case II was carried out in December 1963.

The present report describes all the pertinent findings of Project Cold Case and discusses the general problems of survival in the Arctic as they affect a solitary individual such as a fighter pilot.

SECTION 2. COLD CASE I

Methods. Cold Case I was carried out according to the original test plan drafted at Ent AFB. This plan is presented in An Interim Report on Cold Case and therefore will not be reproduced in this present report.

The first part of the field test phase commenced on 11 February and ran continuously until 13 February 1963. During this period ambient air temperatures ranged between -2° and -16° F. The second part of the field test phase was conducted on 2 and 3 March. Ambient air temperatures ranged between 10° and 28° F.

Pertinent information concerning the conditions of these tests, the type of shelter constructed, the training of the subjects and so forth has been presented in the Interim Report. During the field tests, thermistors taped to the skin of the subjects were used to monitor skin temperatures. Internal body temperatures were measured by means of an insertion-type rectal thermistor.

Results. An examination of the results of Cold Case I revealed the following:

1. Numerous uncontrolled variables, especially the lack of previous arctic survival training of most of the subjects and the great importance of

this training in affecting the ability of these subjects to construct an adequate survival shelter or even a fire, flawed the validity of the test.

2. The skin and body temperature measurements were not useful enough to justify the time spent in obtaining them. To be sure, these data provided a sophisticated "first order" evaluation of the thermal state of the subject; however, a grosser "second order" assessment could be made merely by observing the subject. The calculations of whole body heat loss versus time of exposure provided unreliable indices of the garments' thermal adequacy, since the general poor performance of the subjects in the survival situation adversely affected their thermal states.

3. "Survival times" of the subjects at an ambient temperature of -2° to -16° F ranged between 7 and 15 hours, although a survival school instructor managed to last for 48 hours. Termination of the test was caused by the near freezing of the feet. All the subjects were wearing an Alert-type leather boot, which previous tests have shown to be inadequate for wearing below $+10^{\circ}$ F.

4. Because of the relatively poor thermal insulation of the FPS, certain modifications in "standard" Air Force survival techniques are necessary to insure a reasonable survival time. The A-frame parachute-covered shelter (the "favorite" dwelling of the survival school student) is clearly not the shelter of choice during periods of low temperature. Air temperatures within this shelter are usually no higher than those found outside it. A fire cannot be built inside this shelter, and the parachute acts only as a radiation shield against heat loss to a cold sky or as a windbreak. Measured temperatures within an unheated parachute-covered shelter are too low to support human life for very long.

5. Because of the unusually warm weather, all of the test objectives were not realized during Cold Case I.

SECTION 3. COLD CASE II

Cold Case II was conducted on 16-19 December 1963, according to the revised test plan. This plan, showing the arrangement of subjects and variables, is presented in schematic form in Table I.

Subjects

Three subjects were selected from personnel assigned to AAL. These subjects were the "best" of a group of recent AAL graduates of the Arctic Indoctrination School (AIS). This school, held at Eielson Air Force Base,

TABLE I

TEST PLAN COLD CASE II

Subjects	1	2	3	4	5	6
Variables						
Survival Experts (Survival/PE Tech.)	X	X	X			
Nonexperts (Recent graduates of AIS)				X	X	X
-3 FPS (Authorized cut-off foot of suit)		X		X		
-2 FPS	X		X		X	X
Wool Underwear	X	X	X	X	X	X
Waffle-weave Underwear	X	X	X	X	X	X
Cushion Sole Socks, 1 pr.	X	X	X	X	X	X
Ski Socks, 2 pr.	X	X		X	X	
Alert Boot (Addison Shoe Co.)		X		X		
VB White Thermal Boot			X			X
AF N1B Mukluk	X				X	
Snow House		X	X		X	X
Parachute Cloth Wickiup	X			X		
Parachute	X	X	X	X	X	X
F-106-B Kit	X	X	X	X	X	X
Sleeping Bag, 1-piece Walk-around			X			X
Clothing Outfit, arctic survival, 9-piece				X	X	
Time to Termination (hours)	30	11	72	72	52*	72

* Injured Foot

teaches arctic survival in a 4-day course evenly divided between classroom and field instruction. Three other subjects, one 92270 (Personal Equipment Technician), one B92230 (Personal Equipment Technician, Parachutist) and one B92170 (Rescue and Survival Technician, Parachutist), were sent on temporary duty from Tactical Air Command (TAC) to participate in the experiments. None of these personnel had previous arctic survival experience.

The TAC personnel were sent to attend the 2-day classroom instruction period at the Arctic Indoctrination School. All subjects were then briefed about the importance of the tests and the significance of the results toward solving USAF arctic survival problems. It was emphasized that the pilot must fly with items of equipment which, though inadequate for cold weather camping, are necessary because of operational requirements or space and weight limitations within the aircraft. The purpose of each item of survival equipment and each item of clothing was explained to the subjects. All subjects then were instructed in a 1-day session on the building of snow houses and parachute cloth wickiups. The wickiup is a loosely constructed hut with a frame made of supple, interlaced willow or aspen trees of small diameter covered with parachute cloth. Snow is banked around the bottom, and a fire burns within the hut. Detailed instructions for constructing a snow house are presented in Appendix II.

Survival Equipment

Survival equipment consisted of some of the mandatory components of the kits carried on F-102, F-104, F-105 and F-106 A/B aircraft according to T.O. 1451-3-51. In addition, other nonmandatory items which seemed useful were included in the survival kit. Each subject received a plastic bag containing the following items:

1.	Mirror MK-3	(1)
2.	Signal MK-13, MOD O	(3)
3.	Whistle, police, plastic	(1)
4.	Container, match, waterproof	(1)
5.	Matches, ordinary, water resistant	(150)
6.	Manual, Survival, AF Manual 64-5	(1)
7.	Parachute, complete	(1)
8.	Knife, hunting	(1)
9.	Ration, survival, individual 2 parts	(1)
10.	Candle	(1)
11.	Snare wire, brass, 10 ft	(1)
12.	Fuel, ration heating (trioxane)	(1)
13.	Saw, knife, shovel assembly, ice and snow	(1)
14.	Chapstick	(1)
15.	Glove, MA-1 with insert	(1)
16.	Rifle, survival M-6 22/410	(1)
17.	Ammunition, 410 gauge	(24)

Methods

Each of the six subjects was dressed in one suit of wool underwear, one suit of waffle-weave underwear and one of the footgear assemblies shown in Table I. They were transported by automobile to the survival area, which is located about 3 miles north of the Arctic Aeromedical Laboratory and is fairly representative of interior Alaska in terrain features, vegetation and isolation. Immediately upon arriving at the survival area, the subjects were placed at previously determined sites and were left to survive. Contact between survivors was not permitted. Test monitors checked the condition of the survivors every 3 hours during the course of the test. These monitors could terminate the test and bring the survivors into a heated wanigan within minutes after the appearance of incipient cold injury or the onset of general hypothermia. The subject was given the option of terminating the test if he could not tolerate the cold any longer.

Results

The results of Cold Case II are shown in Figure 1, which indicates ambient air temperatures, hours of daylight, survival times for each subject and other pertinent information. The test was scheduled to run for 3 days and nights. Air temperatures remained below -20° F for the first 2 days and were below -27° F for at least 50% of the time. In the early hours of the third day, a warm air mass moved into central Alaska and the air temperature rose from -29° F to -10° F in 1 hour. At this latitude there were only 4 hours between sunrise and sunset at this time of year.

Survival times were as short as 11 hours (one subject) and as long as 72 hours (three subjects). Because all subjects either wore adequate footgear (the VB White Thermal Boot or the NIB Mukluk) or were instructed to remove the Alert Boot and don a survival mukluk, there was little danger of freezing their feet.

The survival time was considerably increased by the availability of the down-filled clothing assembly. Since a survival test of this nature is full of "unmeasurables," the daily logs of some of the survivors are included in Appendix I. These subjective reports point up some of the difficulties encountered by the survivors, who, it should be reiterated, are probably equivalent to aircrews in their arctic survival training.

Subjects in full pressure suits only. The survival times of the two subjects wearing the FPS alone were 11 and 30 hours. At the end of this time, both subjects were fatigued and suffered from a moderate general hypothermia. There was no evidence of cold injury to the feet or hands. The differences in survival times were due to unmeasurable factors, which included the subjects' motivation and their ability to take care of themselves in an arctic survival situation.

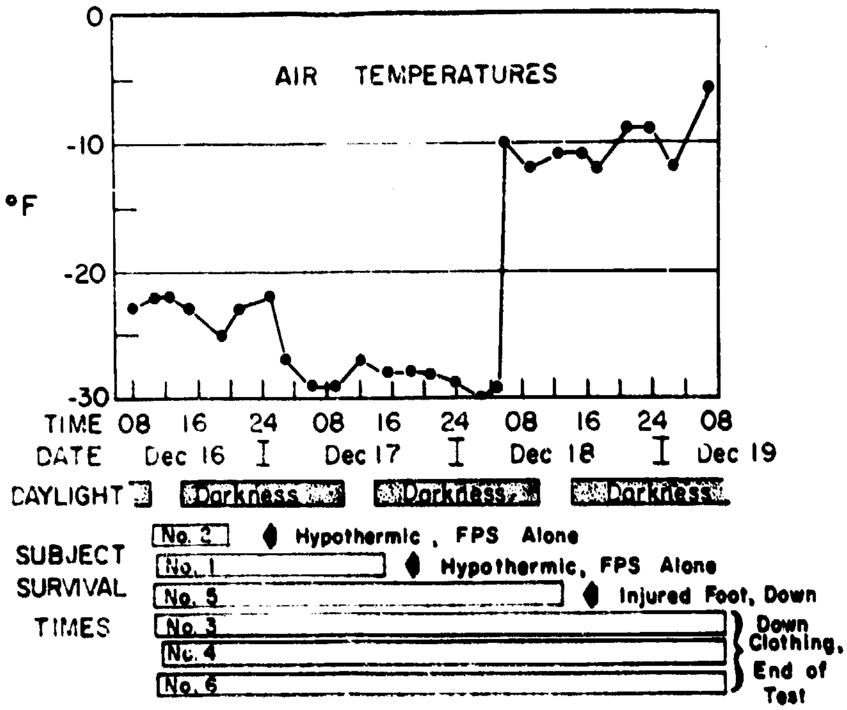

FIGURE 1

Results of Cold Case II Showing Ambient Air Temperature, Hours of Daylight and Survival Time for Each Subject

Subject Number 2 voluntarily came in after 11 hours. He was shivering violently. This subject had worn the Alert Boot for the first 5 hours. Following previous instructions given at the briefing, he then removed the Alert Boot, cut the rubber boot from the FPS and put on a down-filled survival mukluk. He had removed the helmet and donned a wool toque shortly after being placed in the survival situation. He had constructed one snow shelter which had collapsed and had completed another. After taking off the FPS, it was found that the subject's underwear was soaked with perspiration.

Subject Number 1 was removed by the test monitors from his survival site after 30 hours. At this time he was lying rolled in a parachute canopy inside a poorly constructed parachute-covered wickiup. He was tired, not having been able to sleep the previous night because of the low temperatures, and had no firewood on hand for the coming night. According to the FPS technician, the FPS fitted this subject extremely well, consequently, he could not stand completely erect, which added to his fatigue.

Subjects with nine-piece survival clothing. The survival times of the subjects wearing the nine-piece down-filled arctic survival outfit were 52 and 72 hours. At the end of 72 hours, Subject Number 4 was in very good condition. Subject Number 5 injured his foot while breaking firewood and was taken out for medical reasons after 52 hours.

Subjects with ADC Walk-around Sleeping Bags. The survival times for the two subjects wearing the ADC Walk-around Sleeping Bags were 72 hours. Although this garment provided excellent thermal insulation, in its present experimental configuration it was too narrow for the unaided subject to pull over the FPS.

SECTION 4. DISCUSSION AND RECOMMENDATIONS

The Arctic Aeromedical Laboratory was directed to evaluate the cold land survival capabilities of pilots wearing the FPS. Under Project Cold Case I and II it was found that:

1. Below 0° F, pilots wearing the FPS with the Alert Boot would suffer cold injury to the feet in 7 to 15 hours.

2. Below -20° F, pilots wearing the FPS alone but substituting the VB White Thermal Boot or the AF N1B Mukluk for the Alert Boot would be hypothermic in 11 to 30 hours. This hypothermia would be incapacitating and would lead to death.

3. Between -20° F and -40° F, pilots wearing the FPS with the Down-filled Arctic Survival Outfit or the experimental ADC Walk-around Sleeping Bag could survive for at least 7 days by using appropriate arctic survival techniques.

4. Below -40° F, it is estimated that pilots wearing the FPS with the Down-filled Arctic Survival Outfit or the experimental ADC Walk-around Sleeping Bag could survive for at least 7 days if, and only if, appropriate arctic survival techniques were used. These techniques include the construction of a snow shelter (described in Appendix II) or the utilization of a lightweight, portable shelter developed at the Arctic Aeromedical Laboratory. This portable shelter is described later in this report.

These are generalities that are applicable to arctic winter survival and can be used as guide lines for operational planning.

The results of Project Cold Case are applicable to arctic survival in general. The recent ADC decision to restrict the use of the FPS to a few training missions each year does not invalidate the results of Cold Case, since fighter pilots will still wear some type of partial-pressure, anti-G garment with inadequate thermal insulating properties for cold weather wear.

In order to see the results of Cold Case in perspective, one must consider the problems inherent in the escape and survival system available to a fighter pilot. This system concept is useful, for one can then think of the sequence of events which occur in an escape-rescue cycle, triggered by the in-flight emergency which requires ejection and completed when the pilot is rescued and returned to his base. This cycle of events includes:

1. Pre-flight
2. Ejection
3. Parachute Deployment
4. Landing
5. Thermal Balance Maintained
6. Air Rescue Service Alerted
7. Water Balance Maintained
8. Caloric Intake Adequate for Situation
9. Located Electronically
10. Pilot Retrieved

The sequential order of these events is also their relative order of importance. Thus, it is obvious that the best survival ration in the world or the best personal locator beacon available is of no relative value unless the pilot can successfully eject from the aircraft and unless his parachute is deployed. It is also obvious that the maintenance of thermal balance (which means that the survivor does not incur a cold injury to the hands or feet nor become severely chilled) is merely one necessary event in a series of events. The time required to complete the cycle is a function of the efficiency of the Rescue Unit. The efficiency of the Rescue Unit, in turn, is affected by a number of factors. A successful cycle completion requires complete man-machine integration. This man-machine integration is as much a function of training to use particular equipment as it is the equipment itself.

Let us then briefly consider these events in order.

1. <u>Pre-flight</u>

This consists of activities which occur before the actual take-off for any mission. These activities are preparatory in nature and include the checking of the equipment in the escape-survival system by the responsible personal equipment shop and the survival training of the pilot. To be realistic, this training should be on the survival equipment which will be available to him.

2. Ejection

3. Parachute Deployment

4. Landing

These three events require training which presumably all pilots have to a certain degree and does not concern us in this discussion.

5. Thermal Balance Maintained

Thermal balance is maintained if there is no disabling cold injury to the hands or feet or if the pilot does not suffer an incapacitating whole-body hypothermia. Thermal balance is maintained by the insulation of the clothing, the temperature of the microenvironment within the survival shelter, and the activity level of the pilot. An injured pilot is obviously at a disadvantage at very low temperatures unless the insulation of his clothing is sufficient to maintain thermal balance with resting levels of metabolism. Air Force clothing cannot do this for long. A badly injured pilot would not be able to construct a shelter or make a fire.

Investigative work on the problem of insuring that a survivor maintains thermal balance at low temperatures even though he is unable to construct a shelter has been carried out at the Arctic Aeromedical Laboratory since the conclusion of Project Cold Case. The results of this work have shown the feasibility of manufacturing a portable, compressible, lightweight shelter that is well within the space and weight limitations of the fighter aircraft survival kit. In its present configuration this shelter weighs less than [illegible] pounds and can be compressed to 1100 square in. Actual temperature measurements have shown that the metabolic heat generated by a survivor in 1 hour is sufficient to heat the interior of this shelter to +60° F when the ambient air temperature is -40° F. This shelter has been tested in the arctic woodlands and on the sea ice and has given excellent performance in both locations. Air temperatures within the shelter permit arctic survival without fire. Actual tests have shown that sufficient snow can be melted by the heat within this shelter to provide at least a pint of water in a 12-hour period. A shelter of this type will almost insure that an injured, poorly clad pilot can remain warm for an almost indefinite period.

6. Air Rescue Service Alerted

This is an event which automatically occurs after an aircraft is reported overdue.

7. Water Balance Maintained

The maintenance of physiological water balance is second in importance to the maintenance of thermal balance. Water is more important than food for the maintenance of health and fitness. Caloric balance and water balance are mutually independent. It has been shown in numerous field tests carried out by the Arctic Aeromedical Laboratory that survivors on a restricted caloric intake become progressively dehydrated with time. This has important medical implications, for dehydration is partly responsible for the apathy and malaise of a starving man in the cold.

Water balance is affected by osmotic balance. If too much osmotically active material is ingested, water cannot be retained because the kidney will excrete water to dispose excess osmols. The converse is also true; if too little osmotically active material is ingested, water cannot be retained because the kidney will not function efficiently. A higher protein diet provides a high osmotic intake; a pure carbohydrate diet provides too little osmotic intake. Thus, some Air Force survival rations do not contain the foods of choice for a pilot in an arctic area where water is normally locked up in the solid state of snow or ice. These rations were designed to provide maximum calorie foods per unit weight and volume, and the importance of water balance was not considered. It has been shown that the combination of dehydration and starvation leads to hemoconcentration with urinary sodium losses. The sensation of thirst is normally not present. This contracted blood volume means an increase in peripheral vasoconstriction, which predisposes the survivor to a cold injury.

The present state of knowledge concerning the maintenance of water balance in a survival situation seems to indicate that salt tablets and a small amount of bicarbonate should be included with the survival ration. These substances "hold in" the water.

8. Caloric Intake Adequate for Situation

In a study carried out at the Arctic Aeromedical Laboratory, six subjects underwent a 5-day survival ordeal in the cold while starving. These subjects lost an average of 8% of their body weight. The caloric cost of the first day of this survival exercise was measured to be between 4500 to 5500 kcal for each subject. This energy was expended in constructing shelters, cutting wood, making fires and walking in order to stay warm. Such an energy expenditure is equivalent to that of a lumberjack cutting timber. After the first day the caloric cost fell to an average value of 2000 kcal per day, since the survivors tended to sit about their camps after they had been established. The caloric cost also increased with falling temperatures.

The Air Force standard survival ration provided for Project Cold Case has an approximate caloric content of 3669 kcal. The meat food product bars in this ration provide about 2500 kcal of the total amount of 3669. The taste of these meat food product bars is unacceptable to many airmen, which deprives some survivors of an essential source of energy.

The American diet is about 14% protein, 46% carbohydrate and 40% fat. Nutritionists have concluded one important thing from a number of dietary studies conducted on American soldiers: it is not true that if men are hungry enough they will eat anything.

The meat food product bar is a maximum caloric density food and is consequently high in animal fat. The palatability of this ration is low, perhaps because of the age of the ration and the rancid taste of the aged fat. The psychological reactions of survivors to eating this high fat diet seem to range from high acceptability of the ration to complete aversion. In fact, some subjects in simulated survival exercises have vomited the meat food product bar after once having forced it down. Most survival kits contain packets of chili powder or dehydrated onions which are to be mixed with the meat food product bar when it is cooked in a thick gruel.

One can conclude that there is a requirement for the development of a palatable ration (which will not adversely affect physiological water balance) for short-time arctic survival.

9. Located Electronically

The new personal locator beacon (AN/URT-21) used in conjunction with a UHF-ADF receiver in a high-speed, high-flying aircraft should markedly decrease the search time required to locate a survivor in the Arctic. Signal flares should remain in the survival kits as back-up items in the event of radio failure. The pilot must be trained in the simple operation of this personal locator beacon in order to obtain maximal efficiency of rescue operations.

10. Pilot Retrieved.

The pilot must be trained to assist the Rescue Unit in his retrieval. This can be accomplished by familiarizing the pilot with the equipment, especially the helicopter pick-up sling, which will carry out the actual rescue.

The foregoing sequence of events can be considered as a simple schematic diagram. There is certainly sufficient information available from Air Force records of successful or unsuccessful ejections, parachute deployments and parachute landings to obtain statistical probabilities for the chance of success of these isolated events. This information is available in the publication USAF Emergency Escape Experience 1950-1959 prepared by the office of the Deputy Inspector General for Safety (2) and in Bell and Chunn's Summary and Evaluation of Aircraft Accidents and Fatalities (1).

The first of these publications states in part: "Post-ejection survival situations, in which there was an environmental threat to the life of the ejectee, have received a remarkable amount of attention. This is especially true considering the frequency of such situations. This emphasis on survival stems more from emotion than reason with the exception of over water ejections. In fact, there have been only 11 over land ejections (in a total of 1897 ejections) in a ten-year period which required the crew member involved to use the 'survival techniques' of building a fire, erecting a shelter, etc. Most of the items routinely carried in specially designed survival kits have never seen critical use. The exceptions are water flotation equipment and signalling devices. In the latter category the survival radio has been needed but has routinely been inoperative." (2)

These statements are indeed true, and they apply to Air Force tactical aircraft experience gained over a 9-year period which included the Korean conflict. However, sudden deployment of tactical aircraft to an arctic area would require an immediate cold land survival capability on the part of the aircrews. This capability requires that aircrews be trained and equipped well in advance of their deployment.

A previous test of the survival capabilities of pilots wearing winter flying clothing assemblies and the CSU-4P partial-pressure suit yielded similar results as those of Cold Case. The results of this test were reported in an AAL Technical Note, Evaluation of the KC-135 and U-2 Bail-out Survival Kit (3). This report documented the inability of trained Air Force survival technicians to survive for more than 22 hours without severe cold injury after a simulated bailout in a wooded area of arctic Alaska. Ambient air temperatures ranged between -30° and -40° F.

The reasons for this short time tolerance were:

1. Airmen are generally taught in survival schools to construct a parachute-covered A-frame shelter. This shelter provides inadequate protection at very low temperatures.

2. The clothing (winter flying assembly on three airmen and the CSU-4P partial-pressure suit on one airman) provided inadequate thermal protection for sleeping at very low temperatures.

3. The MC-1 sleeping bag provided inadequate insulation for a sleeping survivor when used in a traditional Air Force parachute-covered survival shelter.

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APPENDIX I

DAILY LOGS OF THREE SUBJECTS

Subject Number 2

Arrived at test area at approximately 0915 hours and immediately began working on snow hut. Within 10 minutes I began perspiring around neck and forehead, so I removed helmet. Then felt much better and was able to move more freely. I continued work on snow house. Hands were chilling in the gloves attached to the suit and by this time were very cold. So I removed these FPS gloves and replaced them with MA-1 gloves. Completed piling snow for snow hut.

At approximately 1030 hours while waiting for snow to set, I gathered boughs for a bed and dead wood for fire. I also set two snares on rabbit runs. While working on snow house the bolt on the shovel handle broke and handle was useless to me from then on. I remained fairly comfortable while moving around except for head and ears, so I put wool cap on. At about 1130 hours I began to dig out snow house. The shovel was too cumbersome, so I used retainer plate from parachute for this purpose. This worked out very well. I had the hut completed in about 40 minutes and then decided to build a fire. While working on the fire the snow house fell in. I still had plenty of light, so I immediately began on another hut. I completed this in a very short time and decided to wait at least 1 1/2 hours before digging it out. By this time my hands were very cold, so I replaced the leather gloves with the mittens to the pressure suit. I left the wool inserts on. At that time I cut the parachute and cut a piece out large enough to make a door for the snow hut. I went looking for some rabbits without success, but walking around kept me warm and comfortable. After approximately 1 1/2 hours I dug the snow hut out again. This time I was a little apprehensive of the consequences. I was very careful and did not make it as large inside as I would have liked to. I placed the boughs inside the shelter and folded the canopy in even layers on top of the boughs. During the day and until the sun went down, my feet remained comfortable, but now my feet were chilling rapidly. After I got a fire going, I sat down and removed the quick-don boots and ski socks. I replaced them with the down-filled assembly after I cut the rubber booties off the suit. This was a great improvement, and I might say that these were very comfortable through the remainder of the test. At this point I started getting chills throughout the torso, so I decided to have some hot tea and a half meat food product bar. These went down well but they did not stop the shivering. I walked about some to see if this might help, but it did not. So I decided to see if I could get warm in the hut. I remained in the hut for approximately 1 1/2 hours, and it might be noted at this time that I became very cold at all points of contact with the suit, such as the knees, elbows, shoulder, etc. Lying in the hut between the parachute did not help in the least. So I got back out and built the fire up. There was still no relief. By this time my shaking was uncontrollable and I decided to walk around. My Pressure Suit seemed to be soaking wet and no matter what I did, it seemed to get worse. After approximately 4 hours of uncontrollable shaking I went out of the test. It might be noted that during all this time, both my feet and hands remained absolutely comfortable.

Subject Number 3

Monday. Placed in survival area at approximately 1015 on 16 Dec 63. The site picked to build snow hut and set up camp was on edge of a lake. First thing done was to look over survival equipment. Then I got together some dry wood and built a fire. I took the shovel, put on the handle and proceeded to pile snow. The pressure helmet got very heavy on my shoulders. Got out the stocking cap and put it on in lieu of the helmet. (As of now, can see no survival use for the pressure helmet in the Arctic). The wool stocking hat is a very good and useful item and should be mandatory in all world-wide survival kits.

After I had a pile of snow approximately 4 1/2 to 5 feet tall, I let the pile set. While I was waiting for snow to set good, (approximately 2 hours) I built a lean-to and moved my fire. I also made some tea. This was very hard to do as the only type of container available was the ration container. By the time I had my tea and located all my survival equipment under the lean-to it was time to dig out the inside of the snow house. The sun had set and it was getting dark about the time I finished. I cut a scarf from the parachute canopy to retain the body heat by sealing off opening around neck ring. I made another cup of tea, ate a fruit cake bar and was ready to bed down. When I went to put on the ADC Walk-around Sleeping Bag I found the bottom to be too small to get over the shoulders. I needed assistance in this. I then went into the snow house. I had not any way to close the door, but it was dark and cold and by this time I was tired so I crawled in the house to sleep. At first the temperature in the snow house seemed fine, but that was short lived. I had a candle and matches with me, so I made a light. It was after I had blown out the candle and had done no moving about for approximately 1/2 hour that my feet got very cold. I still had my boots on. A monitor came by at this time (1800 I guess) and wanted to know where the door was. Well, I was not in the mood for silly questions at this time, but he did say I should do something to close up the opening. Well, I fished for the matches and candle, lit the candle, (there is not sufficient striking surface on the match container so I used my finger nail). I had the shovel in the house with me so I took more snow from the inside of the house and moved it to the doorway. This operation took some doing and a lot of moving around from one position to the other (I did not have room to sit up inside). I would shovel for a time, rest for a time. I had all but a couple square inches filled in. In about 30 to 45 minutes the snow made a good fill. It worked out so I had the opening covered. By this time I was really tired, and so I lay down to sleep. My feet were the coldest part of my body. I was unable to get comfortable, did not sleep, only semi-sleep for short periods.

Tuesday. I came out of the snow house at approximately 0730 in the morning, Tuesday, 17 Dec 63. I felt stiff, but the feeling went away by the time I had a fire going. I fixed a cup of coffee and ate a cereal bar. I felt real good then. I spent the day improving camp site, keeping the fire going and putting a pine branch floor in the snow house. I used the parachute harness, seat and back cushion to make a head and shoulder pillow to sleep on. Using the meat bar, onion powder and chili powder in the survival ration I made up a can of soup; ate it and a fruit cake bar. Had a cup of coffee. Cut some logs for a fire the next morning.

I went in the snow house for the night at approximately 1730. I then scooped out some snow, making the inside of the snow house larger. I used this snow to fill the doorway for the night. I took off my boots and tied up the draw string on the bottom of the ADC sleeping bag. I wanted to see how this would work out.

Wednesday. Sleep was a little better on Tuesday night. However, my feet seemed a lot colder than the night before. I had to keep rubbing them together to keep them warm. This, plus the fact that to keep warm I kept my feet pulled up in the sleeping bag, caused me to get cramps in my inner thighs. My hips and shoulders were sore and stiff. When I came out of the snow house at 0800, the first thing I saw was that my lean-to had blown down. The wind had come up during the night and had caused one end to blow down. The other end was secure to a tree on the shore. I made a fire, drank some hot coffee, and ate the last cereal bar. Things then looked a lot better. I set out to move the lean-to. After I had completed the lean-to and made some more soup I felt real fine. I cut wood for the fire, piled more snow on the snow house and just stayed busy. All the work was done in slow time to keep down sweat.

At approximately 1800 hours I went into the snow house for the night. I think that is one thing that can get you down, so much time in the snow house and so little time outside. I left my boots on for the night, and I seemed to sleep a little better for approximately 4 hours at a time. I would lie awake for about 2 hours. The comfort in sleeping did not improve over the previous two nights. I came out of the snow house at 0745 in the morning. I made a fire and coffee and was "rescued" at 0900.

The following things need to be improved in the survival and protective field:

The survival ration needs to be improved. With a little larger second container could use more cereal, sugar, coffee and tea. The survival kits have a need for a medium-size pan and some type of cups. Even a fork and/or spoon would be of great help to one's state of mind in a survival situation. The shovel, saw combination is a bad piece of equipment. When using the handle on the saw and sawing wood of any size the handle keeps coming off.

Subject Number 4

Monday, 16 Dec. I arrived out in the field about 11:15. Built shelter after first removing helmet and donning toque. My neck got a little cool, so I put a piece of parachute material around the neckpiece. Put on the MA-1 gloves. Finished shelter and got firewood — there was plenty available. Shot at squirrel and missed. Shot again and connected. Built fire and ate squirrel. Got ice from lake for water and coffee. Put on down gloves at 1640. Down gloves warmed my hands very quickly. Ate one fruit bar and had one cup of coffee with one sugar at 1900. At 1930 put on down jacket over flight suit. At 2000 took off alert boots, one pair of socks and cut off rubber shoe section of flight suit. Put on one pair of socks, booties and down booties. Got ready for bed and went to sleep about 2045 or so.

Tuesday, 17 Dec. Slept on and off and got about 8 hours sleep. Woke up a little chilled (hands and feet). Put on alert boots and got fire started. I found out later that six of my fingers were partially frostbitten. They got this way while I was trying to start my fire. I kept the down parka and mittens on about all day. They were very warm and comfortable. Set snares about 0830 but no luck all day. Gathered much firewood. Had about 120 cc cool water at 1030. Had one coffee with one sugar and a cereal bar at 1330. I checked Quade about 1430 because I saw no fire or movement around his camp area. He was lying inside his tent, his feet wrapped in chute material. I asked if I could help, but he said no. I told Burkett and Williams about Quade when they came by at 1500. They took him back to the lab. Between 1600 and 2130 I walked around the lake many times (around 25 to 30) to keep warm and also to give me something to do. After Quade left I was completely isolated from the other subjects. I had another coffee with one sugar at 2000. I gathered enough fire wood in the tent so I wouldn't have to keep going out for it. I sat up and read for awhile. Sacked out about 2145. Back sore at base of spine. This was from sitting up in the tent. Wood was much cleaner burning — hardly any smoke.

Wednesday, 18 Dec. Got up about 0910. Got dressed in alert boots and went out to check snares. Got one rabbit. Cooked and ate him about 1040. Had difficulty in thoroughly cooking the rabbit. Had one cup of cool water with the rabbit. Had a cup of tea with one sugar at 1330. Also had 1/2 fruit bar. Felt very tired before this. The tea and fruit bar seemed to restore my energy. Had another tea with one sugar at 1730. I cut all the metal parts off the parachute pack to use as a mattress. Used it Tuesday night but one buckle dug into my hip all night. I couldn't sleep with the arms inside the down bag because it spread the front open too much. I put my arms back outside after one hour on Tuesday night. Sat up by the fire until about 2145 and then sacked out. Had one more coffee with one sugar. I did not defecate in the 72 hours that I was in the field.

Recommendations. 1. That some of the higher calorie freeze-dried rations be tested for use as a survival ration. I feel that a survivor would taste the meat bar, and not liking it would not eat it until absolutely necessary — fourth or fifth day. At that time I feel that the sudden input of a high fat diet would upset his stomach enough to cause diarrhea or vomiting or both. This could lead to a serious situation.

2. That personnel using the down clothing be advised not to turn the arms inside out while sleeping.

APPENDIX II

HOW TO BUILD A SNOW HOUSE

There are two types of snow houses. One type is made of snow blocks cut from wind-toughened snow. The other type is made from light fluffy snow. We are describing the construction of the second type in these instructions.

Why

Winter in the Arctic is characterized by extremely low air temperatures. The temperature of the earth in winter, however, does not get much colder than +18° F. The warm earth beneath the snow provides an inexhaustible heat source which may be used to considerable advantage by a survivor. It is only necessary for the survivor to trap the earth's heat, which he can do by building a snow house directly on the ground. The earth's heat will then warm the air within the shelter up to as high as +18° F. It is not necessary to build a fire in this shelter. Actual temperature measurements have shown that the air temperature within a snow house was +18° F when the outside temperature was -40° F. This difference of 58° between outside and inside temperature would have enabled a downed pilot to survive without fire.

Where

Light fluffy snow is generally found in geographical regions with a continental-type climate characterized by low winter temperatures and little wind. The interior of Alaska is one such area. Other areas are within the spruce forests of northern Canada and within the spruce forests of northern Siberia and European Russia.

How

1. Select a suitable site. The snow should be at least 5 to 6 inches deep. If necessary the snow house can be constructed on river or lake ice.

2. Use part of the survival kit as a shovel. The survival kit container itself, the pilot "chute" or part of the parachute pack can be improvised to make a shovel.

3. Lay out a circular ground plan. Break off a dead stick about 5 ft long and inscribe a circle in the snow with this stick by standing in the center and turning a full 360 degrees.

4. Place this stick upright in the center of the circle. Lay another stick of the same length down on the snow surface. This guide stick shows the radius of the circle and will serve as a guide during the excavation of the snow house.

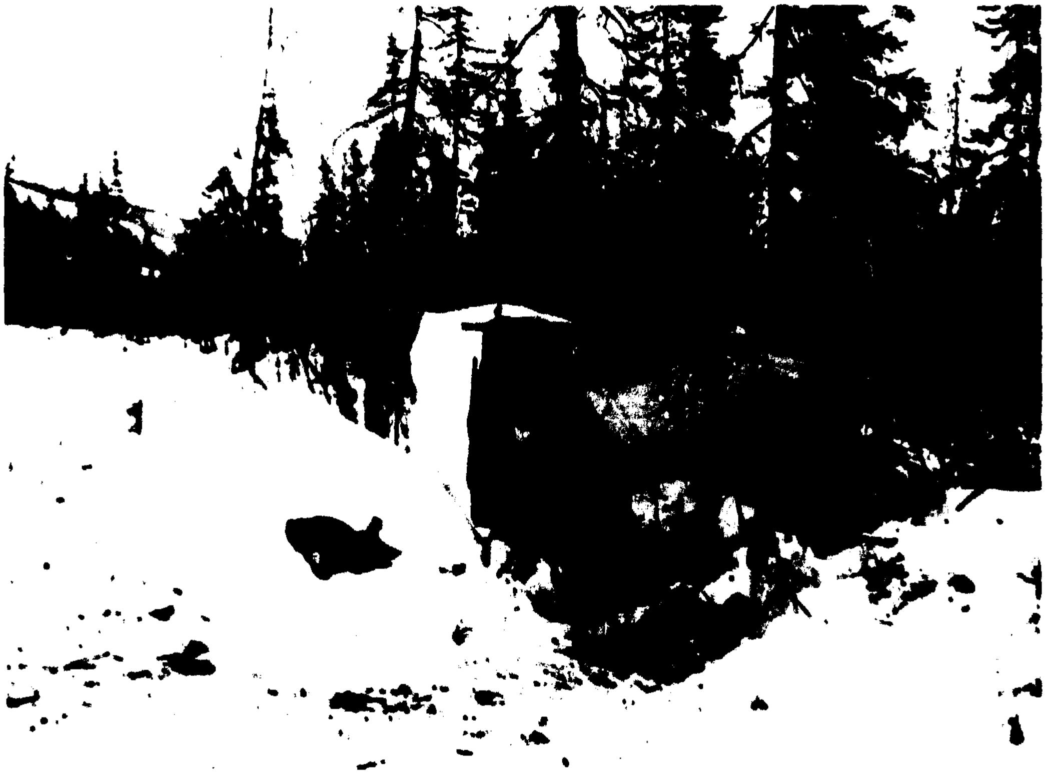
5. Shovel snow into the circle to make a conical heap of snow. The snow should be about 1 ft deep over the top of the stick. This will require about 2 hours of shoveling.

6. Wait 1 hour for the snow to "set."

7. Burrow into the center of the snow house, following the guide stick. Carefully remove the other stick that is at the center. Remove snow from the interior of the snow house, leaving walls about 2 ft in thickness.

8. Remove all snow from the earth's surface. This allows the earth's heat to warm the air within the snow house.

9. Construct a door. You can use either snow piled up in the entrance or part of the parachute pack as a door. Tightly seal the house up with snow after retiring for the night. This procedure will trap all of the earth's heat within the snow house.



PHOTOGRAPH 1

Subject Number 3, who is wearing the FPS, the ADC Walk-around Sleeping Bag and the VB White Thermal Boots, is shown sitting in front of his fire at the survival site. The parachute canopy has been utilized as a wind break. Note the entrance to the snow house at the left.

PHOTOGRAPH 2

Subject Number 6, who is wearing the ADC Walk-around Sleeping Bag over the FPS, is shown standing beside his snow house. This subject has on the VB White Thermal Boots.

PHOTOGRAPH 3

Subject Number 4, who is wearing the complete down-filled survival garment assembly over the FPS, is shown inside the wickiup framework.

PHOTOGRAPH 4

This photograph was taken at the conclusion of the test and shows Subjects Number 4, Number 6 and Number 3. Subject Number 4 (at left) is wearing the down-filled arctic survival garment over the FPS. Subject Number 6 (center) is wearing the FPS alone having just removed his down-filled garment. Subject Number 3 (at right) is wearing the ADC Walk-around Sleeping Bag over the FPS.

PHOTOGRAPH 5

This photograph demonstrates the size and strength of the snow house used by Subject Number 6. This snow house was originally constructed of fluffy snow.