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ANALYTICAL STUDY

QUARTERMASTER SUPPLIES, EQUIPMENT and SERVICES DURING OPERATIONS  
in EXTREME COLD

Quartermaster supplies, equipment and  
services during operations in extreme cold  
by Lt Col J. S. Sandlin. CGSC. 1947-48.

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COMMAND AND GENERAL STAFF COLLEGE  
SCHOOL OF LOGISTICS

DIRECTIVE FOR ANALYRICAL STUDY SUBJECT

8 October 1947  
(date)

6-1  
(Subject No.)

**SUBJECT:** Quartermaster Supplies, Equipment & Services During Operations in Extreme Cold.

**PURPOSE:** To study Quartermaster supplies, equipment and services for use in operations where the temperature may be as low as  $-20^{\circ}\text{F}$ . Consideration will be given to operations both in mountains and in the sub-arctic.

**SCOPE:**

- a. Consider supplies, principally clothing, rations and POL products.
- b. Consider applicable equipment to include kitchen equipment, both individual and unit, tentage, stoves, sleeping bags, packboards, skis, snow shoes and sleds.
- c. Consider services to be supplied for laundry, fumigation and bath, maintenance and repair facilities and animal transportation.
- d. Make specific recommendations for correction of any existing deficiencies in the adaptation of Quartermaster supplies, equipment and service units to operations in intense cold in the mountains or the sub-arctic.

COMMAND AND GENERAL STAFF COLLEGE

Fort Leavenworth, Kansas

31 May 1948

File No. 6 - 1  
To: Quartermaster General, U. S. Army  
SUBJECT: Quartermaster supplies, equipment and services during  
operations in extreme cold.

## I. PROBLEM

To study Quartermaster supplies and equipment for use in operations considering both mountain and Sub-Arctic where temperatures may be as low as minus twenty degrees (-20°F).

## II. DISCUSSION

a. Mental conditioning will allay any fears born of ignorance and give troops confidence in their ability to operate successfully in severe climate. (Annex 1)

b. 1. a. There will be times when as much as one hundred fifty degrees (150°) difference in body temperature and air temperature will occur. The high rate of heat loss increases the appetite for food high in caloric content (fats and carbohydrates). (Annex 2)

b. The sorting and issuing of operational type rations is a time loss and could be expedited with packaging by ration that would make it possible to issue in complete darkness. (Annex 3)

c. The reluctance of individuals to eat or drink in cold areas necessitate some provision for protection when messing. (Annex 4)

2. The present Arctic uniform weighs about twenty three pounds (23 lbs), if fiber glass is used, the number of layers and weights could be reduced to about fourteen (14 lbs) pounds. (Annex 5)

3. Individuals must operate more independently in cold areas than in other latitudes. It will be necessary for equipment to substantiate this fact since movement of individuals is hampered by extreme cold. (Annex 6)

4. In cold areas the population will not be as dense and the available permanent type shelter will not be as great as in warmer climates. Since inadequate shelter can be disastrous, a mobile type shelter is more necessary to the success in Sub-Arctic operations than in the temperate zone. (Annex 7)

c. Deficiencies noted in that:

1. Human adjustment is necessary in Sub-Arctic area.
2. Training is necessary in the use of clothing and equipment.
3. Further research is needed on the effect of cold weather on supplies.
4. Calorie content of the present ration is inadequate.

5. Present Arctic uniforms have an excess weight.
6. Bulkness of present uniform reduces the efficiency of an individual.
7. Uniforms are not of sufficient size to allow proper ventilation.
8. Individuals will work until exhausted to keep from getting cold when inactive.
9. Moisture and frost rises in present sleeping bags.
10. Shoe pack is too flexible and will not support the weight of an individuals foot.
11. Canteens are not insulated to protect liquids from freezing.
12. Present food containers will not keep food warm for long enough time.
13. Heated shelters are necessary for messing in cold areas.
14. Small shelters alone are not adequate.

### III. ACTION RECOMMENDED

1. That proper training be given in the use of clothing and equipment in Sub-Arctic areas.
2. That a mountain type ration be developed with a minimum of forty-five hundred (4500) calories which will permit a variety of menus in one carton and allow issue in complete darkness.
3. That a small individual heating element to be inserted under clothing for heat, be developed; that the size of clothing be increased, weight and number of layers reduced.
4. That suitable insulation be built into present sleeping bag to protect against frost.
5. That a self-heating food container and insulated canteen be developed that will keep liquids hot and cold for twelve to eighteen (12 to 18) hours.
6. That a system of large wall tents back up small shelters to provide heated facilities for messing.

  
JOSEPH C. SANDLIN  
Lt. Col., Infantry

#### Encls:

Annex 1            Annex 4  
Annex 2            Annex 5  
Annex 3            Annex 6            Annex 7



Surrounding the Arctic is a belt of variable width called the Sub-Arctic region, because it has a more severe winter climate than the adjacent temperature zone. It includes most of Alaska, Canada, Siberia, and the Scandinavian countries. The Sub-Arctic climate is broadly divided into two types: maritime and continental. The maritime Sub-Arctic includes the islands and coastal regions, where ocean currents have a pronounced effect. The continental Sub-Arctic includes the inland areas, which have seasonal climatic variations as great as any regions on the face of the earth. Winters are colder than in the Arctic itself; summers are particularly warm. At Verkhoyansk, in central Siberia on the Arctic Circle, a record low temperature of minus ninety degrees (-90°F.) was recorded in February 1892, yet it has an average July temperature of sixty degrees (60°F.) and once recorded as high as ninety three degrees (93°F.) in July. In January, 1947, the town of Snag, Canada near the Alaskan border, experienced a record for North America of minus eighty-two and three tenths degrees (-82.3°F.). Fort Yukon, Alaska, has recorded one hundred degrees (100°F.).

In general, the Sub-Arctic is covered with heavy forests of both coniferous and deciduous growth. These trees are small with very short roots, and are easily uprooted. There are tens of thousands of lakes, the result of poor drainage induced by the presence of permanently frozen sub-soil called 'Perma-frost'. Some of the largest rivers in the world lie in the North--the Yukon in Alaska, the MacKenzie in Canada, and the Ob, Lena, and Yenesei in Siberia.

The other great region of extreme cold is the Antarctic Continent. Since it is a land area with a mean elevation of six thousand (6,000ft.) feet, it is much colder than the Arctic, and is uninhabited except by bird life. There is no 'Sub-Antarctic' region, because the continent is surrounded by oceans which have a temperate climate.

For the purposes of military study, cold climates can be further classified as wet cold, dry cold, heavy winter and summer thaw.

The maritime Subarctic has wet cold. Moist oceans air meets cold air masses flowing from interior highlands, causing heavy precipitation, mists and fogs, and violent windstorms, called 'Williwaws', which are

## C L I M A T E

It is entirely practicable to live in the Arctic and Sub-Arctic regions and modern developments are hastening the civilization to the north. It is interesting to note that more than five hundred thousand (500,000) Russians live and work north of the Arctic circle.





There is a need for a line of delineation between the Arctic and Sub-Arctic regions. Under the present policy of the War Department, that area lying north of the Arctic Circle is designated as the Arctic. Geographic and military Arctic must be distinguished from each other in order to permit a meeting of minds on the proper approach to our designing and testing that is to be carried out in any cold area. Any line of delineation between the two regions will not set a temperature that will be constant but only a mean temperature, that can be used in solving some of our cold area problems.

The Arctic Circle, latitude sixty-six degrees (66°) thirty three minutes north (33'N), is no longer considered the boundary of the Arctic region. Today, the region which has a truly Arctic climate is defined by an isothermal line which lies both inside and outside the Circle. It delineates the region in which the mean temperature during the warmest month of the year (July) is fifty degrees (50°F) or less. Generally speaking, the timber line follows this temperature lines; in other words, the Arctic climate is too cold, even in the warmest month of the year, to sustain the growth of trees and shrubs. The land areas are barren wastes; most of the region is frozen ocean, although the ice cap recedes in summer permitting navigation along the north coasts of Alaska, Canada, and Siberia. Only mosses and lichens grow on the treeless plains, which are called tundras. However, the region is sparsely inhabited by Eskimos, and a variety of animal life is found.





### ARCTIC REGIONS

-  Arctic Area (Tundra)
-  Sub-Arctic Area (Coniferous Forest)
- Boundary between two is Northern Limit of Trees.*
-  *Approx. Limit of Open Water*
-  *Approx. Limit of Pack Ice*







**EXPLANATION**

- Angles of Variation of the Magnetic Compass from the True North shown by Red Arrows
  - Routes of Explorers
  - Warm Ocean Currents
  - Cold Ocean Currents
  - Glaciers and Ice Caps
  - Course of Icebergs
  - Railways
  - H.R.C. Hudson's Bay Co. Stations
- The approximate elevation of the land is indicated by color, viz:
- Over 6000 feet
  - 2000 to 6000 feet
  - 600 to 2000 feet
  - Sea level to 600 feet

**THE ARCTIC REGIONS**  
 PREPARED IN THE MAP DEPARTMENT OF THE  
 NATIONAL GEOGRAPHIC SOCIETY FOR THE  
 NATIONAL GEOGRAPHIC MAGAZINE  
 GILBERT GROSVENOR, EDITOR  
 Scale 1:14,673,400 or 231.6 miles to 1 inch

0 100 200 300 400 500 600 700 800 900 1000  
 STATUTE MILES  
 0 100 200 300 400 500 600 700 800 900 1000  
 KILOMETERS

Azimuthal Equidistant Projection - Pole of Projection at North Pole  
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Longitude East of Greenwich 0 10° 20° 30° 40° 50° 60° 70° 80° 90° 100° 110° 120° 130° 140° 150°  
 Longitude West of Greenwich 0 10° 20° 30° 40° 50° 60° 70° 80° 90° 100° 110° 120° 130° 140° 150°

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cyclonic in nature and frequently exceed one hundred miles (100) per hour in velocity. In the Aleutians, although the temperature does not drop below ten degrees (10°F.), there are no trees; high winds prevent their growth. Because the temperature ranges near the freezing point, snow melts rapidly or turns into rain; precipitation totals as much as one hundred (100) inches per year on the Pacific coast of Canada. Top-soil is muddy and soft, covered by a thick mat of mosses of lichens.

The Arctic and much of the continental subarctic have dry cold. There is little or no precipitation, because most of the moisture is condensed from the air as it passes over the outer fringes of the cold region. However, snow and ice remain indefinitely, because temperatures are below freezing almost continually throughout the six to nine month winter period. The air is very dry and clear most of the time.

Since wet cold and dry cold climates differ radically, it is obvious that areas will be found which have an 'in between' climate, where precipitation is heavy, yet the temperature is low enough to prevent thawing for a few months of the year. These are the areas of heavy winter, such as northern Wisconsin and Michigan, Vermont, and southern Germany. They are characterized chiefly by deep snow.

Summer conditions in the Subarctic are such that travel across country is nearly impossible, except by canoe or float plane. Warm, even hot, weather brings a prolonged surface thaw. Streams are swollen, lakes overflow, surface water stands everywhere on flat terrain, and top-soil turns into bog above the forest level. Insects of all kinds are prevalent; mosquitoes, especially, are a serious menace.

It may be concluded, then, that planning for operations in the Far North requires provision for warmth and shelter of troops against low temperatures and high winds, and for means of movement across deep snow, soft mud, thick forests, and water barriers.

Related physical factors along with climate is important. Climate is naturally the most important consideration affecting operations in the Far North. Certain other physical factors have an important relation to the climate conditions.

The unusual seasonal variation of day and night is important. In mid-summer along the Arctic Circle, there is about twenty hours (20) of daylight, with about twice the amount of insolation (rate of delivery of solar radiation, warming the earth's atmosphere) received in the tropics. In mid-winter there is less than four hours (4) of daylight at Nome, with the sun barely visible above the southern horizon; at Point Barrow there is no daylight at all during December and January. The sun no longer warms the air; the temperature sinks lower and lower.

The moon has an important effect on the Arctic winter night. With the clear, cold air and the snow-covered terrain, moonlight is especially brilliant. There is also the aurora borealis, or "northern lights", a natural phenomenon that often brilliantly illuminates the night sky. The Arctic winter night is not nearly so dark as one might think.

Another natural phenomenon found in the north is mirage. As in the desert, mirage is caused by the reflection of light through layers of air of varying temperatures. Normally, the temperature decreases uniformly as the altitude increases. In extreme cold areas, lighter, warmer air layers may lie on top of dense, very cold air, creating a temperature inversion as great as forty degrees (40°F.) at one thousand five hundred feet (1,500 ft.) altitude. Under certain conditions, particularly at sea, an effect known as 'looming' may occur, in which ships, icebergs, or other objects beyond the horizon appear upside down and greatly magnified on the lower surface of a cloud.

"Ice fog" is another phenomenon of military importance. Under low temperature conditions, beginning about minus twenty degrees (-20°F.) and especially at minus forty degrees (40°F.) and below, the air has practically no ability to retain moisture. Any moisture discharged into the air immediately forms into a suspended cloud of fine ice crystals. It forms vapor trails behind aircraft, dense clouds around buildings, air strips, groups of vehicles when engines are running, and in front of muzzles of weapons as they are fired.

## INFLUENCE ON INDIVIDUALS AND SUPPLIES

Since a future military operations may take place in a cold area, it is necessary that all individuals become acquainted with the difficulties they will encounter. More time is required to execute all movements and the problem of supply is continuously critical. The difficulties encountered by the terrain limits the movement off roads and paths will vary at different latitudes. The time of day, season and weather also create special problems. To overcome them troops must be carefully selected, specially equipped and thoroughly trained in cold weather operations. Even in weather of zero degrees (0°F.), a soldier will experience great difficulty and cannot be fully effective unless he has proper training, clothing, and equipment.

Winter and the thaws before and after greatly alter conditions which a unit must foresee. Excellent trained troops will be limited by the cold, new snow, snow storms, and have difficulty in maintaining themselves. Since frequent and sudden changes in the weather effect the performance of troops they must learn in training how to protect themselves against the effect of weather by making use quickly of all means of protection against cold, rain, and storms especially at night when they are tired. Superior leadership of the troops is necessary in order that the morale and toughness of the troops will not be jeopardized. This will enable the troops to adapt themselves to the extreme changes in the weather. Stamina should be developed through long conditioning periods prior to entering in combat in these areas. The final result is a high moral and Esprit de Corps, although these attributes are likely to find expression in an individualism that conceals the high degree of self discipline imposed by each man upon himself, this attitude is probably the natural outcome of training designed to prepare the soldier for virtually a self-sustaining role. A steady increase in physical endurance during training periods will improve his performance in sub-arctic areas. Consequently every man must be trained to cope with all the dangers and

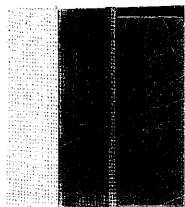
hazards in order to survive in cold area. It is estimated that about seventy percent (70%) of a man's time will be occupied with survival and thirty percent (30) operations. A soldier will encounter snow blindness, sunburn, exhaustion and exposure. The self preservation of one is of prime importance. Insufficient protection from the cold will result in frost bite, exhaustion and some time death from exposure. The extremities suffer most in the cold weather and every precaution must be taken to keep the hands and feet dry. The danger of freezing to death is usually caused by becoming exhausted from lack of sleep, drinking water and food, of carrying heavy loads. All means to overcome sleepiness should be taken if there is not adequate heated shelter.

Villyalmar Stefansson, a Canadian Arctic explorer, has stated, "if required a man may learn to endure the tropics, but it is absolutely essential that he learn to protect himself in the Arctic". Special training in the use of Arctic clothing, skis, snow shoes and shelters and other considerations of survival discussed above, must be given troops prior to exposing to the actual conditions of extreme cold. Mental conditioning is necessary to allay fears born of ignorance and gives troops confidence in their ability to operate successfully in severe climate acclimatization is the process of allowing the body to adjust itself to the need of increased heat production. These adjustments are internal; the skin does not become hardened to cold. Increased appetite for food high in caloric content (fats and carbohydrates) is an example of internal adjustment to climatic conditions. The Canadian army has recommended a period of ten weeks for preliminary training and acclimatization of troops.

## EFFECT OF EXTREME COLD ON MATERIALS

The effect of extreme cold on materials is a subject which needs more field, and laboratory tests. Some of the problems and deficiencies arise in Sub-Arctic areas are:

1. Steel still shrinks and becomes more brittle when subjected to extreme cold and must therefore be handled very carefully.
2. Copper wiring is also brittle when cold and must be handled accordingly.
3. Glass is very susceptible to sudden changes in temperature and the warmth of a man's skin will cause it to shatter.
4. Rubber becomes hard and brittle at low temperatures. Natural rubber is generally better than the present wartime synthetic product for use in cold areas. Although there is a synthetic under development that laboratory tests show that is satisfactory for limited use as low as sixty-seven degrees (67°F.).
5. Canvas will freeze and lose its pliability in cold weather.
6. Wood, due to the freezing and thawing, will become thoroughly soaked with moisture and become very brittle.
7. Lubricants freeze at low temperature and require pre-heating before they can be used. Although there is much controversy regarding lubricants, a great deal of experimenting is going on at present.





## F O O D

Some reports indicate that it takes eight (8) men to keep one man supplied in the front lines in extreme cold areas. The additional burden on supply personnel is great and must be watched with all precaution. The delivery of food to the troops from warehouses or other storage places becomes important in order that it might readily be consumed. This deals particularly with perishables that cannot be delivered in a frozen form. Adequate heated trucks are necessary to perform this mission without damage or loss of a great deal of food. Weather, climatic conditions and terrain affect the supplying of food to the front line troops and everything possible must be done to furnish a hot meal as often as the situation will permit.

Water may be abundant in some areas while in others it will be one of your most difficult problems. Usually melted snow is a source of water supply but should be used only as a last resort. If this is necessary additional personnel<sup>ne'</sup> are required in order to provide the necessary supply of water. Engineers may chop holes in the ice and set their filtration plants near by in heated shelters. These shelters are important since freezing will cause a great deal of damage to the filter units. Also, the storage tanks will freeze over along with the filled water cans. When the water cans freeze solid it is almost impossible to thaw them without damage to the cans. Some type of can should be developed that can be heated directly over the fire. The two hundred fifty gallon (250) water trailers will freeze solid so there is a need for an insulated water trailer to be used in extreme cold areas. There should be a heating unit built into the trailer to keep the water from freezing. The water cans should be stored in heated shelters to prevent freezing.

The temperature in the region will govern the speed and distance that water can be delivered to front lines. Transportation from kitchen to unit heated shelters will keep it at a temperature suitable for drinking purposes. It is well to note that troops will not consume as much water at low temperatures as in warmer regions, this reducing the problem to some extent.

The water, when delivered to the troops, will probably be chilled so that in a short time freezing will take place. The present canteen is unsatisfactory as a container for water in cold areas. It is too bulky to be inserted under the clothing and will freeze if left on the cartridge belt. Individual canteens should not be filled more than three fourths (3/4) full to prevent busting if the contents freeze. There are two means of keeping the water at a temperature desired for drinking purposes which need further development. One, that of a flexible plastic container which fits under the arm. It must not be bulky and fit snugly to the body. The disadvantage being that often it will be necessary to fill with chilled water and persons<sup>ze!</sup> will be reluctant to carry the canteen in the proper position.

Thermos canteens would solve this problem. It must be suitable to keep liquids hot or cold for twelve (12) to eighteen (18) hours.

The following extract from report on exercise 'Musk Ox' dated 14-17 Feb. 46.

a. Food. The original intention was to provide the ~~force~~<sup>force</sup> with fresh rations which would be carried in frozen form, however, it was found on trial exercise that it took too long to unfreeze and prepare and also produced too much steam in the tents when cooking. The force was provided with two types of pack rations. The Canadian Monopack Arctic ration and the U. S. lo in l ration. Fresh rations were issue to the force at various stops, i.e., Baker Lake, Cambridge Bay, etc.

b. Full details of composition of these rations are given below. The diet is designed to give six thousand (6000) calories per day. This figure applies to all persons<sup>ze!</sup> employed on the exercise (extra fats to combat the cold). Rum is also carried for issue nightly.

DETAILS OF RATION PACKS

CDN ARMY MONOPACK RATION

ARCTIC  
8 rations for one day

BREAKFAST

Oat Meal Block  
Bacon  
Milk Pdr.  
Coffee--Biscuits  
Jam - Butter  
Hard Candy

DINNER

Meat Component  
Biscuits  
Milk Pdr.  
Sugar Salt  
Chocolate Bar  
Butter - Carmels

SUPPER

Meat Component  
Biscuits  
Pea Soup  
Cheese - Butter  
Chocolate Bar  
Chocolate Drink  
Sugar - Salt

EXTRA

10 Cigarettes  
Matches  
2 Rolls Life Savers  
Can opener  
Toilet Paper

NOTE:--

8 Separate cartons containing above components in outer carton weighing 35 lbs gross.

U.S.A. 10 - 1 RATION

Menu No. 4

BREAKFAST

Cereal  
Bacon  
Jam  
Coffee  
Milk  
Sugar  
Biscuits

DINNER

Partial Dinner Unit  
(Incl. biscuits, sugar  
and chocolate bar)  
Pork and apple sauce  
Plum Pudding  
Biscuits  
Butter

SUPPER

Corned Beef  
String beans  
Biscuits and Butter  
Chocolate Bars

EXTRA

10 packs 20 Cigarettes  
10 Books Matches  
10 Hand Towels and soap  
50 Tablets - purification (water)  
1 oz. salt  
Can opener  
Toilet paper

NOTE: -

10 - 1 ration is produced in 10 different manus  
Gross weight in carton 49 lbs.  
Rations are packed in 4 containers, 2 marked,  
FIRST HALF, 2 marked SECOND HALF on containing  
tin goods the other pkts, containers etc.

Extract from Report on Winter Operations of the Second Infantry  
Division 1942-1943.

1. Problem Presented: to determine the relative merits and application of rations, type 'B' Expeditionary Force Menu # 2 (Frigid) 'K' and 'Mountain' to winter field conditions.

2. Rations tested and facilities for preparation of the same.

a. Menu used however, was extracted from this menu by office of Quartermaster General and substitutions were made for many items therein tested. Items of regular type 'B' canned vegetables and fruits were substituted for the dehydrated items of type 'B' (Frigid) when the later were not available. Dehydrated items of the type 'B' (Frigid) ration were and used were: Dehydrated eggs, milk, potatoes, carrots and preserved butter.

b. No attempt was made to bake bread with components furnished. Fresh bread was procured locally.

c. Average calories value per ration	4200 calories
Average weight per ration	4.6634 lbs.
Average volume per ration	.1360 cu. ft.

d. Mountain Types ration Menu Nos. 1, 2, and 3.

1. Four rations consisting of breakfast, dinner and supper varied by different menus of compressed, concentrated components packaged in a single cardboard container, containing single packages of each component, i.e., sufficient sugar for the three meals for four men is packaged in one container butter, etc.

2. Caloric value of 1 ration	4000 calories
Weight of 1 ration	36 ozs.
Weight of 4 rations	9 lbs.
Volume of 1 ration	.068 cu. ft.
Volume of 4 rations	.29 cu. ft.

Person<sup>nel</sup> living in extreme cold must have additional nourishment to build energy in the body. Since it is beyond this study to dwell on a time energy chart, it is not known the exact number of calories an individual will require in various conditions. Some observers state that some individuals

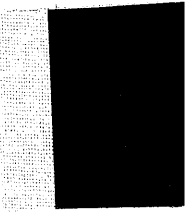
will require as high as seven thousand (7000) calories per day. Despite the rapid heat loss, the body must maintain its normal temperature. There will be times when as much as one hundred fifty degrees (150°) difference in the body temperature and the air temperature will occur. The ration should provide from forty-five hundred (4500) to fifty-five hundred (5500) calories, which is about fifty-six percent (56%) more than normal.



## PACKAGING OF RATIONS

The problem of packaging rations becomes complicated in order to get a variety of menu. The experience in World War II shows that service troops were acquainted with the contents of each different boxed ration and a matter of selection was instigated. Therefore, making all boxed rations the same content or requisition of ration by menu seems a practical solution.

Packages must be water proof to prevent deterioration. Snow, rain and sleet will blow into the cases causing damage. Rations should be capable of being stored in the open indefinitely. The present type of 'E' ration gives some variety but the desired characteristics should give a guarantee of more variety by placing at least six (6) different kinds of ~~meat~~ in the ration. Also, a package snack packed for an in-between meal lunch should be included. In order that this food could be served in unit messes, rations should also be packed by solid components in order to save the time of going through a large number of packages. This brings up the point of having a ration that units can issue in darkness and still give the necessary calorie content to sustain an individual. In order to do this, small cans are necessary along with packaging within the carton. The present type "C" ration has gone a long way toward this end, but an individual still has trouble sorting and issuing out the various cans to the troops.



## MESSING IN SUB-ARCTIC

Shelter is considered essential in messing of troops in cold areas. Various combinations of shelters and methods of feeding troops in bivouacs and on marches and patrols needs further research.

The terrain and climatic condition effect the location of messing areas and delivery of food to the troops. Also, this is important from the stand point of protection from wind. Also, the snow and tundra will cause great difficulties in moving of mobile kitchens in cold area operations.

Food and equipment are closely related. Without suitable equipment it is impossible to feed the troops in the field. Feeding troops in base camps is about the same as encountered in the United States provided there is a satisfactory base camp. Other than securing food, it is not a great problem. The Jamesway shelter may be used for mess halls in cold areas. Cafeteria style feeding will not allow the troops to be out of the cold as long as desirable. This type of feeding the troops is generally the accepted rule, as there will not usually be sufficient shelter to seat all personnel<sup>nel</sup> at one time, particularly if it is not a permanent base camp. Various arrangements of squad and large wall tents will offer facilities. These may be heated with the Herman Nelson heaters down to minus thirty-six degrees (-36°F.). If two M 1941 stoves are used and kept going at full blast along with insulation, the squad tents may be kept at a temperature that will prevent water from freezing.

The immersion heater is a very satisfactory piece of equipment used in Sub-Arctic messing. High winds may cause some difficulty in keeping it operating efficiently. This can be overcome by proper selection of messing areas and extending the heater stove pipe.

It is necessary to install the immersion heaters and corrugated cans under shelter, this preventing steam from being observed. Since the air is dry a great deal more steam fog will rise from the cans than in warmer climate. It is also more convenient to operate the immersion heaters. A danger of having the cans out in the open, troops will get their hands wet and be subject to frost bite. Sanitation makes it impracticable to have the

mess kit wash cans in the same shelter with feeding. Another use of the immersion heater is in heating the operational ration and thawing the five gallon water cans.

The use of individual stoves for heating ration is impracticable <sup>cable</sup> below zero degrees (0°F.). Individuals must remove his gloves to manipulate the valves and there is always the danger of frost bite. Also the eighty (80) octane gasoline commonly used will not generate as quickly as it should which makes the small stove hard to light. When the stove functions properly, direct heating over the flame is impossible. The food will burn before it becomes heated. The operational ration can be submerged in water and heated over the stove but this is time consuming.

To facilitate the feeding, rations must be heated in the kitchens to at least one hundred twenty five degrees (125°F) and delivered to the troops on the march. The present food containers are practical for this purpose. The only exception to this is when the container is opened, in a short time the rations become cold. This operation, of course, depends on how far one must move the ration and time involved. There is a need for a self-heating food container to overcome this problem.

The system of mobile kitchens preparing the food and then moving to the troops with the food is highly satisfactory. The situation might not permit this operation at all times and there will be a tendency for troops to crowd around this type of kitchen when being served and is not as desirable as food containers that can be disbursed. The individuals problem of eating the ration before it becomes cold is difficult.

In case vehicles are on the march, the use of mobile kitchens on the tail of column is not too great a problem. The process of delivery of food in the insulated container is the same as when marching on foot.

The fuel tablets issued with the present ration have proved to be of little value in cold areas. The heat is not sufficient to warm a ration. Wind will blow them out and a great deal of time is wasted, which is important in operations. This brings up a point on fuel tablets which needs more research. With this in view, the development of self-heating ration,

especially soup, which can be used as a snack between meals is desirable.

Air drop is another method used for delivery of food to the troops on marches. This has not proved too successful but has great possibilities. Its limitations are weather and the depth of the snow. In deep snow the percentage of rations lost will become great. Packaging and further research on air drop is advisable.

The length of time a patrol will be out governs the amount of supplies it will carry. A self-heated ration would facilitate feeding personnel on patrols. Carrying of frozen rations put additional burden upon the patrol. These rations have to be thawed, which is time consuming, and adequate equipment must be carried to perform this operation. If containers are carried with preheated rations, the weight will limit their range, if dismantled. This does not create too much of a problem if patrols are mounted because rations can be heated on the vehicle manifold or by equipment carried in the vehicle.



## C L O T H I N G

A man bundled in a large amount of clothing cannot operate as efficiently as one working in a more moderate temperature which requires less clothing. The problem to increase the efficiency of an individual becomes one of reducing the amount of clothing worn by a man and increasing the insulation qualities of the materials used in producing the garment. One line of thought is to develop electrically heated clothing to fit a particular type vehicle is desired by some individuals. All the tests that have been performed prove this type of clothing is satisfactory with some exceptions. It is important to note that the artificially heated suits of the present design, there is difficulty in keeping the feet, hands and knees warm. This reduces the necessity of heating or insulating the vehicle compartment when using the present type clothing. A distinct disadvantage of this is the problem of manufacturing one type of clothing for a particular type of vehicle will create great difficulties on our procurement program and also immobilize the individual to a great extent. An alternate to this might be, that clothing be developed with zipper openings that heating elements could be inserted in the necessary positions (gloves, etc.) to keep a man warm. The heating elements should be a part of the vehicle equipment.

Studies show that the bulkness of the clothing reduces the efficiency of tank man about thirty-five percent (35%). The majority of this is lack of having suitable gloves that permit handling of the machinery.

The problem then becomes the development of functional Arctic clothing that is easier to put on and remove, warmer, more comfortable, and less hampering to body movement than present clothing. In the past, pile and wool clothing have been relied upon. Glass fiber may have an important role in the new developments being made in Arctic uniforms. Now light weight Fiber Glass batting covered with light weight wind resistant, water-repellent cloth is being experimented with as the insulating medium against Arctic cold. Experiments have been conducted in quilting the glass fiber on nylon mesh for lining articles of clothing; however, the stitching has a tendency to cut the fiber glass causing the batting to separate. Consequently, to overcome this difficulty, adhesives are being considered that will make it adhere to the

cloth. In this way it may be possible to have the cloth carry the load, thereby reducing the strain on the batting.

Because the present quality of fiber glass flattens and loses its fluffiness when washed, an effort is being made to develop detachable liners for overcoats, jackets and parkas. These liners are made of fiber glass batting covered with a light weight lining material. They will be attached to the outer shell of the garment by means of fasteners, buttons or slide fasteners; with the liner detachable, it will permit the laundering or dry cleaning of the outer shell without damage to the liner.. A parka fabricated with glass lining weight one and a half pounds ( $1\frac{1}{2}$  lbs.) less than the combined weight of the parka field pile and parka field cotton O.D. and three pounds (3 lbs.) less than the O.D. overcoat. The present uniform weighs about twenty-three pounds (23 lbs.) and the proposed assembly will weight about fourteen pounds (14 lbs.), which is a considerable reduction in weight. From all indications the fiber glass linings are as warm as the Arctic clothing we have in use now, the advantage being in the lightness of weight. Future developments should include the use of this material in boots and gloves. This type of clothing was tested in the Navy operation Nanook which was not available for this study.

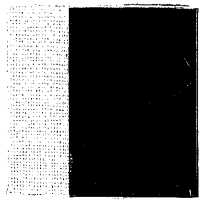
In a discussion of clothing, one should consider from the shirt out as one unit. Also it must be kept in mind that a uniform must be adequate for dry, windy cold, and wet cold. A small number of layers is desirable in order that proper ventilation may be acquired.. Openings must not be considered in order to prevent drafts and should be easily opened and closed and large enough to allow full use of the inside pockets. When an outer garment is taken off the inner garment should be a satisfactory water-repellent outer garment. A hood with some type of fur lining around the edges would keep out the cold air.

The outer parka must be large enough that freedom of movement will not be hindered and allow an individual to draw in his arms. This is considered essential to allow a man to remove his gloves or to warm his hands when there is need. Another necessary item is a pocket on the left shoulder. This will allow access to the cigarettes without opening the clothing.

The following are some comments on clothing.

1. Sweater--inadquate, not warm enough.
2. Parka, reversible--Excellent as a wind breaker and snow shield-not warm in itself.
3. Wool knit caps--Satisfactory under parka hood.
4. Woolen underwear--not large enough.
5. Woolen socks--satisfactory.
6. Pile-lined overcoat--excellent but crawls around the arms.
7. Ski trousers--Excellent but care should be exercised in fitting to insure adequate length as a tight sole strap will impair circulation to the heel.
8. Mittens, Shell Insert--adequate for warmth but too clumsy.
9. Ski Cap--not warm enough.
10. Shoe pack--inadequate for temperatures below zero degrees (0°F.) and is not made to support an individuals foot.
11. Ski Shoes--inadquate for temperature below zero degrees (0°F.)

It is generally accepted that shoe packs are not adequate for temperatures below zero degrees (0°F.) (The shoe is not built on a last that will support the weight of an individuals foot when making long marches.) The insulation qualities are limited and several pairs of heavy socks must be worn in order to protect the feet from frost bite. The new idea of the felt shoe and muckluk combination has been advanced to combat frost from inside the foot wear.



## EQUIPMENT

All the present equipment has been under test in cold climate and the necessary modifications are being made. It has been mentioned above that a mobile kitchen is highly satisfactory. There is under development a type mobile kitchen with shelter attached that can be stretched out from each side of the kitchen for troop shelter. When a move is necessary it can be folded in and will not greatly affect the weight of the kitchen. Some of the important features of a mobile type kitchen are that completed black-out conditions exist, and stoves be set in a position that the fumes can be carried off without danger to the personnel<sup>ne!</sup>. This may be done by having a ventilator in the top of the vehicle and a curtain that can be pulled down to seal out the upper part of the M-1937 ranges. Space is limited and is important to utilize it in a systematic manner.

The type of vehicle the kitchen is mounted on must have mobility and be able to negotiate the difficult terrain in all areas of operations. Some observers, of the cold climate tests, believe a track vehicle similar but larger to our present weasel would be ideal.

The outfit cooking Small detachment is desirable for use in platoon messes. Troops that are in out of way places will have a need for this type of equipment. The unit is adequate to accommodate thirty-five (35) to forty (40) personal when type "A" or "E" rations are used. It has sufficient serving and cooking utensels to justify its use in exceptional cases. The trend on all heating equipment used by troops in cold areas, is for it to be designed to operation liquid fuel. They should be of a type that can readily be converted to other type fuels, thereby, reducing the burden on supply personnel<sup>ne!</sup>.

When it is necessary to heat rations individually the M-1941 one-burner stove is preferred. It is very light, easy to carry, and this is desired over other types now developed. The fuel supply may be at times become critical in areas that are not readily accessible. A supplementary fuel should be issued along with this unit that could be used in emergency. This

does not mean that the fuel will be used in the M-1941 stove, but as a supplement to heat rations when gasoline is not available.

In the near future, a ration condition outfit should be developed that would not be any larger than a man's fist. This piece of equipment would operate with or without pressure and furnish sufficient heat to warm a ration. This will be a difficult engineering job but would solve a great many problems. For example, this unit might be inserted under the clothing to furnish additional heat when an individual is inactive. At this time the unit would not operate under pressure and would be capable of burning from twelve (12) to eighteen (18) hours.

To provide protection in various climates, the army has developed the Arctic sleeping Bag M-1945, Mountain Sleeping Bag M-1945 and Wool Sleeping Bag M-1945 to give the necessary warmth that would be required over and above the ordinary blankets. The Arctic Bag has two bags filled with feathers, one fitting inside the other. The outer shell is made of excellent cotton materials that is water and wind resistant. The disadvantage of this bag is lack of protection against the rise of frost. An individual lying on the frozen ground does not have enough insulation to prevent a gradually decrease in temperature within the bag.

Rubber mattresses prove to be a good insulation against the cold frozen ground or snow. The time consuming operation of blowing or pumping up this mattress in cold weather is not a simple process. The valves will become frozen or the pumps will not operate resulting in a deflated air mattress. A built-in insulation for this protection seems advisable. This could be made of a flexible asbestos cloth or some other good insulating materials which are water repellant.



Annex 7

## S H E L T E R

In cold areas the population will not, in all probability, be dense so the amount of shelter available will decrease in ratio to the latitudes. A permanent type shelter capable of quartering large forces will be non-existent. Therefore, it is necessary that troops know how to take advantage of the terrain so that by using their tents they can set up a weather proof bivouac quickly. They must also know how to make shelters in deep snow as a protection against the wind and snow. A fact that should not be overlooked is that for a long period temporary shelters are not good shelters. The greater the physical demands upon troops and the more severe the weather, the more necessary it is to replace the snow shelters by improvised shelters as soon as the situation permits. The comfort of the troops should be a prime consideration. The tents, huts, and barracks should be heatable and wind-proof. The beds in the shelter should be raised above the ground, whenever possible, to avoid dampness; air holes must be punched into snow huts to prevent the air from fouling.

A dangerous threat in heating the shelter is carbon monoxide poisoning, which kills painlessly without warning. Because this gas is the product of the incomplete combustion of carbon (gasoline, fuel oil, coal) all heated shelter and vehicles must have fresh air ventilation to prevent the accumulation of a lethal concentration. Care must also be taken to set up bivouacs that are safe from snow slides.

There are several types of bivouacs. Some of the bivouacs become semi-permanent which consists of prefabricated huts and tentage. Another type of bivouac is where tentage is predominate. Still another might be the combination of all types of shelter. Sometimes it is difficult to determine whether you have a semi-permanent base or a bivouac. This is due to the genius U.S. soldier which converts in four or five days the temporary bivouac to a semi-permanent base. He tends to make himself comfortable, gets all the scrap timber available and uses it to improve his shelter. The locations will be improved to such an extent it will hardly be recognized as a bivouac.

Efficient operations of a large base installation required permanent type buildings, Quonset huts, etc. Under development are various types of pre-fabricated shelters suitable for quick erection and use in advance bases. Snow houses will give adequate shelter against the cold, and troops can readily learn how to build the Eskimo-type igloo. However, much time and labor is involved in their construction and they do not replace the need for a suitable tent for use as a temporary shelter. Since tentage imposes problems of transport and erection, extensive use may be made of small shelters mounted on sleds (Wannigans which can be towed to desired locations). In extreme cold, vehicles become not only a mode of transportation but a means of shelter. Vitally needed shelter is constantly menaced by the hazard of fire under conditions of severe cold or high wind, when the stoves and heaters are run at full blast. Materials also become highly inflammable in the dry air. The added danger is that freezing water will make the fire fighting equipment inoperative. Destruction of shelter in cold areas through enemy action can have disastrous consequences.

The desirable characteristics of tentage are that they be as low as possible without interfering with the functional requirements, in order to preserve the heat and capable of being easily erected. Sod and snow cloths are very important features that allow the tent to be banked with snow or other materials. The tentage becomes very stiff when treated with fire resistant materials. This also increases the weight and cause difficulty in handling. There may be some question as to the advisability of this treatment. The frosting and icing will make the tents hard and stiff and make it difficult to erect or strike the shelter. De-icing and defrosting as much as possible is necessary in order to fold the tentage in some manner that it can be economically transported. Also, the determination of whether there will be an outside shell will be determined by your ability to defrost the tentage. Test show that a great deal of moisture collects on the inner shell due to heat in the shelters melting the snow then freezing and the warm air striking the cold and condensing.

There is a need for a portable shelter that can be easily erected for maintenance, kitchen, dispensaries, etc. Our present Jamesway type shelter,

with modification would fit this portable shelter need.

All the information available on the cold weather tests of the shelter half and the two man mountain tent proves that they are inadequate in cold climate. We must then have a two man tent of some type. It will be necessary for it to be sectional and transportable by two individuals with a floor for the protection in cold wet areas.

With a desirable tentage developed it can be used throughout the combat area. A system of two man shelter tents in the front lines with larger shelters at company and Bn level would make it possible to have heated shelters to withdraw troops for bathing and changing clothes, etc. This shelter should be of sufficient size to accommodate a squad and a company and have enough to house a platoon, if necessary. Bat~~al~~<sup>alion</sup> should have enough to accommodate the reserve company. A unit may not be able to use the tentage at all times but should be available if the situation permits.

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