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DIRECTIVE FOR ANALYTICAL STUDY

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10 October 1947

SUBJECT: Medical Aspects of Arctic Operations

PURPOSE: To determine the problems Arctic operations will present to the Medical Service, and formulate recommendations for the solution of these problems.

SCOPE: Cover the effects on the individual concerning physical and mental capacity, individual protective measures, diet, and training in personal hygiene. Cover the effects on medical units required, pertaining to evacuation methods, hospitals, types of shelter and special requirements. Make specific recommendations concerning:

- (1) Prescribed individual protective measures, diet and training;
- (2) Types of medical units to be employed;
- (3) Special medical equipment required.

COORDINATE WITH OTHER ANALYTICAL STUDY SUBJECTS:

- 6-1 Quartermaster Supplies, Equipment and Services During Operations in Intense Cold
- 8-6 Logistical Problems Peculiar to Arctic Operations

REFERENCES:

- 4304 Sanitation and Preventive Medicine
- 3703 Army Attack
- 3701 Army Concentration
- 4307 Medical Service - Division and Corps
- 61812 Report on Winter Operations, Camp McCoy, Wisconsin, 2d Inf Div 1942-43
- R5740 Army Training Memo, Australian Mil Forces, 27 Aug 45
- R8004 AGF Report, Battle Experiences #66 ETO, 22 Feb 45
- G10642 AGF Board Report C-741, ETO, 18 Mar 45
- S12839 Intelligence Review No. 25 & 54 - Arctic scientific problems affecting military operations and effect of Arctic conditions on Musk-Ox operations personnel
- G13199 Winter Exercise Musk-Ox WDMIS 21 Feb 46
- R13255 Observers report on Opn Musk-Ox, WDGS 18 Feb 46
- R13294 Observers report on Canadian Exercise, Musk Ox AGF
- G13978 Trends in Development, Vol. 1, #1, AGF, Aug 46
- R11457 German ski training and tactics WDMID, 31 Jan 44
- R11473 German mountain troops WDMIS, Dec 44
- S14349A Interim Report on Exercise Musk-Ox, 1946
- R15578 Alaskan Maneuver, FY1948, Exercise Yukon AGF, 28 May 47
- MN1016 Report Alaskan Department Winter Maneuvers by Canadian Observers 15 Jan - 3 Mar 44

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 SUBJECT TO GENERAL DECLASSIFICATION
 SCHEDULE OF EXECUTIVE ORDER 11652
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ADDED REFERENCES:

- S14349A- Exercise Muskox 1946
- N14349B- Baker Lake Force Rpt
- N14349C- DVSA Observer Rpt on Exercise Musk Ox
- G15799A- Final Report, AGF Task Force Frigid
- G15799B- Final Report, AGF Task Force Frostbite
- G15799C- Final Report, AGF Task Force Williaw
- G16096 MS T-24 Warfare in the Far North
- "Health Conditions Among U. S. Army Troops in Alaska 1942-47" - Health of the Army
- "The Army in the Arctic" - Armored Cavalry Journal, March April 47
- "If War Comes to the Arctic" - Mil Review Jan 48
- "Water in the Arctic" - Mil Review Apr 48
- "Infantry in Mountain Operations" - Mil Review Mar 48
- "Supply Problems in Polar Operations" - Mil Review Oct 47

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Student Detachment
School of Logistics
Command & General Staff College
Fort Leavenworth, Kansas

File No. L-4021 3-1

SUBJECT: Medical Aspects of Arctic Operations

1. **PROBLEM:** To determine the problems Arctic Operations will present to the Medical Service, and formulate recommendations for the solution of these problems.
2. **DISCUSSION:** The medical aspects of Arctic Operations, as well as the problems of other arms and services, have been studied in a series of cold weather operations, and preliminary conclusions have been reached. Conclusions on medical aspects are listed herewith and the problems are discussed in the annexes referred to:
 - a. Personnel must be carefully selected and specially trained. (annex 1.)
 - b. Special individual equipment and clothing and training in its use is essential. (annex 2.)
 - c. Personal hygiene and sanitation require special equipment and special training for all personnel. (annex 3.)
 - d. Messing presents problems in installations, rations, water and sanitation. (annex 4.)
 - e. First aid presents new problems and requires special training for all personnel. (annex 5.)
 - f. Evacuation must be rapid and presents many problems. (annex 6.)
 - g. Medical equipment must be altered and special equipment developed to meet requirements. (annex 7.)
 - h. The majority of hospitals must be base units of permanent or semi-permanent structure. (annex 8.)
 - i. A higher incidence of frostbite and snow-blindness, upper respiratory ailments, and carbon monoxide poisoning is peculiar to Arctic Operations.
 - j. Existing types of medical units are adequate, when properly augmented, trained and equipped.
3. **ACTION RECOMMENDED:** That lessons learned to date be utilized in the selection and training of personnel, in the conduct of training and operations, and in the development of supplies and equipment. That research, development, and testing be continued in order to provide better answers to the many problems which are only partially solved to date.

Donald F. Gibbons
DONALD F. GIBBONS 038724
Major, Cavalry

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Energy is expended at a much more rapid rate in extreme cold than under normal climatic conditions. Col. Paul V. Kane, Commander of Task Force Frigid, is of the opinion that man loses two per cent in efficiency for every degree below zero. He also states that 90 percent of a soldier's time is spent in fighting the elements when operating under arctic conditions. Other commanders and observers bear out Col. Kane's observations to a greater or lesser degree but it is obvious that men who are to fight in the Arctic must be of sound mental and physical health initially and must be fully conditioned if they are to operate efficiently under the added rigors of such campaigning. Studies completed to date, although neither final nor conclusive, indicate that individuals selected for assignments under conditions of extreme cold should possess the following characteristics:

1. A minimum of 12 months military service.
2. High degree of physical fitness.
3. A minimum grade of III on the Army General Classification Test.
4. High motivation and incentive.
5. A "normal" score on psychological tests.
6. Origin from a small community.
7. Mechanical aptitude.
8. Previous experience with cold weather. (Men from most of the northern United States possess this characteristic.)

Training must stress physical conditioning and the "buddy system", whereby pairs of men watch out for each other, must be developed to a high degree. Leadership in all echelons, both in training and in the field, must be of top quality and morale must be kept high under trying conditions. The statement that "incentive is worth an overcoat" has proven true on many occasions. The following basic principles must be perfectly instilled during training and followed religiously in the field:

1. Wear goggles at all times in the open during daylight hours to avoid snow-blindness.
2. Facing the wind or walking into the wind must be avoided whenever possible. With a high degree of windchill, frostbite can occur in one minute and without the casualty knowing it.
3. Avoid exposing uncovered extremities to the elements for long periods. Frostbite can occur at -14°F . An uncovered human hand will start to turn white after two minutes at -50°F . After one hour of exposure at this temperature, it would probably have to be amputated.

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4. Feet must be exercised regularly. Cold feet must be dried and a change to dry socks made whenever the opportunity presents itself.
5. Wet clothing must be dried thoroughly.
6. Supplementary dry handgear and socks must be carried by all personnel.
7. The dangers of carbon monoxide poisoning must be realized and avoided.
8. Proper exercise will increase heat production but exercise should not be sufficient to cause perspiration to moisten clothing. Clothing must be loosened or removed in order to prevent perspiring as the result of necessary exertion.
9. Avoid spilling gasoline or other rapidly vaporizing substances on clothing or skin.
10. Never touch metal surfaces with the bare skin.
11. Never use liquor in any form. Alcohol causes all the outer blood vessels of the body to dilate, and produces a dissipation of body heat and a rapid drop in deep body temperature. A man under the influence of alcohol, if exposed in sub-zero weather, even for only a short time, can rapidly freeze to death.

Adequate instruction in first aid must be given to every officer and enlisted man through the medium of lectures and demonstrations. Frostbite, snow-blindness, trench foot and carbon monoxide poisoning should be especially stressed.

Training in the use of special clothing and equipment is essential (see Annex 2).

Training in personal hygiene and sanitation must be undertaken (see Annex 3).

Special individual clothing and equipment and training in its use is essential.

The arctic clothing which has been developed by the Quartermaster General has proven to be adequate for arctic operations. The newer fiber-glass lined garments are superior to any pile which has as yet been developed and the trend is toward fewer and thicker garments as against the older theory that many layers provide more warmth.

Clothing must be properly fitted and must fit loosely throughout. Fasteners must be so designed and so arranged that they can be adjusted without removing handgear, and clothing must be capable of being loosened and readjusted with minimum effort.

Men must be trained to loosen clothing and allow circulation of air in order to avoid perspiration. Any dampness greatly reduces the insulating value of arctic clothing and must be avoided.

Wool socks, cushion sole, should be worn under ski socks, and cotton drawers and undershirts under woollen drawers and undershirts. The socks and underwear worn next to the skin should be changed every day if possible and at least every other day. Ski socks, woollen drawers, and undershirts should be rotated daily in order that they may thoroughly dry and provide maximum protection. Clean socks and underwear should be automatic issue and supplied with the ration.

Skis and snowshoes in their present state of development are adequate, but considerable training is required before the average soldier can attain any degree of familiarity or proficiency with either. Troops to be utilized in arctic operations should be trained in the use of both skis and snowshoes as it is frequently impossible to move on foot without utilizing one or the other.

All clothing and equipment must be white or covered with white for use in arctic operations.

Although many improvements in individual clothing and equipment can be and are being made, there are relatively few real deficiencies. A thermos canteen must be perfected, a method of heating individual rations in the field must be developed and an individual field shelter must be devised.

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Personal hygiene and sanitation require special equipment and special training for all personnel.

Heated latrines must be provided for troops in the field. Bodily evacuation is most difficult and can be dangerous in sub-zero temperatures which will turn an uncovered human hand white after two minutes exposure and require its amputation after one hour of exposure. At such temperatures most men will put off evacuation until it becomes an absolute necessity and the ills engendered by faulty elimination will inevitably follow. Latrine wannigans, or shelters mounted on sleds, may be constructed to be towed behind both administrative and combat vehicles, and may be left in assembly areas when combat vehicles go into action. These mobile latrines must be provided with removable waste receptacles so that waste can be burned with a mixture of gasoline and fuel oil. Every soldier must be impressed with the necessity for regularity in elimination and provided with the means to allow it.

Heated wannigans with washup facilities should be provided when troops are to be away from such fixed facilities for long periods. Teeth should be washed at least once daily. The body should be bathed at least once a week and when it is impossible to provide for a complete bath the feet, crotch, and armpits should be wiped daily or at least every other day with a clean, wet, soapy cloth. With the exception of socks and underwear worn next to the skin, personal clothing can be worn for long periods of time in the extreme cold. Clean cushion sole socks and cotton underwear should be automatic issue and supplied with the ration. The socks and underwear worn next to the skin should be changed daily if possible and at least every other day. Ski socks, woolen undershirts and drawers should be rotated daily in order that they may thoroughly dry and afford full protection. Periodically, men will have to be sent to a rear echelon where facilities for a complete bath and complete change of clothing are available.

The morale factor provided by a daily washup, shave, clean socks and underwear is obvious but the health factor must not be overlooked. Contrary to popular belief, a beard is but slight protection against the cold in addition to being unsanitary. Dirty, sweaty or greasy bodies, hands and feet result in dirty, moist or greasy clothing and a consequent lessening in the insulating value of the cloth. Slovenliness lowers morale and breeds lack of discipline as well as illness. It must not be tolerated and the means to avoid it must be provided.

Messing presents problems in installations, rations, water and sanitation.

Adequate nourishment is a prime essential if the fighting efficiency of troops is to be maintained in any climate and is doubly important in the Arctic.

In fairly stable situations in the field it is possible to operate a normal mess if sufficient shelter can be provided to allow for preparation and consumption of the food. The Jamesway Shelter provides the best solution to this problem but has the disadvantage of requiring the equivalent of one 2 1/2 ton, long wheel base truck to transport the 2824 pound 16' x 32' shelter and the equivalent of two 2 1/2 ton, long wheel base trucks for the 8427 pound 24' x 48' shelter. As developed at present the smaller Jamesway is by far the more satisfactory of the two. The Jamesway is an insulated shelter with the appearance of half a tube with the semi-circular ends walled in and fitted with doors and windows. Ordinary tentage is unsuitable for cooking or messing because of the excessive frost accumulation on the side walls and ceilings. This frost melts when the tent is warm and causes water to drip into food and on personnel. When the moisture freezes it is impossible to strike the tent.

The "A" ration, with its several unstable components, the large amount of potable water required for its preparation, and the further quantities of water necessary to provide for mess sanitation when this ration is served, pose further problems. When transported over long distances both ration and water must be carried in heated vehicles or containers and stored in heated shelter. These requirements demand careful planning and a high degree of coordination and efficiency as well as special equipment. In spite of the difficulties involved the best ration obtainable must be served whenever possible and every effort must be made to provide an "A" ration of at least 4500 calories as compared to the usual "A" ration of from 3500 to 4000 calories. There is no evidence that extra fats need be added to the ration for use in arctic operations.

The problems incident to the use of the "A" ration preclude its use in unstable or combat situations. For such situations the "E" ration as it is presently constituted is satisfactory and with a few minor improvements it could be excellent. It is sufficiently stable to withstand repeated freezing and thawing, is easily transportable, may be air dropped with minimum damage and can be stored in the open. Heating alone is required in its preparation

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and serving and this feature allows for a considerable reduction in mess equipment and personnel required to handle it and an even greater reduction in mess sanitation problems. An eight can ration provides the 4500 calories required for soldiers operating under conditions of extreme cold. The 10 different meat components, 4 fruit components, bread unit, 2 B units, accessory packet, and cigarette packet now available to make up this ration provide sufficient variety to satisfy all tastes over a considerable period. The following improvements have been suggested:

1. That an egg component or similar breakfast item be provided.
2. That the fruit and bread units each be packed as one container separable into two cans by use of the can opener.
3. That the synthetic beverage powder be replaced by additional coffee and that another source of vitamin C be provided.
4. That each type of unit be partitioned within the packing case to facilitate issue.
5. That soups or light broths be added to the ration, preferably contained in self heating cans. (A self heating can has recently been developed commercially.)

The "E" ration must be heated at a central issue point (as yet no satisfactory method for heating by individuals in the field has been devised), delivered to individuals in insulated containers and consumed from its opened tins with the wooden spoons from the accessory packet. The M1944 insulated container provides for transporting 24 cans of heated rations and one 2 quart can of heated beverage and will keep its contents at edible temperature for 14 hours at a temperature of -54°F. The container measures approximately 20" x 9" x 15", weighs 16 pounds and can be easily manhandled or carried on a packboard.

No separate emergency ration has been developed as yet but the bread unit and items of the B units from the "E" ration lend themselves well to this role if eaten as snacks throughout the day. When a self heating can of soup is perfected and added to the "E" ration an excellent emergency ration can easily be made up.

Potable water presents no great problem to engineers working with standard water purification units if these units and the storage tanks are housed in heated tents. The water may be transported in three quarters full 5 gallon water cans if it is not exposed to extreme cold for more than one

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half hour. If it is to be exposed for a longer period the M1941 container may be used. A thermos canteen for use by the individual is a necessary item which has yet not been provided. The Engineer Board is carrying out experiments with snow and ice melters, winterized water purification plants, and winterized water tank trailers in order to further simplify the water purification and distribution problem. Results published to date indicate that these items are not entirely satisfactory in their present state of development.

Garbage can be disposed of by placing it on top of the snow and allowing it to dehydrate. This waste is then saturated with gasoline or fuel oil and burned. When a unit is in a bivouac of short duration and in a locality known to be inhabited by wild animals, garbage can be left on top of the snow and will eventually be disposed of by the animals. Liquid wastes may be deposited in a spot of low terrain not adjacent to a possible water source.

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First aid presents new problems and requires special training for all personnel.

The bulky clothing worn by the casualty, the gloves necessary to the aid man, and the need for immediate action if wounded men are to survive, will require a better than average knowledge of first aid on the part of every officer and enlisted man who is to engage in arctic operations. Aid men will require assistance from combat troops and combat troops will be required to administer first aid without benefit of aid men.

Men must watch each other constantly for signs of carbon monoxide poisoning or frostbite.

Alcoholic beverages must not be used on any occasion.

Tourniquets must be used with extreme care and must be inspected frequently since cold weather cuts down and impairs circulation to all the extremities.

Splints must be applied over clothing without removing shoes or gloves of the casualty. Avoid handling scissors or splints with ungloved hands. Flesh will stick to any metal object at the temperatures encountered.

Avoid exposing wounds to the elements for extended periods. Although blood will freeze and help control bleeding the exposed tissues will become frostbitten and the healing processes will be materially slowed down.

Use heat carefully and be extremely gentle in treating frostbitten members. Never rub the frostbitten area with snow.

Use morphine normally and make the injection in the neck, using care to avoid large blood vessels. Circulation remains strong in the neck area. Morphine syrettes must be carried close to the aid man's body but if frozen can be thawed by placing them in the mouth for two minutes.

Shock, chest wounds, jaw and face wounds, burns and fractures should be treated in the normal manner but deep body temperature must be maintained and the patient must be evacuated promptly.

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Evacuation must be rapid and presents many problems.

Prompt, rapid and efficient evacuation of casualties is an absolute necessity. Even minor wounds can result in shock with its accompanying loss of deep body temperature and wounded men can die of freezing in a very short time. The casualty must be kept warm while being evacuated. If possible the casualty should be given hot liquids, non-alcoholic, and chemical heating pads should be applied before evacuation is undertaken.

The Bag, Sleeping, Casualty Evacuation, is well suited for use in extreme cold and can be employed in all means of evacuation. In temperatures down to -40°F. , a casualty placed in the bag can be exposed for a period of one hour without danger of freezing.

The Blanket, Electrically Heated, Casualty, is excellent when fitted to operate on the voltage provided by the electrical plant of the evacuating vehicle or plane.

The Adaptor, Litter, Ski, which permits fastening the standard litter to standard skis, or the Adaptor, Litter, Toboggan, which permits fastening the standard litter to the standard toboggan may be used in the absence of better means of evacuation. Evacuation by ski or toboggan is slow, laborious, wasteful in manpower, and is limited to open, smooth, and hard snow covered surfaces. Little, if any, protection is afforded the patient and in a short time the casualty becomes virtually covered with snow. These methods of evacuation should be used only in extreme emergencies.

If satisfactory dogs and drivers can be obtained and trained, dog sleds may be used with considerable success for front line evacuation. The team and driver move with less noise and present a lower silhouette than that presented by a motor propelled vehicle, and can travel from 2 to 5 miles per hour. Only one man is required to operate a dog team and the method is faster and more efficient than evacuation accomplished by ski or toboggan litter. However, from 7 to 8 or 9 dogs are required for each sled, men and dogs must be specially trained and the dogs must be fed and kenneled. Properly employed, this method can be particularly effective in evacuating casualties from the front lines to aid stations from which point further evacuation can be effected by means of Weasels or Helicopters.

The Weasel, or Carrier, Cargo, M29C, used for cross-country evacuation gives excellent service when driven carefully and given proper maintenance. It is a low silhouette, amphibious, full-track laying vehicle, is maneuverable

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and can travel cross country at an average of five miles per hour and go almost anywhere. In its present state of development it can carry one litter case and two walking wounded or two litter cases in addition to the driver. The Weasel can be further improved.

The Helicopter equipped with two evacuation tubes has proven to be very successful in evacuating casualties. Its maneuverability and its ability to land in restricted areas make it an efficient method of evacuation in sub-zero temperatures. 3 or 4 men can clear a landing area sufficient for landing the Helicopter in a matter of 20 minutes. Casualties in electrically heated blankets in evacuation tubes have kept comfortable for periods of 2 hours at -40°F.

Gliders and liaison planes have been used successfully for evacuation but more open terrain and more laboriously prepared landing and take off strips are required than are necessary for the Helicopter.

Further details regarding the Weasel and Helicopter and other vehicles suggested for evacuation are contained in Annex 7.

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Medical equipment must be altered and special equipment developed to meet requirements.

First Aid Kits must be designed so that they can be used with gloved hands.

Kit, Medical Private, should have 6 pill vials instead of 3 and iodine swabs should be replaced with merthiolate swabs. A snap pouch should be designed so that, when open, each item is exposed in an individual pocket. A white cover should be provided for camouflage. Kits should be so designed that they can be used with gloved hands and so that when open the contents are protected from the elements.

Kit, Medical Officer, should embody the same modifications as set out above.

Kit, Medical NCO, should embody the same modifications as set out above and in addition should be provided with bandage scissors or a Case, Instrument, Medical Officer's.

Nylon gloves should be furnished to all medical personnel. Scissors and splints cannot be handled without them as flesh will stick to any metal object at the temperatures encountered. Even with the present gloves (nylon and rayon-nylon) 5 minutes is the safe limit of exposure at -30°F.

The Thomas Arm Splint should be redesigned for use with bulky arctic clothing and the Traction Strap for the leg splint should be made adjustable or larger to accommodate arctic footgear.

The Plasma Unit as presently constituted cannot be used in the field under arctic conditions. It will freeze at temperatures below 32°F. and is difficult to open. The cellophane tape sealing the unit is particularly troublesome.

The Blanket Set, Large Complete, which is T/O & E equipment for the Clearing Platoon is inadequate. The 18 blanket sets will not keep the casualties warm and are excess baggage. They should be replaced by the Quartermaster Bag, Sleeping, Casualty Evacuation.

The Bag, Sleeping, Casualty Evacuation, is in general well suited for use in extreme cold and can be used in all installations and in all means of evacuation. A parka type hood should be attached to give protection to the casualty's head and a six inch zippered slit should be made across the bottom at the casualty's right and left heel, so that in the application of a leg splint, the foot rest can be inserted through the slit and attached to the litter bar.

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The Blanket, Electrically Heated Casualty, is excellent but must be fitted so as to operate on the varying voltages encountered in the different installations and evacuation means. It also should have a parka type hood attached to give protection the casualty's head. A casualty may remain comfortable in this blanket for an indefinite period at extremely low temperatures.

Hot liquids must be made available for treating shock. A thermos type canteen to be carried by individuals should be developed and the M1944 insulated container should be furnished to all units, installations, and evacuation vehicles.

The Chests, Medical Department, Numbers 1 and 2, Complete, are both too large, bulky and heavy for mobility in a forward aid station. The contents of both, as presently constituted, are inadequate for use in a field dispensary. The chests should be redesigned to be broken down to pack sized loads capable of being carried by personnel in addition to personal equipment and with the contents well protected from the elements and easily accessible. Flexible containers should be provided for liquids subject to freezing and any glass containers used for such liquids should be filled no more than three quarters full.

A lightweight, waterproof, insulated, floored shelter should be perfected for use of the Battalion Aid Section in fluid situations. It should be capable of housing 8 patients for treatment and of being transported by two men. The Light Weight Pyramidal Tent, which weighs 46 1/2 pounds complete with aluminum pole, pins and carrying bag is not insulated and is too small for this purpose but can possibly be developed to fill an emergency need.

The Jamesway Shelter, 16' x 32' provides a superior shelter for use by Medical Field Units under extreme cold conditions in all echelons from the battalion aid station to the field hospital. Erected, it forms half an insulated tube with the semicircular ends walled up. The boxes in which the shelter is packed for transportation form the floor and a transom over the door and two windows in each end provide adequate ventilation. One shelter will adequately house an aid station and an eight bed quarters section. Two shelters placed together end to end could easily be made into a 32 bed ward. The shelter's 2824 pounds can be readily transported on the equivalent of one 2 1/2 ton long wheel base truck. It can be erected on a prepared site in one hour by six men and disassembled and loaded in approx-

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imately 45 minutes by six men. These operations can be performed in sub-zero temperatures without particular difficulty.

The 8427 pound, 24' x 48' Jamesway Shelter is unsatisfactory because of its high ceiling and lack of windows or ventilators. It requires some 7 hours to erect and over 2 1/2 hours to disassemble and has many small parts which are easily lost.

The Stove, Tent M1941, has proven to be satisfactory as a method of heating field installations. When coal is used as a fuel the stove uses one half ton per week. When fitted with a gasoline burner adapter, which will also burn diesel oil, the fuel consumption rate is 6 gallons in 24 hours. The stove is simple in construction, easy to transport and assemble, and safe and simple in operation. Two of these stoves will adequately heat a 16' x 32' Jamesway Shelter at -40°F. It is recommended that asbestos sheeting be placed under all stoves to prevent burning the floor but no other extra precautions are necessary.

The most effective U. S. military vehicle developed to date for front line evacuation is the Carrier, Cargo, M29C or Weasel. It is a low silhouette, amphibious, full-track laying vehicle, weighing 4771 pounds (loaded), and has a ground pressure of only 1.9 pounds per square inch. It is maneuverable and when driven carefully and given proper maintenance can travel practically anywhere and average five miles per hour cross country during winter months without damage to the vehicle. In its present design the Weasel can carry one litter case and two walking wounded or two litter cases in addition to the driver. It should be fitted with a closed cab and heaters should be installed.

The Canadian Penguin Snowmobile has apparently proven to be superior to the Weasel in some respects and its possibilities should be explored. The Canadians have recommended that snowmobiles be designed and developed in three classes; 1 ton payload, 4 ton payload, and 10 ton payload, but it is not known how far this development has progressed. The possibilities for long range evacuation, dispensary service, and treatment facilities in such conveyances should not be overlooked. It has been suggested that sleeping accommodations, a galley for cooking, washing facilities and a toilet could be readily embodied in the snowmobile.

The Canadians have also found that the farm bobsled design, if the center of gravity is kept low, is superior to rigid runners or tracks for

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trailers. They also recommend solid rubber tires since pneumatic tires freeze solid at low temperatures.

Another conveyance which might prove to be superior to the Weasel for front line evacuation is the Sno-Cat, developed after 24 years of experiment by E. M. Tucker of California. The Sno-Cat has open-cleated tracks revolving around pontoon skis, a "floating drive" that enables the machine to operate over ice or soft virgin snow with equal ease, at speeds of from four to twenty miles per hour. Front supports are broad skis which can be quickly replaced by wheels if open ground is encountered. A five passenger closed model weighs only 2400 pounds and sells commercially for approximately \$3500. It is believed that this vehicle is a refinement of similar conveyances which are known to operated successfully in Ontario and Quebec as early as 1927.

Motor driven vehicles must be provided with means for pre-heating the motors. The best engine heater developed to date is the Heater, Engine, Perfection Superfex, Model 460. It is a small, pot-type, electrically ignited gasoline burner with which heat may be directed to any desired part of the motor or vehicle. When operated overnight as a stand-by heater it has allowed for instant starting at temperatures down to -62°F. The Heater, Stewart-Warner, Hand Crank, Model 796-A is reasonably satisfactory. It is a self-contained, pre-heating unit designed for use on small gasoline engines and other equipment. Heat is transmitted through a flexible metal duct and it embodies an open flame type burner which depends upon fuel air and ventilating air for operation. It is simple and easily transportable but care must be used because of its open flame characteristics.

The Helicopters L-5 G and YR 13 A have proven to be very successful in evacuating casualties. Their maneuverability and ability to land in restricted areas make them a particularly efficient method of evacuation in snow covered terrain. 3 or 4 men can prepare the required landing area in a matter of 20 minutes and evacuations are rapid and comfortable for the casualties. Helicopters should be equipped with instruments for night flying so that evacuation can proceed on a 24 hour schedule, and should be fitted for a larger fuel supply so that their flying radius will not be limited to the present 150 miles. In their present state of development helicopters require auxiliary cabin heat and heated storage.

Gliders may be used for landing supplies and may even be fitted as laboratories or dispensaries but preparations for their landing will require

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considerable effort in most cases and even further preparation will be required if patients are to be evacuated by glider.

Liaison and transport type planes may be used for evacuation from installations further to rear where adequate landing strips can be prepared. Packed runways or strips are required whether planes are fitted with wheels or skis.

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The majority of hospitals must be base units of permanent or semi-permanent structure.

Only in installations housed in permanent or semi-permanent structures can adequate treatment be efficiently provided under arctic conditions. The problems of messing, housing, heating and sanitation which apply to troops are necessarily multiplied when medical or surgical treatment is required.

Field hospitals, Holding hospitals, Evacuation hospitals, Surgical hospitals, Clearing stations, Collecting stations, and Battalion Aid stations can be housed in Jamesway Shelters. However, the problems listed above make it imperative that the casualty population in forward areas be kept to a minimum and that every effort be made to move casualties well to the rear to the permanent or semi-permanent General and Convalescent hospitals as rapidly as possible.

Consequently most hospitals will have to be base units of permanent or semi-permanent structure with their chain of casualties coming to them by air.

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A higher incidence of frostbite and snow-blindness, upper respiratory ailments, and carbon monoxide poisoning is peculiar to Arctic Operations.

The higher incidence of frostbite and snow-blindness is a natural result of the conditions under which men must live and work during Arctic operations. It can only be reduced by proper training and equipment and by all personnel exercising proper precautions at all times.

Arctic operations to date have resulted in an alarming increase in upper respiratory ailments among the personnel engaged. Part of this increase can be attributed to the fact that the men, while in base camps, were often housed in overheated, poorly ventilated shelters. The increase was probably further aggravated by the fact that new groups of observers arrived at the scene of operations at frequent intervals and brought with them further infections, primarily of the upper respiratory variety. In spite of these contributing factors it is believed that future operations will result in a significant increase in such ailments unless preventive measures are taken.

The Canadians report that in their Operation Musk-Ox some 75% of the personnel suffered from carbon monoxide poisoning. While this operation involved a 4100 mile motor movement and the men were almost constantly with their vehicles, it is evident that in any Arctic operation there is great danger from carbon monoxide poisoning if motor vehicles are employed. All possible steps must be taken to guard against it and facilities provided to treat it when it does occur.

The Canadians also report a significant increase in incidence of minor lesions of the skin, lips and mouth as a result of exposure to wind, cold and sun. They feel that the lack of adequate facilities for normal personal hygiene was a contributing factor and stress the fact that such facilities must be provided.

The other diseases incident to field operations showed no significant trends in the Arctic operations studied. There is no special dental problem. On the whole, accidents were considerably under the average expectancy, but it is believed that under actual combat conditions the accident rate will climb considerably because of the relatively unfamiliar equipment, difficult terrain, bulky clothing, and impaired individual dexterity peculiar to Arctic operations.

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Existing types of medical units are adequate, when properly augmented, trained and equipped.

There is no indication that radical changes in Tables of Organization of existing types of medical units is necessary or desirable for Arctic operations.

Personnel should be carefully selected for physical and mental characteristics and condition and should be thoroughly and specially trained for the work which they will be required to do.

Additional motor maintenance personnel should be provided all medical units employing motorized equipment. A great deal of extra effort is required to keep motor vehicles running properly under extreme cold conditions and the personnel required to keep all vehicles assigned to medical units operative at all times should be provided. Since most of the vehicles to be used by medical units in Arctic operations will be of special types and will present special problems it is essential that the maintenance personnel provided be thoroughly trained in the operation and maintenance of the particular vehicles to be employed.

If dog sleds are to be utilized for front line evacuation efficient drivers and handlers must be provided for their operation.

Medical units must be adequately equipped with special vehicles, shelter, technical equipment, and personal clothing and equipment. All personnel must be thoroughly trained in the care and use of the equipment assigned to them and in the treatment of injuries and illnesses peculiar to Arctic operations. It is essential that all medical personnel selected for training and employment in Arctic operations be thoroughly trained in all other phases of normal medical unit duties before being trained for cold weather duty, and that these basic skills not be lost during the training for Arctic operations.

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