APPENDIX F

ENVIRONMENTAL EFFECTS

Section I. THE ENVIRONMENT

F-1. Terrain

The terrain of northern latitudes consists of exposed bedrock, plains and plateaus covering this rock, and rugged mountains. Much of the area is within earthquake belts with active volcanoes and glaciers present. Sedimentary deposits on slopes greater than 3° are constantly moving.

a. The plains have numerous shallow glacial depressions, sloughs, swamps, ponds, and lakes. These features range from 30 to 1,500 cm (1' to 50') deep with banks from a few centimeters (inches) to hundreds of meters (yards) high.

b. The plateaus have relatively smooth uplands, many rolling hills, and broad sweeping valleys. Scattered rock outcropping are present. The elevations vary from hundreds to thousands of meters over distances of several hundred kilometers (miles).

c. Mountain elevations range from 1,500 meters (5,000') to more than 5,500 meters (18,000') within a few kilometers (miles). Weathering processes as well as mountain forming processes are found.

d. Streams often have swift currents and extremely rocky bottoms. The many glacial rivers are silt-laden with numerous sandbars, shifting channels, and undercut banks.

e. Perennially frozen ground, or permafrost, is found in most of the subarctic and arctic. It varies in thickness from a few centimeters (inches) to several hundred meters (yards) in loosely defined continuous, discontinuous, and sporadic zones. The presence of permafrost affects drainage due to its impervious

nature. When the permafrost thaws, the material changes to muck because of the large water content. Therefore, the presence or absence of permafrost can affect military activities.

f. Heavy forests with dense coniferous tree stands are found where little or no permafrost is present. Certain broad leaf trees will mix with narrow leaf types in zones of sporadic permafrost. As the area of permafrost becomes more continuous, vegetation growth becomes more stunted and is replaced by sedges, grasses, and mosses.

F-2. Atmosphere

a. Cloud cover is extensive and wide, low clouds cause bleak and monotonous conditions. In very high latitudes, overcast often persists for weeks and clear days are rare.

b. Precipitation varies from about 10 to 600 cm (4" to 200") per year, depending upon the area. Snow may fall during any month, but does not always account for the major quantity of precipitation as the ratio in volume of snow to water can vary from 2 to 1 to 10 to 1. Although this area has very little atmospheric moisture, it has relatively high humidity due to the low temperatures.

c. Ground level air temperatures may vary from extremes of -95° F. to $+100^{\circ}$ F. During the period of solar light, the extreme variation for one day might be as high as 100° F.

d. In most areas, visibility is either very good or very poor with average visibility considered uncommon. Fog, blowing snow, and variation in air density can cause impaired visibility. In most areas, fog causes less prob-

lems in late winter. Periods, when blowing snow has reduced visibility below 1,000 meters (1,000 yds) range from 79 hours for an entire winter in one area to 265 consecutive hours in another. Light, reflected at various angles in air of changing density, produces mirages which confuse detail of the landscape. Often, flat terrain features are upended; objects far below the true horizon appear near at hand in sharp relief; and objects above the true horizon completely disappear. In unusual cases, terrain features are reflected in the sky.

e. During winter, long periods of darkness with heavy overcast are a problem. However, at many times, the quality of available light must also be considered. Most activities can be carried on in bright moonlight while light from the stars and the aurora is sufficient for many purposes. Sunlight, when reflected from snow and ice, becomes brighter. This light may be so intense that shadows are eliminated. This absence of contrast can make it impossible to distinguish outlines of terrain features or large objects, even at close range.

f. Wind velocity varies with the particular area and season. Maximum wind speed occurs during periods of changing temperatures and prolonged velocities above 90 knots have been recorded. Snow and silt begin drifting with winds above 8 knots. With moderate winds, it is often difficult to determine whether snow is falling or being swirled up from the surface.

g. Sound transmission depends upon wind, temperature, and surface conditions. Normally, with an increase in elevation, wind speeds increase and temperatures decrease, resulting in above normal sound intensity downwind. However, as temperature inversion is common in northern areas, this effect is not always as pronounced. In addition, soft snow will absorb sound energy while hard-crusted snow or ice will aid sound reflection. Normal conversation has been carried on at a distance of 2.4 km (1 1/2 miles) and shouted words have been heard at 4 km (2 1/2 miles). However, under other climatic conditions, the sound of an aircraft engine at full throttle has been inaudible at 0.8 km (1/2 mile).

F-3. Climate

a. The northern year is divided into winter and summer. These periods are defined by thermometer readings rather than calendar dates. Winter occurs when the average daily temperature falls and remains below freezing, while summer occurs when this average temperature remains above freezing. Periods of transition with wide temperature variation precede each season.

b. Winter progresses from north to south preceded by autumn freezeup and deep penetration of frost as the hours of sunlight decrease. The days begin to shorten with the summer solstice; however, since the daily change is about 6 minutes, the effect is not often noticed until passage of the autumnal equinox. As a result, the gradual descent of the long winter night appears to be sudden. During early autumn, the weather is relatively dry. As winter approaches, there is an increase in precipitation and muddy conditions. Snow and thin ice appear as early as late September and deep cold as early as October. In November, water courses freeze solidly and temperatures fall as low as -50° F in many areas. Snowfall varies but snow depths of 60 to 150 cm (15" to 60") are common, and deep drifts in valleys and hollows change the appearance of the landscape.

c. With passage of the winter solstice, the hours of daily sunlight increase. After the spring equinox, fluctuations in temperature cause daytime thaw and nighttime freeze. Continued melting conditions cause the spring breakup which, in addition to the spring rains, flood lakes and streams and turn the surrounding plains into quagmires.

Section II. EFFECTS ON THE ENVIRONMENT OF MAN

F-4. General

Accommodation to the environment is required of all men. This requires psychological and physiological adjustments, and not all men are equally suited to the requirement. Men with medical histories of upper respiratory tract disease, emotional disturbances, rheumatoid disease, digestive and coronary disorders, high susceptibility to infectious disease, and defective vision are more likely to become casualties to rigorous exposure. However, it is not essential that man be warm to be effective, as the absence of complete comfort can induce increased effort. Neither is it essential that man have a certain number of hot meals each day. The normal human body will remain effective as long as the caloric and fluid intake and dissipation are reasonably matched, nitrogen balance is maintained, and the body is not subjected to destructive influence.

F-5. Cold

a. General. In intense cold a man may become intellectually numb neglecting essential tasks. In addition, the essential tasks require more time and effort to achieve. Under some conditions (particularly cold water immersion) a man in excellent physical condition may die in a matter of minutes. The destructive influence of cold on the human body is defined as hypothermia.

b. Hypothermia. Hypothermia is a term used to describe general lowering of body temperature due to loss of heat at a rate faster than it can be produced. Frostbite may occur without hypothermia when extremities do not receive sufficient heat from central body stores due to inadequate circulation and/or inadequate insulation. However both conditions, hypothermia and frostbite, may occur in the same case if exposure is to below freezing temperatures as in the case of an avalanche accident. Hypothermia may also occur from exposure to temperatures above freezing, especially from immersion in cold water or from the effect of wind. Physical exhaustion and insufficient food may raise the risk of hypothermia, as has occurred when inexperienced and ill-equipped hikers have been caught in mountain storms. Exposure to wet-cold conditions has also led to hypothermia in cave explorers. Aviators downed in cold water, and boating accidents in northern waters are other examples of situations in which hypothermia is a risk. Intemperate use of alcohol leading to unconsciousness in a cold environment is still another condition which can result in hypothermia.

- (1) Dangers of hypothermia. As central body temperature falls from the normal level of 98.6° F, various body processes are slowed. Circulation of blood is retarded, movements become sluggish, coordination is reduced, judgment becomes impaired. With further cooling unconsciousness results. At a deep body temperature below 85° F. there is increased risk of disorganized heart action or heart standstill which results in sudden death.
- (2) Prevention. Prevention of hypothermia consists of all actions which will avoid rapid and uncontrolled loss of body heat. Divers, boaters and aviators operating in cold regions must be equipped with protective gear such as immersion suits and liferafts with spray covers. Ice thickness must be tested before river or lake crossings. Anyone departing a fixed base by aircraft, ground vehicle, or on foot must carry sufficient protective clothing and food reserves to allow survival during unexpected weather changes or other unforeseen emergencies. Traveling alone is never safe. Expected itinerary and arrival time should be left with responsible parties before any departure of base in severe weather. All persons living in cold regions should become skilled in the construction of expedient shelters from available materials. The excellent heat insulating qualities of snow should be emphasized.
- (3) *Treatment*.
 - (a) The objective of treatment is to rewarm the body evenly and without delay, but not so rapidly as to further disorganize body functions such as circulation. A person suspected of hypothermia should be immediately protected by all available dry clothing or a sleeping bag, and then be moved to a warm enclosure. A useful procedure in case of accidental breakthrough into ice water, or other hypothermia accident, is to im-

mediately strip the victim of wet clothing and bundle him into a sleeping bag with a warm companion whose body heat will aid in rewarming. Mouth-to-mouth resuscitation should be started at once if the victim's breathing has stopped or is not regular and of normal depth. Warm liquids may be given gradually to a conscious patient, but must not be forced on an unconscious or stuporous person for fear of strangulation.

- (b) If movement is necessary the hypothermia patient should be handled on a litter since the exertion of walking may aggravate circulation problems.
- (c) A medical officer is needed without delay to attend any serious hypothermia patient, since this condition is life-threatening until normal body temperature has been restored. Immersion of a hypothermia patient in a warm water bath is a rapid means of restoring body temperature, but since this rapid rewarming may aggravate heart and circulation problems temporarily, this procedure should only be done with a medical officer in attendance.

c. Windchill. Frostbite can occur even in relatively warm temperatures if the wind penetrates the layer of insulating warm air to expose body tissue. As an example, with the wind calm and a temperature of — 20° F. there is little danger from windchill. However, if the temperature is -20° F. and there is a wind of 20 kts, the equivalent chill temperature is -75° F. Under these conditions there is great danger and exposed flesh may freeze within 30 seconds (fig. F–1).

F-6. Physical

a. It can generally be expected that exposure to climatic extremes will increase the effects of any physical disorder. Men with heart diseases often become quick casualties due to necessary increased physical exertion. Men susceptible to upper respiratory tract infections become casualties due to the humidity, abrasive silts, and the wide temperature variations. The individual with arthritis suffers from damp and cold plus abnormal physical exertion.

b. In winter, the threat of exposure is matched by the dangers of dehydration and exhaustion as the body must accelerate the production of heat. This results in greater fluid loss. Rigid self-discipline is required to maintain proper habits of elimination. In summer, there are the usual dangers of bacterial contamination of food and water and insectcarried communicable diseases.

F-7. Mental

The isolation of the area, the long periods of darkness and light, and the immobilizing effect of the weather can all effect the mental stamina of man. The cabin fever stories of the trapper and the prospector and the tales of moon sickness of the Indian and Eskimo are not all just myths. The effect will vary with the individual and varies from nervous tension in some to loss of mental equilibrium in others.

F-8. Adjustments

It appears that some racial groups, particularly the Nordics, have been more successful in the physiological and psychological adjustment to the environment than have other groups. This is due, in part, to accepting the natural conditions and adjusting and adapting actions to fit these conditions.

a. The human body must be protected. To remain functional, it must be kept clean, dry, and reasonably warm with normal body processes maintained. Rest and nourishment are vital. A little food and water consumed at regular intervals and at body temperatures are preferable to large quantities of hot food and liquids consumed infrequently.

b. All heat and energy, regardless of the source, must be conserved and profitably used.

c. An operating base to supply basic needs is necessary for efficient operations.

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Figure F-1. Windchill chart.

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Section III. EFFECTS OF THE ENVIRONMENT ON FACILITIES

F-9. Industry

To provide industrial needs, man must solve certain engineering problems in an acceptable time frame and in an economical manner. A major problem which must be solved is the effect of permafrost. During construction, any disturbance of the established temperature balance of the ground, without provision of compensating factors, will change the foundation characteristics. Subsurface strengths and drainage patterns change and affect entire structures. The solution to the permafrost problem is costly and time consuming and can involve the use of insulation, drainage, flotation, excavation, refrigeration, or complicated combinations of these.

F-10. Agriculture

Permafrost, combined with low evaporation rates, low temperatures, sporadic precipitation, and irregular seasons, prevents extensive agricultural development. However, as permafrost prevents precipitation loss by normal drainage processes, many areas having a semiarid climate support luxuriant natural vegetation. This vegetation, by insulating the underlying permafrost, prevents deep thawing, depresses soil temperatures, and prevents deep root systems. This prevents agriculture in continuous permafrost zones. In discontinuous and sporadic zones, only hardy plants which mature in one short growing season can be planted.

F-11. Materials

Low temperatures change the strength, elasticity, and hardness of metals and generally reduce their impact resistance. Leather fabrics and rubber lose their pliability and tensile strength. Plastics, ceramics, and other synthetics are less ductile. Items composed of moving parts and of differing types of materials operate with reduced efficiency.

a. Rubber, in warm weather, is flexible; during extreme cold it becomes stiff, and bending will cause it to break e.g., when a vehicle is parked for several hours during subzero weather, flattened-out areas develop in tires; these flattened-out areas have little resiliency until after the tires have warmed up, incident to operation. Rubber heater hoses, some hydraulic lines and the fuel hose on the Yukon stove may break if they are suddenly bent during periods of extreme cold. Rubber, rubber compound seals and O-rings tend to warp and break.

b. Water freezes and expands; while it is expanding in a restricted space (as in an engine) it has tremendous power, enough to crack the toughest of iron.

c. Canvas becomes stiff much the same as does rubber and it becomes difficult to fold or unfold without damaging it.

d. Glass, being a poor conductor of heat, will crack if it is exposed to any sudden increase in temperature. As an example, the windshield on a vehicle may break if intense defroster heat is suddenly applied.

e. Gasoline will not freeze but becomes more difficult to vaporize. Since only vapor will burn, combustion of gasoline inside an engine is more difficult and unburned gasoline dilutes the oil in the crankcase contributing to the formation of sludge.

f. Oils have a tendency to become thick, and consequently retard the flow through the oil pump to places where it is needed for lubrication. Thickened oils also increase the drag on the entire engine, thus making it more difficult to turn over.

g. Grease, which is a semisolid to begin with, becomes hard and loses a great amount of its lubrication properties.

h. Leather cracks unless properly treated with neat's foot oil.

i. Paint tends to crack very easily when exposed to extreme cold for any great length of time.

j. Dry cold weather produces great amounts of static electricity in the layers of clothing worn by personnel and in liquids being transported. Extreme caution must be exercised when refueling vehicles, stoves, lanterns, etc., because the spontaneous discharge of static electricity may ignite these inflammable fuels. Static electricity should be "drained off" by grounding vehicles or fuel containers prior to starting refueling operations. Personnel

should ground themselves by touching a vehicle or container (away from vapor openings) with the hand.

Section III. EFFECTS OF THE ENVIRONMENT ON VEHICLES

F-12. General

A great amount of effort and research has gone into giving the individual soldier the best clothes to keep him combat effective in cold weather. A vehicle is affected by cold in much the same manner as a man. Consider the effects on a platoon if the platoon leader did not take the necessary steps to compensate for the cold to which his men are exposed. The driver of a vehicle must realize the same effects of cold are suffered by motor vehicles and certain precautions are necessary. The purpose of the following paragraphs is to explain briefly what must be done to reduce the adverse effects of cold weather on vehicles and the extra precautions that must be taken during winter driving. Detailed instructions for the operation and maintenance of ordnance materiel in extreme cold are covered in TM 9-207.

F-13. Maintenance

a. Unless vehicles are kept in the best possible mechanical condition during cold weather they will not operate properly. Successful cold weather operation depends on a high standard of maintenance discipline, proper starting procedures and command supervision. A large portion of deadlines can be attributed to too many cold starts and improper driving habits.

b. All maintenance outlined in appropriate TM's for a particular vehicle must be accomplished and extreme care taken to insure all adjustments are exact as possible. Only adequately powered vehicles can overcome the adverse effects of cold weather. Proper lubricant must be used, these can be readily determined by consulting the appropriate lubrication order. One loose battery terminal, points slightly out of adjustment, a sparkplug wire loose, a ground cable loose or a frozen gasline are only some of the deficiencies that can make starting a vehicle difficult, or prevent starting altogether.

c. Drivers, during cold weather operations, must be disciplined to conduct prestarting, starting, warmup, operation and shutdown and/or, cooldown and stopping procedure exactly as directed in TM 9-207.

d. Additional time must be allowed for "thaw time" before equipment entering a shop can be worked on under "inside conditions." These "thaw times" must be added to otherwise normal average repair times. The length of this additional time is affected by the length and depth of exposure to subzero "cold soak" prior to entering shops.

e. As a safety precaution, all garages, shops and enclosures used for vehicle maintenance or other areas which are subject to carbon monoxide concentrations should be inspected at' least once every 3 months. If inspection reveals a potentially dangerous level of carbon monoxide (50 parts per million or more) immediate corrective actions, such as improving ventilation or removal of personnel from the hazardous area, must be taken by responsible personnel. Test results should be recorded and monitored by the unit for 3 months. Rough terrain operations can result in engine exhaust system component failures. Therefore, all motor driven vehicles should be tested for carbon monoxide concentrations in the cabs and passenger carrying compartments at least once every 3 months. Any vehicle failing this test must be immediately deadlined until cause is isolated and corrective action completed. Tests should be recorded on DA Form 2408-1 (Equipment Daily or Monthly Log). Tests indicated above should be made using the Detector Kit, Carbon Monoxide, Colorimetric.

f. Mechanic efficiency is reduced by the bulk and clumsiness of the clothing that must be worn in extreme-cold areas. As it is impossible to handle extremely cold metal with a bare hand, some form of mitten or glove must be worn at all times. The resulting loss of the sense of touch further reduces the efficiency of personnel. Even the most routine operations, such as handling latches or opening engine enclosures, become exasperating and time consuming when they must be performed with mittened hands. Experiments have proven, for example, that the time required by men to screw a nut on the largest bolt available, was twice as long when mittens were worn over a similar operation conducted with bare hands. The space required to insure access to controls, adjustable devices, and to assemblies which are commonly replaced or which require periodic adjustment, inspection, and cleaning is also increased when the bulky cold weather clothing is worn. The comparison measurements of personnel with warm weather clothing and cold weather clothing are shown below.

Comparison Clothing Measurements

Hand (width)
Wrist (circumference)
Head (circumference)
Breadth across shoulders
Foot (width & length)

F-14. Driving

a. General The basic rules for driving during cold weather include all of the rules that apply under normal conditions. However, the necessity to adhere to these rules with the increased hazards of ice and snow is magnified. All drivers must be trained in proper winter driving techniques before they engage in cold weather operations.

b. Visibility. Good all-around visibility is the first requirement for safe driving.

- (1) Remove all ice, snow, fog, etc., from all windows and keep the windows clear at all times to give all-around vision.
- (2) Use defrosters to keep windshield free from ice.
- (3) Clean and adjust rear view mirror.
- (4) Use lights during snowstorms, while driving in light dry snow or just prior to dusk and dawn, and at all other times when visibility is reduced, providing the tactical situation permits.
- (5) Allow for additional distance between vehicles when exhaust is causing ice fog.
- (6) Use a guide when backing up or where a guide can assist in picking a trail in deep snow.
- c. Traction for Driving and Stopping.

(1) Use chains in deep snow and on ice.

Warm weather	Cold weather
10 cm (4")	15 cm (6")
19 cm (7½")	53 cm (21")
58 cm (23")	96 cm (38")
46 cm (18")	81 cm (32")
9×28 cm	13×35 cm
(3½' × 11")	$(5'' \times 14'')$

They will increase traction for both movement and stops.

- (2) Place brush or burlap under wheels to aid in movement through deep snow and on ice.
- (3) The correct method for applying brakes is especially important. Never jam on brakes as this will lock the wheels and cause the vehicle to skid and require more distance for stopping. The correct method for braking a vehicle on snow and ice is to release accelerator slowly and apply brakes with a feathering action.
- (4) Keep pioneer tools on all vehicles ready for use in removing excess snow and for cutting brush.
- (5) Full tracked vehicle drivers must be prohibited from using neutral steer when the tactical situation permits. Use of the neutral steer capability places avoidable stress and abuse on the suspension system and related power and drive components.

d. Additional Hints for Safe Cold Weather Driving.

- (1) Never sleep in the cab or passenger carrying compartment of a vehicle with engine or heater running. Exhaust gases may cause death by asphyxiation.
- (2) Always adjust speed to road conditions.

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- (3) Keep proper interval and compensate for road conditions (three to eleven times greater stopping distance may be needed on snow and ice).
- (4) Slow down before going around a curve.
- (5) Make slow, steady turns and stops.
- (6) Keep windows open slightly when heaters are being used.
- (7) Never stop in the center of a road.
- (8) Never pull off to the side of a road unless the shoulder has been checked. Large ditches covered with snow give the appearance of a firm shoulder.
- (9) When hauling troops in the rear of a

truck, be certain to instruct them to wait for the driver to assist in their off loading.

- (10) Never overcrowd the cab of a vehicle with extra personnel or extra equipment. This cramps the driver, cuts down on his vision, and prevents him from maneuvering freely.
- (11) During halts, always check the vehicle for any troubles which may have occurred during operation.
- (12) Remove frost from headlights and stoplights.
- (13) Above all, use good judgment, be alert for other drivers errors, and obey all traffic rules and regulations.