Chemical Operations in Extreme Cold

—possible defects and remedies

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When I began studying the impact of chemical operations in an extremely cold environment and vice versa (Ref. 1), one of the first things I did was to borrow a copy of Brian Garfield's *The Thousand Mile War* (Ref. 2) from a friend. I felt the book, being the story of the World War II Alaskan campaign, would give me at least the flavor of war in extreme cold.

While reading Garfield's book, I was reminded of a time I had been extremely cold. Even though I was in a sleeping bag, it was so cold that water froze overnight in a glass beside my head. It happened while I was on a fishing trip in the Sierras in sunny California—in summer! Later, I had to come down to a lower altitude because I had trouble breathing.

High latitudes are not the only areas of extreme cold (all one must do is interchange the "l" and the "a"—giving high altitude); high altitude provides not only extreme cold but additional problems due to the thin air.

With my reading I found that extreme cold has dealt harshly with American troops. At Valley Forge, only two-thirds of the Continentals endured the winter of 1777-1778 and half of those were unfit for duty. Winter quartering practices kept cold casualties down in the Civil War and World War I.

However, in WWII, many of our troops were lost to the cold. The battle for Attu in the Aleutians, in terms of the proportion of casualties, was the second most costly American battle in the Pacific Theater; severe cold injuries accounted for more than 30 percent of the casualties. In Europe, trenchfoot and frostbite weakened US fighting strength; 71,000 cold weather casualties were evacuated in the winter of 1944-1945—more than the current strength of the V Corps.

In Korea, in November and December 1950, one US division lost almost a third of its average fielded strength as nonbattle casualties, chiefly to frostbite and trenchfoot. The American soldier has not fared at all well in winter warfare.

Cold can kill, maim, and disable without any help from a human foe. In extreme cold, the soldier's main effort must be expended in surviving the environment; chemical operations will add to this burden.

The area involved with regions of extreme cold is large. The "area of northern operations," for example, includes about 45 percent of North America and 65 percent of Eurasia

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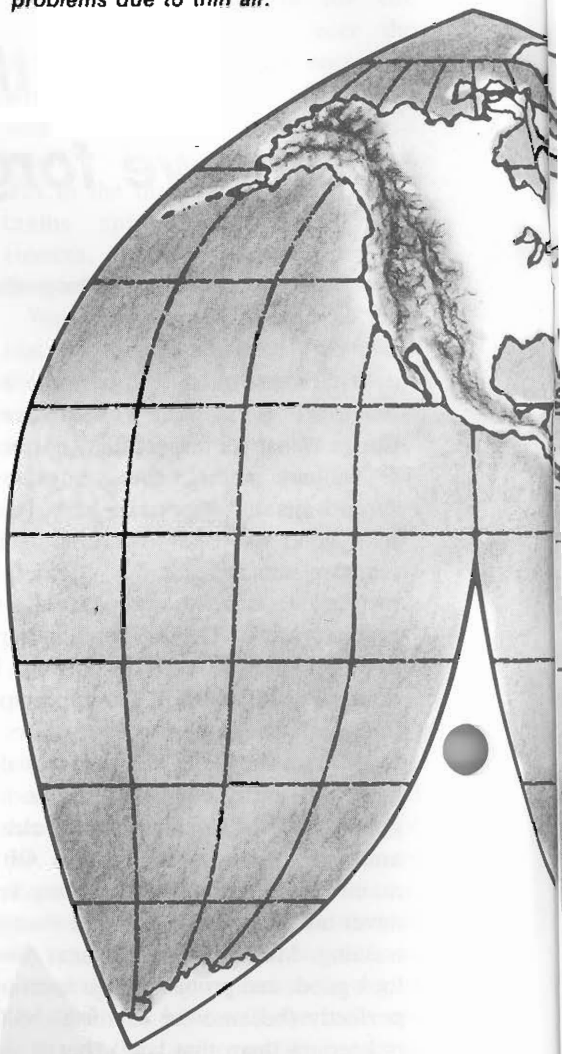
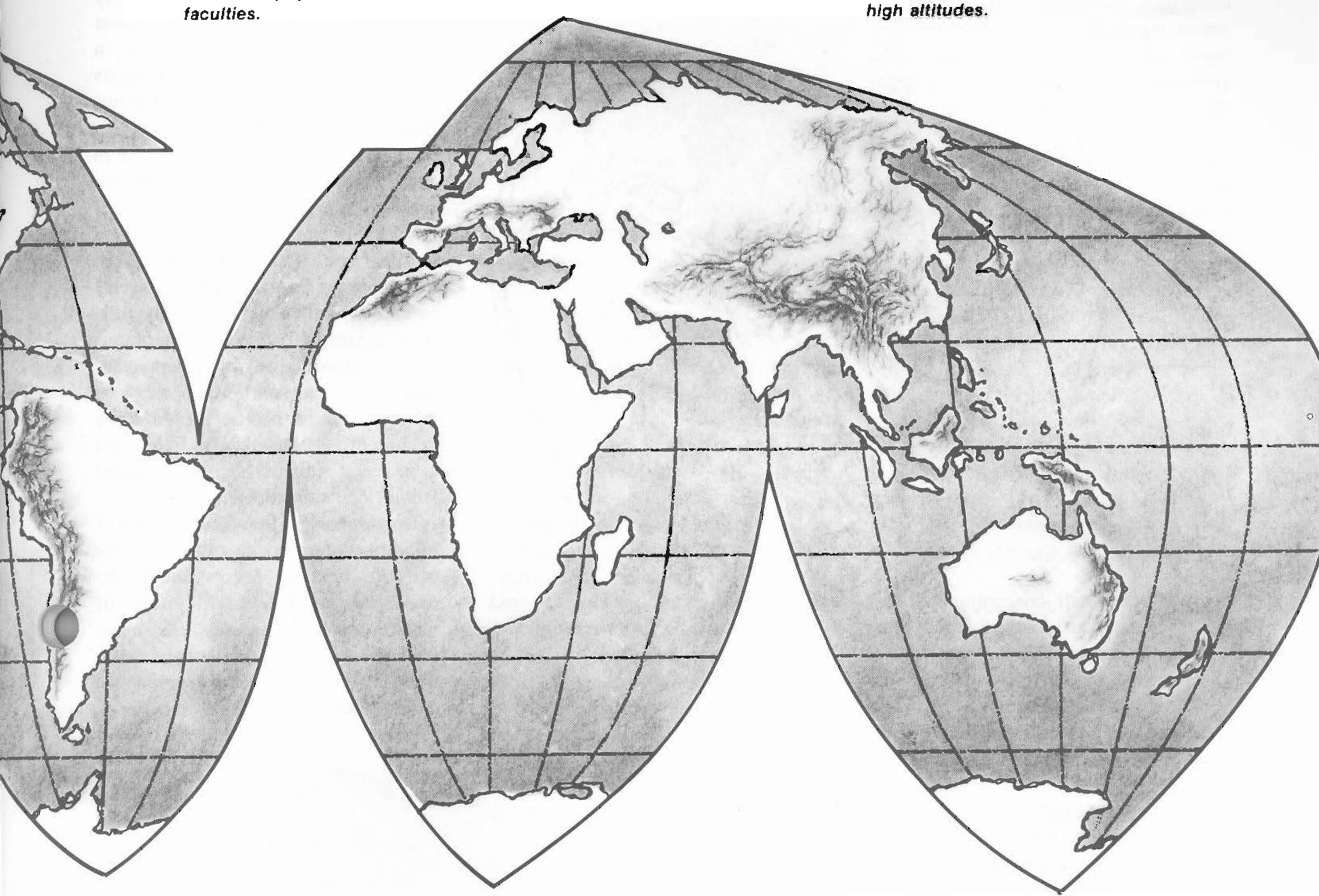


(Ref. 3). A significant proportion of the world's land mass is mountainous. The world's mountain ranges lie primarily along broad belts called "cordilleras." The mountainous region of western North America is up to 1,600 kilometers in width and occupies most of Alaska, Mexico, and Central America as well as more than a quarter of Canada and the contiguous United States. Numerous peaks in this range rise above 3,000 meters.

In western South America, the altitude of the Andes continuously exceeds 3,000 meters for a distance of

Extreme cold affects mental as well as physical faculties.

Troops may require months of acclimitization at high altitudes.



3,200 kilometers. The width of the Andes range is less than 800 kilometers.

The Eurasian mountain belt includes the Atlas Mountains in North Africa; the Pyrenees, Alps, Balkans, and Carpathian ranges in Europe; and the Hindu Kush and Himalayas in Asia. Just east of the Pamir Knot on the USSR-Afghanistan frontier, the Eurasian belt fans out across most of Eastern Asia where it branches: one belt goes south to New Zealand along the rugged island chains and the other belt goes northeast through the Bering Sea to Alaska (Ref. 3).

Extreme cold can cause medical problems that can produce casualties, including dehydration, frostbite, trenchfoot, hypothermia, shock (which will usually develop more rapidly and progress more deeply in extreme cold), sunburn, snow blindness, constipation, and carbon monoxide poisoning.

Extreme cold can have a mental impact as well. When bundled up, troops tend to draw within themselves, assuming a "cocoon-like existence." Groups can also withdraw, remaining in tents or other shelter, with individuals taking to their sleeping bags and neglecting duties including guard and security measures! Errors in judgment are frequent; even experienced Arctic inhabitants and guides have been known to abandon equipment and survival gear and purposely set out in a hopeless attempt to walk out of an isolated location, without a knowledge of the terrain or a sense of direction.

High altitude causes additional problems. The body must adjust to the lower pressure with changes in the

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blood's red cell concentration. This takes time. Acclimatized troops *may* attain as much as 70 percent of sea-level work capacity after *months* in a high-altitude environment (Ref. 4).

During exercises in a cold climate at an elevation between 2,000 and 3,000 meters, marines were estimated to have lost between 50 and 75 percent of the capability they had in more temperate environments. For example, it took 10 marines 45 minutes to move an Akhio (a sled) 91.5 meters up a slope of 15°. The typical load for an Akhio is 160 kilograms (Ref. 5).

High altitude can result in malnutrition and dehydration, above and beyond that due to extreme cold. A soldier's mental acuity is also often affected by high altitude. The effects include errors in judgment, impaired self-evaluation, memory deterioration, shortened attention span, increased errors in simple arithmetic, increased irritability, and decreased vigilance.

In my studies I found that the Russian Army is well equipped and well trained to fight in extreme cold. During cold weather operations little special personal equipment is issued to Soviet troops since standard Soviet equipment and clothing is designed for all-weather use. Soviet training and doctrine emphasize cold weather operations; they are trained and prepared to win in winter. The Army of the People's Republic of China proved its capability to fight in conditions of extreme cold during its campaign against United Nations troops in North Korea.

The reasoning seems to prevail in the American chemical defense community that there may be little if any threat from chemical agents in extreme cold (Ref. 6) because of the low vapor emission of chemical agents in the cold. The feeling is that the main hazard will arise after operations in a contaminated region, when agent-coated clothing and equipment are brought into a heated shelter. The argument is based on field test experience primarily involving ground (snow) contamination.

In contrast, the East German military writer, Franke, states that the use of chemical agents should be expected under all types of meteorologic conditions. He bases cold weather usage on the application of chemical agents in aerosol form (Ref. 7, 8). United States experience

with biological aerosols and with biological simulants shows that aerosols are capable of large area coverage, in the cold. The main problem with using chemical agents as aerosols lies in the relatively large quantities needed and the relevant dissemination methods.

Personnel of the 172d Infantry Brigade (Alaska) have expressed concern over the fact that NBC equipment is degraded in extreme cold (Ref. 6). Any problem raised by an operating field unit must be considered with the utmost seriousness. Any item of equipment, unless it can be operated by the ultimate user, the soldier in the field (in training exercises at the very least), cannot be considered to have "passed the test." US Army troops in Alaska have much to say concerning defects in NBC equipment in cold conditions. Based on their concerns, the following possible problem areas surfaced:

The M256 Chemical Agent Detection Kit: at below freezing temperatures, more time could possibly be required for reagents to react, and soldiers may tend to interpret a slow positive response as a normal negative response; this may lead to premature unmasking. The kit possibly does not work at all below -32° Celsius (C).

The BB501 battery: this battery, needed for operation of the winterized M8 Alarm at below -7°C, may be virtually useless without battery chargers and may be impractical because of the preheat time and the limited operational time in extreme cold.

Protective masks and hoods: there may be problems with the eye lens fogging when the M17 protective mask is put on. Extremely cold rubber could possibly cause frostbite to the face. The M24 and M25 mask faceblanks may crack along the fold. Rubber in the protective mask hoods may become brittle and easily torn. Further, the hood may not be compatible with the Arctic parka.

Protective ensembles: the protective overgarment may not fit over the Arctic parka which might render the parka vulnerable to chemical contamination. The overgarment gloves may become brittle in extreme cold, and sweating may result in frostbite of a soldier's hands.

Decontamination could possibly present problems in extreme cold. The M11 Decontamination Apparatus may need double charging between 0°C and -26°C; below -26°C, Decontaminating Solution Number 2 (DS2) might not be effective. There may be difficulties with the M12A1 Power Driven Decontamination Apparatus (PDDA) because liquids might freeze in the pump and in the lines. Super tropical bleach (STB) could possibly be difficult to mix and apply with the PDDA.

Because of its liquid base, the towelette from the M258A1 Individual Decontamination Kit may cause frostbite when used on the skin. Without high-capacity heaters, decontamination of troops using liquids may be absurd in extreme cold. Obtaining dirt in the Arctic for the shuffle pit may be impossible. When equipment is decontaminated in extreme cold, a stream of water-based decontaminant, even though it is heated, may freeze on contact with a very cold vehicle.

These possible problems with NBC equipment should be confirmed by testing.

NBC equipment may have problems in the extreme cold of high altitudes.

Considering the fact that the soldier has many things to remember to just survive in the cold, the need to operate in a chemical environment, along with possible problems of degraded effectiveness of NBC equipment, along with the numbing of intellect and degradation of unit security brought on by the psychological impact of cold and/or high altitude, could compound the problem.

There is work to be done to improve this country's ability to fight a chemical war in the cold.

The effectiveness of chemical agent aerosols for military operations in extreme cold is a knowledge gap. In view of the interest of Franke, a Warsaw Pact military writer, in the use of chemical agents as aerosols, this knowledge gap should be addressed with tests conducted in extreme cold as required.

In the absence of data on aerosolization of chemical agents in extreme cold, it should be assumed that

The XM40 mask is tested at left at the Cold Regions Test Center (CRTC) at Fort Greely, Alaska. Below, soldier runs an obstacle course at CRTC.

all known chemical agents are capable of being used in combat in extreme cold, possibly as aerosols. US forces should proceed on the assumption that chemical weapons may be used in cold environments.

Both extreme cold and high altitude produce psychological problems. However, current knowledge is insufficient to estimate what the added psychological impact of cold or altitude will be on military operations. Casualty rates cannot help but increase if psychological aberrations slow or stop the normal reaction of soldiers to a chemical attack. The necessary studies should be run.

Overall, there is need for design and testing of new specific, probably nonstandard, equipment for use in extreme cold. Design and development should be *de novo* or started afresh rather than the modification of current NBC equipment. At the very least such equipment should be usable by personnel in NBC training in extreme cold.

Chemical agent detection devices that are not reliant on liquid agents are needed for use in extreme cold. State-of-the-art devices and approaches should be explored. To be usable in extreme cold chemical agent detection devices must be capable of detecting vapors and liquids, including frozen droplets. In view of battery problems, for which modern technology doesn't seem to have an answer, special electrical generators will be needed to supply necessary power for chemical agent detectors and associated alarm systems.

Protective apparel must be redesigned to cover the parka or to cover additional articles of clothing that could replace the protection against the environment offered by the parka. The Arctic parka presents a major problem: none of the protective apparel is designed to cover the parka, leaving the parka to be contaminated in the event of a chemical attack. Only one parka is issued per soldier and, at present, is essential to survival in the cold temperatures that prevail.

There is a need to redesign or replace current plastic and rubber products. When the skin is exposed to these materials in extreme cold, there is rapid loss of body heat and subsequent frostbite. Either materials with lower heat conductivity must be found or some type of insulating lining should be bonded to the products being used. Also the fact that current materials become brittle or tear easily in extreme cold needs to be addressed. For protective apparel in extreme cold, it may be necessary to find new materials to obtain greater pliability.

Heated facilities will be required for personnel and equipment decontamination operations in extreme cold. Tents are inadequate and, with the large unpopulated areas involved, finding a semipermanent structure for a decontamination station is unlikely. Therefore, insulated structures, possibly helicopter-transportable, should be designed to give greater protection from extreme cold.

Donning and doffing procedures have not been developed to the point where the ordinary soldier in the field can get out of contaminated MOPP gear without the risk of contaminating his person and the clothing he wears under the overgarment. In extreme cold, weathering (depletion of chemical agent contamination by evaporation) is slowed down markedly.

The level of contamination on the overgarment will essentially remain the same as when the most recent chemical attack occurred, corrected for whatever contamination a soldier can get rid of subsequently. Of course, previous attacks would produce cumulative results. In the event of an attack involving chemical weapons, the troops will need to remain in full MOPP until they can reach a personnel decontamination station, because there is no way, aside from weathering, that the overgarment can be decontaminated while being worn.

Soldiers undergo Expert Medical Badge Testing during a chemical warfare scenario at Fort Wainwright, Alaska. Skier tests XM30 mask at CRTC.

An impermeable coverall type overgarment should be adopted, at least for use in extreme cold. The protective hood should be an integral part of the overgarment and the resulting overgarment should be firmly interfaced with the protective mask, gloves, and overboot. The resulting MOPP gear would be such that the total exposed surface could be washed down with a liberal application of active decontaminant. A temporary shield could be placed over the filter elements of the protective mask to keep the decontaminant out.

It is recognized that impermeable MOPP gear of this type would be prone to cause overheating during activity and subsequent chilling after the activity ceased. The current MOPP gear will also cause overheating and chilling (Ref. 1) but has the serious drawback that its surface cannot be adequately decontaminated, except by weathering.

Water in the form of ice or snow is available in many of the extreme cold regions and because large quantities of heated water would be needed for water-based decontamination operations, decontamination equipment should have the facility to convert ice and snow to heated water in quantity.

Alternative dry decontamination procedures should be tested. Brushing to remove frozen particles of chemical agent should be tried. Decontaminants normally used in solution, such as STB, should be tested in dry form. It may be possible to cut down on the hot water requirements.

It is apparent that the logistical load will be increased considerably if American troops are attacked with chemical agents in extreme cold. Such an increased load must be planned for.

Based on experience and the current threat, the probability of battles being fought in extreme cold is high. We cannot afford to be complacent about the possibility of chemical warfare in a cold environment.

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