Extreme Cold Weather Decontamination—
The Challenge

By Captain Eric Larimer

Decontamination in extreme cold weather poses a unique challenge that few are prepared to meet. Chemical leaders must start by dispelling the following misconceptions:

- Our enemies will not employ nuclear, biological, and chemical (NBC) agents in the cold.
- Chemical and biological weapons are ineffective in the cold.
- Cold weather decontamination is not worthy of training.

Leaders also must convince maneuver commanders that such ideas are false. They must overcome many obstacles. Cold weather hampers operations, injures soldiers, and breaks equipment. Finally, leaders must overcome the significant lack of reliable equipment, doctrine, and materials required to complete their cold weather decontamination mission successfully.

Enemy Threat

The U.S. military currently operates in Korea, Germany, and the Balkans. Sixty-five percent of Eurasia and 45 percent of North America are characterized by extreme cold and deep snow during winter months. These areas include the republics of the former Soviet Union, China, and several other nations. Many have known stockpiles of chemical weapons and are experiencing political turmoil. We must maintain the capability to operate effectively in these regions.

The former Soviet Union developed a variety of agents specifically designed to be effective in cold weather. Some reports also indicate that the Russians used a biological agent in their recent offensive into Grozny, which attacked electrical systems effectively in cold weather. Table 1 identifies the volatility of seven common chemical agents based on work done by the Cold Re-gions Research and Engineering Laboratory(CRREL).

Agents AC, CK, and CG (in the Table) retain enough volatility to be lethal down to -65 degrees Fahrenheit (F). Although the other agents are not lethal at cold temperatures, they still pose a threat; as temperatures get colder, persistency increases. The transfer hazard of tracking these and other agents becomes very significant. Agents mix with frozen water and adhere to vehicles, equipment, and clothing. They are tracked and/or carried into heated areas such as warming tents, tactical operations centers, maintenance facilities, and buildings. This creates an off-gassing of contaminated vapor. This is the greatest threat that liquid and solid contaminants pose in a cold weather environment.

Table 2 (page 56) lists the freezing points and hazards of selected chemical agents as illustrated in Table 6-2 of FM 3-5, *NBC Decontamination*.

Friendly Threat

Unfortunately, most leaders in the Army compound the issue of cold weather decontamination by ignoring this significant threat and failing to conduct cold weather decontamination training. As the platoon leader of the only chemical platoon in Alaska, I encountered this attitude often. Leaders cited the increased risk of injury caused by working with water in the extreme cold and the increased risk of breaking equipment. They also were convinced that agents

Table 1. Volatility of seven agents

	32°F	0°F	-2[illegible]°F	-40°F	[illegible]5°F	State (Gas, Liquid, Solid)	Lethal Dosage (mg-min/m[illegible])
AC	4.4x10[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L<78°F S<5[illegible]°F	[illegible]
CK	1.6x10[illegible]	6.6x10[illegible]	[illegible]	[illegible]	4.5x10[illegible]	L<56°F S<2[illegible]°F	[illegible]
CG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L<46°F	[illegible]
HD	75	[illegible]	7.4	2.1	[illegible]	S<5[illegible]°F	[illegible]
[illegible]	[illegible]	235	85	27	[illegible]	S<3[illegible]°F	[illegible]
GB	4100	7[illegible]	[illegible]	96	[illegible]	S<-6[illegible]°F	7.0-10[illegible]
VX	1.3	0.2	0.04	5.3x10[illegible]	[illegible]	S<-2[illegible]°F	[illegible]

would be ineffective in the cold; therefore, no enemy would employ them. When pressed to explain why the leaders believed this, they could produce no credible evidence. While it is true that hazards in training increase with the cold, proper risk management techniques can be employed to negate the risks. We cannot ignore this important task.

Current Research and Doctrine

Fortunately, some groups recognize the importance of cold weather decontamination. The CRREL in Hanover, New Hampshire, is one. Listed below are some recommended research topics it hopes to start as early as winter 2001. It intends to make informed recommendations for improvement in doctrine, training, and materiel.

Table 2. Freezing points of chemical agents

Agent	Symbol	Contact Hazard	Vapor Hazard	Freezing Point
Nerve				
Tabun	GA	Extreme	Low-Moderate	-58°F
Sarin	GB	Extreme	Extreme	-69°F
Soman	GD	Extreme	Probable	-44°F
	VX	Extreme	Negligible	60°F
	VR-55	Extreme	Probable	Unknown
	TGD	Extreme	Probable	Variable with Thickness
Blister				
Distilled mustard	HD	Extreme	Negligible	58°F
Mustard-lewisite	HL	Extreme	Low	-13 to -25°F
Nitrogen mustard	HN-1	Extreme	Low	-29°F
Nitrogen mustard	HN-2	Extreme	Low	-76°F
Lewisite	L	Extreme	Negligible	0°F
Nitrogen mustard	HN-3	Extreme	Low	25°F
Phosgene oxime	CX	Extreme	Low	-1°F
Blood				
Hydrogen cyanide	AC	Low	Extreme	8°F
Cyanogen choride	CK	Low	Extreme	20°F
Arsine	SA	Low	Extreme	-176°F
Choking				
Phosgene	CG	Slight	Extreme	-198°F
Diphosgene	DP	Slight	Extreme	-71°F

Effectiveness of vapor detectors in cold temperatures. The detectors include the M8 alarm, the M22 automatic chemical agent alarm, the chemical agent monitor, and the improved chemical agent monitor. Cold temperatures pose problems for these detectors for two reasons. First, the life of the battery is reduced sig-nificantly. A battery that lasts 24 hours at 45 degrees F may last less than an hour at -45 degrees F. Second, the volatility of liquid and solid agents in cold weather is often too low for the instruments to detect. False readings may occur that lead soldiers to believe that they are clear of contamination when it is actually all around them.

Impact of snow and ice particles on standoff detection systems. Blowing snow or very fine ice crystals may impede standoff detection capabilities. These instruments may not be able to distinguish the difference between an ice cloud, a weaponized aerosol, or an ice cloud mixed with a weaponized aerosol.

Effectiveness of M256 detection kits in cold weather. The solutions inside the ticket may freeze. Chemical reactions also occur more slowly at cold temperatures or may simply not occur at all. M256 kits will give false readings of no contamination when the chemical reactions from different portions of the ticket are not given sufficient time. Soldiers need either a cold weather ticket or instructions on how to modify the use of M256 kits in cold weather.

Effectiveness of the battle dress overgarment in cold weather. We do not know the effects of cold, snow, and ice particles on the activated carbon in the battle dress overgarments (BDOs). Also, we do not know what effects these conditions have on dry decontamination agents such as those in the M291and M295 kits and the new sorbant decontamination system (SDS).

The impact of cold weather on computers. Computer prediction models such as the Joint Warning and Reporting Network and Hazard Prediction Assessment Capability may be inaccurate in cold temperatures. Computer modeling of how chemical vapors and aerosol clouds move under a thick inversion layer will be tested.

Working in Extreme Cold Weather

The first step in a successful cold weather decontamination operation is the ability to work efficiently in extreme cold weather conditions. This takes practice. The following is a short list of challenges commanders face during cold weather missions:

Time. A good rule of thumb is, what takes you 1 hour to accomplish under normal conditions will take at least 1 1/2 hours in extreme cold weather. Soldiers need to rotate into warming shelters. They move slower and lose flexibility and agility when wearing several layers of clothes.

Cold weather injuries. These types of injuries can inflict anyone, especially those not accustomed to cold weather. Heated facilities are required to ensure that soldiers are able to warm themselves. Leaders must be especially vigilant in checking soldiers for injuries. Include visual inspections of the face, fingers, and toes. Ensure that soldiers change their socks often.

Vehicle/equipment use. If a vehicle is turned off in extreme cold weather, it may not start again until the entire unit is warmed. Oil thickens, fuel gels, and moving parts simply freeze. Batteries die in just a few short hours when left in the cold. Winterization kits that include a battery blanket, an engine block, and oil-pan heaters are required for garrison activities. Electrical sources are usually not available in the field. This forces units to keep their vehicles running continually for the duration of deployments. Fuel consumption and training cost increase greatly. Every device that uses an internal combustion engine experiences the same problem. Keep these machines warm if you expect them to turn on in the cold.

Drinking water. People expend large quantities of water in cold weather and become easily dehydrated. Most soldiers either don't feel thirsty, or they think they will feel colder if they drink cold water. Five-gallon water cans and water buffaloes will freeze quickly if left in the cold. Plenty of hot liquids such as soup or hot chocolate in warming areas is great.

Decontamination in Extreme Cold Weather

FM 3-4, *NBC Protection*, and FM 3-5 provide a good starting point for decontamination operations in the extreme cold. This doctrine was developed as a result of tests done in Alaska in the early 1980s. The chemical platoon of the 172d Separate Infantry Brigade (SIB) at Fort Wainwright, Alaska, and the 59th Chemical Company at Fort Drum, New York, use them regularly. Another source is the article, *Extreme Cold Weather Decontamination—A Chilling Scenario,* by Captain Ian McCulloh, commander of the 11th Chemical Company, Fort Lewis, Washington (see *Army Chemical Review,* January 2000). He draws from his experience with the 59th Chemical Company to provide important cold weather tips. The issues listed below are a collection of the most important techniques discussed in published doctrine and those you won't find in the books.

Prepare to operate in arctic climate. FM 3-5 states, "With present technology, equipment decontamination problems in the field are difficult to overcome in an arctic climate. Commanders may seriously consider fighting dirty in arctic regions. Fresh units can be rotated into the field so that dirty units can be moved back to built-up areas to decontaminate . . ." in heated areas. A reliable source of heat is the key to success in any cold weather decontamination operation because DS2 does not function in temperatures colder than -25 degrees F. At temperatures less than 0 degree F, it becomes very thick and the contact time required to neutralize agents is greatly increased. Water poses a greater problem because it freezes on contact with cold metal. The spray also creates large clouds of ice fog. Dry decontamination agents such as those in the SDS or the M291 and M295 kits or STB or STH will be ineffective in physically removing frozen contaminants, especially if they are mixed with snow and ice. Solvents such as JP-8, kerosene, and diesel fuel may be used to physically remove contamination, but the runoff will remain contaminated and create a fire hazard. At temperatures below 10 degrees F, decontamination missions should be performed in a heated environment if at all possible. Additional research should be conducted to provide a nonaqueous decontaminate that won't freeze and is chemically effective in the cold.

Select a site. Captain Paul Sigler, commander of HHC 172d SIB, recommends that chemical decontamination units adopt trailers like those of the Army chemical depots. These vehicles are heated, converted 18-wheeler trailers with built-in liquid and vapor barriers and would be used as a detailed troop decontamination or mission-oriented protective posture (MOPP) gear exchange site. Other options are frame tents or general purpose mediums, both of which are bulky and hard to set up. These would become contaminated during the operation and need to be disposed of after each use. A hard site such as a hangar or a warehouse also could be used and decontaminated upon completion of the mission.

Provide warming tents for contaminated soldiers. Soldiers can suffer cold weather injuries even in MOPP4. Place M8 or M22 chemical agent alarms in all warming tents. They are much more effective inside because they are usually inoperative in the cold due to low vapor pressures and dead batteries.

Drain water tank and pump units of all water before storage. This prevents freezing. Water will usually not freeze while its tank is in motion; however, when left stationary for several hours, tanks will need to be heated.

Minimize digging. Contaminants often become trapped in layers frozen beneath the surface. Digging exposes these layers, creating either a new transfer hazard or a new vapor hazard if warmed. Take a core snow sample when entering a new assembly area. Melt the snow to liquid and test with M8 paper, M9 paper, and a chemical agent monitor.

Take necessary precautions. If a unit is forced to decontaminate in the cold, use an additional decontamination apparatus at each water blivet simply to heat your water source. Redirect all spray wands back into the blivet when not in use. This prevents water in the wands and hoses from freezing.

Carry protective masks beneath outer garments. Body heat will keep the mask warm and flexible and reduce the hazard of contact frostbite. This will increase the time required to properly don the mask. To do so, complete the following six actions:

- Stop breathing and close your eyes.
- Lower your parka hood and remove ballaclava and any hats.
- Remove your gloves or mittens, as needed, to don the mask properly.
- Don the mask; do not clear by exhaling a large amount of air. This prevents frosting the eye pieces and freezing the valves.
- Put on any hats required and raise your parka hood.
- Refasten your outer garment.

To remove your mask—

- Brush snow and ice off the outside of your mask.
- Remove your parka hood, hats, gloves, or mittens, as necessary, to remove the mask.
- Remove your mask and immediately dry your face and the inside of your mask to prevent freezing.
- Store your mask in carrier and refasten your outer garment.
- Put on any hats required and raise your parka hood.

Modify MOPP. MOPP gear requires modification in a cold weather environment. Soldiers must follow the layering principle to prevent cold weather injuries. The layer closest to the skin must always be one that wicks moisture away from the body. Army issue Polypro works best. Wear BDOs as your second layer. Put your protective mask in its carrier and place it under your left armpit. Then don your heavyweight Gortex pants and jacket. The last layer of clothing is your overwhite camouflage pants and jacket. Finally, put on your load carrying equipment or load bearing vest and Kevlar. Soldiers find this uniform quite bulky, and it reduces flexibility. Part of this problem will be solved when the new Joint Service Integrated Suit Technology overgarments are fielded. These suits are less bulky than BDOs and are about the same thickness of winter-weight battle dress uniforms. The problem with wearing a mask as large as the M40 under the arm can also be diminished by providing units operating in a cold weather environment a smaller mask such as the M45.

Extreme cold weather vapor-barrier boots provide adequate protection against chemical and biological agents. Chemical protective overboots are not required. Wear wool glove liners under your butyl rubber gloves instead of cotton to wick away perspiration from hand surfaces. Also wear trigger finger or arctic mittens over the chemical protective gloves to provide adequate warmth.

The figure below provides a recommended layout for a detailed equipment decontamination (DED) in extreme cold weather.

Conclusion

Decontamination operations in an extreme cold weather environment are both a significant challenge and a necessity. Leaders within the chemical community must overcome the difficulties discussed above to meet the challenge properly. Improvements in doctrine, materiel, and training and an increased command emphasis are the keys to our future success.

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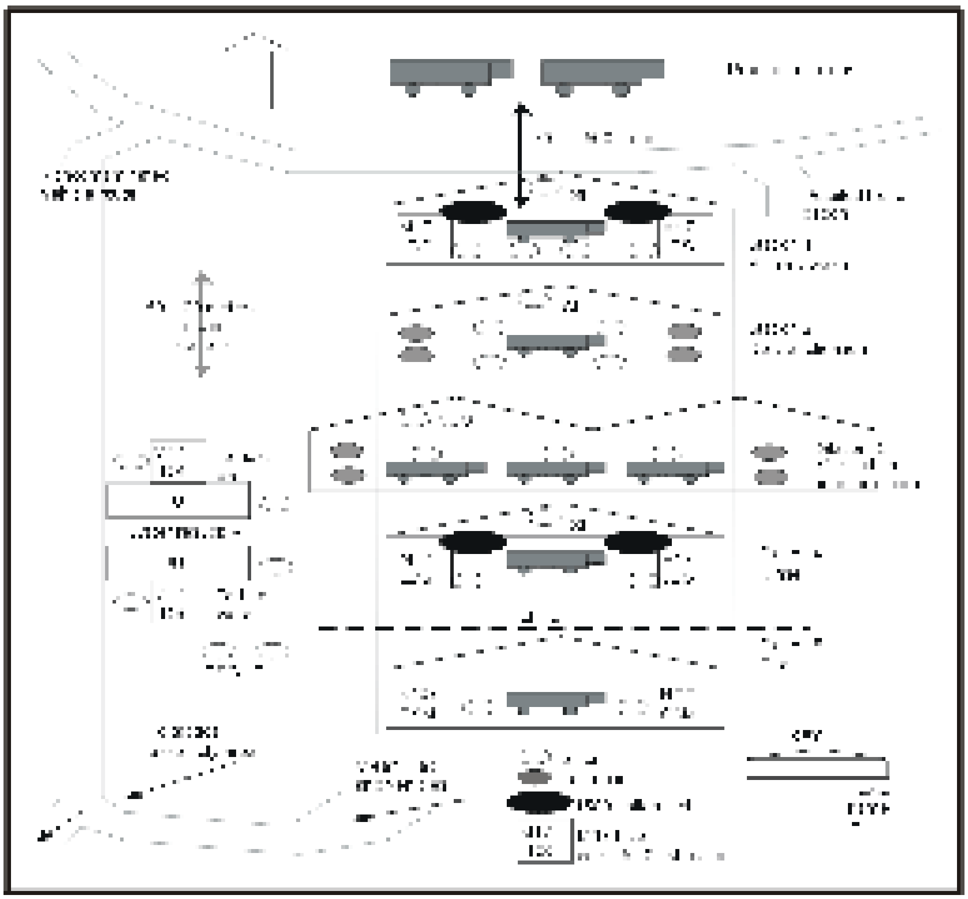

Figure. Recommended layout for DED in cold weather