civil defense
Technical Bulletin
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CHEMICAL WARFARE DEFENSE SERIES—5
A DIGEST OF TECHNICAL INFORMATION

WAR GAS DECONTAMINATION

This is the fifth in a series of technical bulletins on civil defense against chemical warfare agents. The other bulletins in the series are listed on page 6.

This technical bulletin is concerned with decontamination following war gas attacks, with special emphasis on nonmilitary defense aspects of the problem. It contains information on decontaminants and their use, and on their preparation for use. Personnel decontamination and recommended procedures for decontamination of various types of surfaces also are discussed.

Definitions of "chemical warfare agent," "war gas," "decontamination," and "decontamination materials" are included in the second in this series of technical bulletins on Chemical Warfare Defense, *General Concepts of Chemical Warfare*, TB-11-26, and will not be repeated here.

Detection is a necessary step before decontamination. The nature of the war gas and extent of contamination must be known to determine the proper decontamination procedure. A method of detecting dangerous concentrations of certain war gases is covered in the fourth in this series of technical bulletins, *Chemical Agent Detector Kit, CD V-810*, TB-11-29.

Decontamination Objective

The objective in decontamination is to reduce the contamination to a permissible level with the least expenditure of labor and materials, and within such time as the situation allows. A decontamination job, therefore, must be based on a careful and sound estimate of the situation.

The need for the decontamination of buildings, equipment, and areas depends upon the emergency need for the particular building, equipment, or area, and the length of time that the contamination would remain.

Personnel Decontamination

Personnel decontamination is a special and urgent problem of nonmilitary defense. Immediate and thorough action is necessary in removing nerve gases from any part of the body. Nerve gases are quickly absorbed and a small amount can cause death. Quick action is necessary in removing liquid blister gases from the skin. Liquid blister gases also are quickly absorbed.

Immediate Decontamination Vesicant Agent. Protective Ointment, CD V-820, developed

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by the Army Chemical Corps, and available through the Federal Contributions Program, is used for immediate decontamination of blister gases in contact with the skin. It may be used both as a preventive and a decontaminant. Absorbent cloths are supplied with the ointment to blot drops of blister gas off the skin and to aid in applying and removing the ointment. The piece of cloth used to blot drops should not be used thereafter to apply ointment.

In the absence of protective ointment, water and soap may be used to wash blister gases from the skin. Quick action is necessary in removing liquid blister gases from the skin because they are quickly absorbed.

Soap and water, rather than protective ointment, may be used for decontamination of the nerve gases. As stated earlier, immediate and thorough action is necessary in removing nerve gases from any part of the body. Nerve gases are quickly absorbed and a small amount can cause death.

BAL Ointment, CD V-821, which is available through the Federal Contributions Program, is used to neutralize lewisite or other arsenical war gases in and around the eyes. It is also of value in emergency decontamination of material that has been contaminated by a small amount of lewisite. BAL reacts with lewisite to change it into a chemical harmless to the skin. It is effective when it can be brought into direct contact with lewisite.

Common Steps in Decontamination Operations

Weather

(*a*) *General.*—Chemical agents are removed after a period of time by the effects of weather. Evaporation or decomposition are the principal means by which weathering accomplishes decontamination. Weathering is by far the simplest method of decontamination. Lack of time, unfavorable weather conditions, or proximity of contamination to unprotected personnel may decrease the effectiveness of weathering. Contaminated areas too extensive for other means of decontamination, or not important to emergency operations, may be decontaminated by weathering.

(*b*) *Elements.*

(1) *Air.*—Aeration promotes decontamination. High winds rapidly disperse the vapors of chemical agents.

(2) *Temperature.*—High temperatures speed up the change of liquid to gas and increase the dispersion of chemical agents in the air. The persistency of war gases increases as the surrounding temperature decreases.

(3) *Humidity and Precipitation.*—Presence of moisture tends to hydrolyze chemical agents. Most chemical agents hydrolyze slowly. (Hydrolyze means to undergo hydrolysis, and hydrolysis is the chemical process of decomposition involving addition of the elements of water.) Rain, in addition to causing some hydrolysis, aids decontamination by mechanically removing chemical agents. However, rain may cause concentrations of the agents in drainage areas.

(4) *Sun.*—Bright sunlight serves as a decontaminating element. Even in cold weather, the direct rays of the sun warm surfaces above the air temperature and speed up the evaporation and decomposition of chemical agents.

Water

(*a*) *Action.*—Flowing water mechanically washes chemical agents from surfaces and hydrolyzes some chemical agents. Adding soap or detergents, commonly found in most households, makes water a more effective decontaminant. Effectiveness of water depends upon its temperature. Hot water is most effective. Water hydrolizes lewisite, but a toxic and blistering residue is formed. Scrubbing with soap and water where practicable will physically remove the residue. Water alone should not be used for decontaminating lewisite when it is practicable to use bleach or a caustic solution.

(*b*) *Use.*

(1) *Washing.*—Flushing an exposed surface with an excess of water washes away the chemical agent. High-pressure application produces a better cleansing action than low-pressure. If the contaminated surface is porus, washing removes the surface contaminant but does not completely decontaminate liquid that has penetrated the surface. (A coating of paint will not always prevent the penetration of chemical agents.)

(2) *Soaking.*—Soaking contaminated items in boiling water is an excellent means of decontamination. Soaking items in cold water is not so effective because cold water reacts slowly with most chemical agents. If hot or boiling water is harmful to the equipment to be decontaminated, warm water (up to 140° F.) may be used. However, this may not always produce complete decontamination. *Lewisite is not decontaminated by soaking because water reacts with it to form an oxide that is toxic.*

(*c*) *Disposal.*—Water used for decontamination by washing is contaminated. It must not, therefore, be disposed of in places where it may flow or be washed into streams or bodies of water, or where it may contaminate ground water used as a water supply source. Disposal areas so used must be marked "contaminated," or be decontaminated.

Earth

(*a*) *Action.*—Earth is used to seal in contamination or as an absorbent for wiping off liquid contamination.

(*b*) *Use.*—Covering a contaminated area with 3 or 4 inches of earth gives protection as long as the earth is not stirred and the chemical agent exposed again. An area thus treated may be walked on or driven over safely. In the absence of better absorbents, liquid contamination of human or animal bodies can be reduced by using earth to remove the chemical agent. Contamination of equipment also can be reduced in this manner. Earth so used becomes contaminated and must be appropriately disposed of so that it does not spread contamination.

Fire

(*a*) *Action.*—Fire destroys or vaporizes war gases. Some war gases such as mustard gas, are combustible and upon burning are converted into relatively harmless products.

(*b*) *Use.*—Use of fire is a rapid, simple, and effective means of decontaminating areas or objects. Fire can be used for decontamination of waste material and terrain. When material to be decontaminated is not flammable, fuel (diesel oil, gasoline, kerosene, or fuel oil) may be used to start a fire or to carry it to all of the contaminated areas. When large contaminated areas are burned, a distance of about 1,500 yards downwind may contain a dangerous concentration of vapors of the war gas. Guards should be posted to warn people of the dangerous concentration and keep unprotected people out of the area. Weather, concentration of gas in area burned, and amount of combustible material in the area are factors that determine the extent and danger levels of the downwind area. Heavily contaminated terrain decontaminated by burning may retain part of its toxicity for some time after burning. The best time to burn is on a hot sunny day—to insure the least downwind carry of toxic vapors.

Chemical Decontaminants

There are a number of chemicals that are useful in decontamination operations. All strong alkalies and oxidizing agents destroy most of the war gases. In general, alkalies such as caustic soda are more effective than bleaches in nerve gas decontamination; and oxidizing agents such as bleaches are more effective than caustic soda against mustard gases.

Ordinary Powdered Bleach

Ordinary powdered or household bleach is widely distributed throughout the United States. It is an effective decontaminant against the blister gases, and to a lesser extent against the nerve gases. It is prepared as a slurry, for spraying or application with

a brush, by adding an equal weight of water to the powdered bleach.

Sodium Hypochlorite

In solid form, sodium hypochlorite is an unstable substance with a disagreeably sweet odor. As a common household bleach, it is normally marketed as a solution because this form is more stable. Commercial solutions vary in strength, but usually contain up to 14 percent available chlorine.

Like most decontaminants, sodium hypochlorite liberates chlorine and, upon contact with persistent war gases, changes them to less toxic chemicals. Normally, sodium hypochlorite solution is used full strength. Sodium hypochlorite is a strong bleaching agent and will damage fabrics if applied full strength or nearly full strength and allowed to remain on the fabrics. However, the solution may be handled without danger to human beings.

Sodium hypochlorite is a fairly rapid decontaminant. Hand decontaminating apparatus may be filled easily with it for immediate use. The solution also may be applied conveniently with swabs.

High-Test Bleach

High-test bleach, frequently used in industrial processes, may be used in a dry mix or slurry for decontamination operations. Like ordinary bleach, high-test bleach releases chlorine which reacts with blister gases, destroying their toxicity, and hydrolyzes nerve gases.

High-test bleach contains twice as much available chlorine as ordinary bleach. Generally, it is a more effective decontaminant when used as a dry mix than a slurry, but it is also more dangerous. It may, for example, react violently with liquid mustards, causing fires and explosions.

A slurry is prepared for spraying by mixing 2 parts high-test bleach with 3 parts of water by weight. (Unlike ordinary bleach, high-test bleach in a 1 to 1 mixture by weight with water forms a mass too thick for spraying.) It does not form slurry as well as ordinary bleach, and loses its chlorine rapidly when prepared as a slurry.

High-test bleach is more stable in storage but more corrosive than ordinary bleach. It is an oxidizing material, and its shipment must conform to Interstate Commerce Commission regulations.

Caustic Soda (Lye)

The chemical name for caustic soda is sodium hydroxide, but it is more commonly known by its household name, lye. It is a white solid that dissolves easily in water. Considerable heat is liberated when solutions of caustic soda are prepared, and the containers must not be handled with the bare hands.

Caustic soda solution destroys certain war gases on contact and is particularly effective in decontaminating lewisite and persistent nerve gases. It does not destroy mustard gases except when the hot solution is kept in prolonged contact with them. Caustic soda is dangerous to handle because both the solid and solution form attack skin, eyes, and clothing on contact. Caustic soda does not give off a poisonous vapor, but is poisonous if swallowed. It hastens hydrolysis of war gases and thereby destroys them.

Solutions of caustic soda are effective in most concentrations, but normally the more concentrated the solution the faster the decontamination. A 5-percent solution (5 pounds caustic soda to 12 gallons of water) is recommended for most decontamination operations. Solutions should not be mixed in aluminum, tin, or zinc containers. Iron or steel containers are suitable; glass or earthenware containers can be used if the solid is added slowly and the solution is stirred constantly to keep the temperature down.

An excellent method for simultaneous mixing and application, when the solution permits, is to sprinkle caustic soda on the contaminated area and then dissolve it with a spray of hot water or steam. Care must be taken to see that the water or steam does not wash the caustic soda off the contaminated surface until decontamination is completed.

Washing Soda

The chemical name for washing soda is sodium carbonate, but it is also known as soda ash, sal soda, and laundry soda. Washing soda is a white, powdery substance possessing

alkaline properties. Commercial grades may contain large amounts of sodium bicarbonate.

Washing soda does not destroy persistent war gases as readily as does caustic soda or bleach. It brings about decontamination of war gases by hastening their hydrolysis and thereby destroying them.

A solution is best prepared by adding 5 pounds of washing soda to 12 gallons of very hot water and stirring rapidly. The hot solution should be applied to the contaminated surface.

Washing soda has no serious effect on the skin, eyes, or clothing. Its dust should not be breathed, however, as it is somewhat irritating. If the washing soda solution or dust gets into the eyes, they should be washed with water and dilute boric acid solution.

Washing soda is inexpensive and is safely and easily applied, but is a rather slow-acting decontaminant.

Soaps and Cleansing Chemicals

Soaps and cleansing chemicals, also called detergents and wetting agents, are found in most households. When dispersed in water, they provide a good medium for removal of surface contamination because of their cleansing action.

Soaps and cleansing chemicals lower the surface tension of water, thus increasing its wetting power and permitting the water to loosen contaminated dirt. By this action, persistent war gases, such as mustard gas, are emulsified and carried off. Hot soapy water is good for decontaminating nerve gases. The soapy water is effective as long as suds can be maintained.

An important use of soap is in personnel decontamination. Soaps and cleansing chemicals are used in laundry water to decontaminate clothing. They are also added to water for flushing dirt and grease from contaminated surfaces.

Other Chemicals

Other chemicals that may be used to destroy war gases include ammonia, baking soda, quicklime (or hydrated lime), chloramine-T, dichloramine-T, chlorine, caustic potash, and sodium sulfite.

Other Decontaminants

Explosives

Explosives are of special value for blasting paths through contaminated vegetation such as high grass. Explosives remove only part of the contamination because the ground adjacent to the path cleared by the explosives may remain contaminated. However, people may traverse the path cleared by explosives with reduced danger from liquid contamination.

Organic Solvents

Common organic liquids, such as gasoline, kerosene, motor oil, carbon tetrachloride, and alcohol, are solvents for many war gases. Carbon tetrachloride is toxic and personnel using it in quantity must be masked. Solvents decontaminate by washing the war gases from contaminated surfaces; they do not destroy the war gases. The value of the solvent varies with the nature of the contaminated surface.

Heat

Heat vaporizes war gases. All war gases are less persistent at high temperatures, and heat is used to drive off liquid contamination. Hot air blowing over a contaminated surface decontaminates the surface by evaporating the war gas. Steam, especially from high-pressure application, both hydrolyzes and evaporates war gases. Caution must be observed not to overheat and injure materials that do not withstand heat. Contaminated electrical instruments, (radios, generators, and motors) may be decontaminated by continued operation of the instruments if sufficient heat is liberated during operation to vaporize the war gas.

Protective Measures and Safety Precautions

Protective measures must be taken and safety precautions must be observed by all personnel engaged in decontamination work. *All* personnel *must* be properly masked.

Liquid chemical war gases on the skin should be blotted, and not rubbed off. This is to avoid further penetration. Evacuation to uncontaminated areas should be carried out as soon as practicable, and the advice of medical or other skilled personnel on the treat-

ment of gas casualties should be obtained as soon as possible.

If liquid war gases are present, decontamination personnel in addition to being masked, should wear heavy rubber gloves and boots and have protective clothing. If blister gas vapor is present, all parts of the body should be protected.

In the case of liquid nerve gases, impermeable protective clothing is essential. (An OCDM motion picture entitled "Nerve Gas Casualties and Their Treatment" is obtainable on loan through State civil defense organizations or may be obtained through the Federal Contributions Program.)

Marking Contaminated Areas

Areas contaminated by war gases should be reconnoitered and marked. Large areas are normally evacuated, and warning signs posted on all avenues of approach. The sign should show the date of discovery and indicate the agent, if known. To indicate chemical contamination, the word GAS is printed near the edge of the sign as shown in the figure below. This sign has been approved by the North Atlantic Treaty Organization. Details of contamination markers are given in OCDM Advisory Bulletin 128, revised March 1, 1960.

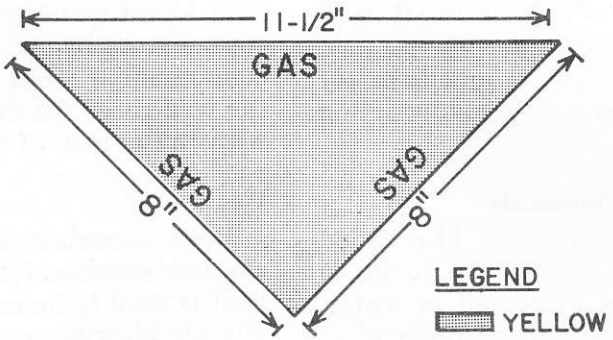

Figure 1.—Front view of Chemical Contamination Marker.

The first four technical bulletins in the Chemical Warfare Defense Series are:

1. *Introduction to Chemical Warfare,* TB-11-25, July 1956.
2. *General Concepts of Chemical Warfare,* TB-11-26, July 1956.
3. *Chemical Warfare Agents of Special Significance to Civil Defense,* TB-11-28, January 1957.
4. *Chemical Agent Detector Kit CD V-810,* TB-11-29, April 1957.

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