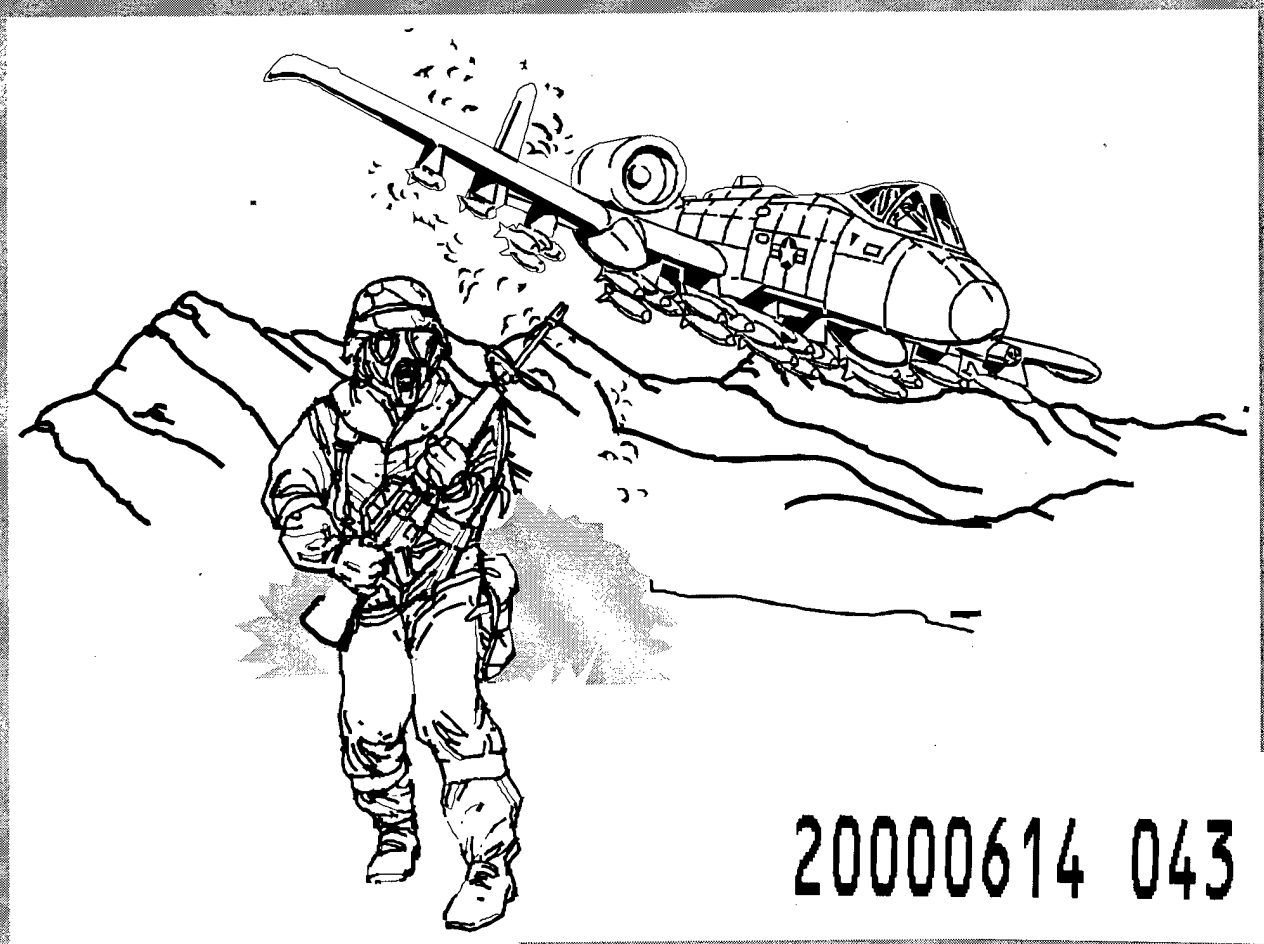
AIR FORCE HANDBOOK 32-4014, Volume 2
1 DECEMBER 1997

USAF OPERATIONS IN A CHEMICAL AND BIOLOGICAL (CB) WARFARE ENVIRONMENT, CB HAZARDS



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AIR FORCE HANDBOOK 32-4014, VOLUME 2
1 DECEMBER 1997

Civil Engineer

USAF OPERATIONS IN A CHEMICAL AND BIOLOGICAL WARFARE (CB) ENVIRONMENT, CB HAZARDS

This handbook implements AFPD 32-40, Disaster Preparedness, and AFMAN 32-4005, Personnel Protection and Attack Actions. AFH 32-4014, Volume 2, provides Civil Engineer Readiness Flight personnel with general information and technical data concerning chemical and biological agents of military interest. Information on planning and analysis, equipment, and defense procedures can be found in Volumes 1, 3, and 4. The information contained in this guide was extracted from AFJPAM 32-4008, Technical Aspects of Military Significant Chemical Agents/Compounds and AFJMAN 32-4009, Technical Aspects of Biological Warfare Agents.

OPR: HQ AFCESA/CEXR (MSgt Steven J. Reed)
Certified by: HQ AFCESA/CEX (Colonel Randall L. Turner)
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Figures

SECTION 1 GENERAL INFORMATION

Introduction

The threat of the use of chemical and biological weapons occurs across the spectrum of military operations. The number of nations capable of developing and possessing these weapons is steadily increasing. Developing nations are receiving these weapons or means to develop them through technological transfer, overt or covert direct transfer, or support to belligerent groups or governments. The potential for their use can range from blackmail or acts of terrorism during peace to escalation during conflict or war.

Historical Precedence and the Threat Today

Chemical and biological (CB) operations are not new. Historical records show previous use of chemicals, smoke, and flame in warfare. In World War I the Allies and the Germans used them extensively. Many nations developed and manufactured agents during World War II, and some have used these agents since then.

Crude forms of biological warfare date back to ancient times. Poisoning of water supplies with rotting carcasses was a common practice. During the late middle ages, corpses of plague victims were catapulted over the walls into the besieged city of Kaffa. History suggests that fleeing survivors of this siege spread the disease that caused the "black death," an epidemic that swept Europe and decimated the population. Both the Spanish and the British introduced smallpox among Indians in the Americas as a means to defeat them.

It is increasingly likely the United States Armed Forces could encounter the use of CB weapons and/or improvised devices at the operational and tactical levels in a regional conflict. Use of these weapons at the operational would be effective against rear area targets such as air bases, as these resources are considered critical to U.S. efforts. Targeting these areas would degrade air operations but would be far enough removed from belligerent forces to permit the use without seriously jeopardizing the attacker's objectives. The objective of a CB attack against U.S. forces would likely be to cause casualties and degrade operations, greatly reducing sortie generation rates and attempting to deny the U.S. the critical advantage of air superiority.

Chemical Warfare Agents and Their Properties

To simplify the medical terminology that may sometimes hinder the understanding of what is taking place as exposure to an agent runs its course, keep the following definitions in mind.

- **ICt_{50}** is the product of concentration of the agent times the length of exposure time to the agent which causes **nonlethal** casualties in 50% of the exposed population; referring to vapor, aerosol, or gas exposure.
- **LCt_{50}** is the product of concentration of the agent times the length of exposure time to the agent which causes **lethal** casualties in 50% of the exposed population; again referring to vapor, aerosol, or gas exposure.
- **ID_{50}** is that dose which produces **incapacitating** effects in 50% of the exposed population.
- **LD_{50}** is that dose which produces **death** in 50% of the exposed population.
- **ED_{50}** is that dose that causes an **effect** in 50% of the exposed population.

Classification of Chemical Warfare Agents

Chemical agents are classified according to physical state, physiological action, and use. The terms persistent and nonpersistent describe the time chemical agents remain a threat in a targeted area. Chemical agents maim, kill, seriously injure, or incapacitate unprotected people. These agents include blood, nerve, choking, blister, and incapacitating agents. Threats to Air Force operations revolve primarily around the persistent nerve and blister agents.

Chemical agents may exist as solids, liquids, or gases. To a certain extent the state in which an agent exists determines its use, duration, effectiveness, and physiological action. The physical state of an agent also contributes to a determination on munitions delivery vehicle and methods used for its dissemination.

Nerve agents, when inhaled, ingested, or absorbed into the body through the skin, inhibit cholinesterase enzymes throughout the body. This inhibition permits

acetylcholine, which transmits many nerve impulses, to collect at its various sites of action. The major symptoms are:

- Pinpoint pupils (miosis); tightness in chest; nausea, vomiting, and diarrhea; and secretions from the nose, mouth and air passages.
- Muscle stimulation with uncoordinated contractions, followed by fatigue and eventual paralysis.
- Disturbances in thought, convulsions, coma, and depression of vital centers of the brain, leading to death.

Blister agents (vesicants) are readily absorbed in both the exterior and interior parts of the body. Agent vapors attack moist tissue. Vulnerable areas include the eyes, mucous membranes, and respiratory tract. These agents cause inflammation, blisters, and general destruction of tissues.

Chemical Agent Effectiveness

Several factors determine the time a chemical agent remains effective. These include the method of dissemination, physical properties of the agent, and environmental factors such as weather, terrain, and target conditions.

The size of the particles disseminated greatly influences the effectiveness of liquid or solid agents. Gaseous (vapors) or aerosols (air-contaminating agents) do not persist as long as liquid or solid agents used to contaminate terrain and materiel. Physical properties of the agent influence the rate of evaporation. Vapor pressure and volatility are especially important in determining the duration of effectiveness of an agent. Gases (vapors), aerosols, and highly volatile liquids tend to disperse rapidly after release. Thus, they present an immediate short-duration hazard. Liquid drops remain a hazard longer than finely divided particles. Also, viscous materials tend to adhere and not spread or flow readily and increase persistency.

In explosive munitions the degree of division depends on the amount and the type of burster charge and the fuzing of the munition (air or ground burst). Nonexploding types of munitions, such as aerosol generators and spray tanks, can vary the degree of dispersion and thereby influence the duration and effectiveness of agents.

Many weather factors influence the duration of effectiveness. The most important are temperature, temperature gradient (stability) and wind speed. See Army FM 3-6 for a detailed discussion of the impact of weather on duration. In general, the

higher the ground or surface temperature, the quicker a liquid chemical agent will evaporate from it. High winds increase the rate of evaporation of liquid agents and also disperse chemical clouds more rapidly than low winds. Stable (inversion) conditions require less munitions to create the same casualty effects as in neutral or lapse conditions. During an inversion, airborne agents tend to remain near the ground, while unstable conditions disperse and dilute vapors due to increased air mixing.

The terrain plays an important part in the duration and effectiveness of an agent at the target. Chemical agents cling to vegetation, increasing the area for contact and slowing evaporation. Low wind speeds and reduced temperatures in heavily wooded and jungle areas will retain vapors longer. Liquids quickly soak into porous surfaces and soils which make them evaporate more slowly than nonporous surfaces. This increases the duration of any vapor hazard, although it reduces vapor cloud concentration. Finally, toxic clouds follow the contour of the surface of the terrain. These clouds tend to go around obstacles such as hills and persist in hollows, low ground and buildings.

Selected Chemical Warfare Agents.

Although not all inclusive, the following pages provide a thumbnail sketch of selected chemical warfare agents that present a likely threat to airbase operations. Nerve agents are provided first followed by Mustards and Arsenical vesicants. More detailed information is available in AFJPAM 32-4008, Technical Aspects of Military Significant Chemical Agents/Compounds, or the Threat Compendium, Worldwide Threat to Airbases: 1995-2005, NAIC-2660F-265-95, 1 September 1994.

Tabun (GA)

GA is a brownish to colorless liquid that gives off a colorless vapor. GA was the first of the nerve agents developed by the Germans before World War II. It enters the body primarily through the respiratory tract, but is also highly toxic when absorbed through the skin and digestive tract. It is approximately 20 times more persistent than GB but not as stable in storage.

Figure 1. Tabun (GA)

Tabun (GA)	
Physical State	Colorless to brown liquid that gives off colorless vapor.
Odor	Faintly fruity; none when pure.
Skin and Eye Toxicity	**Eyes:** Very high toxicity; much greater through eyes than through skin. Very low concentration of vapor (estimated 2.5 mg-min/m^3) causes pupil of eyes to constrict, resulting in difficulty in seeing in dim light (miosis). **Skin:** Very toxic. Decontamination of smallest drop of liquid agent is essential. Liquid penetrates skin readily.
Protection Required	Protective mask and protective clothing. Clothing off gasses G-agents for about 30 minutes after contact with vapor; consider this fact before unmasking. Immediately remove all liquid from clothing.
Decontamination	**Eyes:** Flush eyes with water immediately. **Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. Calcium hypochlorite (HTH), supertropical bleach (STB), household bleach, caustic soda, and diluted alkali solutions are effective on equipment. Use steam and ammonia or hot, soapy water in a confined area. Note: GA may react to form Cyanogen chloride (CK) in bleach slurry.
Persistency	Depends on munitions used and the weather. Heavily splashed liquids persist one to two days under average weather conditions. GA evaporates about 20 times more slowly than water. GA in water can persist about one day at 20^0C and about six days at 5^0C. GA persists about twice as long in sea water.

Sarin (GB)

The Germans developed GB after they developed GA, hence the designation GB. It is a volatile liquid at room temperature. Pure GB is odorless and colorless. The physiological symptoms of GB are essentially the same as those of other nerve agents

Figure 2. Sarin (GB)

Sarin (GB)	
Physical State	Colorless liquid.
Odor	Almost none when pure.
Skin and Eye Toxicity	**Eyes:** Very high toxicity; much greater through eyes than through skin. Very low concentration of vapor (estimated 2.5 mg-min/m^3) causes pupil of eyes to constrict, resulting in difficulty in seeing in dim light (miosis). **Skin:** Lethal dose (LD) is 1.7 grams per person. Liquid does not injure skin but penetrates it rapidly. Immediate decontamination of smallest drop is essential. Vapor penetrates skin also. Death usually occurs within 15 minutes after absorption of fatal dosage.
Protection Required	Protective mask and protective clothing. Clothing off gasses G-agents for about 30 minutes after contact with vapor; consider this fact before unmasking. Immediately remove all liquid from clothing.
Decontamination	**Eyes:** Flush eyes with water immediately. **Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. Calcium hypochlorite (HTH), supertropical bleach (STB), household bleach, caustic soda, and diluted alkali solutions are effective on equipment. Use steam and ammonia or hot, soapy water in a confined area.
Persistency	Depends on munitions used and the weather. Evaporates at approximately the same rate as water or kerosene. GB is less persistent than GA.

Soman (GD)

GD is a colorless liquid that gives off a colorless vapor. Soman is the most poisonous of the G-agents, apparently because of the ease with which it can penetrate into the central nervous system. The physiological effect of GD is essentially the same as that of GA and GB However, after a few minutes, antidotes are not as effective for GD as they are for other nerve agents. The addition of thickeners increases GD persistency and hazard. The usual thickened form of GD is designated TGD. VR-55 is probably another designation for thickened Soman.

Figure 3. Soman (GD)

Soman (GD)	
Physical State	Colorless liquid that gives off colorless vapor.
Odor	Fruity; impurities give it the odor of camphor.
Skin and Eye Toxicity	**Eyes:** Very high toxicity; much greater through eyes than through skin. Vapor causes pupil of eyes to constrict, resulting in difficulty in seeing in dim light (miosis). **Skin:** Extremely toxic by skin absorption. The estimated LD50 is 0.35 grams per person on bare skin (1.4 grams per person in ordinary clothing). Liquid does not injure skin but penetrates it rapidly. Immediate decontamination of smallest drop is essential. Death usually occurs within 15 minutes after absorption of fatal dosage.
Protection Required	Protective mask and protective clothing. Clothing off gasses G-agents for about 30 minutes after contact with vapor; consider this fact before unmasking. Immediately remove all liquid from clothing.
Decontamination	**Eyes:** Flush eyes with water immediately. **Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. Calcium hypochlorite (HTH), supertropical bleach (STB), household bleach, caustic soda, and diluted alkali solutions are effective on equipment. Use steam and ammonia or hot, soapy water in a confined area.
Persistency	Depends on munitions used and the weather. Heavily splashed liquids persist one to two days under average weather conditions. GD is calculated to evaporate about four times as slowly as water. Addition of agent thickeners can greatly increase persistency.

GF (No Common Name)

GF is a fluoride-containing organophosphate. It is a potential nerve agent. It is a slightly volatile liquid that is almost insoluble in water. It enters the body primarily through the respiratory tract but is also highly toxic through the skin and digestive tract. It is a strong cholinesterase inhibitor. It is approximately 20 times more persistent than Sarin.

Figure 4. GF

GF	
Physical State	Liquid.
Odor	No information given.
Skin and Eye Toxicity	Toxicity information reports LD_{50} values in mice from 16 to 400 micrograms per kilogram, compared to LD_{50} of 200 micrograms per kilogram for Sarin (GB).
Protection Required	Protective mask and protective clothing.
Decontamination	**Eyes:** Flush eyes with water immediately. **Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. Calcium hypochlorite (HTH), supertropical bleach (STB), household bleach, caustic soda, and diluted alkali solutions are effective on equipment. Use steam and ammonia or hot, soapy water in a confined area.
Persistency	GF is about as persistent as Tabun (GA). GF evaporates about 20 times more slowly than water. .Heavily splashed liquids persist one to two days under average weather conditions.

VX (No Common Name)

The U.S. standard V-agent is VX. It is a very persistent, odorless, amber-colored liquid, similar in appearance to motor oil. Although VX is many times more persistent than the G-agents, it is very similar to GB in mechanism of action and effects. Because VX has low volatility, liquid droplets on the skin do not evaporate quickly, thereby increasing absorption. VX by this percutaneous route is estimated to be more than 100 times as toxic as GB. VX by inhalation is estimated to be twice as toxic as GB.

Figure 5. VX

VX	
Physical State	Amber-colored oily liquid.
Odor	None.
Skin and Eye Toxicity	Extremely toxic by skin and eye absorption; about 100 times as potent as GB. Liquid does not injure the skin or eye but penetrates rapidly. Immediate decontamination of the smallest drop is essential. The rate of action is very rapid. Death usually occurs within 15 minutes after absorption of fatal dosage.
Protection Required	Protective mask and protective clothing.
Decontamination	**Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. Calcium hypochlorite (HTH) and supertropical bleach (STB) slurries, and household bleach are effective on equipment.
Persistency	Depends on munitions used and the weather. Heavily splashed liquid persists for long periods under average weather conditions. In very cold weather VX can persist for months. VX is calculated to be approximately 1,500 times slower in evaporating than GB.

Vx

Another V-agent of interest is Vx, called "V sub x". Another designation for Vx is "V gas". The properties of Vx are similar to those of VX. It is nearly ten times more volatile than VX but is very persistent in comparison the G-agents. The physiological action, protection, and decontaminants for Vx are the same as for VX.

Levinstein Mustard (H)

Levinstein mustard is the original mustard (gas) of World War I vintage. It contains about 30% sulfur impurities, which gives it a pronounced odor. These impurities lessen the effectiveness of H but depress its freezing point two to five degrees. Other properties of H are essentially the same as those for distilled mustard which is presented on the next page.

Distilled Mustard (HD)

HD is a colorless to amber-colored liquid with a garlic like odor. It has less odor and a slightly greater blistering power than H and is more stable in storage. It is used as a delayed-action casualty agent. HD is heavier than water, however small droplets will float on water surfaces and present a hazard. HD effects are usually delayed 4-6 hours but latent periods have been observed for up to 24 hours. Wet skin absorbs more mustard than does dry skin. For this reason HD exerts a casualty effect at lower concentrations in hot, humid weather because the body is moist with perspiration.

Figure 6. HD

HD	
Physical State	Oily, colorless to amber liquid.
Odor	Like garlic or horseradish.
Skin and Eye Toxicity	Eyes are very susceptible to low concentration; incapacitating effects by skin absorption require higher concentrations.
Protection Required	Protective mask and permeable protective clothing for vapor and small droplets; impermeable clothing for protection against large droplets, splashes, and smears..
Decontamination	**Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. STB and scorching with fire are effective for confined areas.
Persistency	Depends upon the amount of contamination by liquid, the munitions used, the nature of the terrain and the soil, and the weather conditions. Heavily splashed liquid persists for one to two days or more in concentrations that produce casualties of military significance under average weather conditions, and a week to months under very cold conditions. HD on soil remains vesicant for about two weeks. HD is calculated to evaporate about five times more slowly than GB. Persistency in running water is only a few days, while persistency in stagnant water can be several months. HD is about twice as persistent in sea water.

Nitrogen Mustard (HN-3)

Nitrogen Mustards (HN1,2,and 3) are similar to mustard in properties and effects, however it is more volatile and less persistent than mustard. HN-3 is the principal representative of the nitrogen mustards because its vesicant properties are almost equal to those of HD and it is the most stable in storage of the three nitrogen mustards. Because of its low volatility, HN-3 does not constitute a grave vapor hazard to the skin in open air. HN-3 is a liquid that has no odor in its pure form. It is used as a delayed-action casualty agent that has a persistency that is considerably longer than HD.

Figure 6. HN

HN	
Physical State	Oily liquid.
Odor	None when pure.
Skin and Eye Toxicity	Similar to HD. Nitrogen mustards are not detoxified by the body, therefore effects are cumulative.
Protection Required	Protective mask and permeable protective clothing for vapor and small droplets; impermeable clothing for protection against large droplets, splashes, and smears..
Decontamination	**Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. STB and fire are effective for confined areas.
Persistency	Considerably longer than for HD.

Lewisite (L)

Lewisite is the principal arsenical of military interest. It is used as a moderately delayed-action casualty agent with a persistency somewhat shorter than that of HD. When humidity is high, L hydrolyzes so rapidly that it is difficult to maintain a concentration sufficient to blister bare skin. It produces effects similar to mustard with the main difference is that L produces immediate pain. Lewisite warns of its presence by irritating the eyes and skin and has a rapid rate of action. Liquid L causes immediate burning sensation in the eyes and permanent loss of sight if not decontaminated within one minute with large amounts of water.

Figure 7. HN

HN	
Physical State	Colorless to brownish liquid.
Odor	Like geraniums. Very little odor when pure.
Skin and Eye Toxicity	**Eyes:** Even limited concentrations of L vapor cause extreme irritation of the eyes. Burning, pain, sensitivity to light, tearing and swelling of the eyelids result. An exposure of 1,500 mg-min/m3 produces severe and probably permanent corneal damage to the eyes. Liquid L causes severe damage to the eye. **Skin:** L has about the same blistering action on the skin as HD, even though the lethal dosage for L is much higher.
Protection Required	Protective mask and permeable protective clothing for vapor and small droplets; impermeable clothing for protection against large droplets, splashes, and smears..
Decontamination	**Skin:** Use skin decontaminating kit for liquid agent on the skin **Equipment:** Decontaminate individual equipment with the individual equipment decontamination kit. HTH, STB, household bleach, and caustic soda are effective for confined areas.
Persistency	Somewhat shorter than for HD; very short duration under humid conditions.

SECTION 3 BIOLOGICAL WARFARE AGENTS

Classification of Biological Agents

Biological agents can be classified according to their biological type, uses, operational effects, and physiological action. Operationally, biological agents are best thought of as either pathogens or toxins. Pathogens "bugs" are living organisms. As such they require certain conditions of temperature, humidity, protection from sunlight, and a susceptible host population in order to wreck havoc. They must overcome host natural defenses and essentially "set up housekeeping" before illness occurs. This takes time. Therefore, the most likely use of these pathogens will be in SOF, covert, terrorist or other "non-conventional" attack. That way, the target population isn't alerted to the release immediately, the bug has time to spread through a larger population, and identification of the pathogen becomes much more difficult. Toxins are really no different than familiar GA, GD, VX etc. chemical agents. They are chemical compounds produced by some living organism.

Specifically:

Pathogens are disease-producing microorganisms, such as bacteria, mycoplasma, rickettsia, fungi, or viruses. Pathogens are either naturally occurring or altered by random mutation or recombinant deoxyribonucleic acid (DNA) techniques.

Toxins are poisons naturally produced through the metabolic activities of living organisms such as proteins, polypeptides, and alkaloids, that come from microorganisms and various plants and animals. Although toxins were initially isolated from living organic sources, manufacture of some by chemical synthesis or other biochemical process is feasible. Industrial fermentation processes can obtain large amounts of highly concentrated bacterial toxins.

Biological Agent Effectiveness

General factors:

The duration of effectiveness of a biological agent refers to the persistency of the agent in the environment. It depends on the characteristics of the agent, the influence of environmental factors, and any residual hazard generated through resuspension of settled biological particles by the movement of wind, vehicles or personnel in the affected area. Solar (UV) radiation, relative humidity, wind speed

and temperature gradient are the most important weather factors in determining duration of effectiveness. UV light affects most biological pathogens and some toxins.

Biological agents may be disseminated as aerosols, liquid droplets (toxins only), or dry powders. To a certain extent the state in which an agent normally exists determines its delivery state, use, duration of effectiveness, and physiological action. It also determines the type of system used for its dissemination. Live microorganisms usually grow in a moist environment. Therefore, these agents lend themselves to dissemination in a liquid medium as wet aerosols. However, technology exists to store microbiological materials as a powder. Dissemination of spores and certain toxins as dry powders is likely. Many toxins are water soluble, and dissemination could be as sprays or wet aerosols. In general, agents disseminated as a dry powder will survive longer than those disseminated as wet aerosols.

Pathogens: Because pathogens are living organisms (exhibiting feeding, excretory, respiratory, reproductive, and defensive functions) any factors that reduce their viability will reduce the duration of effectiveness.

Toxins: The duration of effectiveness of a toxin relates to its physical properties, however vapor pressure or volatility are not as significant factors for biological agents as for the more familiar chemical agents. Some toxins(for example, Staphylococcus enterotoxin, Type B) are stable in the environment and are more resistant to heat, hydrolysis, or vaporization than G or V nerve agents. The chemical structure of toxins can strongly influence the stability of the agent to environmental factors. High-molecular-weight toxins, such as proteins, are usually more sensitive to ultraviolet (UV) light, heat and oxidation than low-molecular-weight, nonprotein toxins. Many toxins are water soluble. Impurities in crude toxin cultures can stabilize the toxins and/or enhance toxicity.

Selected Biological Warfare Agents

The following pages provide a thumbnail sketch of selected biological warfare agents that present a likely threat to airbase operations. More detailed information is available in AFJMAN 32-4009, Technical Aspects of Biological Warfare Agents.

Pathogens:

Anthrax

Anthrax, a bacteria is primarily a disease of cattle and sheep caused by the spore-forming bacteria Bacillus anthracis. Respiratory anthrax, caused by inhalation of air-borne anthrax spores is the dominant biological warfare threat. Remarkably little anthrax is necessary to infect. Anthrax spores are destroyed in a matter of hours by sunlight, but air-borne spores are remarkably stable at night. Spores in soil survive for years. Anthrax has a primary military potential as an anti-personnel agents.

Figure 8. Anthrax

Anthrax	
Physical State	Biological warfare agent anthrax can be liquid slurry or dry powder. In either case it will be converted into air-borne particles for BW attack. These will seldom be visible
Effects	The symptoms of respiratory anthrax appear as soon as two days after exposure, or possibly as late as 30 to 60 days after exposure. Early symptoms are flu-like. Once symptoms appear breathing becomes more difficult, fever and weakness worsen over the next 2 days. Coma can develop. Victims usually die within three to four days of symptom development.
Protection Required	Vaccination produces a substantial level of immunity to anthrax. Individual Protective Ensembles provide physical protection against biological agents. Biological weapons produce ground-level clouds of air-borne BW agent particles that move with the wind. IPE protection requires that you be in it before the agent cloud arrives, and stay in it until the cloud has completely cleared the area. Good mask fit and careful mask donning are imperative. Early treatment with antibiotics can cure respiratory anthrax. Well developed cases respond less favorably.
Decontamination	Personal decontamination with towelettes is required at the time of removal of the IPE. Anthrax deposition near the point of munition function is substantial, justifying thorough decontamination. Further downwind deposition is minimal. Skin contact with low level anthrax contamination is not highly dangerous. Because they are proteins, heat, acids, or alkalies can be used for detoxification. Chlorine can be used.

Brucellosis

Brucellosis is produced by any of several variants of the bacterium Brucella (Brucella suis, Brucella melitensis, Brucella abortis). These Brucellas are primarily diseases of domesticated animals. Biological warfare infection with the agent is designed to result from inhalation of air-borne Brucella organisms. Very little Brucella needs be inhaled to produce an infection, but Brucella does not survive exceptionally long when air-borne. Nighttime dissemination is therefore preferred. Brucella is expected to soon be part of a number of BW arsenals.

Figure 9. Brucellosis

Brucellosis	
Physical State	Brucella can be prepared for Biological warfare use as dry powders or liquid slurries
Effects	A period of weeks is common between exposure to Brucella and the first onset of symptoms. The symptoms are nonspecific. Fever, chills, listlessness, sweats, weakness, joint and muscle pain are usually reported. The symptoms last for months, even with treatment. Brucella are highly infective, but do not withstand the rigors of air-borne transmission and environmental exposure well.
Protection Required	Although there is no US vaccine for Brucellosis, the organisms respond to a number of antibiotics. The disease is not communicable from man to man. The primary means of infection is through inhalation of air-borne organisms, therefore mask protection is of critical importance. Other means of transmission is through ingestion of unpasteurized dairy products and uncooked meats.
Decontamination	Contaminated materials are easily sterilized or disinfected by common methods such as Chlorine. Pasteurization and proper food preparation is effective for contaminated meats and dairy products..

Plague

Plague, or Black Plague, is a disease caused by the bacteria Pasteurelia pestis. It occurs as three primary types in man: bubonic, septicemic, and pneumonic. Plague is transmissible to man by the bite of an infected flea, or from man to man by the respiratory route. Like other common BW agents, it relies on inhalation of air-borne organisms for infection. The disease naturally occurs in many parts of the world. The plague is moderately infective by inhalation, but not very hearty once released into the environment, nor does it seem to penetrate intact skin easily. Antibiotic resistant strains are possible.

Figure 10. Plague

Plague	
Physical State	Biological warfare agent preparations can be in the form of water-based slurrys, or possibly dry powder. Dry forms are more efficient, but more difficult to prepare.
Effects	Inhalation (pneumonic) plague symptoms typically appear two to three days after inhalation of the organism. The onset is abrupt, with fever, chills, headache, cough and rapid heart rate. Sputum is blood-flecked, later pink to red. Most untreated patients die within 48 hours of symptom onset.
Protection Required	USAF personnel have, for some time been vaccinated against Plague, not so much as a biological warfare defense as a defense against exposure to the organism during deployment to naturally plague-ridden areas. IPE provides physical protection against the organism. Since large amounts of the agent are released from typical BW munitions, good mask fit is essential. Antibiotics provide a third tier of protection against this agent. Antibiotic use within a few hours of symptom development reduces the fatality rate to less than 5%.
Decontamination	The organism is killed by exposure to heat at 130° F for 15 minutes. Decontamination can be effected by boiling, dry heat above 130° F, steam, or treatment with lysol or chlorine.

Tularemia

Tularemia is also known as rabbit fever. It is produced by the bacterium Francisella tularensis. Like most BW agents F. tularensis is typically prepared for air-borne dissemination. F. tularensis is not a spore forming organism, and is not extremely stable when released into the environment. But it is highly infective. It is best released at nighttime. Some isolates produce few enough fatalities to be considered incapacitating agents.

Figure 11. Tularemia

Tularemia	
Physical State	BW Tularemia preparations can be either wet slurries or dry powders
Effects	Symptoms appear within 4 to 7 days of inhalation of airborne F.tularensis. They include the sudden onset of fever, chills, cough, headache, with a tendency for pneumonio do develop.. Untreated, the disease has a fatality rate of approximately 30%, and may last for months. When treated with antibiotics the fatality rate is less than 1%.
Protection Required	F. tularensis responds to any of several antibiotics. And although the Department of Defense has an experimental vaccine that has been successfully used with several thousand subjects there are no immediate plans for its widespread use. As with other BW agents, IPE, most notably the protective offers considerable physical protection against airborne agent.
Decontamination	F. tularensis is easily killed by heat at 113°F or above for a few minutes or by 0.5 percent phenol in 15 minutes. Chlorine can be used as a decontaminant.

Smallpox

Smallpox is an infective human disease caused by the virus Variola. The virus ranges from 0.15 to 0.2 micron in size and can pass through most filters. It has been eradicated in nature. The last natural case occurred in Somalia in October 1977. The virus has no known animal reservoirs. It survives in various laboratories, and presumably in biological warfare arsenals. There are many related animal pox viruses; however, it is unlikely that these will cause severe effects in man.

Figure 12. Smallpox

Smallpox	
Physical State	Biological warfare preparations of variola virus can, presumably, be prepared in liquid slurry or fine dry powder.
Effects	Smallpox is a highly contagious disease. Fever, headache, backache, and prostration the first symptoms of the disorder, appear seven to seventeen days after exposure. A rash typically appears within two days of the onset of fever. Over the next few days the rash converts to pus-filled blisters (Pustules), scab over, and the scabs separate in weeks two and three of the disease. The rash is easily identifiable as smallpox. Case fatality rates of 30-35% are common for the more virulent of the variola strains.
Protection Required	Vaccination provides an effective, long-lasting protection against small pox. However few people born since the mid 1970s have been vaccinated (the disease was eradicated in 1977). IPE provides a significant level of physical protection. Biological warfare uses of smallpox are expected to rely on respiration of air-borne virus particles, implying that mask protection is of particular importance.
Decontamination	Decontamination can be accomplished by exposure of the organism to alcohol and acetone for 1 hour at room temperature, or chlorine, but the virus is resistant to some other disinfectants. Moist heat above 140°F and dry heat above 212°F are effective in 10 minutes.

Viral Encephalitis

Viral encephalitis is caused by any of several viruses. Some common encephalitis viruses are Venezuelan, Eastern and Western Equine Encephalitis viruses, St.Louis Encephalitis, and Japanese Encephalitis. Many infections by these viruses result in relatively mild illness. However, a percentage of infected people develop central nervous system involvement (encephalitis and/or meningitis). These cases are severe and may be fatal.

Figure 16. Viral Encephalitides

Viral Encephalitides	
Physical State	Viral Encephalitides can be prepared as either a liquid slurry or as a dry powder. These agents will likely be dispersed as an aerosol to create an inhalation hazard. Use of infected insects is another possible means of disseminating these viruses.
Effects	Headache, drowsiness, fever, vomiting, and muscle pain are the usual initial symptoms for these viruses. Tremors, mental confusion, convulsions, and coma may develop rapidly in cases of CNS involvement. Paralysis of the extremities occurs occasionally. Fatality rates depend upon specific strain of virus, but are usually low. The incubation period for Venezuelan Equine Encephalitis, a typical member of this group, is 2 to 4 days with the acute phase of the disease lasting 2 to 6 days.
Protection Required	Vaccines for several of the viral encephalitides are available on a limited experimental basis. The IPE provides effective protection against aerosols of these agents. As these agents are likely to be disseminated as an aerosol, good mask fit is important.
Decontamination	Personal decontamination of individual equipment should be performed after De-Warn. Standard decontaminants and methods are effective with these viruses. Contact with low level contamination is not generally considered a great hazard unless the agent is re-aerosolized.

Q Fever

Q Fever is the disease caused by the rickettsia Coxiella burnetti. It is maintained in nature as inapparent infections in domestic animals such as cattle and sheep. Transmission is usually by infective aerosols. The disease can also be spread by ticks.

Figure 17. Q Fever

Q Fever	
Physical State	Q Fever may be prepared as either a dry powder or as a liquid slurry. It will be dispersed as an aerosol to create an inhalation hazard.
Effects	Q Fever has an incubation period of 2-3 weeks. Onset of symptoms is abrupt with acute fever, headache, chills, weakness, and profuse perspiration. A nonproductive cough is common. Acute phase of the disease may last 1 to 3 weeks. Mortality rate is less than 1% even in untreated patients. Acute Q Fever responds well to antibiotic treatment. Chronic forms of the disease may respond poorly to antibiotics.
Protection Required	An experimental vaccine effective against Q Fever is available on a limited basis. Acute forms of Q Fever respond well to antibiotics. Antibiotic treatment will usually shorten or eliminate period of incapacitation in infected personnel. The IPE provides effective protection against aerosols of Q Fever. As Q Fever is highly infective by inhalation, good mask fit is imperative.
Decontamination	Q Fever organisms are very persistent in the environment and are hard to kill. They can survive for months in soil. Standard decontamination methods may not be entirely effective in disinfecting Q Fever, but can at least remove the organisms. Personal decontamination of individual equipment should be performed after De-Warn. Thorough decontamination should be performed as soon as feasible.

Toxins:

Botulinum Toxins

Botulinum toxins, the cause of botulism food poisoning, are a family of high molecular weight neurotoxins produced by the bacteria Clostridium botulinum. Botulinum toxins are lethal, considerably more poisonous than nerve gases, and are among the most toxic substances known to man. The type A toxin is the most potent of the toxins produced by this organism. BTA is the dominant toxin threat agent and would likely be used as an aerosol to create an inhalation hazard.

Figure 13. Botulinum Toxins

Botulinum Toxins	
Physical State	Botulinum toxins can be prepared as either a dry white powder or as a liquid slurry. It is stable in solution up to seven days when protected from heat and light.
Effects	Botulinum toxins act by preventing the release of acetylcholine, a neuromuscular transmitter chemical. This results in extreme muscular weakness, malaise, dilation of the pupils, blurred vision, and dizziness. Respiratory paralysis and cardiac arrest occur in lethal cases. Symptom onset occurs in 12 to 72 hours. Recovery in survivors may take months.
Protection Required	An experimental vaccine effective against Botulinum toxins type A, B, C, D, and E is available and was used on limited basis during Operation Desert Storm. There is a polyvalent antitoxin available for treatment of botulinal intoxication. It may not be available in quantity, however, and needs to used very soon after intoxication. The individual Protective Ensemble (IPE) provides effective protection against toxins disseminated as an aerosol. As Botulinum will probably be dispersed as an aerosol, good mask fit and careful mask donning are imperative.
Decontamination	Basic skills decontamination for personnel would prove effective on neutralizing this toxin. The toxin can withstand acids, but chlorine or other alkaline solutions can destroy it. This toxin is sensitive to heat. Boiling for 15 minutes or, when in food, cooking for 30 minutes at 175°F will destroy it.

Staphylococcal Enterotoxin, Type B (SEB)

Various bacteria produce toxins that induce fever, vomiting, and diarrhea. These toxins, called enterotoxins, are a common cause of food poisoning. They are militarily important as they cause incapacitating effects at very low doses. One of the most potent of the bacterial enterotoxins is Staphylococcal Enterotoxin type B (SEB). This toxin is produced by certain strains of the bacteria Staphylococcus aureus.

Figure 14. Staphylococcal Enterotoxin, Type B (SEB)

Staphylococcal Enterotoxin, Type B (SEB)	
Physical State	SEB can be prepared as either a dry powder or as a liquid slurry.
Effects	Intoxication by SEB causes fever, nausea, vomiting, abdominal pain, and watery diarrhea. While SEB is generally considered an incapacitating agent, fatalities will occur in cases of high doses. Symptoms usually occur within one-half to six hours (average three hours) after ingestion. Symptoms cn appear within a few minutes after exposure to large doses by aerosol. Incapacitation is brief, usually one day or less.
Protection Required	There is no specific treatment for SEB intoxication, therefore physical protection is imperative. As SEB will likely be disseminated as an inhalable aerosol, good mask fit important.
Decontamination	Use large amounts of soap and water to decontaminate personnel, equipment, and supplies. SEB is difficult to decontaminate with active chlorine (STB, HTH). Formaldehyde detoxifies SEB.

Ricin

Ricin is a lethal, delayed-action cytotoxin. The toxic properties of the castor bean have long been known. The active toxin in castor beans is the toxin ricin. This is a high molecular weight protein toxin that is highly toxic. Forms of ricin that could be used as a warfare agent range from crude castor bean cake to a highly purified extract.

Table 15. Ricin

Ricin	
Physical State	Ricin can be prepared as either a dry powder or as a liquid slurry.
Effects	Inhalation of ricin causes a severe hemorrhagic pneumonia. Initial symptoms usually appear between six to ten hours and three days. The first symptoms are nause, vomiting, bloody diarrhea, abdominal cramps, breathing difficulty, renal failure, and circulatory collapse. In survivors of serious exposures, hospitalization of 10 or more days may be required. Death in may occur a few days after exposure.
Protection Required	Antitoxin is available; its early administration is necessary to prevent severe tissue damage, therefore physical protection is imperative. IPE provides effective protection as ricin will likely be disseminated as an inhalable aerosol, good mask fit is important.
Decontamination	Personal decontamination of individual equipment should be performed after De-Warn. Use soap and water to remove contamination from personnel, equipment, and supplies. Chlorine can be used as a decontaminant.

WILLIAM P. HALLIN, Lt General, USAF
DCS/Installations and Logistics