(BEWARE 4) 33/5

O R E G O N S T A T E D E F E N S E C O U N C I L

MANUAL FOR

GAS RECONNAISSANCE OFFICERS

Compiled by
Civilian Protection Division
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The material contained herein consists of lectures presented at the series of State Gas Schools conducted by the Oregon State Defense Council during the months of June, July, August 1943.

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In addition to the lecture material contained three hours of field exercises were included in the course of instruction.

NON PERSISTENT AGENTS

The first two talks that you will be asked to listen to will deal with the general descriptions of chemical agents which have been tried and have been found to be suitable against armed forces or civilians. Chemical warfare, of course, is not new; it is as old as recorded history. The early warriors used pitch brands and sulphur and other such nauseating and foul-odored materials which could be projected against their enemies to make them give up more easily.

On April 22, 1915, the Germans released chlorine gas against the French and Canadians at Ypres in Belgium. The Germans were in a very favorable position at the time of the releasing of the gas. They were entrenched at the top of a hill; the Allies at the bottom of the hill. The wind was blowing over the German trenches toward the Allies downhill. The Allies were unprepared; their casualties were heavy. A number of thousands were killed and other thousands made casualties. The gas phase of the first World War continued with the French and British attempting to retaliate with other gases, mostly without success. The French in particular tried to release hydrogen cyanide (the gas used in lethal chambers) against the Germans and to the best of anyone's knowledge the results were completely nil. The assumption was made that if it was so extremely poisonous, it could be used as a chemical agent in warfare. As you well know, mustard gas was later developed and became known as the king of gases. Phosgene was repeatedly used during the last war by both sides. Lewisite was developed in America but was not used in combat. So with that very brief outline, I want to go into my own subject, namely, that of non persistent agents.

Chemical agents are classified in many ways depending upon what property is under consideration. Persistency lends itself as a basis of classification and upon this basis we divide gases into two classes: persistent agents and non persistent agents. By persistency is meant the length of time a gas will remain in casualty-producing concentration at the point of release. Persistent agents, which will be discussed by Dr. West, are agents which will produce casualties thirty minutes or longer after release, at the point of release. In fact persistent agents may continue to exist at casualty-producing concentration for several weeks. The non persistent agents are those which are casualty producing agents for a period of less than thirty minutes. Of course you recognize that this thirty minutes dividing line is arbitrary, perhaps we could have divided on twenty five minutes or thirty five minutes or some other value. The line of demarcation is rather pointless because there are very few non persistent gases whose persistency lasts for thirty minutes. The persistent agents persist for longer than thirty minutes and the non persistents for much less than thirty minutes. The non persistent agents are frankly of not too great interest to us in Civilian Defense but for the record it is important to name them and discuss their characteristics.

When one thinks of a non persistent war gas, the first one which comes to mind is chlorine (the chemical warfare symbol of chlorine is CL). In Continental Europe, it is called Yperite. Chlorine is a yellowish-green gas two times as heavy as air; it has a choking, nauseating odor and its principal effect is upon the lungs. It irritates the lung tissue but it is not breathed deeply into the lungs. It causes intense coughing and is a definite injurant to the respiratory tissues; its delayed after effects often times include pneumonia and sometimes death.

Phosgene, (chemical warfare symbol CG) is a much more effective war gas than is chlorine. It is a highly volatile liquid having the odor of new mown hay, freshly cut corn, or ensilage. Phosgene has the property of being breathed far deeper into the lungs than chlorine. It produces more deep and lasting injury to lung tissue.

In fact phosgene goes to the limits of the bronchial tree to the area where the carbon dioxide is taken out of the blood and exchanged for oxygen. It stops the gas exchange which of course is equivalent to suffocation. Moreover, it injures the tender respiratory tract tissues and the body behaving as it normally does tries to heal those injuries. Most of you have scraped the skin from your hand or barked a knuckle. You know that a thick white fluid appears quickly. The same process takes place in the lungs. That more or less thick colorless fluid is blood plasma, and one of its purposes is to heal wounds. If the lungs are badly hurt, plasma flows into the lung in such quantity that the lung fills up. Thus the victim literally drowns in his own juice. And if that were not enough, if the victim has not already suffocated or drowned then the blood which is getting thicker and thicker all the time, due to loss of its plasma, is becoming hard to pump through the system thus overtaxing the heart. This may result in heart failure. The results of phosgene poisoning are delayed sometimes for four or five days, always for a number of hours and due to the rather pleasant odor of phosgene one may inhale considerable quantities of the gas without realizing it. Thus the individual who has been gassed with phosgene tends to minimize the danger that he has been subjected to. Phosgene does not produce much coughing, because it goes down so deeply into the lungs. The victim is not in much pain. He goes on and maintains his normal actions. The victim keeps on using up his energy until the effects finally do set in; the effects of the gas are more severe with this individual than would have been the case had he rested. You will be told more about these effects this evening when the medical aspects of gas warfare will be discussed. The victim should get out of the gassed area and not exert himself. He should take mild stimulants and should be under a doctor's care.

Another non persistent agent which has been used and which I will mention in order to complete your records on the subject is chlorpicrin. The chemical warfare symbol is PS. Chlorpicrin is a highly volatile liquid having the general odor of licorice or fly paper. Chlorpicrin is a lung irritant. It produces some crying, but its principal reaction is to produce nausea. Within a few minutes after breathing chlorpicrin, it produces an intense desire to vomit. It was for that purpose it was used in the first World War. It was used by the Germans in connection with phosgene. First a few shells of chlorpicrin were laid down. The chlorpicrin would be breathed by the men before they were able to mask and many would have breathed so deeply of it that the nausea would overtake them soon after they had masked. With the old type of masks (with the nose clip and tube in mouth) the more mechanics of vomiting were disagreeable and hampered, so men would unmask. During the time they were unmasked they breathed a great deal of phosgene which had been sent over immediately after the chlorpicrin.

Some other non persistent agents are tear gases (one of which we will have a great deal of experience with in the field tomorrow) with the chemical warfare symbol CN. These agents or gases have rather characteristic odors. You will smell them tomorrow and become impressed with the odors. The only physical effect is crying. To the best of my knowledge I have never heard of a more serious casualty being caused by tear gas. Another agent which is classed as non persistent is adamsite, one of the sneeze gases. Sneeze gases or sternutators are finely divided solids which can be dispersed in air and which get into the nasal passages and produce intense sneezing. A soldier cannot hold a very good aim if he is sneezing.

There are two points which I would like to emphasize: First, I have minimized the value of chlorine. However, had I written the chemical formulas of all the war gases you would have noticed that they all contain chlorine as a component. Chlorine will not be used in chemical warfare except as a component of other chemical agents and as such it lends itself to more deadly and efficient use than in the pure form. Secondly, I want to call to your attention what persistency or non persistency depends upon. We talk about "gases"; we are afraid of a "gas attack". If we would be subjected to such an attack the warden would shout "GAS"! The word "gas" has a strong hold upon our vocabulary. Now, to the chemist, the word "gas" has a particular significance. It is a state of matter in which the molecules have no essential attraction for one another, in which the molecules are far separated and are moving at high speed. Such substances as oxygen, hydrogen, etc. are gases. Air is a mixture of gases. With the exception of chlorine none of the agents that I have mentioned belong in the category of true gases. Practically all chemical warfare agents are either liquids or solids, however, the word "gas" persists in describing these agents. Without doubt this is because chlorine which is a true gas was the first agent to be used in modern chemical warfare. The word was justified at that time.

Persistency is based upon the volatility and density of the chemical agents, most of which are liquids. Imagine with me an experiment. Suppose on the street we should pour out a cup of gasoline. The street is rather warm. If you would pass by there in a few minutes you wouldn't see any evidence of the gasoline having been there. The gasoline molecules would have danced around and disappeared into the atmosphere. Suppose also that on a spot near there we should pour a cupful of lubricating oil. Even if it were an extremely hot day followed by a number of equally hot days it would take a long time for the oil to disappear. This difference between gasoline and lubricating oil illustrates the difference between persistency and non persistency. Gasoline is a more volatile substance than lubricating oil. Gasoline would be a non persistent agent, the lubricating oil would be a persistent agent.

Now for a brief recapitulation:

Chemical agents are either persistent or non persistent depending upon their volatility. More than likely, such chemical agents as are used will be persistent agents. The word "gas" is definitely misused; the term "chemical agent" should be substituted. War "gases" are generally volatile liquids sometimes even solids. I have attempted to describe some general characteristics and some physiological effects of the principal non persistent agents.

There is one thing more which might be of interest to you. I will list along with the names of the agents certain symbols which the Chemical Warfare Service has chosen to represent these agents. In order to keep those symbols in mind some individual has taken upon himself to paraphrase many of them by taking descriptive words of the same initial letters as in the chemical warfare symbols. For example: CG, the chemical warfare symbol for phosgene is described as Choking Gas, certainly a descriptive term. PS, chemical warfare symbol for chlorpicrin is remembered as, Puke Stuff; tear gas which is represented by CN, Cry Now. Adamsite with the symbols DM is described as Dirty Mixture.

PERSISTENT AGENTS

GENERAL PROPERTIES

It has been pointed out that persistent agents are those that will linger for about fifteen minutes or longer in an area after being dispersed. One of the chief properties that distinguishes persistent from non-persistent agents is the greater density of the persistent agents. Most of these agents are liquids under normal conditions. These more dense liquids do not evaporate as readily as the less dense. In a like manner dense lubricating oil does not vaporize as readily as gasoline under the same conditions.

The high persistency of an agent effects not only the methods of its use in warfare, but also the protective measures to be taken against their use. It is important to realize that the maximum concentration of vapor arising from a persistent liquid agent in any area is not likely to be as great as the concentration of vapors near an exploded gas shell of a non-persistent gas agent. The lower concentration of vapors from the persistent agent is due primarily to its greater density.

It is equally important to realize that since the persistent agents do not evaporate as readily they will therefore remain in the area for a longer period of time.

The physiological effect of breathing persistent agents is quite like those which Dr. Dedrick described for non-persistent agents. An added general property is the vesicant or blister producing ability of the persistent agents. Such action may result from exposure to the vapor or from direct contact with the liquid on the skin.

A less likely manner in which persistent agents may cause injuries by the swallowing of saliva or food contaminated by the agent.

The most likely persistent agents to be used appear to be mustard, lewisite, and a group of gases called nitrogen mustards.

MUSTARD

In the spring of 1917 all the warring nations had quite adequate masks for protection against all the gases being used. That fact lead to a stalemate. To break this stalemate the Germans secretly developed mustard gas, the blister gas which has come to be known as the king of all war gases. Its first use was in July, 1917, the first attack was all over hours before any injuries were apparent. This insidious character of mustard was capitalized upon to the fullest extent. Used nightly for two to three weeks 14,000 casualties were produced, 500 of them dying. The effectiveness of the gas is further shown by the British statistics, 77% of their gas casualties being due to mustard.

The Allies were not prepared for the use of such a gas. They were obviously impressed by its properties and replied in kind as soon as they could but that was 11 months later.

Pure mustard is a colorless oily liquid. However the technical product likely to be used is a dark brown fluid resembling the appearance of used crank case oil. The U. S. Chem. Warfare service calls it H. S. "hot stuff". Its odor, due mainly to its impurities, is usually described as that of garlic, although to some it resembles mustard, horse radish, or like a "greasy hamburger joint". Its odor may be easily masked if it is mixed with some other agent. Thus to rely solely on the sense of smell to identify a gas may lead to an erroneous conclusion which might delay proper medical treatment. The density of liquid mustard is one and one-third times as heavy as water. The liquid is slightly soluble in water. When the two liquids are together the mustard sinks to the bottom. Liquid mustard freezes at 56° F. Since solids tend to evaporate slower than liquids, some solvent or another liquid war gas is generally put with the mustard to keep it in the liquid state at all temperatures likely to be encountered. Japanese prisoners have been reported to be carrying grenades filled with a mixture of mustard and lewisite.

Mustard is soluble in organic solvents such as kerosene, gasoline, alcohol, etc. It is readily absorbed by all porous materials; e. g. clothing, soil, leather, bricks, cement, wood and even rubber to some extent. Even iron is attacked to some extent. Skin absorbs it almost as readily as if it were a blotter. If the weather is warm, liquid mustard will persist on the ground for about one week. After that time most of it has been neutralized by moisture or it has vaporized, or it has been oxidized and thus destroyed by the air. Persistency will be greater in cooler weather and in sheltered areas where sun and wind does not have access to it. Persistency will obviously also depend upon the original quantity and concentration. When small amounts are covered with water more than half is neutralized after 24 hours. Hot water will neutralize it faster than cold.

The chemical which reacts with and thus neutralizes mustard more rapidly than most others is chloride of lime, sometimes called bleaching powder. The reaction with the dry powder is so violent that smoke or flame results. A water slurry of bleaching powder is also very effective. The common household bleach such as Clorox or Purox is also an excellent material to neutralize the gas.

When mustard reacts with water an acid is formed. Thus the reaction will be more rapid if an alkaline substance is added to neutralize this acid. Lye, sodium hydroxide, washing soda, and strong soap are all alkaline and therefore may be used to neutralize mustard. Soap serves a double purpose since it also removes the oily liquid by emulsifying it just as soap is used to remove oil and grease from the hands.

The greatest danger of mustard gas is not from its blister producing qualities but rather its effects on the respiratory system. There are no immediate effects but after a delayed action of from 2 to 48 hours (usually about 12 hours) a sore throat, loss of voice, a hoarse cough, or pains in the chest develop. In more severe cases there will be bloody sputum, and hemorrhage from the nose, throat and lungs. Secondary effects such as bronchitis, edema and pneumonia are frequent after the mucous membrane of the throat has been "burned" by the gas. In World War I, most hospital cases were cured and the men sent back to the troops after 4 to 8 weeks.

The effects noticed after exposure to mustard vapors, after the delayed action, is a smarting of the eyes, nose, or the most tender parts of the skin. The time of the delayed action is from 2 - 24 hours, usually about 12, but it depends to some extent upon the individual. Blondes are generally more sensitive than brunettes, negroes are very resistant to burns.

The liquid agent, being much more concentrated than the vapors, usually produces more serious burns. After the delayed action a reddened area develops. A blister then forms in the middle of the area. This is surrounded by a reddened area, thus differing from a lewisite blister. The liquid in the mustard blisters is not vesicant.

The time of absorption of the liquid into the skin depends upon the particular portion of the skin and to the concentration of the agent, but is generally a matter of only minutes, and after that length of time the mustard has already done its damage to the skin. Vapors or the liquid agent will also be absorbed by the eyes, causing inflammation.

The burns resulting from a vesicant agent are quite like those of a thermal burn or the burns from poison ivy. Whereas the mustard burns may mean hospitalization they by no means mean death. In the first world war there were probably no deaths resulting directly from blisters. Major Tegnell, now at Fort Stevens, has told some of us his experience in having liquid mustard on his hand for fifteen minutes. Whereas serious burns resulted he still has his hand in good shape.

A less likely method of injury from mustard than from breathing vapors or getting skin burns, is to swallow saliva or food that has been contaminated by the gas. If very much is present in the mouth its taste would be warning enough. However, the accumulative effect of swallowing only small amounts will lead to abdominal pain, nausea, diarrhea and general weakness of the body.

Repeated exposure of skin to mustard vapors makes the skin on the hands very tender so that it is frequently broken by seemingly insignificant bumps or by rubbing.

LEWISITE

Lewisite was prepared by an American, Lewis, and by a German at about the same time in 1918. The Germans were apparently not greatly impressed by its properties and did nothing further about it but the Allies prepared it in large quantities. When the Armistice was signed the first shipment had not yet reached Europe. Consequently we do not have casualty statistics to compare to mustard casualties. But on the basis/of its properties we believe it is superior to mustard in some but not all respects.

Our chemical warfare service calls it M 1. It has been dubbed "Moan One" or "Mustard Imitator". The pure product is a colorless oily liquid, nearly odorless. However the technical product likely to be encountered in warfare has a strong fragrant odor of geraniums even from only a trace of the agent. It has a lower boiling point than mustard which accounts for its being less persistent than mustard. If the liquid is sprayed on open ground in warm weather the agent would disappear in less than 24 hours. One of the chief disadvantages of lewisite as a warfare agent is its rapid reaction with water. For that reason it cannot be used to advantage in foggy damp weather. The product formed by the reaction with water is a white solid, insoluble in water, non-volatile, but is still a vesicant agent. However the blister producing qualities of this hydrolysis product is not as great as the original lewisite. The agent is soluble in, or is absorbed by, the same materials as mustard. Kerosene and other solvents dissolve and dilute but do not destroy the agent.

When lewisite reacts with water it also produces hydrochloric acid the same as does mustard. Therefore any alkaline agent will hasten the reaction destroying the agent. In this case the products produced are water soluble and non-vesicant. However, the reaction with an alkali does produce an arsenic compound which should be washed away with lots of water.

Hydrogen peroxide neutralizes lewisite very readily-- bleaching powder does so only slowly.

The presence of the element arsenic in lewisite adds an additional method by which one may be injured by this agent. The liquid lewisite or its vapors are readily absorbed into the skin thus introducing arsenic (systemic) poisoning into the blood in addition to producing other physiological effects on the lungs and skin much the same as mustard.

Lewisite has less delayed action than mustard. Liquid lewisite will be absorbed by the skin more readily than mustard, usually in about 3-5 minutes. Reddening of the skin results in 30 minutes. The affected area darkens after 3 hours. In 12 hours many small blisters form and after 24 hours the small blisters grow into one large blister. The blister is not surrounded by a reddened area, thus differing from a mustard blister. The lewisite generally burns deeper than mustard, going into muscle as well as fatty tissue. The fluid in the blister contains arsenic and is vesicant. Arsenic in the system produces nausea, vomiting, and diarrhea.

If liquid lewisite gets into the eyes extreme lacrimation results. The accompanying odor in this case is likely to be missed and the victim may believe he has been exposed to only a tear gas.

NITROGEN MUSTARDS.

Less than a year ago Civilian Defense officials were given some restricted information concerning the possible use of new war gas agents known as nitrogen mustard HN2 and HN3. The chemical composition of these were given. They were described as having only a faint odor of fish or of soap. The general properties were believed to resemble mustard. That was the extent of the information given at the Seattle Civilian Protection School.

In the last few months the above information, and more, has reached the public through magazines and newspapers.

Various foreign and American chemical journals describe at least eighteen toxic compounds comparable to HN2 and HN3 all having a nitrogen base. Most of them appear to be unstable and therefore difficult to prepare in a pure state. However the object in their preparation is not for a pure product but rather for one which has toxic properties. Consequently such agents are likely to be mixtures of varying toxicity. Some are solids and some liquids. That which we have prepared at the State College is HN3, the chemical formula of which is $N(CH_2CH_2Cl_3)$. It has practically no odor, is slightly soluble in water and in alcohol. It penetrates rubber slowly, reacts slowly with hydrogen peroxide, is unaffected by bleaching powder.

The nitrogen mustards are alkaline substances in contrast to mustard and lewisite. However closely related compounds of the nitrogen mustards which may be used in warfare give acid reactions, thus complicating means of identification by its acid or alkaline properties.

A few drops of an alcoholic solution of nitrogen mustard hydrochloride placed on a rat's back caused the rat to hemorrhage profusely from the nose 48 hours later. Likely the rat got its nose into the agent on its back where the blister was produced.

Those of us working in the laboratory can verify the vesicant action of nitrogen mustards. The blisters are much like lewisite blisters, appearing 12-20 hours after contact.

Some of the nitrogen mustards damage the eyes more than ordinary mustard and others damage them less. A mild exposure produces slight lacrimation and smarting of the eyes 5 to 20 minutes after exposure. These symptoms disappear after a few minutes and may be overlooked. They reappear at intervals with increasing frequency and severity until they finally become persistent 2 to 3 hours after exposure. Maximum damage may not appear for 24 hours or longer.

The sinuses are affected causing headaches.

The effect on the respiratory tract is generally much less than with ordinary mustard.

It has been reported that on animals nitrogen mustards will produce paralysis, destroy white blood cells, lymph glands, and bone marrow.

ETHYL DICHLORARSINE   E D
METHYL DICHLORARSINE   M D

These agents were used in World War I with moderate success. They are clear oily liquids with fruity odors that persist from one to six hours. They contain arsenic, react slowly with water, rapidly with bleaching powder.

Their vesicant action is very slight as compared with mustard. Their chief use would be as lung injurants and sternutators. They have no delayed action.

DIMETHYL SULFATE

This agent is a colorless oily liquid which is a powerful lung injurant, a good vesicant and lacrimator. It is almost as toxic as mustard. Were it not for the fact that it is extremely easily neutralized by moisture it would be a better agent than mustard. In dry weather it is especially dangerous. Germany did not use it in World War I only because they were short on wood alcohol which is used in its preparation.

GENERAL GAS PROTECTION

Since we treat protection against gases differently depending upon where we are and under what conditions we meet the gas, I want to divide my discussion into two parts. First of all, we shall deal with the protection of the individual who comes into actual contact with gas. Such an individual may be an air raid warden or merely a passerby in the area during the time of a gas attack. Secondly, I wish to discuss the protection of the individual who does not come into actual physical contact with the gas as most of us will not. If indoors at the time, what should the individual do? To remain in contact with a gas of either persistent or non persistent nature requires protection, particularly to the lungs and eyes. The entire skin surface must be protected from vesicants and so if an individual is to be in a gassed area for any length of time he must wear protective clothing. As you have gathered from the talks you have heard previously the lasting danger from gas is to the lungs and to the eyes, and so the major protective agents are those designed to protect those parts of the body.

The gas mask in its present form is complete protection against all known war gases in any probable field concentration. That means, that as far as we know, anything about gases at the present time, the mask is complete protection to that part of the body which it protects, namely; eyes and lungs. The gas mask of course does not protect other parts of the body and in order to obtain complete protection against vesicants, there are various types of protective clothing of which this is an example. (Shows sample)

This is an official model of protective clothing made out of resistant material very similar in construction to the old slicker type of material made of treated fabric. It is made in such fashion that it can be bound up at the ankles, around the wrists; it zips up completely in front. The hood fits closely to the head and is so cut that it fits around the eye pieces of the mask; it buckles around chin. The belt is of questionable value, but it completes the outfit. When completely clothed in this regalia the wearer does not have one single cell or pore exposed. To complete this protective outfit, one first puts on a pair of chemically impregnated long sox. These are impregnated with a chemical substance which has the ability to neutralize vesicants. The material is a rather uncomfortable substance; has a dirty, greasy feel, but it does protect against mustard. Next, an impregnated high shoe is put on. The ones I have worn were GI shoes which had been treated with a waxy material, the formula for which I was not given, but it has been suggested by those who have used it, that it appears to be very similar to floor wax or furniture polish. In fact, it has been recommended that since civilians will not be able to obtain shoe impregnite, floor wax be substituted. Large quantities of the material are required to completely treat the shoes. The content of a can three or four inches in diameter (rather like a large shoe polish can) is rubbed into the shoes a number of times so as to completely seal the shoes. So far as I know the action of this material is entirely mechanical. It simply blocks out the gas by sealing up the pores in the leather. Dressing in this outfit further requires the donning of cloth gloves impregnated with the same material as used on the socks. Since the suit fits tightly around the ankles and wrists, it prevents vesicants from getting into the openings of the gloves and shoes. To complete the outfit, one dons a pair of thick rubber gloves which electricians use and describe as a ten thousand volt glove. In this suit, one is completely encased.

The one point against the use of such equipment is the fact that not one part of the body is exposed to the air at any point. There is no way in which the body can breathe so one simply melts down. In cool weather, it is not uncomfortable for a number of hours. On a warm day from fifteen to twenty minutes is all that one can possibly stand, then one must get out of the gassed area and out of the suit.

These suits are commercially available if one can get delivery on them, but we find it desirable to recommend that improvised equipment be used rather than to spend the rather absurd prices that are asked for the suit. The cost price for the suit alone is something like thirty five dollars and the suits are of not too good material. I saw a rather pompous individual who had, while wearing one of these suits, simply ripped the seat out of them by stooping over once.

At this point it is well to look into the permeability of vesicants through various materials. Notice that we are putting our emphasis on vesicants, as far as chemical agents are concerned. If we look into the common materials we find that ordinary cloth, paper, leather, and wood offer virtually no protection at all against liquid mustard or liquid lewisite. They all slow up the passage of the liquid toward the body, but the liquid will diffuse through those substances just as water or other liquids, so we cannot put any confidence in ordinary clothing if one has to be in a gassed area for an extensive time. However, it is noted that rubber offers considerable resistance. Rubber will hold liquid mustard out for a period of twenty to twenty four hours and so first of all, if available, it would be a good idea to have hip boots or at least a pair of rubbers when walking around in a mustard or lewisite affected area. Cellophane, particularly the water proof type, offers an astonishing resistance to the passage of liquid mustard. Figures that Dr. West and I have seen would indicate that liquid mustard could be held on one side of a water proof membrane without getting through to the other side for a period of 26 hours, which is a rather astonishing resistance. Heavily waxed cardboard and extremely heavy waxed paper are also quite resistant. Impregnated cloth of the nature of the decontamination suit which you examined, the ordinary farm type of slicker is very good and in non-priority communities the recommendation is made that protective clothing consist of slickers and sou'westers, gas masks and a pair of rubbers. So much for the individual who has to stay in a gassed area.

What protection can we offer the individual who simply is caught in a gassed area; one whose duties does not demand that he stay in the area? Ordinary clothing will protect the body fairly well. Remember ordinary clothing will not offer lasting protection. This ordinary business suit I wear would not be a satisfactory article of clothing in a rain storm; it is not made of water proof cloth. Yet, I could walk a short distance in rain without having my body become wet. In the same fashion, ordinary clothing will keep the vesicants from the body for awhile. If I should get this suit contaminated with liquid mustard, it would be just a matter of a few minutes before it would soak through. Therefore, I could walk through a mustard area wearing this suit. It would give me momentary protection but I would have to discard the clothing as soon as possible.

I would like to say here something that has not been said in words as yet during this school, and that is, <u>that the greatest protection of all against these agents is a lack of fear of them.</u> We should have the greatest of respect for these agents and what they can do and we should have as complete knowledge as we can of how to identify them, but we should have no fear of them and if I might digress farther, we are likely to be most afraid of those things we know the least about. The primary purpose of these schools is to allay fear of chemical agents, to know what these gases are and what they do so that we can build up a respect and remove fear from our minds concerning them. I would not have any particular fear of walking through a mustard area, but I would discard my clothes as soon as I got out of the area.

I shall not go into the subject of first aid or self aid. We have a medical doctor on our staff who will go into that in detail. We will have a film indicating more clearly than can be described by words, the procedure to be followed in self cleansing so I shall merely say that the best protective measure an individual can use is to get out of the area and when having done so to discard his clothing and take self aid. So much for the moment for those out-of-doors who come in contact with the gas.

I don't believe Dr. West or I have mentioned how these gases are likely to be distributed. If we are not attacked directly by a landing party, any gas that we get will come from the air from planes. Two methods of dissemination are in general use and are to be expected. The two methods are of about equal importance and probability. First the chemical bomb. Chemical bombs vary in size. A typical one is some three to four feet in height, four to six inches in diameter, of light gauge metal material completely filled with chemical agents except for a light detonating charge. It éxplodes upon contact and as such will spray the liquid agent over an area of fifty or seventy five feet in radius. The area covered is not exceptionally large. I don't know the exact figures for bombs but it is known that the exploding of a 15MM gas filled shell causes casualty production over an area of only one hundred seventy seven square yards. This is a quite a small area.

The second method is the airplane spray which utilizes nothing more than wing tanks filled with liquid agents. When the pilot gets over his target, he opens two valves, one at the top and one at the bottom of the tanks. The liquid runs out in a stream. When this liquid stream which is moving at the speed of the plane hits the relatively still air it splits into small droplets and settles to earth as a fine mist. Using such apparatus, a large area can be covered in a very short time. Protective clothing is needed to protect against vesicants which are disseminated in drops in air spray or as spray from a bomb. Should one be indoors at the time a gas bombing occurs he is safe. The gas bomb will not break any windows and the splash can not penetrate throughout the house. A house also offers amazing protection against sprayed agents. This is proved by experiments carried out by the British.

They used an old game keepers cottage which had not been lived in for a number of years but which had doors and windows which would close. The first experiment was to release during the period of an hour, one ton of chlorine on the windward side of the house from a distance of sixty feet, width of a city lot. This amount of chlorine is equivalent to the amount that could be contained in forty gas bombs. The probability that forty gas bombs would land in one lot in a period of an hour is very slight. So they were subjecting the test equipment to almost impossibly severe conditions. Men were stationed in a downstairs room in this house. A fire was burning in the fireplace. The men reported that from seven to nine minutes elapsed after the gas had been released before they had to mask. I might say to those who are not chemists that chlorine presents an extremely difficult problem compared with most war gases; it is lighter, diffuses more easily, the molecules move faster at a given temperature than most gases. Because it is already a gas, it does not have to be vaporized to get into the vapor stage. Because its molecules are smaller than those of more effective gases, they will go through openings which would stop bigger molecules. Thus chlorine was a most efficient material to use as a test gas because of high penetrability. But even under these severe conditions, a considerable time elapsed before masking became necessary.

The same house was also tested for its ability to protect against mustard. Since the wind was apt to change during the test pans containing liquid mustard were placed all around the house at a distance of sixty feet from the house so that regardless of the direction the wind was blowing it would be blowing mustard vapor against the house. Then believing that this was not a severe enough test, they sprayed liquid mustard into the air thirty feet to the windward of the house for one hour. The entire experiment lasted for a period of twenty hours. Test animals placed in the house suffered no ill effects.

The same two experiments were repeated later after the house had been fixed up according to suggested recommendations put out by the air raid protective service of the British Isles. They first of all took gummed paper and sealed up all cracks. They took wet newspapers, large sheets, and stuck them up along the sides of the windows. They took shredded newspapers and made them into pulp by soaking in water and crammed it under doors and windows. They put out the fire in the fireplace. In other words they eliminated all cracks and drafts. To make a long story short they found that the house now afforded almost complete protection against both chlorine and mustard. After the severe mustard test, there was not enough mustard found inside the house to cause any individual who might have been inside the slightest bit of danger or discomfort. These results constitute the most heartening information we can give to our fellow townsmen. If they will only keep their heads, close doors and windows, get into an upstairs room, seal it up, stop all drafts, put out fires, plug ventilators, they will be perfectly safe against all accept extremely heavy attacks and these would have to be heavier than the ones I have described. So if the individual who is indoors during a gas attack will stay indoors with doors and windows closed and no drafts, he may consider himself to be safe.

We have discussed the individual who is out-of-doors during a gas attack and must stay there and must wear protective equipment and we have described such equipment. Secondly, we have discussed the plight of the individual who is gassed but who does not have to remain in the area and who must discard his clothing. Thirdly, we have considered the individual who is indoors at the time of the attack whose house has not been damaged.

During this period we have considered the generally unbelievable concept that one can be gassed and suffer no lasting consequences if he will keep his head and act quickly and efficiently. In other words, the gases used in warfare under the conditions which exist in the field do not produce instantaneous death. Full realization of this simple statement probably constitutes the most effective protection against these agents. During the closing few minutes of my remarks I wish to try to make this point clear by telling briefly some instances which I have experienced and then attempt to point out the significance of these experiences. Some months ago the City of Eugene was staging an incident to test the general efficiency of its Civilian Defense set-up. One phase of this incident called for a gas attack at a certain point. In preparation for this incident some of us on the staff of the Department of Chemistry at the University, unknown to those staging the incident, made up a large quantity of extremely active tear gas. We poured this material around the bonfire which had been kindled at the site of the incident only a minute or so before the firemen came. We thought it would be sport to keep the firemen away from the fire. However, the firemen casually put out the fire (they wore no protective equipment against gas) and not a tear was shed. From the standpoint of getting satisfaction from our prank the experiment was a failure but the significance of the lack of tears on the part of the firemen is of great importance to us in our attitude toward gas. The second 'story' which I wish to relate is simply to tell you that as a matter of record I have (as has each of us on your staff here) been subjected to reasonably heavy concentrations of war gases for short periods of time, yet I am obviously alive and have suffered no observable ill effects.

During the first World War, a German Chemist by the name of Fritz Haber headed up the German equivalent of the American Chemical Warfare Service. It was he who is responsible for most of the German innovations in chemical warfare. I believe that it was he who engineered the chlorine attack at Ypres and that it was he more than any other man who is responsible for the German introduction of mustard as a chemical agent. But Herr Haber also made a close study of the effects of gases and as a result of his researches he found that for every gas, there is a so-called 'lethal constant' which describes the relative deadliness of the gas.

However, he also found that this lethal constant is composed of two factors, concentration and time, and that it may be considered as the product of these two terms. Let me demonstrate the significance of this concept. Let us assume that the lethal constant for a certain gas is 48 units. This value may be arrived at by various means. Let us multiply various numbers together so as to obtain 48 as a product. Let us place these number in columns and head one of the columns 'concentration and the other 'time'.

Concentration	x	Time	=	Lethal Constant (48)
1	x	48	=	48
2	x	24	=	48
3	x	16	=	48
4	x	12	=	48
6	x	8	=	48
8	x	6	=	48
etc.	etc.	etc.		
48	x	1	=	48

Notice that there are many ways of attaining the lethal constant. Notice that as the concentration increases the length of time needed to produce death decreases and vice versa. Also notice that a low concentration for a long period of time will produce the same results as will a high concentration for a short period of time. To return to the incidents mentioned above, it should now be obvious what they signify. The firemen did not weep at the scene of the tear gas infected fire because in the out-of-doors the gas diffused away so quickly that the concentration was not sufficient to produce tears even though the firemen stayed in the area for a prolonged period of time. The fact that many of us have been in the presence of fairly high concentrations of gas for short periods of time and suffered no ill effects is due simply to the fact that the time factor was too short to produce undesirable results.

Protection against gases by civilians is possible and feasible. It consists primarily of understanding what gases are and what they can do and particularly what they cannot do. Clothing may be improvised which will protect the individual who anticipates gas. First aid is effective for the individual who is caught without protective clothing. Homes without any changes made, offer fair protection and after a few very simple modifications, are turned into extremely efficient gas-proof shelters. If only the civilian will appreciate these facts the danger due to gas will be lessened immensely.

DECONTAMINATION

The process of decontamination refers to any means used by which a dangerous liquid or solid chemical agent on or in contact with terrain or objects is removed, destroyed or changed to harmless compounds. When applied to personnel the process is called first aid.

By the very volatile nature of non-persistent agents they present no problem since they are carried away by air currents in a matter of minutes after being released.

After a gas attack of a persistent agent on a congested area normal life can not be resumed until at least the "beaten paths" have been decontaminated. The magnitude of the problem is indicated by Major Arnold's statement that a million man-hours time is needed to decontaminate a city after a 10 minute attack.

Methods of decontamination may be grouped under one of four headings: Weathering, Removal, Destruction, or Sealing.

WEATHERING

Weathering includes the action of the sun, wind, and moisture. The heat of the sun will cause vaporization of the liquid material from contaminated surfaces and dilution with air dissipates the toxic vapor with the aid of the wind. The vaporization of lewisite will be much more rapid than that of mustard. Most of the nitrogen mustards will also vaporize more readily than mustard.

If the contaminated area is not in a congested area it may be necessary or most practical to mark off the area with "danger" signs and allow nature to do the decontaminating. The prevailing direction of the wind should be noted and judgment used concerning advisability of evacuating nearby residents in the down wind direction. The natural impulse of the Reconnaissance Agent will be to make certain he does not allow residents to remain in a dangerous area. Towards this end he is quite likely to be over-cautious and over-estimate possible damage from a contaminated area. Fixed rules for marking off an area cannot be set up because of so many variables such as amount of gas, concentration of gas, how much wind gets to the area, the amount of moisture present, the distance to the nearest residence, the nature of the gas, etc.

The number and locations of areas affected after a gas attack will determine the priority number or order in which decontamination squads clean up the areas. If buildings are contaminated only with vapors the only decontamination that needs to be undertaken is to ventilate the building.

Clothing contaminated only by mustard vapors may be decontaminated by hanging up the garments so they will be exposed to sun and wind for two days, more time in cool weather. This method can not be advocated for clothing contaminated with lewisite since moisture will hydrolyze it leaving a solid vesicant in the clothing.

Weathering is also accomplished by rain or any form of moisture. Lewisite is very readily hydrolyzed, mustard and nitrogen mustards to a lesser extent. All of these gases react with water so readily that an enemy would not plan an attack in rainy or foggy weather.

In the case of mustard the product formed by the reaction with water is entirely harmless. However the hydrolysis of lewisite is a white blister-producing solid which contains arsenic. Fortunately it is non volatile but since it is vesicant it must be washed away very carefully. Its arsenic content may cause trouble if the sewage goes to a sewage disposal plant.

Most nitrogen mustards are only slightly effected by water.

REMOVAL

The decontamination squad may remove agents by hosing with a strong stream of water. In addition to washing away the agent mechanically with water, some of it will be neutralized by the water. Much of the gas will soak into the earth with the water. On hard surfaces such as pavement most of the agent can be washed down the drain. It should be recalled that the vesicant agent are all heavier than water so that if they are washed through a plumbing "trap" some of them may be caught, causing fresh sources of contamination.

Removal may also be accomplished by the use of an organic solvent. Kerosene is one of the cheapest solvents for this purpose. This method is particularly applicable in removing an agent from greasy machinery. The vesicants are readily soluble in kerosene but are not neutralized by it. Therefore care must be used to insure safe removal of the washings. The purpose is to reduce the concentration of the agent letting the washings down the drain, soak in the ground or be burned.

The solvent method has the disadvantage of spreading the contamination over larger areas. However it is about the only feasible method on machinery because if chloride of lime is used most metals corrode very rapidly.

DESTRUCTION

Burning will offer the best means of destroying wooden articles, furniture, or clothing that are grossly contaminated. It should be remembered that the burning will produce a high concentration of toxic vapors in the surrounding atmosphere.

If not too badly contaminated, small objects and clothing may be decontaminated by boiling. In case of lewisite an active chlorine compound or an alkali must be added to the water to destroy the white, solid vesicant that forms when lewisite reacts with water. The product which is thus produced is water-soluble and non-vesicant although it does contain arsenic.

The most important method of destruction is that of adding chemicals which will neutralize the agent. Water is the cheapest of all chemicals that have a neutralizing effect. The great abundance of water and its ease of application makes it of greater importance than any other chemical. Not only does water hydrolyze and thus have a neutralizing effect on the war gases but it also dissolves them, thus diluting the agents. Hot water is better than cold but is generally less available in large quantities from faucets. If an area is contaminated with only lewisite it can be decontaminated with water alone.

A positive method of destroying mustard gas in clothing is to subject it to steam. If the clothing has been exposed only to vapors, steam for 2 hours; if spattered with liquid, 4-6 hours. Laundries usually have adequate equipment for steam disinfection but improvised equipment may be readily assembled. Woolens will withstand steaming much better than boiling.

If a cylinder of chlorine is available it may be used to shorten the steam treatment. The chlorine should be used first for 10-15 minutes followed by the steam for 30 minutes. Caution: chlorine is a non-persistent poisonous gas and is also a bleaching agent.

Clothing contaminated with either HS or M1 may be decontaminated by heating in a 3% solution of washing (not baking) soda at 180° Fahrenheit for two hours. Do not allow the solution to boil.

The chemical for decontamination that is accepted as being about the most effective as well as being relatively inexpensive is chloride of lime. It is also known as bleaching powder. It reacts with mustard so rapidly that burning results. The reaction is much less violent on lewisite and nitrogen mustard. To moderate the reaction earth or sand or sand may be mixed with the chloride of lime in the proportions of about 1 shovel of lime to 3 of earth or a water slurry may be made in a 50-50 mixture.

Bleaching powder should be kept in air-tight containers to avoid rapid decomposition due to air or moisture. When freshly packed the chloride of lime may have up to 35% available chlorine. A similar bleach called HTH or Perchloron contains up to 70% available chlorine but such products are expensive and hard to get. Household bleaches like Chlorox contain about 5% available chlorine and should be used if nothing stronger is at hand.

Unless the area to be decontaminated has been only slightly affected by gas it will require the equivalent of about one pound of 35% chloride of lime for each square yard of area.

The chloride of lime is very corrosive to metals so if it is used on valuable metal equipment it should be washed off immediately afterwards with kerosene or soap and water.

Pools of liquid agents or large visible splashes on the ground or vegetation are rarely found. This is especially true if the gas was sprayed from an airplane. In most cases the mustard will be perceptible only by its odor or by chemical tests. If shrubbery is in an area being decontaminated it should be cut down and burned. It is well to cover the earth-lime-mustard mixture with a layer of earth.

With lots of work the walls and ceiling of a building, if not too heavily contaminated with mustard, may be neutralized by spraying and swabbing with slurry. A pressure-type apparatus such assused for garden sprays may be used to good advantage where the area is not easily reached with brooms and brushes. Care must be taken to filter the slurry to avoid its clogging the spray apparatus.

SEALING

Covering a contaminated area with earth or sand has already been mentioned as a temporary, or in some cases permanent means of avoiding the chemical agent.

If the area is cement or any other hard surface it can be coated with a solution of water glass, sodium silicate. Whereas this is not very water-proof it does make an impervious barrier to the agent. It is a cheap chemical and may have application to sidewalks, etc., which have soaked up a considerable amount of liquid agents that cannot be washed out or neutralized.

Sodium silicate may be purchased in large amount from the L. H. Butcher Co., Portland, Ore.

The army training sound film on Decontamination Procedures illustrates many of the above decontamination methods.

SELF AID AND FIRST AID

The instruction given in the gas course on Self Aid and First Aid was largely in the form of a black board "Chalk Talk" supplemented by a movie entitled, "What To Do In A Gas Attack".

The outline which follows covers the scope of the subject matter and gives the essential points which the civilian should know.

DEFINITIONS

Self Aid is the assistance which an individual exposed to war gases, but otherwise uninjured, provides for himself in preventing and minimizing the effects of war gases.

First Aid is the assistance which an individual exposed to war gases and who is not able to help himself due to other injuries, receives at the hands of trained individuals, before he comes under the supervision of a physician and hospital.

I. SELF AID (when exposed to vesicants)

A. Prevention --- Stay indoors preferably in a well sealed room on upper floor. Most war gases are heavier than air and they will not readily enter a closed space unless drawn in by currents of air.

B. If exposed --- Remove self from gassed area as soon as possible, moving up and across wind and to a higher elevation, since war gases settle in low places. Consider the location of the nearest water.

Having arrived at an uncontaminated area, remove outer clothing as soon as possible. Fumes of vesicant gases on clothing will form due to body heat and penetrate clothing causing severe skin burns as well as lung irritation.

Look for the nearest source of water, an outside faucet on some residence or an attached garden hose. Wash the eyes thoroughly. This should be done within five minutes. Time is the essence.

The skin, except for the hands which might contaminate the eyes, can be taken care of after the eyes are thoroughly flushed. Having quickly washed out the eyes with water and removed the gas contamination from the skin, seek immediately to enter the nearest residence where a complete head to foot lathering can be secured. Leave garments, which have not already been removed, on the outside. If possible use a shower and powdered or liquid soap for speed. Rinse the mouth and nose with 2% soda water. (Heaping tablespoonful to a quart of water).

II. SELF AID (when exposed to lung irritants)

A. Prevention --- Stay indoors as described above.

B. If exposed --- Move out of the gassed area as soon as possible. Seek nearest shelter and warmth and lie down. If any unusual symptoms develop, seek medical aid. If exposure has been to adamsite, inhale dilute chlorine fumes if available.

If phosgene has been inhaled, symptoms may not appear until later. It is most important in the meantime to keep quiet and warm. Call for medical assistance if symptoms develop.

III. FIRST AID

The principal points in connection with first aid are as follows:

A. First aid begins at the scene of the incident and may continue until the patient enters the hospital.

B. Time is the essence and the patient should be removed from the gassed area as soon as possible by persons who are trained and equipped or who understand fully how this should be done.

Special first aid squads or rescue parties for gassed patients should be trained and equipped with protective clothing and gas masks and provided with remedies for war gases, such as: sodium bicarbonate solution, chlorine, soap, jars of water, gauze, and cotton.

C. Patients' clothing should be removed at edge of gassed area and some of the gas first aid procedures such as flushing out the eyes and blotting off splashes of liquid from the skin instituted at once. Keep patients warm to prevent shock.

The customary first aid procedures in connection with physical injuries should be carried out, either before, after, or simultaneously depending upon which seems to be the most urgent from a life-saving and sight-saving standpoint. As a rule the eyes should be taken care of first except in the presence of severe hemorrhage.

D. Where a large number of gas casualties have occurred, it will probably be necessary to do some sorting in the field, sending those who are more seriously injured to the hospital cleansing station earlier. Watch for patients in shock.

E. Remove to the hospital in a special gas ambulance, first aid treatment can be continued if necessary provided the ambulance is properly equipped with supplies and the distance to the hospital cleansing station is great.

F. The details of the use of medicaments in first aid for gas casualties are covered in the section under cleansing stations. The care of the patient in the hospital itself is a medical problem.

TREATMENT OF CONTAMINATED (WAR GAS) FOOD AND WATER SUPPLIES

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To the technically-trained man, the subject of treating contaminated food and water supplies for the removal of poisonous war gases opens up a field of wide speculations and many chemical problems. This is due to the fact that we have a number of possible contaminating war gases, used under a number of possible conditions and upon a possible great number of varieties of food stored under different situations. Under certain conditions, the treating of contaminated foods by war gases, each could be and probably would be a separate problem involving different methods of decontamination. It is my belief, therefore, at a meeting of this kind, that we should only touch upon the major considerations and not allow ourselves to become confused with the many possibilities.

The principal reason for this discussion is for you as gas officers to be in a position to advise your community before and after an attack as to what can be done in a general way. It is not expected that you will be able to handle this work from a technical angle. It is expected that you will be familiar with the general aspects of food and water protection and its decontamination. Your O. C. D. handbooks will be of help.

The first essential for you to remember is that <u>protection</u> of food is preferable to trying to clean it up after contamination. That brings up the question of how is food best protected. The same general rules that apply to general gas defense, such as getting under cover, applies to food; that is, keep the food in covered or tight containers. Containers of metal, glass, cellophane, refrigerators, cold storage plants - all offer excellent protection to war gases if they are not damaged.

You should keep in mind that gas contamination depends, principally, upon two factors whether it is food, equipment or personnel that is involved. These factors are: 1 - concentration; 2 - time. Putting it another way, if we have a heavy concentration of gas, such as a liquid contaminating our food, our method of treating will be different than if the food is subject to vapor contamination only. At the same time, if food is in contact with vapor for sufficient length of time, the result will be much the same as a short contamination of liquid.

We have mentioned liquid and vapor in our preceding remarks. As you know, our persistent gases are liquids and vaporize depending upon local conditions. In gas contamination of food or water, by far our greatest trouble is with the vesicant gases such as Mustard or Lewisite. There is a smaller danger from some of our arsenical smokes but in the main we are concerned with vesicants in this discussion. In passing, we might mention also that contamination occurs from not only the gas as such, but also from decomposition products of the gas when it reacts chemically with the food with which it comes in contact. Chemically, this is spoken of as "hydrolysis", but for the most of us this is of a technical nature and will not be considered in detail. One should keep in mind, however, that in cases of arsenical gases such as Lewisite, these reaction products are dangerous.

Now then, with this brief introduction to the problem, what are you, as gas officers, going to do in case of food after a gas attack? It is not possible to set down any hard and fast rules due to the variety of conditions under which it is possible for contamination to take place. There are, however, a few general things to keep in mind. One of these is that two types of food are especially susceptible to gas contamination. These are the fatty foods such as butter, lard and cooking fats in general, and secondly, those foods with high moisture content such as meats and vegetables. Contamination of these probably is best handled by destruction or their diversion for making war fats, fertilizers, etc. after suitable decontamination. In case of light contamination by vapor only, it is very likely that Mother Nature will be the best decontamination agent for those food products which can be exposed to air and sunlight for periods of two to three days. For heavy contamination, especially liquid, destruction is probably the simplest control. However, there is always going to be the question of how bad is an article contaminated and is it or is it not safe to use. With the equipment and personnel available, most of you are not going to be in a position to answer that question. For that reason, we are asking you, as gas officers, in case of attack in which gas is used, to first outline the probable contaminated area, quarantine this area, and report to state defense office. Upon receiving your report, we will arrange for trained help to come to your aid. This is available from a number of sources and will be able to make chemical tests definitely proving the condition of the food in question. In a country such as ours in which there is at present an abundance of food, the general rule to follow in case of any reasonable doubt is, don't take a chance.

In passing, it might be well to remember that most of the remarks applied to food will apply equally to supplies of stock feed. They too can be contaminated and be a source of danger to our livestock.

Water supplies, due to large volume of water with resulting dilution of war gas, are not, in my opinion, a great source of danger in case of contamination. Present purification safeguards will tend to also protect against war gases. In cases of heavy contamination, dumping of water reservoirs should probably be done. Help of a technical nature, when needed, is available to local water departments. Water supplies, being at all times under centralized control, can be more easily watched and the community should look to their water departments for advice concerning condition of water supply.

In the safeguarding of food supplies, a factor sometimes overlooked should be mentioned. This is not a war-gas danger but a contamination resulting from flying glass splinters and fragments due to high explosives. This type of contamination can be serious and should be checked on in case of an attack. Future use of food contaminated with glass will depend upon particular conditions encountered.

Finally, although not connected with food or water protection, a study should be made of means of recovering gas contaminated wearing apparel. Many times, clothing so contaminated may be saved by prolonged airing and exposure to sunlight. Other clothing may have to be subjected to several hours exposure to steam or even chemical treatment. These treatments are more or less severe on clothes and people should be told that clothes may be ruined due to such treatment.

As in other cases, treatment depends primarily on type and degree of gas contamination and no method can be laid down for all conditions. Leather articles are unusually hard to decontaminate. Some person, preferably connected with local laundry industry, should make this field his particular responsibility.

Summarizing, what do we expect of the gas officers of the community so far as food and water supplies are concerned. We want you to know the general facts about gas and its action on food and water, not as experts or technical men, but in order to give advice and answer questions. As gas officers in your community, you will be looked to for such and your answers will go a long way in maintaining morale. More specifically, we want you to do the following things:

1. Where possible, avoid exposure of food by proper storage protection.

2. Quarantine all suspected gas-contaminated food or drinks.

3. Call the following agencies for help;
    1. State gas officers (through State Defense Council)
    2. Board of Health who have supervision of water supply.
    3. State Department of Agriculture who are responsible for condition of food.

The State Department of Agriculture have a number of field men who are trained in food work and can be assigned to any part of the state if an emergency occurs. If they are needed, they will cooperate with your local leaders. Also, through the Department of Agriculture a number of food committees have been formed in various towns. These men deal with the principal types of foods such as wholesale grocer, meat, dairy, etc., and in case of emergency will be asked to help in checking their particular field.

Finally, although I feel that there is a minimum of danger to water and food supplies from gas, I would like to leave with you this thought: It takes careful tests to be sure of freedom from gas contamination in foods and water, so, when in doubt - don't take a chance.

CARE, ISSUE, CHARACTERISTICS AND FITTING OF MASKS

The gas mask is an important item of protective equipment against gases that are used in warfare. Therefore, its care as an article for training purposes and for actual protection of the individual in war is of paramount importance. Extreme care should be exercised at all times to insure the extension of its useful life as much as possible. The primary responsibility for care of a gas mask rests with the individual to whom it is issued. However, some general supervision should be exercised in the use, storage and repair of all masks within any organisation.

The knowledge that an individual may have concerning the more essential parts and operation of a gas mask will aid him to thoroughly understand what occurs to a gas mask when not properly handled. The gas mask itself consists essentially of three main parts--the facepiece, canister, and carrier; the purpose of the canister being to purify contaminated air that is breathed by the individual, the carrier being used to place the facepiece and the canister when not in use. In the civilian mask which is the non-combatant type and similar to the army training type gas mask, the canister is attached directly to the facepiece. This facepiece consists of a rubberized fabric and is fitted with eyepieces, outlet valves and head harness straps, the latter being used for adjustment purposes. The canister, itself, being a purifying medium, is a most important component of the gas mask. It contains, essentially (1) a mechanical filter and (2) a chemical filter. The mechanical filter consists of a porous material which filters out dust particles, the chemical filter, of activated charcoal and soda lime to render harmless by a direct neutralizing action, toxic gases that may be breathed. It is important to remember that all gas masks of different types as far as chemical warfare gases are concerned operate practically in the same manner.

As a matter of information, the chief causes of deterioration of a gas mask are, (1) age, (2) prolonged dampness, (3) heat, (4) improper storage, (5) rough usage, and (6) neglect of minor repairs.

The rubber parts of a gas mask gradually deteriorate with age, through oxidation--the action being more rapid in the presence of moisture, heat, and sunlight. The facepiece and valve, being of rubber material, are particularly subject to deterioration from the latter named exposures as well as by continued distortion. Water and excess moisture in the canister will destroy the chemicals and cause corrosion of the metal parts.

Prolonged exposure to moisture and heat causes rotting of the fabric parts of the gas mask, loosening of the binding tape, rusting of exposed metal parts and sometimes causing mildew or discoloration of the transparent plastic eyepieces.

Improper storage frequently causes a permanent set in the facepiece which destroys the fit. Rough usage will break the canister, puncture the facepiece, tear the head harness and break the head harness attachments.

The proper storage procedure of the gas mask within an organization when not in use is such that the facepiece should be filled out by a crumbled newspaper form or the prescribed form, and the mask properly placed in the carrier without distortion, and then hung by the carrier shoulder strap from a hook in a cool dark compartment or locker.

Under no circumstances should the gas mask or its component parts, carrier and so forth, be washed or cleaned with any cleansing materials except as may be prescribed by proper authority, and only when such action may be necessary, due to the unsightly soiling of the equipment.

Disinfection of the gas mask by the use of a three percent solution of formaldehyde in a prescribed manner may be necessary from time to time due to wearing of the mask for long periods and for general sanitary reasons. The mask must positively be disinfected when turned in by individuals prior to issue to others.

In case of breakage or parts of the gas mask becoming worn, or unserviceable, this fact should be immediately reported to the proper authority by the individual whose mask is damaged, and arrangements made for replacement.

The non-combatant type of gas mask under this discussion, provides for the protection against chemical warfare gases only, and is not intended to be used for (1) fighting fires; (2) for protection against motor gas exhaust, carbon monoxide, or ammonia gases; (3) in enclosed spaces where supply of oxygen is too low to support life; (4) in high toxic concentrations; (5) in fumigation work of any kind.

As a matter of information, it is possible in the absolute absence of a gas mask during a gas attack to secure a certain amount of necessary protection by breathing through a cloth saturated with a solution of bicarbonate of soda.

We have been fortunate to secure the use of a film which will be shown here this morning on how a gas mask drill is conducted. In this film I would like to ask you to note particularly, three important points of the exercise, namely, (1) clearing of the facepiece when the mask is adjusted, (2) checking the gas mask for fit, and (3) testing for gas.

It is important to keep in mind that if you are in a contaminated area that has been gassed, that a certain amount of gas will accumulate in the facepiece between the time it takes to draw the mask out of the carrier and adjust it. Following the alarm of "GAS", the first very important act is to stop breathing; after the mask has been adjusted to the face, you will note that the individual in the film will then place his fingers over the outlet valve of the mask to shut off the air before he blows into it in the act of clearing the facepiece. From this he proceeds to breathe as usual.

Checking the mask involves testing for leaks by placing your hand against the bottom of the canister and inhaling. If no leaks are present, the facepiece will obviously collapse inward.

The third phase of this series of points is that of testing for gas before removing the mask.

The second film which will be shown will involve particulars in connection with the inspection of a gas mask and just what is done to keep the equipment in proper working condition.

This afternoon on the field we will conduct a regular gas mask drill similar to that shown in the film using the non-combatant type of civilian gas mask. Following this exercise, and checking for proper fit, a regular gas chamber exercise will be conducted.

METHODS OF DETECTING AND SAMPLING

One of the primary purposes of this school is to train individuals in methods of detecting chemical agents. There are a number of methods which can be used. I shall attempt to describe certain of the more obvious and elementary methods of detection and leave to Dr. West, who will follow me, the special methods of detection.

The first and most obvious test that will be made will be by means of ordinary physical senses, and by that I mean particularly the sense of sight and the sense of smell. For example, persistent agents are liquid and regardless of the method by which they are distributed they will appear as liquid on the sides of buildings, on vegetation, etc. These liquids insofar as I know them are heavy, oily, dark brown substances which after they are sprayed or splashed on surfaces will look very much like drops or puddles of crankcase oil or molasses. I am told that when the army wishes to simulate persistent agents on maneuvers, it uses molasses because that substance has the general appearance and the persistency which is generally associated with the typical vesicant gas. So detection from standpoint of sight consists of looking for liquid droplets, puddles, or splashes of dark, oily liquid on the sides of buildings or on the ground or on vegetation which might appear to be splashes of lubricating oil. Further use of the eyes will be of value in case you see the agents actually being released. For example, you will notice this afternoon when phosgene is being released by means of detonation that there will be a persistent white cloud around the point of release. This white cloud persists for a longer period of time than any similar cloud associated with the detonation of any other agents. So if you happen to be near the point of release and see the agent disseminated the presence or absence of a white cloud will be of value to you in identifying the agent. While we are speaking of eyes, it is well to remember that many of the agents produce lacrimation which will be of value in identifying the different agents. Those who were present yesterday will remember that Dr. West cited the case where persons had been victims of lewisite believing it to be tear gas because of the lacrimation produced. Chloripicrin is a definite lacrimator, its primary purpose is producing nausea.

A second and undoubtedly a primary method of detecting gas is by means of odor. I think you will find that the odor test is considerably overrated, for this reason; it is extremely difficult without a great deal of practice to describe an odor so we describe the odor of an agent as being similar to the odor of some common substances such as: fly paper or freshly cut corn. When you smell the agent you are quite likely to get some entirely different impression. Most substances have individual odors. To try to compare the odors of one substance with that of another is not satisfactory. And to continue this thought may I call to your attention the extremely varying substances to which the odor of some agents are compared. You will find that most agents are apt to smell like two or three common substances. It is quite obvious that one substance cannot smell like two or three others. For example, the odor of mustard has been described as being like garlic, greasy hamburger stands, onions, and so forth. Different samples of mustard have affected the same people in different ways. The obvious conclusion is that it doesn't smell like any one of these substances but that impressions rather than odors are obtained. Another difficulty with odors is that pure vesicants have virtually no odor at all; only the impurities incident to the manufacture of these substances have odors. Pure mustard gas is a fairly white, oily liquid having no dark coloration at all. Upon standing the simple molecules combine together to form larger, dark colored molecules and this dark colored substance is the odor producer. The dark colored substance does not have the properties of a vesicant agent like mustard. The odor of lewisite is perhaps as definitely agreed upon as any as being like that of geraniums. But pure lewisite is odorless; impurities are the source of the geranium odor.

So the odor of these agents may vary from no appreciable odor at all up to an intense or varied odor depending upon purity. Another thing wrong with the odor test exclusively is the fact that the odors of certain agents may be deliberately masked. Some highly odorous substances might be mixed in so as to completely mask the odor of the gas and so add to all of the previously mentioned difficulties. Nitrogen mustards have odors which are hardly perceptible at all. Unlike mustard and lewisite, these substances may be manufactured under such conditions that they are essentially odorless. So while the odor test or the sniff test will be used and definitely should be used and cultivated, there is reason for additional methods of detecting these agents.

Simple chemical tests should be evolved whereby a person with little chemical training can go out in the field and identify the agents. Another reason for detection by chemical means lies in the psychology of the situation. Air raid warden, Joe Doakes has never been in an air attack before. The plane drops something. Joe doesn't know what it is. He smells something. It may be the odor of a detonating high explosive bomb or it may be simply the odor of the burning rubber on the bottom of his shoes as he leaves the scene or it may be magnesium burning or it may be gas. I hold to the theory that Joe on his first test will go to the telephone and call the control center and yell, GAS. He probably is more afraid of gas than of anything else and doesn't know too much about it. The commander at the control center needs to know if there is gas. If there is no gas, he can send his services out in the field without worry. If there is gas, he cannot. So if Joe reports gas when there isn't any gas then services will be held up because services will not be sent out in the field if gas is present. It becomes a case of necessity to know whether there is gas or not. So reliable, reproducible tests must be used as checks on the odor test.

I want to demonstrate for you some of the simpler tests which can be made. First the odor test. I want you to get effect of the odor. I want you to smell the agents that I pass around. I want you to be able to say that you held a bottle of live mustard in your hands. Many hundreds of people who have smelled that bottle know the point I am getting at. I shall pass two samples of live mustard. You will find that you can't depend **conclusively** upon your nose for identification because the two samples will smell differently. Next, I shall send a sample of lewisite around.

There is available in priority areas such as this, a detector paper which is coated with some substance which will react with any of the vesicant agents. It has an olive drab color which when in contact with a liquid vesicant turns red. (Demonstrates with mustard and lewisite). You notice the reddening of the paper everywhere the cap of the bottle touched the paper. The test unfortunately is not specific; certain organic solvents will also produce the same test. We find, however, that common substances such as lubricating oil, gasoline, etc. do not turn the color of the paper, so that most liquid droplets found under field conditions which give a positive test with the paper can be definitely classed as vesicant gases. In use a small bit of paper is torn off and rubbed over the suspected area. You will have opportunity to use this test this afternoon.

Here is a crayon which turns blue in the presence of mustard or lewisite. It can be chipped off by thumb nail. If the material of which the crayon is composed comes in contact with mustard or lewisite in liquid form, it will turn from olive drab color to blue. Here is vesicant detector paint that can be had in some areas. It contains the same agent as the detector paper. This paint can be put on sides of buildings, on radiators of cars or on test boards; if this paint comes in contact with a vesicant, it will turn red as test paper does.

The above tests, however, are indicative and should not be counted as complete confirmation. In closing I should like to make a specific test for mustard. This test utilizes a specific piece of equipment that the army supplies. Dr. West will show later how the test can be modified for detection of lewisite. This is the so-called M-4 kit. (Demonstrates). There is silica gel in the tube for concentrating the agent. This silica gel is mixed with a secret agent called DB3. In operation the small tube is connected to a suction bulb and the gas-laden air is drawn through the silica gel. The silica gel concentrates the gas by adsorption. The tube is then heated until the red dot changes to yellow. Then one drop of sodium hydroxide is added. If mustard is present the otherwise colorless silica gel will turn to a deep blue color. There are those who say they can use this kit to determine the quantity of gas present. However, under field conditions this is not necessary. The kit is rather compact; it consists of a bottle labeled A which contains the little test tubes and a suction bulb. The tube is placed in the end of the bulb. By squeezing the bulb, air is made to enter through the end of the tube through the silica gel. In the field, you will pick out a suspected spot; such as a puddle or drops on a bush or something like that, assemble the bulb and tube and take several bulbs full of air. I have taken a sample of gas here. The next step is to heat the tube until this red dot turns yellow. Heating with a match will undoubtedly give you a great deal of charcoal on the outside. In order to improve visibility of the silica gel, it is wise to wipe off the charcoal. This gives the tube an opportunity to cool for a minute. Next, by means of the dropper which you will find in the kit, you add a drop or two from bottle B which contains sodium hydroxide or lye. The result is a blue coloration in the tube. I do not know the composition of DB3. That blue coloration is specifically a test for mustard. Now in order that you may become better acquainted with the kit, I am going to pass one around so that you may see all of the component parts.

To recapitulate:

For the war gases which one is apt to meet in the field we need specific chemical tests to aid the impressions given by the ordinary senses. Not only do we need to know that there is some gas present but from the standpoint of treatment and from the standpoint of the record we need to know what that gas is without question.

It is to make you familiar with these specific chemical tests that we have asked you to study with us today.

SPECIAL METHODS OF DETECTION

SAMPLING

It is the duty of the Gas Reconnaissance Agent to identify war gases used in an attack and also to collect samples of such gases for future examination by the Senior Gas Officer, the State C.D. authorities or by the army. The technique of collecting a sample is dependent upon the type of warfare agent.

Non-persistent agents will likely be diluted by air currents to such an extent that scarcely any may remain at the time the Reconnaissance Agent arrives at the scene of the incident. However, if there is a suspicion of gas, a sample of air may be "sampled" by using a rubber atomizer bulb to draw the contaminated air through a small glass tube filled with charcoal or cotton. The volatile gases persist longer in bomb craters, basements, and sheltered places than in the open. The glass tube packed with charcoal and/or cotton serves as a minute "gas mask" adsorbing the vapors on its surface. After many squeezes of the bulb a relatively high concentration of warfare agent will adhere to the filler in the tube. It may then be taken out of the gassed area and analyzed under more favorable conditions. The gas may be gradually released from the filler by gentle heating.

Persistent agents which are in the liquid state under average atmospheric conditions are more easily sampled. Small droplets of these liquids will likely be observed on the soil, grass, pavement, or buildings. A portion of the contaminated material may be placed in a small stoppered vial. If the agent is on a hard surface it may be blotted up with a small piece of cloth or cleansing tissue and this placed in a stoppered vial. To avoid skin contact with the agent during sampling, a splinter of wood may be used as a spatula for filling the sample vial. In the event a persistent agent is suspected but no droplets of liquid are found, the vapors in the air may be sampled as has been described for non-persistent agents.

Ideally the Reconnaissance Agent will be able to identify the gas at the scene of the incident. However, since mixtures of gases or new gases may be expected, a complete analysis in the field will be quite unlikely. Consequently the importance of the collection of samples cannot be overestimated.

TEST FOR ACIDITY

Some information regarding the nature of a warfare agent may be had by testing it, or its water solution, for acidity or alkalinity. Mustard, lewisite, phosgene, diphosgene form acid solutions in water. Nitrogen mustards are slightly alkaline.

The approximate acidity or alkalinity of a gas or liquid may be found by exposing test strips of commercially available papers such as "Universal Indicator" or "Alk-acid Indicator" to the gas or solution of the gas. By a comparison of the color produced on the paper with the colors given on the accompanying color chart the acidity or alkalinity may be expressed by a number which will usually be between one and ten, seven being neutral, less than seven being acid, and greater than seven, alkaline.

TEST FOR CHLORINE

Mustard, lewisite, chlorpicrin, phosgene, diphosgene, some nitrogen mustards and some other less common agents contain the element chlorine. When these gases hydrolyze (react with water) the element chlorine is in such form that it will react with a solution of silver nitrate to form a white insoluble substance.

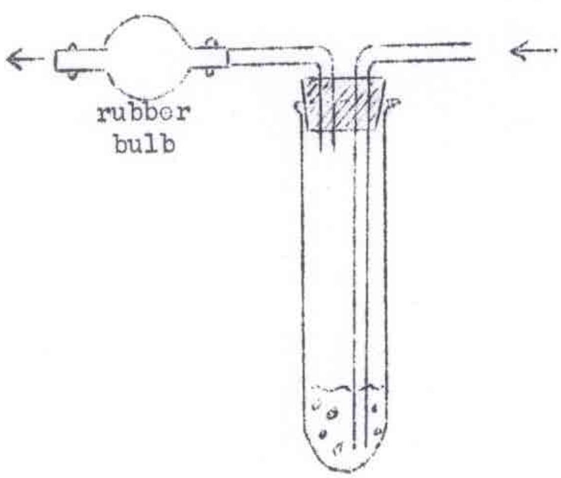
If this white substance is insoluble in nitric acid but soluble in ammonia the warfare agent must have contained chlorine.

TEST FOR ARSENIC

Arsenic is present in lewisite and in other gases which contain the word arsenic. Its presence may be proved as follows: the sample to be tested (contaminated earth or water) is placed in a test tube to which a piece of zinc has been added. Dilute sulfuric acid is added. A plug of loose cotton dipped into lead acetate is placed in the neck of the tube. A strip of dry paper previously dipped into a solution of mercuric chloride is held near the mouth of the tube. The paper turns from white to yellow or brown if arsenic was present in the sample. A control test should be run to make certain no arsenic is present in the acid or in the zinc used in the performance of the test.

TEST FOR MUSTARD (IODOPLATINATE TEST)

In the absence of an M-4 test kit the following test is an excellent substitute. The contaminated vapors are sucked through a starch iodoplatinate solution as shown in the accompanying figure. This test is the most specific test known for mustard. No other gas will give the test. When mustard vapors are drawn through the reddish solution a dark blue color is produced. It is planned to have the solution used for this test available through Mr. Patterson, State Gas Consultant.



TEST FOR LEWISITE

A specific test for lewisite may be made by using a suction bulb and small glass tube similar to the apparatus used in the M-4 test for mustard. Since lewisite is readily adsorbed on cotton the filler in the glass tube is only cotton.

After several squeezes of the bulb a few drops of a special "lewisite reagent" are added. Heating is not necessary. A red color confirms lewisite. The lewisite reagent and the cotton filled tubes will be available through the State Gas Consultant.

TEST FOR CHLOROPICRIN

Dimethylaniline test papers, used dry, turn yellow in the presence of a rather large concentration of chloropicrin. The color soon fades. Phosgene gas in high concentrations will also give a faint test with this test paper.

Freshly prepared papers are most sensitive to chloropicrin.

TEST FOR PHOSGENE OR DIPHOSGENE

Harrison's reagent test paper (paradimethylaminobenzaldehyde and diphenylamine dissolved in carbon tetrachloride) changes from white or pale yellow to deep orange in the presence of phosgene, diphosgene, chlorine or hydrogen chloride.

TEST FOR NITROGEN MUSTARDS

Thus far the Office of Civilian Defense has made no mention of specific tests for nitrogen mustards, however, we have observed that a solution of picric acid in water will produce a yellow insoluble solid when added to a water solution of nitrogen mustard. The reagent picric acid will not only react with nitrogen mustard but may be used to neutralize and destroy the vesicant properties of the agent.

When familiar with the odor of nitrogen mustard one may be able to detect the presence of the gas under ideal conditions by odor alone. Its odor is quite marked but so different from the odor of any other substance that comparison of odors is of little assistance.