FOOD CONTAMINATION AND DECONTAMINATION

F-1. General

a. Food Susceptibility. Stored, transported, and prepared food is susceptible to NBC contamination throughout the TO. Planning for any battle or operation must include food protection from contamination; food contamination detection; and contaminated food disposition (decontaminate or destroy).

b. Countermeasures. There are three primary countermeasures to overcome or reduce the NBC hazard to food:

(1) Contamination avoidance.

(2) NBC agent detection.

(3) NBC agent decontamination.

c. Priorities. The priorities for conducting NBC countermeasures are--

(1) Contamination avoidance. Contamination avoidance includes using natural and fabricated barriers to prevent, or significantly reduce the spread of contamination. Also, using specific procedures for entry and exit between contaminated and uncontaminated areas reduce the potential for spreading contamination. Use of these barriers and procedures may reduce the subsequent need for detection and decontamination.

(2) Detection, measurement, and identification. These activities are essential for determining the presence, extent, and nature of NBC contamination. This information is essential in identifying the existence of uncontaminated supplies, or decontamination requirements.

(3) Decontamination. Decontamination removes the contaminant and provides food that is safe for consumption.

d. Decontamination. Decontamination efforts require an extensive amount of labor, time, and supplies. The use of hasty decontamination is emphasized. That is, decontaminate just enough to sustain operations and keep fighting, rather than to make a contamination-free environment. Normally, decontamination efforts will be limited to the packaging and packing materials. Food decontamination will only occur in critical situations where other food supplies are not available.
Most decontamination is performed in or very near the AO. Before beginning decontamination procedures, divide exposed food items into groups based on protection of item at time of exposure. These groups establish priorities based on ease of decontamination and the ability to monitor the food.

(1) Group I--Canned or packaged items exposed only to a chemical agent vapor.

(2) Group II--Canned or packaged items that are contaminated on the outside with a liquid chemical agent, a biological agent, or radioactive fallout.

(3) Group III--Unpacked or poorly packaged items that have been exposed to any NBC of agent.

(4) Group IV--Food contaminated through the food chain.

F-2. Protection of Food from Contamination

An adequate defensive posture for a chemical attack will also protect food against biological contamination and radiation fallout.

a. Operational Rations. Operational rations include, but are not limited to: T rations, meals ready-to-eat (MREs), survival rations, B rations, and medical B rations.

(1) Packaging materials and storage methods normally protect these rations. The packaging and packing of operational rations protect the contents from deterioration. As a result, the contents are protected from moisture, to include chemical liquids, chemical vapors, and biological agents. Operational rations delivered to an AO will usually have increased levels of packaging and/or packing protection. Operational rations are substantially protected while contained in the shipping cases, especially if protected with an overlay of fiberboard, shrink wrap, or film wrap.

(2) Enclosed storage is used whenever possible. Refrigerated warehouses, cold storage rooms, and even prefabricated refrigerators and trailers provide excellent protection. Underground shelters, caves, and tunnels that can be made airtight provide maximum NBC protection. Buildings provide protection depending on how well they can be closed and sealed. The basement of a building is a good storage place. However, keep in mind that chemical vapors tend to seek out low-lying areas. Storing rations indoors will protect them from liquid droplet and fallout contamination unless the building is damaged by an attack. Complete protection against chemical vapors is only offered by airtight closed spaces like cold storage facilities.

(3) Chemical protective measures are to be integrated into daily logistical operation to avoid the contamination of operational rations. Maximum use is made of alarm and detection equipment, overhead shelter, shielding materials, and protective covers. Back up stocks of operational rations should be dispersed to minimize the risk of destruction or contamination.

(4) An NBC Protective Cover or similar equipment will help greatly. The NBC Protective Cover is discarded and replaced upon becoming contaminated; it reduces overall decontamination requirements; and it improves the survivability of supplies and equipment. The NBC Protective Cover provides 24-hour protection against liquid chemical contamination. Detection paper used on the NBC Protective Cover will rapidly identify a contaminated cover.

b. Bulk and Fresh Foods.

(1) Field expedient or improvised storage may be the only choice available under high risk conditions. Expedient storage for food supplies may be a natural or man-made depression lined to protect contents against moisture, and then covered with earth and sod. The

earth gives good protection against all forms of chemical or biological contamination and nuclear fallout.

(2) Foods are only stored outdoors or in partially protected areas when absolutely necessary. Only cases of foods packed in cans, bottles, or airtight foil or film wraps, and foods packed in sealed boxes or multilayered wrappings can be subjected to exposed storage. Partial protection is provided by open sheds, temporary roofing, or tents. When subsistence must be stored in the open, give as much protection as possible. Protection material may include NBC Protective Covers, tarpaulins, tarpaulin sheds, or any other available covering such as plastic sheeting. Tarpaulins and other treated or waterproof coverings do not prevent contamination by chemical vapors, but they do reduce contamination from liquid agents. Canvas will keep out more than 95 percent of liquid contamination for a short period of time after the attack. The canvas must be removed soon after the attack to prevent the agent from seeping through onto the subsistence; placement of spacers between the covering and the food will greatly reduce this problem. Even the thinnest material will offer some protection and is better than nothing at all. Therefore, food supplies must be covered by whatever material is available.

F-3. Nuclear

a. Contamination.

(1) Following a nuclear detonation food can become contaminated in three ways:

Direct contamination. Direct contamination results by fallout collecting on plants, animals, and stored food (surface contamination). Fallout has two effects. First, it produces a gamma radiation field over the fallout area. Second, it contaminates the surface of anything on which it is deposited. The whole-body gamma irradiation hazard to an individual far outweighs any potential hazard from food contamination. The basic rule is: If you can safely be in the area to salvage the food, then the food salvaged is safe to use (although slightly contaminated).

Indirect contamination. This form of contamination can be spread throughout the food chain. Humans can ingest contamination by eating plants which have absorbed radioactive isotopes; products (milk or meat) from animals allowed to graze on contaminated pastures; or fish from contaminated water.

Induced radiation. It is possible that food will be exposed to sufficient neutron flux (an increase in the number of free neutrons) as the result of a nuclear explosion to produce considerable induced radioactivity in food without it being destroyed by blast and heat. This is possible with enhanced radiation weapons in the energy range of 1 KT where the radiation kill radius exceeds the blast destruction

zone. The elements that are most prominently involved are sodium, potassium, sulfur, copper, bromine, zinc, and especially phosphorous. Thus, in an area of induced radiation, foods requiring the most caution are dairy products, high salt content foods, dry beans, raisins, and ready-mixed cake and biscuit flours. The radioactivity has a short half-life; therefore, the radiation will decay very rapidly. It should be possible to consume foods containing induced radiation within a week or two. Cans, particularly those with "C" enamel, may incur a high level of induced radiation (from zinc in the enamel, not from iron in the can). Glass, because of its high salt content, will show very high levels of activity; clear glass will turn brown. Container radioactivity has no bearing on the food, it is safe to use. The radioactivity is not transferred to the contents. No significant toxic by-products are formed in the exposed canned food.
(2) Consumption of food contaminated with radioactive fallout may cause a risk of radiation injuries from internal radiation; that is, radiation from radioactive sources within the body. Most isotopes will pass through the digestive tract or be excreted very quickly. However, the intestinal tract may receive a considerable dose. Some isotopes are more hazardous because they are absorbed from the digestive tract and enter the metabolism of man and animals.

Strontium-89 (Sr-89) and Strontium-90 (Sr-90) are beta emitters and have half-lives of 51 days and 28 years respectively. Therefore, Sr-90 is the greatest radiation hazard in the long term. These two isotopes are absorbed in the body and used in the same way as calcium. They accumulate in bone, where bone marrow with its blood forming cells is vulnerable. Milk and other dairy products are the primary sources of Sr-89 and Sr-90 in the human diet.

Iodine-131 (I-131) is a beta and gamma emitter and has a short physical half-life of approximately 8 days. It is efficiently absorbed and used by the body. Iodine-131 will contaminate plants which will be eaten by grazing animals. Smaller amounts can also be absorbed by breathing contaminated air. Cattle will excrete a large amount of I-131 in milk. Milk and other dairy products are the primary sources of I-131 intake. One can also get smaller amounts by eating contaminated fruits and vegetables. Iodine-131 will be concentrated in the thyroid gland. The intake of I-131 will have its greatest impact the first few days to weeks following a nuclear explosion.

Cesium-137 (Cs-137) is a beta emitter and has a half-live of 30 years, but is eliminated relatively quickly from the body. The biological half-live is 70 to 140 days. Cesium-137 is found in most tissues of the body, but it will concentrate in muscle tissue. Cesium-137 is absorbed and used the same way as potassium. Meat and milk are the primary sources of Cs-137. Much precipitation, lack of minerals in the soil, and extensive cultivation increase the plants' absorption of Cs-137; thus, the contamination of plant products.

(3) Operational rations are safe when surface decontamination is performed before breaking the package. Operational rations stored close to ground zero may become radioactive from induced radiation. It is more likely, however, that the food will be damaged or destroyed by the blast and thermal effects of the nuclear explosion.

(4) Bulk and fresh food stored in the open without protection will be contaminated. Decontamination is very difficult and time-consuming. Efforts should be made to ensure proper packing to prevent food contamination from radioactive fallout. Packing made from hard and nonporous materials, such as plastic or multilayer cardboard with a smooth surface, should be used. In addition, storage facilities should be enclosed to avoid the entry of fallout. Any material used as a protective cover will give some protection against nuclear fallout. Protection against induced radiation, blast, and thermal effects requires a hardened shelter or underground storage.

(5) Food supplies require protection throughout the chain of production or procurement. Protection of the civilian based food supply includes countermeasures along the production chain. Meats and milk are the most vulnerable products because of the possibility for concentration of radioactive isotopes (Strontium, Cesium and Iodine). The primary, and possibly the only, protection of animal products is to keep the animals in-doors and to avoid contaminated fodder. Immediate slaughter of food animals is recommended if there is a shortage of uncontaminated fodder. Also, food animals exposed to fallout should be considered fit for consumption and slaughtered using routine procedures. Unharvested crops cannot be protected.

b. Inspection and Monitoring.

(1) Fallout close to ground zero, especially after a surface burst, may be visible as dust. The presence of dust is an immediate indicator of contamination. Fallout on unprotected food produces a grittiness which is unpleasant and warns against eating the food. The degree and means of food protection (packaging and storage facilities) must be considered. Food in a building that remains intact should not receive enough contamination to be dangerous when eaten.

(2) Veterinary units have the IM-174A/PD to conduct ground or aerial surveys for gamma radioactive contamination levels in an area. The measurement of the external gamma radiation in the fallout area is an indication, but not a quantitative measure, for the degree of hazard from food contamination. These units also have the AN/PDR27 Radiac Set to detect point sources of gamma and beta radiation and to measure gamma radiation. Food monitoring is conducted in an area with low background radiation. If the storage area is contaminated, the food must be moved to a cleaner area for monitoring. With the AN/PDR27, the initial food monitoring is performed with the probe window closed and the probe passed approximately 6 inches from the surface. If the reading is twice the background dose rate, the food is

considered contaminated. If the reading is not above the background level but contamination is still suspected, place the probe closer to the food with the beta shield open. Monitor meat and fish with the probe open; pass the probe approximately one-half inch from the surface of the food.

(3) Monitoring food contaminated through the food-chain is more complicated; depending on the detection instrument used, special procedures must be followed. Gamma and beta emitting radionuclides in small volumes may be detected using radiac sets such as the AN/PDR27; however, alpha emitting ones cannot. They are rough instruments and may be used only for screening surface contaminated food. To evaluate the hazards; the isotopes contributing to the radioactivity must be identified. Surface contaminated food will contain a mixture of isotopes with some more hazardous than others, depending upon whether they are used by the body. Milk will contain mostly I-131, Cs-137, Sr-89, and Sr-90. Meat and fish will contain mostly Cs-137. To verify I-131, Cs-137, Sr-89, and Sr-90 contamination, samples must be sent to laboratories equipped to analyze the samples.

(4) All newly selected food supplies must be surveyed. Begin continuous monitoring immediately following receipt of a fallout warning, or when increased levels of radiation are detected by periodic monitoring.

(5) Periodic monitoring is needed to establish baseline levels of background radiation in the environment and various food products. This monitoring is performed during peacetime, when possible, and throughout the time US forces are deployed in a TO.

NOTE The IM174A/PD and AN/PDR27 are being replaced by the AN/VDR2 Radiac Set. The AN/VDR-2 detects lower levels of gamma and beta radiation than the AN/PDR27 and higher levels of gamma radiation than the IM-174A/PD.

c. Decontamination. There are two methods for nuclear decontamination: aging and removing. Aging is the process of allowing natural radiation decay to occur. The time necessary for this decay to take place depends upon the isotopes present; each has a different decay rate (half-life). Aging may not be possible when there is a short food supply. In some instances, such as with induced radioactivity, it may be the only way to decontaminate. Removing nuclear contamination from areas, personnel, food, or moving equipment to another location eliminates the immediate hazard. To determine which decontamination method is required, food supplies are divided into groups. See Table F-1 for additional information on food items and decontamination.

(1) Group II--Food in sealed and dust-proof packing such as cans, jars, fiberboard, and cellophane. These products are easily

decontaminated by removing the radioactive dust covering the packing. This is done by brushing, washing with soap and water, or removing the packing (depending on the type of packing material). If radiation is still detected after removing the dust, repeat the brush/wash procedure and remonitor. If radiation is still present, the food itself is then considered radioactive (induced radiation) and is unfit for consumption. Decontamination of induced radiation is possible only through aging. After aging one to two weeks, the food should be safe for consumption. After surface decontamination, the contents are safe to eat unless the food has induced radiation.

(2) Group III--Unprotected food. The method chosen to decontaminate unprotected food items will depend upon whether or not the food supply is critical. If the food supply is not critical, the contaminated items are isolated and allowed to decontaminate by aging. If the food supply is critical, food with surface contamination can, in principle, be decontaminated by removing the contaminated surface, or by washing.

(3) Some products can be decontaminated by washing, peeling, or trimming the outer skin or leaves. Decontaminate potatoes and hard-skinned fruits and vegetables by washing or scrubbing under running water, followed by peeling or scraping, then washing again. Potatoes, carrots, beets, and turnips can be washed at the supply depot. However, do not wash beans, rice, and onions until they are delivered to the field kitchen; washing reduces their storage quality and shelf life. Citrus fruits, pineapples, corn, peas, beans, melons, pumpkins, cabbage, and nuts can be peeled. Decontaminate cucumbers, tomatoes, cherries, cranberries, grapes, pears, plums, and thin-skinned squash by soaking in a water or detergent solution and rinsing with vigorous agitation or brushing. Apricots, peaches, most berries, asparagus, broccoli, and leafy vegetables cannot be satisfactorily decontaminated because of fuzzy surfaces, irregular shapes, or small size which makes washing difficult.

Fresh carcass meat, sausages, and fish can be decontaminated by several washings with cold water. The exterior layer of the food item is removed if radioactivity is still present. There is, however, a risk of contaminating the inner parts of the foodstuff in the process. Cooking with several changes of water is the last step in decontamination.

Decontaminate hard cheeses, margarine, and butter by cutting off the outer layer to a depth of 2.5 to 3 cm.
Let cooking oils stand for 3 to 5 days, then pour off the contaminated layer; use a funnel to control spillage.

Nonperishable items that are hard to decontaminate, such as flour, sugar, and salt can be set aside allowing natural radioactive decay. When supplies are short, dilute the contamination by mixing with uncontaminated food, This will reduce the total amount of

radioactive exposure in foods prepared using these contaminated items. Decontaminate air permeable, double sacked goods by removing the outer sack. If the inner sack is free of radiation, double sack the food again to restore protection. However, when contamination is present on the inside bag, the food in contact with the bag is likely to be contaminated. Three methods can be used to handle this type of contaminated product. The easiest method involves spraying the bag of dry goods (except sugar or salt) with water. This will wet a layer of the food inside the bag. The wet layer can be removed when the bag contents are emptied. The uncontaminated contents are scooped back into clean packaging. Another method involves using melted paraffin to uniformly coat the outside of the bag. The paraffin solidifies after 30 to 40 minutes, then the bag with the radioactive contamination can be removed from the contents. Although this method will seal the radioactive substance in the wax, it probably will not remove the layer of contaminated food product inside the bag. For the third method, form a piece of sheet metal into a cylinder the same height as the bag and 4 to 6 cm smaller in diameter. Insert the cylinder into the bag, then remove the top 3 to 4 cm of the contaminated product. Carefully scoop the remaining product out into a clean sack. With the cylinder still in place, fold the bag down catching the contaminated product on plastic sheeting, or a tarpaulin. When using this method, mixing the contaminated portion with the uncontaminated portion is a problem. Check for contamination remaining in the product.
Boiling or cooking has no effect on radioactive contamination.

(4) Group IV--Food contaminated through the food-chain. It is not practical to decontaminate this food. Meat and milk are the two most common foodstuffs contaminated in this way.

Milk may be decontaminated to a safe level by a complicated ion exchange process. The I-131 activity will decline rapidly during storage of milk and milk-products, although the Cesium and Strontium activity will remain almost constant for years. In an area with high-level fallout, milk is withdrawn from human consumption. The duration of withdrawal will be dependent upon the type of fallout and levels.

Meat may be decontaminated to a safe level by soaking in water or brine. Cesium is loosely bound in the meat. By repeated soaking of meat cut in small pieces, most of the Cesium activity will be removed. Traditional meat preserving, such as salting with brine, will remove up to 60 to 70 percent of the Cesium activity. See Table F-2.
Fruits, vegetables, root-crops, and grain products may also contain hazardous amounts of radioactivity if ingested.

(5) Food animals. Food animals that have been exposed to fallout should be considered fit for consumption and slaughtered using routine inspection and slaughter procedures. In those cases where the animal has been exposed to fallout, but is not scheduled for immediate

slaughter, the radiation burden can be reduced by moving the animal to an uncontaminated area (barn if available) and washing it with soap and water. Mild radiation sickness does not necessarily mean that the animals cannot be used for food. If the animals have been exposed to an internal radiation hazard, the meat can be eaten if the internal organs are discarded. Chickens that have eaten radioactive material may lay contaminated eggs, but most of the radioactivity will be concentrated in the shells. The white and yolk will be free of harmful amounts of radiation and can be eaten. Chickens will not lay eggs if the radioactive body burden is large enough that their eggs are unfit to eat.

d. Considerations When Decontamination is Not Possible. When food cannot be decontaminated, sealing the product in a wrapping material or container may be needed. Sealing the product can reduce or shield the emanation of the contamination and/or fix the contamination in place. The hazard from contaminated food is small compared with that from external gamma radiation. Hungry people or animals should not be denied food because of possible fallout contamination. It is not practicable or desirable to pre-set maximum permissible limits of gross fallout radioactivity as a basis for judging whether or not food should be used. Common sense must be applied in establishing priorities for distribution of available food. For example, use the least contaminated and the most protected food first; hold milk products for 1 to 2 weeks before use.

F-4. Biological

a. Contamination. Biological warfare agents exist in the form of toxins and microorganisms. The normal packaging and packing of food (to protect against moisture, dust, and bacterial or other contamination) provides protection against most biological agents. The exception may be toxins and biologically derived substances. However, the protective methods used for chemical agents will also protect against toxins and derived substances. Food in freezers, refrigerators, and in refrigerated trucks or rail cars will be safe if these containers remain sealed until the outer surfaces are decontaminated.

(1) It is unlikely that a biological agent will affect the appearance, taste, or smell of the food enough for the change to be apparent.

(2) Packaging and packing materials are not life supportive to pathogenic agents and are therefore self-decontaminating with the exception of spore-forming organisms.

(3) Most operational rations are packaged in metal containers, or encased in heavy aluminum laminated plastics that can withstand boiling water; also, they are impervious to arthropod penetration. This food is highly resistant to biological agents.

(4) The use of unpackaged items (unwrapped meats, fresh fruits, and vegetables) should be restricted; use only operational rations. Unprotected fresh food stored in the open and close to the source of dissemination will become contaminated.

b. Detection.

(1) Rapid identification of agents used is absolutely essential to implement effective countermeasures. Agent identification must be achieved quickly; it is the first step in answering critical management questions. What adjustments must be made in food preparation and distribution? What are the essential countermeasures? What is the expected outcome of the incident?

(2) Samples of food that are suspected of being contaminated are transported to the designated supporting laboratory. Samples must be accompanied by a description of the samples, the sample collection procedures, and the circumstances which prompted the collection. The designated medical laboratory in the TO will provide a presumptive identification of the agent(s). Positive identification is accomplished by designated laboratories in CONUS.

c. Decontamination.

(1) Food contaminated with toxins is handled in the same manner as food contaminated with chemical agents. Food contaminated with microorganisms is handled in the same manner as when contaminated with the more common foodborne disease-producing microorganisms.

(2) Several methods are available to decontaminate food items contaminated with biological agents. The following decontamination methods are considered to be the minimum. See Table F-1.

(3) Group II food that is sealed in containers that are resistant to the passage of biological agents require only that the exterior of the container be decontaminated. Decontamination of these items are as follows:

For containers made of metal, glass, plastic, or porcelain:

1. Thoroughly wash the container in potable water and soap, or in a disinfectant solution. If the water used for washing is contaminated, the soap and water wash may increase, not reduce, the contamination hazard. After which, the food containers are immersed in a disinfectant solution for 30 minutes (see Table F-3); then rinsed with potable water, if available and time permits. Chlorine solutions are not as reactive or corrosive as DS2.

2. Place the containers in boiling soapy water for 15 minutes; then rinse with potable water.

NOTE 1. The chemical field decontamination kits do not meet the requirements to decontaminate food supplies exposed to biological agents.

2. The same procedures should be followed even if there is only suspicion of a biological warfare attack.

(b) Thoroughly wipe containers that will not withstand soaking with a cloth soaked in a chlorine-detergent solution. Remove the food from the container and place it in Group III.

(c) Metal or glass containers determined to have trichothecenes (Yellow Rain) present can be decontaminated using DS2. Allow a contact time of 5 to 30 minutes for the DS2 to neutralize the toxin. Then rinse the container with potable water.

(4) Group III food items that are not protected by the packaging material are decontaminated or disposed of as follows:

(a) Decontaminate foods that can be peeled or pared by immersing them in a disinfectant solution for 30 minutes, and then rinsing them with potable water (see Table F-3). Peel or pare the items after decontamination, then wash and, if appropriate, cook before eating.

(b) With the exception of certain heat-stable toxins, heat is the most practical means of decontaminating food. Several heating methods may be used, but the method chosen depends upon the type of food to be decontaminated. The key is to apply as much heat as possible without rendering the food unfit.

1. Cook in a pressure-type cooker with 15 pounds of pressure at 250 F (121 C) for 15 minutes.
2. Cook in a low-pressure cooker at 228 F (109 C) for 1 hour.
3. Bake bread or related items at 400 F (204 C) for 40 minutes. Bread made with toxin contaminated flour (especially with trichothecenes) is still toxic.
4. Bake or roast meat at 325 F (163 C) for 2 hours.
5. Boil for at least 15 minutes when no other method is available.

(c) Although decontamination methods are provided above, vegetables such as lettuce, broccoli, and cauliflower, or unwrapped meats that have been exposed to biological agents should not be eaten.

(d) Foods, such as butter, ice cream, and bread, that will not withstand any of the above treatments must be destroyed.

(5) Established meat inspection procedures are followed when animals exposed to biological agents must be used for food. The meat must be thoroughly cooked.

F-5. Chemical

a. Contamination.

(1) Contamination of foodstuffs by a chemical agent may occur at any point on the battlefield. This contact may render the food unpalatable also. In many cases, decontamination is difficult, thus, emphasis must be placed on protection. Keep food supplies covered at all times. Take special precautions to protect food that is not packed in protective packages. Unprotected food, forage, and grain supplies may be so contaminated that their consumption will produce gastrointestinal irritation, or systemic poisoning. Nerve agents, vesicants, and arsenicals are the most dangerous. Field concentrations

of phosgene, hydrocyanic acid, irritants, and smokes will seldom be high enough to cause serious food contamination. The effect of CK on food is not known. As a precaution, foods exposed to CK should be considered toxic.

(2) The effects of chemical agents on food depend on the nature of the agent and the type of the food. The extent to which chemical agents penetrate food also depends on the amount, form of dispersal (liquid [droplet size], or vapor) and duration of exposure. Nerve agents and mustard will penetrate deeply into unprotected fatty foods and will readily penetrate granular products such as grain and sugar. Liquid food products can be completely contaminated. Arsenicals readily hydrolyze to poisonous arsenical oxides in some foods. Foods can be divided into three categories based on their water content, fat content, and crystalline structure:

(a) Foods having a high water content, a low fat content, and/or a crystalline structure (fresh vegetables, fruits, sugar, salt, and eggs), will absorb mustard and nerve agents, either as a liquid or as a vapor. Nerve agents will be hydrolyzed slowly.

(b) Foods having a low fat content and an irregular (amorphous) structure (flour, bread, grain, rice, cereals, dried fruits, dried vegetables, tea, coffee, peas, and beans), readily absorb mustard and nerve agent in liquid form. As a vapor, these agents are absorbed to some extent, but are easily removed by airing.

(c) Foods having a low water content and a high fat content such as butter, fat, fatty oils, ham, cheese, milk, bacon, fatty meat, and fish, absorb mustard and nerve agents such that removal of the agents is virtually impossible.

(3) Chemical agents can be physically and chemically absorbed into food. In addition to the toxic effect, they often adversely affect taste, smell, and the appearance of the food. However, chemical agents can cause the food to become very toxic without causing any other changes in the food. Table F-4 shows the effects of a number of chemical agents on food. Since food can be contaminated without any outward change in appearance, the possibility of contamination must be assumed in a chemical agent environment. Treat the food with the same precautions as established for known contaminated items.

(4) The protective properties of packaging materials are dependent upon a number of factors. The factors include the form of the agent (liquid versus vapor); concentration and exposure time; weather (temperature, wind speed, and humidity); and packaging material (the type of material, thickness, and the presence of folds, tears, and small holes). Even the thinnest material will offer some protection and is better than nothing at all. Therefore, always cover food supplies with whatever material is available. Table F-5 summarizes the protection values of various packaging materials against vapors and liquids.

(a) Operational rations (B rations, T rations, and MREs) are substantially protected while contained in the shipping cases and especially if stored in the original palletized unit load with an overlay of fiberboard, shrink wrap, or film wrap. The worst case is pallets of subsistence contaminated by liquid droplets during an attack. After the attack, high vapor concentrations will exist in the vicinity of the palletized loads. If the outer barrier is permeable such as fiberboard, it is possible that a liquid agent can seep through the overlay fiberboard and contact the shipping containers in liquid form. Normally, with seepage resistant materials such as shrink wrap as the outer barriers, only the vapors of the agent are found within the pallet.

(b) While MREs are stored, the food is protected by up to six layers of material. Multilayer barriers result in a complex diffusion process of the agent from the outside towards the interior. Vapor penetration into nonhermetically sealed spaces is a simple gaseous diffusion process. Permeation through packaging is a much more complex process regardless of whether the challenge is a liquid or a vapor.

1. Liquid is adsorbed into permeable materials such as fiberboard or chipboard. With permeation-resistant materials (such as shrink wrap), the agent dissolves into, seeps through, then desorbs from the barrier material. Shrink wrap provides adequate protection. Fiberboard sheathing provides adequate protection against mustard agents, but not against nerve agents.

2. The low density polyethylene used to construct the menu bag can absorb chemical agents and possibly toxins. If the menu bag is removed from the shipping container and is exposed to liquid contamination, enough agent may pass through the bag to create a health hazard. Keep MREs in the shipping container until issued to the soldier. The menu bags should then be kept under the same degree of protection as the soldier.

3. The aluminum laminated materials used to construct the MRE (retort and nonretort) pouches protect food from chemical contamination if hermetically sealed. The only item in the MRE meal bag that is not adequately protected is the spoon.

(5) Mylar and cellophane are resistant to chemical agents.

b. Detection.

(1) Currently, a field method for detecting chemical agent contamination in food does not exist. Contamination is not always spread evenly throughout food; this makes it impossible to take a single sample and determine the presence or absence of chemical agents in the entire lot. Additionally, standardized laboratory tests have not been developed for determining levels of chemical agents in food. Until a specific method to detect chemical agents in food is available, reliance will have to be made upon determination of contamination, or lack thereof, on the packaging material; the

integrity of the packaging material; the protective qualities of the packaging material; and the penetration characteristics of the suspected chemical agents.

(2) Food may become toxic without any change in outward appearance. Never taste or smell food to determine if contamination is present in food.

(3) Veterinary and subsistence units have the following equipment available to detect chemical agents in the field:

(a) The M8 Automatic Chemical Agent Alarm System consists of the M43 detector unit and the M42 alarm unit. The detector unit is a portable, automatic, point-monitoring device that is designed to be hand carried from point to point. The M8 is used to provide early warning of a toxic agent position and detects the presence of chemical vapors and aerosols. The M43 detects all nerve, blood, and choking agents, and some blister agents. The M43A1 (the replacement for the M43) only detects nerve agents.

(b) The M256 Chemical Agent Detector Kit detects and identifies nerve, blood, and blister agents. The M256 is the most sensitive of the chemical agent vapor detectors available. However, it is not a continuous, real time monitoring system. It requires 15 to 20 minutes for sampling and analysis.

(c) The ABC-M8 VGH Chemical Agent Detector Paper can detect and differentiate between nerve and blister agents by color change. It is intended to be used by blotting and wiping surfaces suspected of contamination. The M8 paper will respond with a visual color change in 10 seconds or less.

(d) The M9 Chemical Agent Detector Paper will detect liquid nerve (G & V) and blister agents (H & L), but will not identify the specific agent or differentiate between nerve and blister agents. The M9 tape is sensitive to droplets as small as 100æ, and will respond with a visual color change in 10 seconds or less.

(4) All subsistence in a chemical attack area are considered contaminated until a survey can be conducted, preferably by veterinary and chemical personnel. Personnel must be at MOPP Level 4 while conducting the survey. Concentrate the initial portion of the survey on the adequacy of the storage facility and other protective measures in preventing chemical agent contact with subsistence items. The area surrounding the storage facility is examined for the presence of animals, rodents, birds, and arthropods acting unusual, or dead in unusual numbers. If animals are present and assistance is required in identifying the NBC agent, specimens can be collected and submitted to the AML. Damage such as broken windows, holes, or loss of structural integrity of the storage facility is noted. This information combined with knowledge of the agent form (liquid or vapor), type of agent (which will indicate the degree of persistency), and approximate time of attack will provide a risk assessment. Liquid agents should not

significantly penetrate an intact facility, but may produce vapor contamination by offgassing.

(a) Upon entering the storage facility, the M8 can be used to determine the presence of chemical vapors. However, precautions must be taken. The M42 alarm is not to be used inside shelters, vehicles, vans, or other interior modes. Therefore, when checking food storage facilities, the alarm unit must be left outside, turned off, or disconnected. Do not tilt the M43 detector more than 45 degrees (because of the liquids it contains). This is not a problem with the improved M43A1, but the M43A1 requires attachment of an exit port filter when used indoors. The M256 Chemical Agent Detector Kit can be used to sample the air.

(b) Pre-position M9 chemical agent detector paper in food storage areas; especially on the least protected pallets and in areas where droplets may enter, such as near doors or windows. Examine the M9 paper for indications of liquid chemical agents. If the M9 paper is positive, or if the packaging materials show the presence of liquids or stains, use the M8 detector paper to determine the type of the agent. If an agent is not indicated by the detector paper, then the amount of agent present will be insufficient to cause secondary contamination when the outer package is removed.

(5) Detection procedures become more complicated if a chemical agent has penetrated or permeated through the packaging and packing materials. Unless liquid has seeped through the cardboard, any agent in the interior of the shipping case will be in a vapor form. Liquid seeping should be obvious. The sampler-detectors in the M256 Chemical Agent Detector Kit do not have an aspirator for sampling the interior of the case. However, there are several procedures that can be used. One is to open the case, place the activated sampler-detectors inside the case, and then reclose the case. Another is to punch holes in the case, place the activated sampler-detector over the holes, and cover the sampler-detectors with an empty box or can (open end down) to concentrate the vapors escaping from the case. Alternatively, remove the food from the case and place it in a plastic bag with the sampler-detectors to concentrate the vapors. These procedures require two sampler-detectors; one for blood agents and one for nerve and blister agents. Neither method is very sensitive in low concentrations of vapor as is expected to be present inside shipping containers. A better method is to modify to M43 detector with a field expedient probe of Teflon tubing attached to the detector's air inlet. Insert the open end of the tubing into a hole in the case or package to sample the interior air. When available, the CAM can be used; its design will allow aspiration of air from inside shipping cases. The CAM can also be used to detect and identify liquid agents on a surface provided the agent is vaporizing in sufficient quantity. The CAM gives a visual representation of a hazard evaluation.

c. Decontamination.

(1) Decontamination is only required for contamination remaining 10 minutes or longer. Decontamination efforts on subsistence items will normally be limited to removal of the containers and carton overwrap material.

(2) The need for decontamination is primarily dictated by the type of chemical agent used. The method of decontamination selected will depend upon the type of packaging material used and the urgency with which the food is required.

(3) Food supplies in storage are not likely to be seriously contaminated if reasonable protection precautions are taken. For this reason, large supplies of food are not to be condemned as a whole simply because they have been exposed to possible chemical contamination. A prompt and careful survey of the supplies may reveal that only a few items have been contaminated to a level that decontamination is required. Prompt segregation of the heavily contaminated portions will prevent, or minimize contamination of the remainder. Foods without protective packages constitute the major difficulty.

(4) Individual decontamination is performed by each soldier on those subsistence items in his possession at the time of the attack. Individual decontamination is limited to operational rations that are in original, intact containers. Unit-level decontamination is performed by unit personnel under the supervision of unit NBC personnel. Support decontamination is attempted at major subsistence storage facilities. Again, decontamination is limited to packing material. Decontamination of food itself is only attempted in emergency situations when alternative supplies are not available.

(5) Start decontamination operations with the easiest method and proceed to the most difficult. This allows for the removal of a relatively large portion of the contamination in a minimum of time. The simplest procedure is to allow the materials to age and air ("weather"). Substantial selfdecontamination will occur with most agents. Exception are thickened mustard, thickened GD, and VX. Table F-6 provides the length of time for which contaminated subsistence supplies may present a contact hazard. Weather elements that affect decontamination are--

(a) Warm temperatures speed liquid agent offgassing and hasten the dispersion of chemical agents into the air.

(b) High winds rapidly disperse chemical agent vapors and speed offgassing from surfaces.

(c) Moisture causes chemical agents to react with water to form nontoxic or less toxic chemicals. Heavy rain or rain of long duration can aid decontamination by mechanically removing chemical agents.

(d) Even in cold weather, direct sun rays warm surfaces above the air temperature and hasten the offgassing and decomposition of chemical agents.

(6) Active decontamination is attempted only when weathering will not decontaminate the packaging material in sufficient time. Decontamination procedures can be enhanced by using heat to vaporize the chemical agent; by reaction with decontaminants; or by removing with hot soapy water.

(a) The simplest (standard) decontamination materials are water and detergents. An effective decontaminant is hot water used with the addition of soap or detergent and scrubbing. Commercial abrasive powdered cleansers are effective decontaminants for many surfaces (metal, glass, Formica), but not wood or soft plastics.

(b) Water can be used to flush chemical agents from surfaces. High-pressure application produces a better cleansing action than low pressure. If the surface has absorbed the agent, flushing will remove the surface contamination, but will not affect the agent that is absorbed.

(c) Soaking contaminated items in boiling water is an excellent decontamination method for some agents. Water alone will not be sufficient to decontaminate all chemical agents. Soaking in warm or cold water may reduce the contamination slightly; however, the hazard may not be reduced sufficiently even after prolonged soaking. If hot water is not available, or if it might cause damage to the item, other methods of decontamination should be considered, such as decontaminating solutions or a caustic solution followed by thorough rinsing.

(d) Fibrous materials such as cloth and canvas are best decontaminated by washing and scrubbing.

(e) Glass, metal, porcelain, and plastic surfaces are best decontaminated by using hot water or hot soapy water. Some toxic materials are readily removed with no more than slight abrasion or brushing.

(f) Painted, varnished, and waxed surfaces are generally smooth and nonporous. Dust and liquids are readily removed by wiping, brushing, or vacuuming. Absorbed materials are removed by hot water, detergent, or completing agents. None of these surfaces stand up well to heavy abrasive techniques. Agents can be attacked and removed by caustics, acids, and organic chemicals. Some of these surfaces readily absorb agents, so weathering following decontamination is advisable.

(g) Rubber is a porous material that can absorb agents. It is not easily decontaminated by abrasive techniques. Warm, soapy water used with brushing is effective since it removes some absorbed contamination. Strong acids, alkalies, and organic solvents may deteriorate and decompose rubber articles.

(7) Operational rations are the primary rations issued; always issue uncontaminated stocks first. This allows for decontamination of

contaminated stocks without interrupting supply support. Normally, contaminated stocks are not issued. The decision to issue contaminated items is based on the tactical situation, criticality of the items, type and extent of contamination, and the time and resources available for decontamination. Decontamination efforts on subsistence items are limited to the containers and carton overwrap material.

(a) The MRE retort and nonretort food pouch may be decontaminated with soap and water wash. The chemical agents will be removed by the solutions.

(b) Semipermeable materials (polyethylene menu bag, shrink wrap, and film wrap) may have chemicals deposited not only on the surface, but also dissolved into the matrix of the material. The chemicals can be removed from the surface by washing with hot soapy water, but contaminant dissolved in the material is not removed. The remaining agent can only be removed by weathering which can be accelerated through the use of heat and sweeping the surface with air.

(c) Fiberboard is both sorbent and permeable and acts like a blotter. Liquid decontaminants can force the contaminant further into the fiberboard. Any attempt to decontaminate fiberboard would be futile. The only alternatives are to remove the fiberboard, or to allow it to weather.

(d) Palletized unit loads of MRE outerwraps can be decontaminated through the aid of a forced clean air sweep in 4 to 5 days, compared to 3 weeks or more under natural conditions without a forced air sweep.

(8) Contaminated food supplies are only handled by personnel trained in decontamination methods and in MOPP Level 4. Contaminated food items are divided into three groups as described below (see Table F-1 for additional information).

(a) Group I consists of canned and unopened packaged items which have been exposed only to agent vapors. Most items in this group will be safe to issue after a brief period of outdoor airing to remove clinging vapors. Table F-7 lists the decontamination procedures for packaging materials contaminated with nerve agents, mustards, and arsenical.

(b) Group II consists of canned and unopened packaged items which have been contaminated with a liquid chemical agent.

1. Attempts to decontaminate porous packaging materials, such as cardboard or wood, are likely to be unsuccessful and may result in spreading the contamination. The best procedure in handling such items is to strip off the outer contaminated coverings and examine the inner layer to see if penetration of the agent has occurred. If it has, continue stripping off layers until an uncontaminated layer is reached and place it in Group I. If the agent has penetrated to the food, place it in Group III.

2. Food in cans or in other sealed, impermeable containers is not

in danger of chemical contamination. Because contamination is confined to the outer surface of the sealed container, decontamination is accomplished by: immersion in boiling, soapy water for 30 minutes and rinse; immersion in boiling water for 30 minutes; spray with DS2; or to wash in hot soapy water, rinse, and aerate. Under no conditions should contaminated containers be opened before they have been decontaminated and monitored.

3. Supertropical bleach and DS2 can be used on the polyethylene menu bag for up to 24 hours without a significant change in appearance, tensile properties, and size of the plastic. The use of DS2 will cause significant degradative changes to most other plastics, while STB will cause little or no change. Also, DS2 may cause false positive readings when using M8 or M9 paper, or the M256 Detector Kit to check completeness of decontamination.

(c) Group III will consist of unpackaged or poorly packaged items which have been exposed to an agent in either vapor or liquid form. Foodstuffs in this group should be decontaminated only when absolutely necessary. The decision to use foods that have been contaminated is to be made by the commander. Decontamination procedure to be followed, in order, is: trim surface fat and grossly contaminated areas; wash with water or 2-percent sodium bicarbonate solution; then boil in water.

1. Boiling in water may be eliminated when the contamination has been only with the vapors of irritant agents. When such an exposure has been light, aeration for a short time may be used for decontamination.

2. Frying, roasting, or broiling will not remove traces of blister agents from meats. In general, salvage of foods heavily contaminated with droplets of the blister agents, especially the arsenical blister agents, is not practical. Foods of high water or fat content are unfit for consumption and reclamation is not practical when contaminated with liquid mustard or a liquid nitrogen mustard.

3. When foods have been exposed to blister agent vapor, they can be reclaimed by washing with sodium bicarbonate solutions and rinsing with clear water, by intensive cooking, or in the case of dry provisions, by 24 to 48 hours of aeration. Lean meat contaminated with mustard vapor can be reclaimed by boiling in water for 30 minutes or more. With nitrogen mustard vapor contamination, the meat should be boiled in a 2-percent sodium bicarbonate solution. Discard the water used to boil the meat.

4. Nerve agent contamination is treated the same as blister agent contamination.

5. Food such as potatoes and hard-skinned fruits and vegetables can be decontaminated by washing or scrubbing, followed by peeling or scraping, then washing again.

6. Prepared food in open containers will be contaminated; it must be temporarily isolated, or disposed of (bury or as directed by

commander).

7. A food item that is contaminated with irritants can be decontaminated by airing. Consumability is determined by taste rather than toxicity.

8. Phosgene is rapidly hydrolyzed, therefore, washing the food with water or airing it will usually suffice.

9. Food contaminated with white phosphorous should be destroyed.

10. Normally, hydrocyanic acid will have little effect on food supplies. The exposures will most likely be as a vapor. However, foods with a high water content may become unfit for consumption after exposure to high concentrations.

11. The effect of CK on foods is not known. Foods exposed to CK vapors are considered toxic.

12. Table F-8 lists the decontamination procedures for unpackaged food contaminated with a chemical agent.

(9) Decontaminating cattle, poultry, and other livestock is only attempted when other sources of food are not available. Heavily contaminated animals should be destroyed. Livestock contaminated lightly by phosgene, nerve agents, mustards, and arsenicals (such as vapor or liquid) may be slaughtered in the early stages of poisoning before the full effects of exposure are shown. If these animals are slaughtered in the preliminary stages of poisoning and all tissues exposed to the agent (the head, blood, lungs, organs, and local areas) are discarded, there is no danger in consumption of the meat, provided the animal passes a pre-slaughter and slaughter inspection. This is true even of animals poisoned by arsenical agents since the edible tissue will contain amounts of arsenic too small to be toxic. Organs (liver, brain, heart, kidney, and lungs) will contain more arsenic than the musculature and are discarded. The meat must be well cooked. Personnel involved in slaughtering procedures must be careful to prevent spreading contamination to the meat and to themselves.

(10) Decontaminating forage and grain exposed to only chemical agent vapors is by aeration. Aerated supplies, especially if mixed with larger amounts of uncontaminated supplies, produces no ill effects when fed to animals. Forage or grain heavily contaminated by liquid vesicants, especially arsenicals, should