ATTACHMENT A

FACT SHEET

"PROJECT SHAD" HAZARDOUS ENVIRONMENTAL EXPOSURES

1. <u>Project Shipboard Hazard and Defense (SHAD.</u> Project SHAD was a series of tests conducted by the Department of Defense (DOD) during the l960s. The tests were intended to evaluate the effectiveness of shipboard detection and protective procedures against a variety of chemical and biological warfare agents, and related simulants.

a. Based on information available today to the Department of Veterans Affairs (VA), it is understood that these tests involved possible exposures to:

(1) Chemical warfare agents sarin and VX (including P^{32} radiolabeled VX); and the bacteria:

(a) *Bacillus globigii,*

(b) *Coxiella burnetii,*

(c) *Pasteurella tularensis,*

(d) *Serratia marcscens,* arid

(e) *Escherichia coli.*

(2) Staphylococcal enterotoxin B.

(3) Tracer material zinc cadmium sulfide (ZnCdS).

(4) The decontaminant beta-propiolactone.

b. Although other substances were used, those reviewed here were selected based on the availability of significant information about their human health effects. DOD is actively investigating its records to determine the names of ships and crew members who participated in these tests, and is seeking additional information on the hazardous materials involved. *NOTE: This Fact Sheet will continue to be updated as new information regarding additional tests becomes available on web site: www. va.gov/SHAD.*

2. <u>Long-term Health Effects from Sarin and VX</u>

a. Sarin and VX are highly toxic chemical warfare nerve agents.

(1) In 1998 VA requested the National Academy of Sciences (NAS) to review possible long-term health effects from exposure to sarin. Although NAS focused on sarin, their findings are applicable to related nerve agents, including VX.

(2) The NAS committee came to three conclusions about long-term effects of sarin exposure based on whether the exposure was high, medium, or low. They concluded that "there is sufficient evidence of a causal relationship between exposure to sarin and a dose-dependent acute cholinergic syndrome that is evident seconds to hours subsequent to sarin exposure and resolves in days to months." Thus, humans exposed to high doses of sarin show a well-characterized acute cholinergic syndrome as evidenced by acute cholinergic signs and symptoms. Synaptic buildup of acetylcholine following sarin exposure results in widespread over-stimulation of muscles and nerves. Resulting cholinergic signs and symptoms are evident in seconds to hours after exposure and usually resolve in days to months. At high doses, convulsions and death can occur.

b. The Institute of Medicine (IOM) of the NAS committee further concluded that "there is limited and/or suggestive evidence of an association between exposure to sarin at doses sufficient to cause acute cholinergic signs and symptoms and subsequent long-term health effects." Subsequent to acute cholinergic poisoning, some individuals show persistent symptoms that include:

(1) Fatigue;

(2) Headache;

(3) Visual disturbances such as asthenopia, blurred vision, and narrowing of the visual field;

(4) Asthenia;

(5) Shoulder stiffness;

(6) Symptoms of post-traumatic stress disorder (PTSD); and

(7) Abnormal test results, of unknown clinical significance, on the digit symbol test of psychomotor performance, electroencephalogram (EEG) records of sleep, event-related potential, visual evoked potential, and computerized posturography.

c. The committee also concluded that "there is inadequate or insufficient evidence to determine whether an association does or does not exist between exposure to sarin at low doses insufficient to cause acute cholinergic signs and symptoms and subsequent long-term adverse health effects." In other words, there is not sufficient evidence to conclude that persistent

symptoms will be observed in the absence of immediate signs and symptoms of acute cholinergic poisoning. However, it is important to note that there are no well-controlled studies of long-term health effects in humans exposed to sarin at doses that do not produce acute signs and symptoms.

d. **Summary.** The IOM committee noted that exposure to high doses of sarin can result in widespread over-stimulation of muscles and nerves, and convulsions and death can occur. The committee also concluded that there is limited or suggestive evidence of an association between exposure to sarin at doses sufficient to cause acute cholinergic signs and symptoms and subsequent long-term health effects, including fatigue, headache, visual abnormalities, asthenia, shoulder stiffness, symptoms of PTSD, and abnormalities on various psychomotor and EEG tests. This conclusion was based on the review of the reports of a group of industrial workers in the United States accidentally exposed to sarin and two groups of civilians exposed during terrorism episodes in Japan. VX, the other related chemical warfare agent involved with Project SHAD, is likely to have similar toxicological properties as sarin.

e. **Radiolabeled P^{32} VX.** In some SHAD experiments, radiolabeled VX (in which some atoms are chemically replaced by a radioactive atom) was used to detect the spread of VX by measuring radioactivity following its release into the environment. The radioactive atom used was P^{32}, an isotope of phosphorus that produces ionizing radiation, which was substituted for some of the normal non-radioactive phosphorus atom in VX. The P^{32} radioisotope is a beta emitter with a half-life of about 14 days; it has been widely used as a radioactive tracer in scientific studies for many years. It has also been used in radiation therapy for human cancers and other diseases.

(1) According to U.S. Department of Health and Human Services, ionizing radiation, like heat and light, is a form of energy. It includes particles and rays given off by radioactive material, stars, and high-voltage equipment. Most radiation occurs naturally, but some is produced by human activities, such as these experiments using radiolabeled VX. At very high doses, ionizing radiation can cause illness or death. Any dose might cause cancer after a long delay of many years, but it usually is not possible to conclude that a particular cancer is the result of a specific radiation exposure incident.

(2) Although details about the amount of radiolabeled VX used in SHAD experiments are not available, only a very small amount of radiolabel is required to trace the radiolabeled material in the environment following its release. Therefore, it is likely that U.S. service members involved in the SHAD experiments would have received low exposures to radiation, and the greater health hazard was probably from the chemical toxicity of the VX itself (radiolabeled VX would be just as poisonous as non-radiolabeled VX). However, some veterans may have participated in more than one SHAD test, which could have increased their exposures to particular chemical agents.

3. Long-Term Health Effects from Bacillus globigii

a. *Bacillus globigii* (BG) was referred to in older medical literature as *Bacillus licheniformis.* Members of the genus *Bacillus* are aerobic or facultatively anaerobic gram-positive or gram-variable spore-forming bacteria that are found ubiquitously in decaying organic matter, dust, soil, vegetables, and water. A species related to BG, *Bacillus anthracis,* is pathogenic for humans and is the basis of anthrax biological weapons (adapted from Principles and Practice of Infectious Diseases, ed, GL Mandell, JE Bennett and R Dolin, eds, 2000).

b. BG is not normally considered to be harmful. DOD selected BG as a less infectious biological warfare agent "simulant" in the Project SHAD tests. However, BG is associated with a number of opportunistic infections, particularly in a hospital setting with debilitated, immune-suppressed, or traumatized patients. Opportunistic infectious diseases would be expected to occur shortly after exposure to BG, and long-term infections are not expected among individuals exposed decades in the past.

c. Clinical manifestations from infection by some *Bacillus* species include acute food poisoning, localized infections related to trauma; for example: ocular infections, deep-seated soft tissue infections, and systemic infections like meningitis, endocarditis, osteomyelitis, and recurrent bacteremia.

(1) Risk factors associated with acquiring *Bacillus* infections include: intravenous drug use, sickle cell disease, foreign bodies including intravenous catheters, and immune-suppression from various causes, including infection with human immunodeficiency virus (HIV).

(2) BG specifically has been clinically associated with intravenous catheter-acquired sepsis. BG has also been reported in acute food poisoning cases in which cooked meats and vegetables were most commonly implicated. The median period of incubation was about 8 hours, and the predominant symptom was diarrhea with vomiting.

d. **Summary.** *B. licheniformis/globigii* is not generally considered to be pathogenic, but is recognized as a cause of such acute infections from intravascular catheter-acquired sepsis and from food poisoning.

4. Long-Term Health Effects from Coxiella burnetii. *Coxiella burnetii* (OU) causes Q fever in humans. Domestic animals (sheep, cattle and goats), cats, wild animals and ticks usually host *C. burnetii.* Humans become infected after contact with contaminated materials, such as feces or blood, inhaling contaminated dust or droplets, or ingesting contaminated food or unpasteurized milk. Symptoms of this infectious disease include fever, headache, muscle pains, arthralgia and a dry, non-productive cough. Hepatitis or pneumonia also may develop during the early stages of disease. In rare occurrences, Q fever can cause endocarditis and subsequent aortic heart valve complications. Generally, infected and appropriately treated patients recover completely.

5. Long-term Health Effects from *Pasteurella tularensis*. *Pasteurella tularensis* (UL) causes the infectious disease tularemia (rabbit fever, deer fly fever, Ohara's disease), most commonly in people who handle infected wild rabbits. Other infected animals, ticks, or contaminated food or water also transmit tularemia. The symptoms of this infection, high fever, and severe constitutional distress appear suddenly within approximately 10 days of exposure. One (or more) ulcerating lesion develops at the infection site, usually the arm, eye, or mouth. The regional lymph nodes enlarge, suppurate, and drain. Pneumonia, meningitis, or perionitis may complicate this infection, which has a mortality rate of about 6 percent.

6. Long-term Health Effects from Staphylococcal Enterotoxin B. Staphylococcal enterotoxin B (SEB) is one of seven enterotoxins produced by the bacterium *Staphylococcus aureus.* The staphylococcal enterotoxins are the most frequent cause of common food poisoning, which presents with nausea, vomiting, and diarrhea shortly after exposure. Therefore, many people have been exposed to SEB. Although in high doses SEB may cause fatalities, it was developed for military use as an incapacitating agent to hinder combat effectiveness on the battlefield. For use as a biological weapon, SEB is spread as an aerosol that can be inhaled. After exposure to an aerosol of SEB, symptoms develop rapidly in 3 to 4 hours. The major symptoms include acute fever, chills, non-productive cough, shortness of breath, headache, and nausea and vomiting. There is no test for exposure to SEB after acute symptoms have resolved. And there are no known long-term health effects from exposure to SEB, but follow-up studies of exposed populations have not been conducted.

7. Long-term Health Effects from Zinc Cadmium Sulfide

a. Zinc cadmium sulfide (ZnCdS) was used by DOD as a tracer material for studying potentially harmful particles dispersed in air. ZnCdS particles dispersed in air behave similarly to some biological agents, and because they fluoresce under ultraviolet light, the spread of ZnCdS particles can easily be detected. DOD used ZnCdS in Project SHAD and in other tests conducted in the 1950s and 1960s in several urban and rural locations in the United States and Canada.

b. In 1 994, DOD asked the National Research Council (NRC) to review the potential human health risks of ZnCdS. In their 1997 report, the NRC committee reviewed the toxicokinetics, bioavailability and toxicity of ZnCdS as related to the studies conducted in the l950s and l960s. **NOTE:** *The full report is available on-line at http: //www.nap.edu/books/030905 7833/html/index.html.*

c. The NRC committee reported that animal data indicate that ZnCdS is not acutely toxic when given orally, consistent with its low solubility and apparent lack of bioavailability. The committee found that the particle size used in these tests could have been inhaled and deposited in the deep lung. Given the lack of reports of toxicity of inhaled ZnCdS, the committee instead reviewed related toxicity data on cadmium as the most toxic component of ZnCdS.

d. The NRC Committee concluded that "inhaled cadmium has been shown in occupational studies and laboratory studies of animals to cause lung cancer, but not cancer at other body sites." Further, "cadmium inhalation exposures associated with increased lung-cancer risk in animal studies involved higher concentrations (100 - 1,000 times higher), longer periods (lifetime exposures), and more-soluble compounds than the exposures to cadmium from ZnCdS in the Army's testing program." The estimated upper-bound, lung-cancer risks ranged from less than 0.01 X 10-6 to 24.0 X 10-6 (less than one per million to twenty-four per million).

e. **Summary.** The NRC previously concluded that the risks to civilian populations of non-cancer health effects and lung cancer from ZnCdS tests conducted by DOD appear to be low.

8. <u>Long-term Effects of β-propiolactone</u>

a. According to the U.S. Department of Health and Human Services, National Toxicology Program, β-propiolactone is placed in the category of "reasonably anticipated to be a human carcinogen," based on sufficient evidence of carcinogenicity in experimental animals. That category includes many common industrial and other chemicals, such as diesel exhaust particulates and certain pesticides. It is important to note that there are no data available to assess the carcinogenicity and mutagenicity of β-propiolactone in humans.

b. β-Propiolactone is used to sterilize vaccines, tissue grafts, surgical instruments, blood plasma, water, milk, and nutrient broth, and as a vapor-phase disinfectant in enclosed spaces. Its sporicidal action is used against vegetative bacteria, pathogenic fungi, and viruses. It rapidly hydrolyzes in water (half-life 3.5 hours), but it is more persistent as a gas following atmosphere release. Personnel at greatest risk of possible exposure included disinfectant workers and makers of virucidal agents. The American Conference of Governmental Industrial Hygienists (ACGIH) has set a threshold limit value for exposure to β-propiolactone in the workplace at *0.5* ppm (8-hour time-weighted average). Occupational Safety and Health Administration (OSHA) regulates β-propiolactone on the basis of its carcinogenicity in animals under the Occupational Safety and Health Act, requiring: protective clothing, use of respirators, training in hygiene, medical surveillance, engineering controls to limit contamination, sign requirements for posting in regulated areas, and labeling requirements for containers.

c. According to the National Toxicology Program, the probability that a U.S. citizen will develop cancer in their lifetime is 30 percent to 50 percent. How much of this risk may be due to environmental factors (including lifestyle, and chemical, biological, and radiation exposures) is unknown. Moreover, "the probability of developing cancer-depends on many things, including the intensity, route, and duration of exposure to a carcinogen or carcinogens. Individuals may respond differently to similar exposures, depending on personal factors such as age, sex, nutritional status, overall health, and inherited characteristics. Only in a few instances, where studies of long-term human exposures and cancer incidence in restricted environments are available, can risk be estimated with confidence."

9. Summary. In summary, the biological agents used in Project SHAD are unlikely to have produced long-term health effects without observable health problems at the time of exposure because these infectious agents do not cause chronic infections without symptomatic disease. The chemical agents used in project SHAD are most likely to have produced long-term health effects if they caused clinically significant illnesses during or shortly after exposure. However, there are no good, long-term studies of the health effects of exposure to low levels of the chemical agents used in Project SHAD. A scientific study is currently being planned by the Institute of Medicine to determine whether SHAD veterans are experiencing any long-term adverse health outcomes.

10. References. Medical and toxicology texts may be consulted for more information on the agents; however, the following summarize the currently accepted information on the risks of exposure for selected agents:

a. Gulf War and Health. Volume 1. Depleted Uranium, Sam, Pyridostigmine Bromide, Vaccines, Institute of Medicine, National Academy of Sciences, 2000.

b. Mandell et. al., Principles and Practice of Infectious Diseases, 5th edition, 2000 pages 2220-2226.

c. Toxicologic Assessment of the Army's Zinc Cadmium Sulfide Dispersion Tests, National Research Council, 1997.

d. Mitretek Systems website, www.mitretek.org/missionlenvene/biological/agents/rickettsia.htm

e. University of Maryland School of Medicine website, umm.drkoop.com/conditions/ency/article/001337.htm

f. Colorado State University, Environmental Health Services website, chemdat1. ehs.colostate.edu/LARmanual/tular.htm

g. The Columbia Encyclopedia, 6th ed., New York: Columbia University Press, 2001, website, www.bartleby.com/65/

h. Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for ionizing radiation. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. www.atsdr.cdc.gov/tfacts149.html

i. Ninth Report on Carcinogens, Revised January 2001, U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, http://ehp.niehs.nih.gov/roc/toc9.html