FACT SHEET

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Deseret Test Center
Project SHAD

Folded Arrow

Project Shipboard Hazard and Defense (SHAD) was part of the joint service chemical and biological warfare test program conducted during the 1960s. Project SHAD encompassed tests designed to identify US warships' and ashore installations' vulnerabilities to attacks with chemical or biological warfare agents and to develop procedures to respond to such attacks while maintaining a war-fighting capability.

The purpose of Folded Arrow was to study over-ocean downwind travel of a biological aerosol material when disseminated from a submarine-biological system; to demonstrate the submarine weapon system capability to carry out an effective biological attack against an island complex; and to study the effects of a biological attack against a naval port facility. The data obtained from the test were related to mathematically generated estimates of casualties expected from exposure to *Venezuelan equine encephalitis*.

Six trials (Group A trials) were designed to ascertain the downwind travel of a biological aerosol produced by the submarine-biological-disseminator system. The submarine released the biological simulant *Bacillus globigii*. The Group A trials were conducted at sea approximately 80 nautical miles south-southwest of Oahu, Hawaii. Five light tugs stationed at pre-determined locations along the downwind path of the aerosol conducted over-ocean sampling.

Two trials (Group B) demonstrated the system's capability to attack an island complex. Sampling stations were established at 15 locations on the northern half of Oahu (that portion of the island north of Pearl City) to best depict movement of the aerosol cloud across the island. *Bacillus globigii* simulant was used in both trials.

The port facility attack consisted of two trials (Group C) during which the submarine disseminated *Bacillus globigii* simulant along a line offshore from Kaneohe Marine Corps Air Station.

In addition to demonstrating the feasibility of a submarine-biological-disseminator, Folded Arrow was also designed to determine the biological-contamination hazard to which the submarine crew would be subjected in operating the system. To determine the contamination hazard to the crew, an evaluation program was designed. This consisted primarily of aerosol and contact (swab) samples taken from numerous points inside and outside the submarine before, during, and after aerosol dissemination. Under the conditions of this test, no contamination of the submarine's interior was detected. Calcium hypochlorite and betapropriolactone were both used as decontaminants during this test. No trace of betapropriolactone vapor was detected within the submarine during the decontaminant tank-filling operation or during the system decontamination phase accomplished while under way.

Folded Arrow was conducted in the vicinity of the island of Oahu, Hawaii during the period of April and May 1968.

Test Name	Folded Arrow (DTC Test 68-71)
Testing Organization	US Army Deseret Test Center
Test Dates	April – May 1968
Test Location	Oahu, Hawaii and surrounding waters
Test Operations	To study over-ocean downwind travel of a biological aerosol material when disseminated from a submarine-biological system and to demonstrate the submarine weapon system capability to carry out an effective biological attack against an island complex; and a naval port facility.
Participating Services	US Navy, US Marine Corps, Deseret Test Center personnel
Units and Ships Involved	USS *Carbonero* (SS-337*)* USS *Granville S. Hall* (YAG-40) Five Army light tugs
Dissemination Procedures	*Bacillus globigii* was disseminated from a fleet submarine using a submarine-biological-disseminator.
Agents, Simulants, Tracers	*Bacillus globigii*
Ancillary Testing	Not identified
Decontamination	Calcium hypochlorite betapropriolactone
Potential Health Risks Associated with Agents, Simulants, Tracers	*Bacillus globigii* Now considered to be *Bacillus subtilis var. niger,* a close relative of *Bacillus subtilis*, this bacterial species was used as a simulant and considered harmless to healthy individuals. *Bacillus subtilis* and similar *Bacillus* species are common in the environment, and are uncommon causes of disease.

	They have been associated with acute infections of the ear, meninges (brain lining), urinary tract, lung, heart valve, bloodstream, and other body sites, but always or nearly always in individuals whose health has already been compromised. Long-term or late-developing health effects would be very unlikely (except perhaps as a complication of the acute infection).(Sources: Tuazon CU, *Other Bacillus Species* (chap. 197), in Principles and Practice of Infectious Diseases, 5th edition (vol. 2), ed., Mandell GL, Bennett JE, Dolin R, Churchill Livingstone, Philadelphia, 2000, p. 2220-6; US Environmental Protection Agency, *Bacillus subtilis* Final Risk Assessment, February 1997, available at http://www.epa.gov as of October 4, 2002.) Betapropriolactone Modern uses for betapropriolactone include vaccines, enzymes, tissue grafts, and surgical instruments; to sterilize blood plasma, water, milk, and nutrient broth; and as a vapor-phase disinfectant in enclosed spaces. Its sporicidal action kills vegetative bacteria, pathogenic fungi, and viruses. The primary routes of potential human exposure to betapropriolactone are inhalation, ingestion, and dermal contact. There is evidence betapropriolactone is a carcinogen; however, the results of animal testing in mice, rats, hamsters, and guinea pigs are questionable due to a lack of controls in the study. An International Agency for Research on Cancer (IARC) working group reported no data are available to evaluate the carcinogenicity of betapropriolactone in humans.(Source: Department of Health and Human Services, National Institutes of Health website: http://ntp-server.niehs.nih.gov/htdocs/8_RoC/RAC/betapropriolactone.html).

	Calcium hypochlorite. Modern uses for calcium hypochlorite include bleach, cleaning solutions, and disinfectants for drinking water and wastewater purification systems and swimming pools. When released into the air, it is broken down by sunlight and compounds commonly found in the air. It does not accumulate in the food chain. You can be exposed to low levels if you use disinfectants like household bleach. You can also be exposed swimming in pools where calcium hypochlorite has been added to kill bacteria. Calcium hypochlorite if ingested in small amounts (3-6% hypochlorite) can cause gastrointestinal irritation. If a more concentrated amount is ingested (10% or higher hypochlorite), effects can range from corrosive injuries to the mouth, throat, esophagus and stomach with bleeding, perforation and eventually death. Inhalation of chlorine gas may cause nasal irritation, sore throat, and coughing. Contact with skin may cause burning pain, inflammation, and blisters. Long-term exposure to low-levels of hypochlorite can cause dermal irritation. The International Agency for Research on Cancer (IARC) has determined that hypochlorite salts are not classifiable as to their carcinogenicity to humans.(Source: ATSDR http://www.atsdr.cdc.gov/tfacts184.html) as of June 3, 2003)