Prepared by the staff of The Honolulu Advertiser

Ridding ourselves of

# The chemistry of death

By Jim Borg
Advertiser Science Writer

Two soldiers with their mule — all equipped to fend off the mustard gas attacks of World War I.

Two days before Christmas 1936, Gerhard Schrader sprayed a chemical potion on some leaf lice in his laboratory at the I.G. Farben conglomerate in Germany.

He watched in amazement as the bugs quickly died.

Schrader, a scientist with Bayer, the company that developed aspirin, was searching for new insecticides. Here now was a particularly powerful combination of organic phosphorus compounds.

As he continued his experiments over the next several weeks, Schrader struggled for breath. His pupils shrank to pinpoints.

"In the darkness of early January, it was hardly possible to read by electric light, or after working hours to reach my home by car," he recounted.

Schrader was lucky to survive.

What he had stumbled upon was the world's first nerve agent, known as Tabun or GA.

The Nazi war machine quickly recruited Schrader and other scientists for an intensive effort to develop and produce weapons containing Tabun and later its more potent cousin, Sarin or GB.

Hitler's so-called "secret weapon" never was used in World War II, but Schrader's lethal legacy lives on today in

# Science

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Typhoon Lola lashed central Vietnam, killing seven people before unleashing further flooding in parts of northern Thailand still recovering from Typhoon Ira. Radio Hanoi reported that 110 of the 145 villages in coastal Thua Thien-Hue province were submerged. In Thailand, 34 people and 3,000 farm animals drowned in the

which washed ashore showed they were infected with the Mobilli virus. The disease is similar to canine distemper, and Riddell believes the dolphins could be treated with a vaccine similar to one used for dogs. So far, the outbreak has only affected Stenella dolphins in the western Mediterranean, the most common species in the region.

some restaurants also kill the bears and use them to make bear's paw soup. Exotic dishes like bear, snake, and cat stir-fry are commonplace in southern China.

*Additional Sources: U.S. National Hurricane Center, U.S. Military Joint Typhoon Warning Center at Guam, U. S. Climate Analysis Center, U. S. Earthquake Information Center, and the World Meteorological Organization.*

# Principal chemical agents

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|---|---|
| Chlorine | Strips lining of bronchial tubes and lungs; first used by the German army near Ypres, Belgium, on April 22, 1915 |
| Phosgene | World War I's second battlefield gas; colorless, and more dreaded than chlorine, it slowly drowns victims in lung fluid |
| Mustard (H, HD, HT) | Upon contact, turns skin into a mass of oozing blisters and strips bronchial tubes of mucous membranes. HD at Johnston Island in mortars, 105mm and 155mm artillery shells and ton containers |
| Lewisite | Intense mustard-style irritant, causing immediate excruciating pain in eyes, followed by respiratory distress, nausea and vomiting |
| CS, CN | Standard tear gases |
| Adamsite (DM) | Arsenic-based vomiting agent used in World War I |
| Tabun (GA) | The original nerve agent, developed by Germans in 1936, it disrupts body chemicals that control muscles; symptoms include frothing, vomiting, diarrhea, twitching, convulsion and death |
| Sarin# (GB) | A rapid-acting, fast-evaporating nerve agent absorbed through lungs, eyes, skin, especially through cuts, scrapes. Death by lung paralysis. At Johnston Island in rockets, artillery shells, bombs and ton containers |
| Soman (GD) | Developed by Germans in 1944, but never put into production; main Soviet nerve gas, used in Afghanistan |
| VX | A persistent nerve agent about the thickness of motor oil. A drop the size of a freckle can kill. At Johnston in rockets, mines, artillery shells and ton containers |
| BZ# | LSD-like incapacitant |

## Delivery methods

Chemical weapons can be carried by virtually any means used for conventional explosives. Here are some methods.


# tested in Hawaii in 1966-67

the form of hundreds of thousands of nerve-gas munitions in the United States, Soviet Union, Iraq, Libya and possibly several other nations.

So repugnant are chemical weapons in general — and nerve agents in particular — that the 40-nation Conference on Disarmament in Geneva is working, however slowly, toward a global ban on their production and possession.

In Washington on June 1, President Bush and Soviet leader Mikhail Gorbachev agreed to huge cuts in the U.S. and Soviet chemical stockpiles. Congress had already ordered the U.S. arsenal of older "unitary" weapons destroyed by April 1997, although the Army has the option to keep 10 percent in an emergency.

The United States also agreed to halt production of "binary" weapons, which carry two chemicals that mix to reach full potency on the way to the target.

For the most part, the U.S. chemical arsenal consists of about 30,000 tons of mustard and nerve agents in rockets, bombs, mines, mortar shells, artillery rounds, spray tanks and ton containers. All were manufactured before 1969, some are more than 40 years old and many are beginning to deteriorate and leak in storage.

But putting Schrader's genie back in the bottle is proving difficult, increasingly expensive and possibly dangerous. Ironically, some of the stiffest opposition to the current plans for defusing this environmental time-bomb comes from environmentalists.

The Soviets' pilot disposal plant in Chapayevsk on the Volga River has been sidelined because of environmental concerns over a possible chemical encore to Chernobyl.

The United States has promised technical assistance, but the Army's own program of chemical "demilitarization" has drawn fierce resistance in Maryland and Kentucky, two

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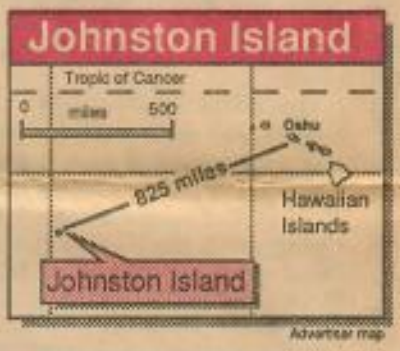


# Disposal

## Freezing weapons before incineration would save $1 billion, tech firm says

**By Jim Borg**
Advertiser Science Writer

Praise is sung for U.S. intentions to destroy chemical weapons, but there's no harmony in the chorus over the best way to do it.

Some critics of the Johnston Atoll Chemical Agent Disposal System (JACADS) say it suffers from its sheer complexity.

The plant sends disassembled components to four incinerators, one each for the liquid agent, the metal parts, the explosives and propellants, and the refuse or "dunnage" — such things as wood pallets, lab wastes and used protective clothing.

Equipment also must be reconfigured for each type of weapon — rockets, mines, artillery shells and so on — and chemical agent, which includes mustard agent and two types of nerve agent, for a total of 16 types.

With so many varied steps, the combined probability that something will go wrong is fairly high, some industry and former Army analysts allege. The plant's bumpy start-up seems to bear that out.

"If you have one portion of your processing line down, it isn't going to take long before the whole thing goes down," says one observer. "Also, when you have a hang-up on those machines, you have to put people in rubber suits in there to fix the problems. There is a risk involved anytime you put somebody in a contaminated environment."

Greenpeace, which is involved in a legal battle with the military, wants the Army to reexplore a process called chemical neutralization.

Nerve agent GB, for instance, can be rendered harmless by mixing it with caustic sodium hydroxide, a technique the Army tried in the early 1970s at the Rocky Mountain Arsenal in Denver and at the Chemical Agent Munitions Disposal System at Tooele, Utah.

The Army says the process takes too long and creates too much waste brine, also subject to federal disposal regulations. Further, the Army adds, it's expensive to verify down to the necessary nanogram that GB has been removed from the brine.

Greenpeace says advances in the knowledge of the relevant chemistry might solve those problems and cut costs. But the Army points to a National Research Council study that concludes incineration is simply the best route to take.

Now comes General Atomics, a San Diego-based high-tech manufacturer, offering an alternative advertised as

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# Disposal: Freezing weapons may help

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cheaper and more reliable than the one at work at Johnston.

Wayne Willis, the company's Washington, D.C.-based director of defense programs, says cryofracture can shave at least 30 percent — or more than $1 billion — from the cost of the Army's nationwide disposal program.

Derived from the Greek *kryos* for cold, the process involves dipping weapons in liquid nitrogen until the metal becomes brittle at about minus 200 degrees Fahrenheit. That not only makes the metal casings easy to crack, but it desensitizes the high-explosive, reducing the chances of a detonation, he says.

As a result, says Willis, every weapon in the inventory can be crushed whole in a hydraulic press and incinerated in a single rotary kiln.

Demonstration facilities in San Diego are run by computers, robots and workers at remote TV consoles, so human exposure to the weapons and contaminated machinery is minimized, says Willis.

"These robots are not specially designed robots," he says. "They are the kind you find in the automobile industry, for example."

A major advantage of cryofracture over the current system is that the weapons don't require disassembly, says Willis.

"In the cryofracture approach, you don't even take them out of the boxes," he says. "You freeze them in the boxes and crush them in the press while they are still in the boxes. The objective we achieved was to keep people out of the processing line altogether."

Largely at the insistence of U.S. Rep. John Murtha, D-Pa., chairman of the House Defense Appropriations Subcommittee, the Army has about $15 million this year for continuing studies that may lead to a demonstration cryofracture plant at Tooele, Utah, in 1992 or '93.

"I don't have any doubt in my mind that what the Army is doing there is safe," Willis said of Johnston Island. "The Army is being very careful on safety, but the real question is reliability. How well is the plant going to work and how much is it going to cost?"

# Death: The lon chemical trail to

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of eight states where weapons are stored.

The first full-scale disposal plant, at Johnston Island southwest of Hawaii, has suffered delays and start-up problems that keep it idle half the expected operational hours. And the retirement to Johnston of the U.S.-NATO chemical arsenal, consisting of 100,000 nerve-gas artillery shells from Germany, has enflamed tempers in the Pacific.

"A catastrophic accident of untold proportions could take place," warned Skip Spaulding, a Honolulu attorney with the Sierra Club Legal Defense Fund, at a University of Hawaii forum recently.

Meanwhile, the cost of the disposal program is likely to top $3.4 billion, double the estimate of five years ago, according to the General Accounting Office. Scientific American reported last month that the final tally could be $5 billion — 50 times more than it cost to produce the weapons in the first place.

Nerve agents like GA, GB and VX work by disrupting the action of a key enzyme, cholinesterase.

Cholinesterase controls muscles by breaking down acetylcholine, the chemical that triggers muscular contraction. Even a tiny dose of nerve agent absorbed through the lungs or skin can cause acetylcholine to build up to dangerous levels, eventually sending muscles into wild clenching spasms, a death dance that typically includes drooling, vomiting, urination, defecation, convulsions and death by asphyxiation.

Standard chemical warfare gear includes antidotes, typically administered in the back of the thigh by spring-loaded syringe canisters.

There is no antidote for mustard, first used in World War I to blister the skin, lungs and mucous membranes. It's fatal in large doses.

On the Big Island, the Army secretly tested GB and another chemical, a non-lethal, LSD-like drug called BZ, in the Upper Waiakea Forest Reserve in 1966 and 1967.

The terms of the state lease specified that the land was to be used for "classified meteorological and related tests," but in fact the Army was testing how fast and efficiently the chemicals spread in a jungle environment.

There were three GB tests and one BZ test in 1966 and two BZ tests in 1967, none of them involving human or animal subjects (apart from wildlife, presumably), according to the Pentagon, which owned up to the program in 1969. Monitors showed that none of the chemicals drifted outside the fenced, 1.5-square-mile area 15 miles from Hilo, the military said.

By November 1969, when President Nixon announced U.S. curbs on chemical and biological weapons, the public was distressingly aware of the effects of nerve agents:

■ On March 13, 1968, in a test at Dugway Proving Ground, Utah, an F-4 Phantom dropped liquid VX from a tank slung beneath the aircraft. About 20 pounds of it stayed in the tank, however, dripping out as the plane climbed away from the target area. The resulting cloud of VX drifted 20 miles north to Skull Valley, where it killed 6,400 sheep.

■ On July 8, 1969, 23 U.S. soldiers and an American civilian employee of the Army

# g and clouded Johnston Island

were exposed to GB while doing maintenance at a chemical weapons storage site on Okinawa. They were hospitalized briefly for "minor symptoms" and recovered.

But the Japanese government, which was negotiating for the return of Okinawa from U.S. control, was incensed to learn of the theretofore-secret stockpile. There was speculation that some kind of leak was behind the mysterious illness of school children at a nearby beach the summer before.

Within two weeks, the U.S. government promised to remove the weapons.

The destination was to have been Umatilla Army Depot in Oregon, but Congress stepped in and outlawed shipments to the continental United States.

The Army's options narrowed further when a public outcry applied the brakes to Operation CHASE (Cut Holes and Sink Em), specifically a plan to scuttle another 27,000 tons of obsolete chemical agents and munitions in the Atlantic.

With sea dumps unsanctioned, the arsenal on Okinawa was moved in 1971 to Johnston Island, where it remains today, minus some 3,000 GB rockets that have been incinerated since June.

Upon the advice of the National Academy of Sciences, the Army in the early 1970s undertook a program to destroy the unitary arsenal in place at Johnston and each of eight Mainland storage sites. The method selected was a self-contained, automated system that chops and burns the weapons at high temperature and then filters waste gases to remove toxic by-products.

A prototype plant, the Chemical Agent Munitions Disposal System (CAMDS), was built at Tooele Army Depot, Utah.

Between 1983 and 1987, eight accidents at the plant resulted in the release of nerve gas, according to documents obtained last year by Lee Davidson, Washington bureau chief for the Desert News in Salt Lake City.

One of the alarms sounded during a May 1985 tour of the plant by community leaders from five states due to get the full-scale version. A smokestack filter had malfunctioned when it became soggy from rain.

Only a small amount of gas was released, but the incident didn't boost confidence in the system.

On Jan. 28, 1987, faulty valves and gaskets and another malfunctioning filter allowed nerve-agent vapors to drift through the ventilation system from a controlled area to other parts of the building. The plant was promptly shut down for a year for repairs and redesign.

Later reports criticized technology transfer in the chemical disposal community as "inadequate," meaning the full-scale Johnston Atoll Chemical Agent Disposal System (JACADS) was not getting the full benefit of lessons learned at Tooele.

A MITRE Corp. report similarly recommended that no full-scale incinerators be built in the continental United States until after the JACADS shakedown, under way through October 1991. "It is likely that some features of JACADS at first will be found less than optimum," the report said prophetically.

Construction of the second full-scale plant is under way at Tooele.

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