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**THE HISTORY OF AGENT ORANGE USE
IN VIETNAM
AN HISTORICAL OVERVIEW FROM
THE VETERAN'S PERSPECTIVE**

Summary DIOX2002-16

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THE HISTORY OF AGENT ORANGE USE IN VIETNAM

Background

Much of South Vietnam is covered with very dense jungle vegetation. This dense vegetation was used as cover by the forces opposing the United States and South Vietnamese armies. One means of counteracting this tactic was the use of herbicides to kill and defoliate vegetation. Herbicides were widely used to destroy enemy cover, food crops and to clear United States base perimeters of vegetation. These chemicals were applied by airplanes (Operation Ranch Hand), helicopters, trucks, riverboats and individual backpacks.

A variety of herbicides were used for these purposes. They included Agents Orange, Blue, Green, Pink, Purple and White. These names represent the color of the stripe on the barrel that was used to identify the herbicide. The most widely used of these agents was Orange. Agent Orange was a 1:1 mixture of the n-butyl esters of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). A byproduct contaminant of the manufacturing process for 2,4,5-T is 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD), commonly referred to as dioxin. Because of the large military demand for Agent Orange, the manufacturing processes were accelerated, resulting in higher levels of dioxin contamination than in the 2,4,5-T produced for civilian applications.

Three million acres of South Vietnam were sprayed with 50,000 tons of Agent Orange and other herbicides, containing over 500 pounds of dioxin. Because herbicides were used in Vietnam to destroy crops and defoliate jungle cover, the military used 27 times more herbicide per unit area than most domestic applications, which are primarily used to prevent weed growth. Dioxin is the focus of veterans' health concerns because of its toxicity. However, many different chemicals with the potential for producing health problems were used in Vietnam.

Dioxin Overview

The toxicological profile of phenoxy herbicides in laboratory animals shows that major pathological phenomena occur in the liver and the reproductive system. These chemicals are carcinogenic and teratogenic in laboratory animals. The human epidemiological picture for phenoxy herbicides is not as well-defined as the toxicological one. Swedish investigators have found associations between various cancers and exposure to these herbicides. Cancer associations in other epidemiological studies have been inconsistent. The most consistent associations are seen with non-Hodgkin's lymphoma and soft tissue sarcomas. In July 1993 the NAS (National Academy of Sciences) released its report on the scientific evidence.

Veteran Exposures

There are a variety of means by which veterans could have been exposed to Agent Orange in Vietnam. Veterans may have taken part in the actual spraying which involved airplanes, helicopters, in Vietnam river boats, trucks or backpacks. They may also have been exposed to Agent Orange by consuming contaminated food or drinking water. Veterans could have been in areas while spraying occurred or in areas that were recently sprayed and areas that were sprayed and then burned. Burning increases by 25% the dioxin toxicity of the Agent Orange present.

For those of us who served in the US armed forces in Vietnam during the war, it is the war that will not end. It is the war that, in our view, continues to claim its victims decades after the last shots were fired. It is the war of rainbow herbicides, Agents Orange, Blue, White, Purple, Green and Pink.

PLANTS RESEARCH

Agent Orange had its genesis as a defoliant in an obscure laboratory at the University of Chicago during World War II. Working on experimental plant growth at the time, Professor E.J. Kraus, chairman of the school's botany department, discovered that he could regulate the growth of plants through the infusion of various hormones. Among the discoveries he made was that

certain broadleaf vegetation could be killed by causing the plants to experience sudden, uncontrolled growth. It was similar to giving the plants cancer by introducing specific chemicals. In some instances, deterioration of the vegetation was noticed within 24-48 hours of the of the chemicals.

Kraus found that heavy doses of the chemical 2,4-dichlorophenoxyacetic acid (2,4-D) could induce these growth spurts. Thinking this discovery might be of some use in the war effort, Kraus contacted the War Department. Army scientists tested the plant hormones but found no use for them before the end of the war.

ARMY EXPERIMENTS WITH DEFOLIANTS

The Army continued to experiment with 2,4-D during the 1950s and late in the decade found a potent combination of chemicals which quickly found its way into the Army's chemical arsenal.

Army scientists found that by mixing 2,4-D and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and spraying it on plants, there would be an almost immediate negative effect on the foliage. What they didn't realize, or chose to ignore, was that 2,4,5-T contained dioxin, a useless by-product of herbicide production. It would be twenty more years until concern was raised about dioxin, a chemical the Environmental Protection Agency (EPA) would later call "one of the most perplexing and potentially dangerous" known to man.

According to the Encyclopedia Britannica, "The toxicity of dioxin renders it capable of killing some species of newborn mammals and fish at levels of five parts per trillion (or one ounce in six million tons). Less than two millionths of an ounce will kill a mouse. Its toxic properties are enhanced by the fact that it can pass into the body through all major routes of entry, including the skin (by direct contact), the lungs (by inhaling dust, fumes or vapors), or through the mouth. Entry through any of these routes contributes to the total body burden. Dioxin is so toxic, according to the encyclopedia, because of this: "Contained in cell membranes are protein molecules, called receptors, that normally function to move substances into the cell. Dioxin avidly binds to these receptors and, as a result, is rapidly transported into the cytoplasm and nucleus of the cell, where it causes changes in cellular procession."

After minimal experimentation in 1961, a variety of chemical agents was shipped to Vietnam to aid in anti-guerilla efforts. The chemicals were to be used to destroy food sources and eliminate foliage that concealed enemy troop movements.

RAINBOW HERBICIDES

The various chemicals were labeled by color-coded stripes on the barrels, an arsenal of herbicides known by the colors of the rainbow, including Agent Blue (which contained arsenic), Agent White, Agent Purple, and the lethal combination of 2,4-D and 2,4,5-T, Agent Orange.

On January 13, 1962, three U.S. Air Force C-123s left Tan Son Nhut airfield to begin Operation Hades (later called Operation Ranch Hand), the defoliation of portions of South Vietnam's heavily forested countryside in which Viet Cong guerrillas could easily hide. By September, 1962, the spraying program had intensified, despite an early lack of success, as U.S. officials targeted the Ca Mau Peninsula, a scene of heavy communist activity. Ranch Hand aircraft sprayed more than 9,000 acres of mangrove forests there, defoliating approximately 95 percent of the targeted area. That mission was deemed a success and full approval was given for continuation of Operation Ranch Hand as the U.S. stepped up its involvement in Vietnam.

SIX TO TWENTY-FIVE TIMES STRONGER THAN RECOMMENDED

Over the next nine years, an estimated 12 million gallons of Agent Orange were sprayed throughout Vietnam. The U.S. military command in Vietnam insisted publicly the defoliation program was militarily successful and had little adverse impact on the economy of the villagers who came into contact with it.

Although the herbicides were widely used in the United States, they usually were heavily diluted with water or oil. In Vietnam, military applications were sprayed at the rate of three gallons per acre and contained approximately 12 pounds of 2,4-D and 13.8 pounds of 2,3,5-T. The military sprayed herbicides in Vietnam six to 25 times the rate suggested by the manufacturer.

In 1962, 15,000 gallons of herbicide were sprayed throughout Vietnam. The following year that amount nearly quadrupled, as 59,000 gallons of chemicals were poured into the forests and streams. The amounts increased significantly after that: 175,000 gallons in 1964, 621,000 gallons in 1965 and 2.28 million gallons in 1966.

AIR FORCE KNEW OF HEALTH DANGER

Scientists involved in Operation Ranch Hand and documents uncovered in the late 1980's in the National Archives present a troubling picture. There are strong indications that military officials were aware as early as 1967 of the limited effectiveness of chemical defoliation and they knew of potential long-term health risks of frequent spraying.

Dr. James Clary was an Air Force scientist in Vietnam who helped write the history of Operation Ranch Hand. Clary says the Air Force knew Agent Orange was far more hazardous to the health of humans than anyone would admit at the time. "When we (military scientists) initiated the herbicide program in the 1960s," Clary wrote in a 1988 letter to a member of Congress investigating Agent Orange, "we were aware of the potential for damage due to dioxin contamination in the herbicide. We were even aware that the 'military' formulation had a higher dioxin concentration than the 'civilian' version, due to the lower cost and speed of manufacture. However, because the material was to be used on the 'enemy,' none of us were overly concerned. We never considered a scenario in which our own personnel would become contaminated with the herbicide. And, if we had, we would have expected our own government to give assistance to veterans so contaminated."

MIST DRIFT

One of the first defoliation efforts of Operation Ranch Hand was near a rubber plantation in January, 1962. According to an unsigned U.S. Army memorandum dated January 24, 1966, titled "Use of Herbicides in Vietnam," studies showed that within a week of spraying, the trees in the plantation "showed considerable leaf fall."

"The injury to the young rubber trees occurred even though the plantation was located some 500 yards away and upwind of the target at the time of the spray delivery." The memo went on to say that "vapors of the chemical were strong enough in concentration to cause this injury to the rubber." These vapors, "appear to come from 'mist drift' or from vaporization either in the atmosphere or after the spray has settled on the vegetation."

The issue of "mist drift" continued to plague the defoliation program. How far would it drift? How fast? Wind speed and direction were of major concerns in answering these questions. Yet, there were other questions, many of which could not be answered.

What happened in humid weather?

How quickly did the chemicals diffuse in the atmosphere or were they carried into the clouds and dropped dozens of miles away? How long would the rainbow herbicides linger in the air or on the ground once they were sprayed?

A November 8, 1967 memorandum from Eugene M. Locke, deputy U.S. ambassador in Saigon, once again addressed the problem of "mist drift" and "significant damage" to rubber plantations from spraying earlier in the year. According to Locke, "the herbicide damage resulted from a navigational error; some trees in another plantation had been defoliated deliberately in order to enhance the security of a U.S. military camp. The bulk of the herbicide damage must be attributed,

however, to the drift of herbicide through the atmosphere. This drift occurs (a) after the spray is released from the aircraft and before it reaches the ground, and/or (b) when herbicide that has already reached the ground vaporizes during the heat of the day, is carried aloft, then moved by surface winds and eventually deposited elsewhere. "There is a lack of agreement within the Mission regarding the distances over which the two kinds of drift can occur. When properly released (as required at 150 feet above the target, with winds of no more than 10 mph blowing away from nearby plantations) herbicide spray should fall with reasonable accuracy upon its intended target. The range of drift of vaporized herbicide, however, has not been scientifically established at the present time. In recognition of this phenomenon and to minimize it, current procedures require that missions may be flown only during inversion conditions, i.e., when the temperature on the land and in the atmosphere produces downward currents of air. Estimates within the Mission of vaporized herbicide drift range from only negligible drift to distances of up to 10 kilometers and more."

Ten kilometers and more. More than six miles. In essence, troops operating more than six miles from defoliation operations could find themselves, their water and their food doused with chemical agents, including dioxin-laced Agent Orange.

More than four months later, on March 23, 1968, Gen. A.R. Brownfield, then Army Chief of Staff, sent a message to all senior U.S. advisors in the four Corps Tactical Zones (CTZ) of Vietnam. Brownfield ordered that "helicopter spray operations will not be conducted when ground temperatures are greater than 85 (degrees) Fahrenheit and wind speed in excess of 10 mph." But the concern was not for any troops operating in the areas of spraying, as was evident in the memo, but for the rubber plantations. The message ordered that "a buffer distance of at least two (2) kilometers from active rubber plantation must be maintained." No such considerations were given for the troops operating in the area.

PROJECT PINK ROSE

One of the U.S. government's worst planned and executed efforts to use herbicides was a secret operation known as "Project Pink Rose." According to a declassified report released in 1990, on "Project Pink Rose," the operation had its genesis in September 1965 when the Joint Chiefs of Staff received a recommendation from the Commander in Chief Pacific "to develop a capability to destroy by fire large areas of forest and jungle growth in Southeast Asia."

On March 11, 1966, a test operation known as "Hot Tip" was documented at Chu Pong mountain near Pleiku when 15 B-52s dropped incendiaries on a defoliated area. According to the declassified memo, "results were inconclusive but sufficient fire did develop to indicate that this technique might be operationally functional." What neither the government nor the chemical companies told anyone was that burning dioxins significantly increases the toxicity of the dioxins. So, not only was the government introducing cancer causing chemicals into the war, it was increasing their toxicity by burning them. Nevertheless, "Project Pink Rose" continued.

In November, 1966, three free strike target areas were selected: one in War Zone D and two in War Zone C. Each target was a box seven kilometers square. The target areas were double and triple canopy jungle. The areas were heavily prepped with defoliants, the government dumping 255,000 gallons on the test sites.

The three sites were bombed individually, one on January 18, 1967, another January 28, 1967 and the last on April 4, 1967. According to the memo, "the order and dates of strikes were changed to properly phase Pink Rose operations with concurrent ground operations", which means that U.S. and Vietnamese troops were living and fighting in these test sites on which 255,000 gallons of cancer causing defoliants had been dumped.

The results of "Project Pink Rose" were less than favorable. According to the memo, "The Pink Rose technique is ineffective as a means of removing the forest crown canopy." The conclusion:

"Further testing of the Pink Rose technique in South Vietnam under the existing concept be terminated."

DEFOLIANTS DUMPED ON PEOPLE AND INTO WATER SUPPLIES

In addition to the planned dumps of herbicides, accidental and intentional dumps of defoliants over populated areas and into the water supplies was not unusual, according to government documents.

A memorandum for the record dated October 31, 1967, and signed by Col. W.T. Moseley, chief of MACV's Chemical Operations Division, reported an emergency dump of herbicide far from the intended target. At approximately 1120 hours, October 29, 1967, aircraft #576 made an emergency dump of herbicide in Long Khanh Province due to failure of one engine and loss of power in the other. Approximately 1,000 gallons of herbicide WHITE were dumped from an altitude of 2,500 feet. No mention was made of wind speed or direction, but chemicals dropped from that height had the potential to drift a long way.

Another memorandum for the record, this one dated January 8, 1968 and signed by Col. John Moran, chief Chemical Operations Division of MACV, also reported an emergency dump of herbicide, this time into a major river near Saigon. "At approximately 1015 hours, January 6, 1968, aircraft #633 made an emergency dump over the Dong Nai River approximately 15 kilometers east of Saigon when the aircraft experienced severe engine vibration and loss of power. Approximately 1,000 gallons of herbicide ORANGE were dumped from an altitude of 3,500 feet."

The American Association for the Advancement of Science (AAAS) in the summer of 1968 sent a letter to the Secretaries of State and Defense urging a study to determine the ecological effects of herbicide spraying in Vietnam. That letter prompted a cable from Secretary of State Dean Rusk to the U.S. Embassy in Saigon. The cable, dated August 26, 1968, sought additional information but informed embassy officials of the tactic State was going to take in its reply to the AAAS. "The Department of State's proposed reply notes that the limited investigations of the ecological problem which have been conducted by agencies of the USG thus far have failed to reveal serious ecological disturbances, but acknowledges that the long-term effect of herbicides can be determined definitively only by long-term studies." Rusk suggested releasing "certain non-sensitive" portions of a study on the ecological effects of herbicide spraying in Vietnam done earlier that year by Dr. Fred H. Tschirley, then assistant chief of the Corps Protection Research Branch, Corps Research Division of the U.S. Department of Agriculture in Beltsville, Maryland. Tschirley went to Vietnam under the auspices of the State Department early in 1968 and returned with exactly the report the U.S. government and the chemical companies wanted.

Tschirley foresaw no long-term ecological impact on Vietnam as a result of the herbicide spraying. In addition, in his report of April 1968, later reprinted in part in the February 21, 1969 issue of Science magazine, Tschirley exonerated the chemical companies. "The herbicides used in Vietnam are only moderately toxic to warm-blooded animals," Tschirley wrote. "None deserves a lengthy discussion except for Agent Blue (cacodylic acid), which contains arsenic." This despite evidence within the chemical companies that dioxin, the most toxic ingredient in Agent Orange, was responsible for health problems in laboratory animals and workers at the plants that produced the chemical. "There is no evidence," Tschirley wrote, "to suggest that the herbicides used in Vietnam will cause toxicity problems for man or animals."

Rusk urged Tschirley's report be made public. In his cable to Saigon, he wrote: "Its publication would not only help avoid some awkwardness for Tschirley, but would provide us with valuable documentation to demonstrate that the USG is taking a responsible approach to the herbicide program and that independent investigation has substantiated the Midwest Institute's findings that there have been no serious adverse ecological consequences." What Rusk did not mention was that Tschirley's report had been heavily edited, in essence changing its findings.

USE OF CHEMICALS CONTINUED IN VIETNAM

While the debate over the danger of Agent Orange and dioxin heated up in scientific circles, the U.S. Air Force continued flying defoliation sorties, and the troops on the ground continued to live in the chemical mist of the rainbow herbicides. They slept with it, drank it in their water, ate it in their food and breathed it when it dropped out of the air in a fine, white pungent mist.

Some of the troops in Vietnam used the empty Agent Orange drums for barbecue pits. Others stored watermelons and potatoes in them. Still others rigged the residue-laden drums for showers. The spraying continued unabated in 1968, even though, according to military records, it apparently was having minimal effects on the enemy. A series of memorandums uncovered in the National Archives and now declassified indicate that defoliation killed a lot of plants, but had little real effect on military operations.

ORANGE AEROSOL DISCOVERED

Meanwhile, the military continued to learn just how toxic Agent Orange could be. On October 23, 1969, an urgent message was sent from Fort Detrick, Maryland, to MACV concerning cleaning of drums containing herbicides. The message provided detailed instructions on how to clean the drums and warned that it was particularly important to clean Agent Orange drums. "Using the (Agent) Orange drums for storing petroleum products without thoroughly cleaning them can result in creation of an orange aerosol when the contaminated petroleum products are consumed in internal combustion engines. The Orange aerosol thus generated can be most devastating to vegetation in the vicinity of engines. Some critics claim that some of the damage to vegetation along Saigon streets can be attributed to this source. White and Blue residues are less of a problem in this regard since they are not volatile." Not only was Agent Orange being sprayed from aircraft, but it was unwittingly being sprayed out of the exhausts of trucks, jeeps and gasoline generators.

In March 1969, Lt. Col. Jim Corey, deputy chief of CORDS in I Corps reported to his boss, R.M. Urquhart, unusual defoliation in Da Nang. "A large number of beautiful shade trees along the streets in the city of Da Nang are dead or dying," Corey wrote. "This damage appears to be entirely a result of defoliation chemicals." There was no evidence of insect or fungus damage to the vegetation, according to the memo. "In every instance of tree and garden plot damage," Corey wrote, "empty defoliant barrels are either present in the area or have been transported along the route of the damage." The use of herbicides was not confined to the jungles. It was widely used to suppress vegetation around the perimeters of military bases and, in many instances, the interiors of those bases.

VETS BEGIN DEVELOPING HEALTH PROBLEMS

As soldiers who had served in Vietnam attempted to settle back into civilian life following their tours, some of them began to develop unusual health problems. There were skin and liver diseases and what seemed to be an abnormal number of cancers to soft tissue organs such as the lungs and stomach. There also seemed to be an unusually high number of birth defects among children born to Vietnam veterans who had been exposed to Agent Orange. Some veterans experienced wild mood swings, while others developed a painful skin rash known as chloracne. Many of these veterans were found to have high levels of dioxin in their blood, but scientists and the U.S. government insisted there was no link between their illnesses and Agent Orange. In the mid 1970s, there was renewed interest in dioxin and its effects on human health following an industrial accident in Seveso, Italy, in which dioxin was released into the air, causing animal deaths and human sickness.

STUDIES CONTRADICTORY AND CONFUSING

By 1983, the results of studies of Agent Orange and dioxin exposure began to trickle in. They were, for the most part, contradictory and confusing. A series of studies conducted between 1974 and 1983 by Dr. Lennart Hardell, the so called Swedish studies, showed a link between exposure to Agent Orange and soft tissue sarcomas and non-Hodgkin's lymphoma. And in July 1983, the

US Department of Health and Human Services (HHS) released a report citing "an association" between dioxin exposure and incidence of soft tissue sarcoma. Barely two months later, in February, 1984, the U.S. Air Force released the first part of a three part study on Operation Ranch Hand pilots and crewmen. It concluded that the 1,269 pilots and crewmen involved in the herbicide spraying program in Vietnam suffered no higher death or serious illness rates than the general population.

TEST RESULTS CONTINUE TO BE MIXED

Results of Agent Orange tests continued to be mixed. The results varied greatly, depending on who was doing the testing. In December, 1985, the Air Force released the third of its Operation Ranch Hand studies. It confirmed the other two: that there was no evidence that Agent Orange had any adverse effects on those who handled it during the war. "At this time, there is no evidence of increased mortality as a result of herbicide exposure among individuals who performed the Ranch Hand spray operation in Southeast Asia," the Air Force concluded.

In the summer of 1986, the House Veterans Affairs Subcommittee on Hospitals and Health Care held hearings to assess the progress of the CDC study of Agent Orange, mandated seven years earlier. Testimony from witnesses from the Office of Technology Assessment (OTA) shocked and angered members of the committee, according to Sen. Tom Daschle. "OTA reported that the Centers for Disease Control had changed the protocol for the study without authorization," said Daschle. "OTA also reported at that particular hearing that petty arguments at CDC were interfering with the study's progress and that progress had virtually come to a standstill."

After seven years of study, the CDC had made no progress on one of the most important and highly publicized issues of the war in Vietnam. In charge of the CDC study was Dr. Vernon Houk, director of the agency's Center for Environmental Health and Injury Control. The White House's Agent Orange Working Group was supposed to supervise the CDC study while the Pentagon's Environmental Support Group was charged with providing the CDC with records of Agent Orange spraying and troop deployment. Houk's CDC team complained throughout the study that those records were too spotty to make a scientific study of the effects of Agent Orange on soldiers.

Not so, said the Pentagon. Richard Christian, head of the Pentagon's Environmental Support Group, testified before Congress in mid 1986 that the records of troop movements and spraying were more than adequate for a scientific study. Christian's testimony was bolstered by two other sources. Retired Army Maj. Gen. John Murray had been asked by Defense Secretary Casper Weinberger in early 1986 to undertake a study to determine if Pentagon records were adequate for purposes of the study. After four months, Murray also determined that the records for a comprehensive study of Agent Orange were more than adequate.

In addition, the Institute of Medicine, an arm of the National Academy of Sciences, had used outside consultants to study reports of troop deployment and Agent Orange spraying to determine if they were sufficient for CDC purposes. Its conclusion: the Pentagon had the necessary records. The Institute of Medicine also was highly critical of the CDC research methods, charging that it excluded from its study the veterans most likely to have been exposed to Agent Orange.

STUDY CALLED A FRAUD

But again, there was more information available that was never presented. The Institute of Medicine in the weeks before the CDC released its results of blood tests wrote a stinging rebuke of the CDC's tests methods. It said that none of the CDC's conclusions was supported by scientific data. The CDC refused to turn this report over to the White House. "Either it was a politically rigged operation or it was a monumentally bungled operation," said Rep. Ted Weiss (D-NY), chairman of the Government Operations Human Resources and Intergovernmental Relations Subcommittee. Other information began turning up that there were concerted efforts by various

agencies of the government to conceal records and information about the effects of Agent Orange. Daschle learned that there were major discrepancies between a January 1984 draft of the Air Force's Operation Ranch Hand study and the February 1984 report. According to Daschle, the draft showed there were twice as many birth defects among the children of Ranch Hand participants. "The draft also reported that the Ranch Handers were less well, than the controls by a ratio of 5 to 1," said Daschle.

But these results were deleted from the final Ranch Hand report, which said there had been no adverse effects from exposure to Agent Orange. "The Air Force deleted these findings from the final report at the suggestion of a Ranch Hand Advisory Committee set up by the White House Agent Orange Working Group," said Daschle.

Air Force scientists involved in the study said they were pressured by non-scientists within the Air Force and the White House to change the results and delete critical information for the final report. Daschle says he has even obtained two versions of the minutes of the meeting in which that pressure was applied. One confirms what the scientists told him. Another set deletes that information. "What happened there was a fraud perpetrated by people whose names we still do not know," said Daschle.

In a study released March 29, 1990, the CDC admitted that Vietnam veterans face a higher risk of non-Hodgkin's lymphoma, but denied that it was a result of exposure to Agent Orange. It said the studies showed that Vietnam veterans do not have higher rates of soft tissue sarcomas, Hodgkin's disease, nasal cancer, nasopharyngeal cancer and liver cancer.

BIZARRE FINDING

One of the more bizarre aspects of this report from the CDC was the claim that those veterans who suffered most from non-Hodgkin's lymphoma had served on Navy ships off the coast of Vietnam. It said that those who had served in III Corps, which had some of the heaviest Agent Orange spraying of the war, seemed to be at lower risk.

Description	TCDD (Dioxin) Amounts
Agent Orange	1.77 to 40 ppm
Agent Blue (Purple)	32.8 to 45 ppm
Agent Red (Pink)	65.6 ppm
Agent White (Green)	65.6 ppm
Silvex	1 to 70 ppm

Some Chemicals Used in Vietnam General use

Insecticide, DDT - Pyrethrum aerosol, G-1152, 12-oz. can.
 Insecticide, Dichlorvos, 20% impregnated strips
 Insecticide, Lindane, 1% dusting powder, 2-oz. can
 Insecticide, Pyrethrum, 0.6% aerosol, 12-oz. can
 Insecticide, Pyrethrum, 0.4% solution, 1-gal. can
 Repellent, Clothing and personal application, m 75% DEET, 6-oz. aerosol can
 Repellent, Clothing and personal application, m 75% DEET, 2-oz. plastic bottle
 Repellent, Clothing and personal application, m 75% DEET, 4-oz. bottle (component of survival kit)
 Rodenticide, Anticoagulant, Ready mixed bait, 5-lb. can
 Rodenticide, bait block, diphacin, 8-oz. Block

Supervision Required

Insecticide, Aluminum phosphide, tablets, can
 Insecticide, Aluminum phosphide, pellets, flask
 Insecticide, Baygon, 1% solution, 1-gal. Can
 Insecticide, Baygon, 2% bait, 5-lb. Bottle
 Insecticide, Carbaryl, 80% powder, 15-lb. Pail
 Insecticide, Carbaryl-DDT, Micronized dust, 1-gram
 Insecticide, Carbaryl-DDT, Micronized dust, 5-gram
 Insecticide, Carbaryl-DDT, Micronized dust, 13-gram

Insecticide, Chlordane, 72% emulsifiable concentrate, 5-gal. Pail
Insecticide, Chlordane, 5%-6% dust, 25-lb. Pail
Insecticide, Diazinon, 0.5% solution, 1-gal. Can
Insecticide, Diazinon, 48% emulsifiable concentrate, 1-gal. Can
Insecticide, Dieldrin, 15% emulsifiable concentrate, 5-gal. Pail
Insecticide, DDT, 25% emulsifiable concentrate, 5-gal. Pail

* For disinsectization of aircraft in compliance with Public Health Quarantine.

** For use in control of body lice.

*** For disinsection of aircraft in compliance with Agricultural Quarantine.

Insecticide, DDT, 75% wettable powder, 20-lb. Pail
Insecticide, Dichlorvos, 20% impregnated pellets, 30-lb. Pail
Insecticide, Dursban, 40.8% emulsifiable concentrate
Insecticide, Lindane, 12% emulsifiable concentrate, 5-gal. Pail
Insecticide, Lindane, 1% dusting powder, 25-lb. Pail
Insecticide, Malathion, 57% emulsifiable concentrate, Grade A, 1-gal. Can
Insecticide, Malathion, 57% emulsifiable concentrate, Grade B, 55-gal. Drum
Insecticide, Malathion, 57% emulsifiable concentrate, Grade A, 5-gal. pail
Insecticide, Malathion, 95% solution concentrate 55-gal. Drum
Insecticide, Methyl bromide, 98%, 150-lb. cylinder
Insecticide, Methyl bromide, 98%, 1-lb. can
Insecticide, Naled, 85% solution concentrate, 15-gal. drum
Repellent, Clothing application, M-1960, 1-gal. can
Repellent, Clothing application, 90% Benzyl benzoate, 1-gal. Can
Rodenticide, Anticoagulant, Universal concentrate, 1-lb. can
Rodenticide, Calcium cyanide, 42% powder, 1-lb. can
Rodenticide, Zinc phosphide, 80% powder, 1-oz. bottle
Fungicide, Pentachlorophenol, 5% moisture retardant, 55-gal. Drum
Soil fumigant, SMDC (VAPAM) 32.7% solution
Herbicide, Borate-Bromacil mixture, 50-lb. bag
Herbicide, Bromacil, 80% powder, 50-lb. drum
Herbicide, Chlorate-Borate mixture, 50-lb. bag
Herbicide, Dacthal, 75% powder, 50-lb. bag
Herbicide, Dalapon, 85% powder, 50-lb. drum
Herbicide, Dicamba, 49% solution, 1-gal. bottle
Herbicide, Diquat, 35.3% solution, 5-gal. drum
Herbicide, Diuron, 80% powder, 50-lb. drum
Herbicide, DMA, 63% disodium methylarsonate, 100-lb. drum
Herbicide, Monuron, 80% powder, 50-lb. drum
Herbicide, Picloram + 2,4-D, 5-gal. drum
Herbicide, Picloram, 11.6% pellets, 50-lb. drum
Herbicide, Silvex, Low Volatile Ester, 4-lb./gal., 5-gal. drum
Herbicide, Simazinc, 80% powder, 5-lb. can
Herbicide, 2,4-D, Low Volatile Ester, 4-lb./gal., 5-gal. can
Herbicide, 2,4-D, Amine, 4-lb./gal., 5-gal. can
Herbicide, 2,4,5-T, Low Volatile Ester, 4-lb./gal., 55-gal. drum
Herbicide, 2,4,5-T, Low Volatile Ester, 4-lb./gal., 5-gal. Pail
Tactical
Herbicide, Cacodylic Acid (Blue), 55-gal. Drum
Herbicide, Picloram + 2,4-D, (White), 55-gal. drum
Herbicide, 2,4-D + 2,4,5-T, High Volatile ester (Orange), 55 gal. Drum

RAINBOW HERBICIDES AND THEIR COMPONENTS:

Agent Orange: 2,4-D and 2,4,5-T; used between January 1965 and April 1970.
- Agent Orange II (Super Orange): 2,4-D and 2,4,5-T; used in 1968 and 1969.
- Agent Purple: 2,4-D and 2,4,5-T; used between January 1962 and 1964.
- Agent Pink: 2,4,5-T; used between 1962 and 1964.
- Agent Green: 2,4,5-T; used between 1962 and 1964.
- Agent White: Picloram and 2,4-D.
- Agent Blue: contained cacodylic acid (arsenic).
- Dinoxol: 2,4-D and 2,4,5-T; used between 1962 and 1964.
- Trinoxol: 2,4,5-T; used between 1962 and 1964.
- Diquat: Used between 1962 and 1964.

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- Bromacil: Used between 1962 and 1964.
- Tandex: Used between 1962 and 1964.
- Monuron: Used between 1962 and 1964.
- Diuron: Used between 1962 and 1964.
- Dalapon: Used between 1962 and 1964.

USAF Ranch Hand Herb Tapes - Herbicide Amounts from August 1965
Grand Total: 8,165,491 gallons

I Corps - 2,355,322 GALLONS

Location	Orange	White	Blue	Total Gallons	
A Shau	53,550	2,550	6,128	62,228	
An Hoa	6,500	1,800	11,250	19,550	
Binh Hoa	8,220	0	1,600	9,820	
Cam Lo	80,375	8,660	12,785	101,820	
Camp Carrol	78,200	5,400	5,050	88,650	
Camp Eagle	14,250	0	0	14,250	
Camp Esso	53,410	5,600	0	64,510	
Camp Evans	18,690	0	880	19,570	
Camp Henderson	68,155	7,040	4,800	79,995	
Chu Lai	12,170	4,150	1,598	17,918	
Con Thien	84,700	12,460	10,925	108,085	
Da Nang, China Beach	13,800	0	2,000	15,800	
Dong Ha	54,385	5,060	9,935	69,380	
Duc Pho, LZ Bronco	46,225	14,400	1,175	61,800	
Firebase Jack	140,875	11,900	3,280	156,055	
Firebase Rakkassan	150,145	23,900	2,510	176,555	
Firebase West	15,405	3,690	18,480	37,575	
Hill 63	20,500	3,200	0	23,700	
Hill 69	11,620	4,150	1,598	17,368	
Hoi An	17,520	3,000	13,950	34,470	
Hue	41,395	0	5,070	46,465	
Khe Sanh, Firebase Smith	43,705	3,040	4,300	51,045	
Lang Co Bridge	50,610	5,600	3,500	59,710	
LZ Baldy	15,430	3,000	13,950	32,380	
LZ Dogpatch, Hill 327	4,490	0	8,250	12,740	
LZ Geronimo	22,535	14,000	468	37,003	
LZ Jane, Firebase Barbara	91,150	6,750	3,700	101,600	
LZ Langley, Firebase Shepard	72,105	7,040	4,800	83,945	
LZ Profess, Hill 55	39,300	13,000	17,209	69,509	
LZ Rockcrusher, Hill 85	47,800	0	0	47,800	
LZ Rockpile	110,050	15,440	7,650	133,140	
LZ Ross	15,405	6,720	18,508	40,633	
LZ Sandra	118,780	20,210	24,755	163,745	
LZ Snapper, Firebase Leather	11,350	0	3,000	14,350	
Marble Mountain, Hill 59	15,405	6,720	8,508	40,633	
Phu Bai	54,300	3,000	120	57,420	
Phu Luc, LZ Tommahawk	78,250	4,000	0	82,250	
Quang Nai	25,605	0	1,800	27,405	
Quang Tri, LZ Nancy	68,000	2,750	3,700	74,450	Total: 2,355,322 gallons

II Corps - 1,054,406 GALLONS

Location	Orange	White	Blue	Total Gallons
An Khe, Camp Radcliff	37,810	6,400	5,610	49,820
An Lao, LZ Laramie	68,970	490	10,570	80,030
Ban Me Thuot	16,000	9,250	0	25,250
Ben Het	80,495	7,230	3,000	90,725
Bon Song, LZ Two Bits	80,643	630	6,000	87,273
Bre Nhi	6,600	0	0	6,600
Cam Ranh Bay	21,227	1,373	0	22,600
Camp Granite	59,310	2,075	5,390	66,775
Che Oreo	0	1,800	0	1,800
Da Lat	575	0	0	575
Dak To	49,460	600	34,800	84,860

Firebase Pony	43,490	0	3,800	47,290
Kontum	0	415	0	415
LZ Dog, LZ English	63,073	630	6,000	69,703
LZ Oasis		No Data		
LZ Putter, Firebase Bird	50,095	0	7,200	57,295
LZ Uplift	43,455	3,220	275	46,950
Nha Trang	6,950	325	0	7,275
Phan Rang	110	2,075	0	2,185
Phan Thiet	5,000	330	220	5,550
Plei Ho, SF Camp	15,300	1,260	110	16,670
Plei Jerang	98,220	51,235	1,800	151,255
Pleiku	1,210	11,640	1,950	14,800
Puh Cat, LZ Hammond	29,700	7,210	0	36,910
Qui Nhon	53,215	1,800	4,125	59,140
Song Cau	5,650	55	0	5,705
Tuy An	13,215	3,740	0	16,955
Tuy Hoa	29,565	4,485	0	34,050
				Total: 1,054,406 gallons

III Corps - 4,086,229 GALLONS

Location	Orange	White	Blue	Total Gallons
An Loc	77,000	79,830	0	156,830
Ben Cat	87,250	83,640	20,105	190,995
Ben Hoa	35,045	124,525	3,950	163,520
Cholon	320	0	0	320
Cu Chi	59,150	67,540	14,105	140,795
Dau Tieng (Michelin)	32,370	45,800	3,800	81,770
Dien Duc, Firebase Elaine	66,850	25,800	0	92,350
Duc Hoa	750	0	0	750
Firebase Di An	6,000	0	1,595	7,595
Firebase Frenzel	13,445	57,560	900	71,905
Firebase Jewel, LZ Snuffy	219,550	146,010	7,300	372,860
Firebase Mace	34,280	23,350	730	58,360
Katum	299,420	239,395	20,000	558,815
Lai Khe	57,120	22,300	1,800	81,220
Loc Ninh	46,660	103,710	1,800	152,170
Long Binh, Firebase Concord	13,445	57,560	0	71,005
LZ Bearcat	17,840	75,470	0	93,310
LZ Fish Nook	44,000	23,800	0	67,800
LZ Schofield	38,640	17,210	7,800	63,650
Nha Be (Navy Base)	119,725	121,925	6,000	247,650
Nui Ba Den, Firebase Caroline	50,020	66,500	2,100	118,620
Phouc Vinh	484,383	146,576	12,810	643,769
Phu Chong	39,848	62,230	12,055	114,130
Phu Loi	79,000	83,430	0	162,430
Qua Viet	50,610	5,600	3,500	59,710
Quan Loi	44,190	34,300	0	78,490
Saigon			No Data	
Song Be	1,900	9,220	0	11,120
Tan Son Nhut	6,320	0	1,595	7,915
Tay Ninh	720	3,225	600	4,545
Trang Bang	32,365	39,560	6,000	77,925
Vo Dat, Firebase Nancy	14,180	29,100	0	43,280
Vung Tau	7,350	0	0	7,350
Xuan Loc	23,865	58,750	660	83,275
				Total: 4,086,229 gallons

IV Corps - 669,534

Location	Orange	White	Blue	Total Gallons
Ben Luc	45,900	14,838	0	60,738
Ben Tre	24,800	24,750	0	49,550
Can Tho	15,160	13,915	11,685	40,760
Cao Lanh	1,875	2,935	830	5,640
Dong Tam	5,870	605	165	6,640
Firebase Grand Can(yon?)	0	1,540	0	1,540
Firebase Moore	9,820	0	0	9,820
Ham Long	3,275	1,620	0	4,895
Moc Hoa	12,400	6,590	0	18,990
My Tho	13,320	7,316	965	21,601
Nam Can	150,345	64,295	0	214,640

Phnom	0	184	0	184	
Phu Quoc	19,000	0	0	19,000	
Rach Gia	0	2,155	0	2,155	
Seafloat	4,700	0	0	4,700	
Soc Trang	3,410	2,391	1,280	7,081	
Tan An	89,550	36,450	0	126,000	
Tieu Con	8,700	0	0	8,700	
Tra Vinh	9,885	8,000	0	17,885	
Vinh Loi	30,010	0	0	30,010	
Vinh Long	8,360	9,755	890	19,005	Total: 669,534 gallons

Note: This does NOT include US Army helicopter or ground applications, or any form of the insecticide programs by GVN, or the US military. The amount represents gallons within eight (8) kilometers of the area. Thus, each area is 9.6 miles in diameter.

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