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SAN ANTONIO AIR LOGISTICS CENTER

**DIRECTORATE OF ENERGY
MANAGEMENT**

KELLY AIR FORCE BASE, TEXAS

**USE OF HERBICIDES IN
SOUTHEAST ASIA**

HISTORY PREPARED AS AN ACTIVE DUTY ASSIGNMENT BY:

Dorothy A. Craig
Lt Col, USAFR

1 August 1975

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Herbicide Producers

All herbicide products were produced in the United States. The products showing total amount produced of each by manufacturers and costs are shown below. (Reference individual contracts)

	<u>Orange</u>		
	<u>Gallons</u>	<u>Price</u>	<u>Average</u>
Monsanto	3,561,040	\$23,259,233.74	\$6.53
Hercules	2,406,041	\$15,947,155.01	\$6.63
Diamond Alkali	696,685	\$ 4,689,671.25	\$6.73
US Rubber	694,802	\$ 4,730,447.60	\$6.81
Dow	4,002,534	\$28,028,212.16	\$7.00
Agrisect	100,028	\$ 653,682.98	\$6.53
Thompson-Hayward	1,036,475	\$ 7,317,513.50	\$7.06
Thompson	333,685	\$ 2,347,566.10	\$7.04
Hoffman Taff	<u>22,440</u>	<u>\$ 159,324.00</u>	<u>\$7.10</u>
Total	12,853,730	\$87,132,806.34	\$6.78
	<u>Blue</u>		
Ansul	1,581,859	\$ 7,113,907.00	\$4.50
Diamond Shamrock	<u>26,070</u>	<u>77,688.60</u>	<u>\$2.98</u>
Total	1,607,929	\$ 7,191,595.60	\$4.47
	<u>White</u>		
Dow	5,764,215	\$39,724,653.81	\$6.89
<hr/>			
TOTAL PROGRAM	20,225,814	\$134,049,055.80	\$6.65

USE OF HERBICIDES IN SOUTHEAST ASIA

The purpose of this history is to document the events from the inception of the herbicidal program in Southeast Asia to the present time.

The Vietnam Defoliation Program was initiated to strip leaves from plants in order to control jungle growth, thereby exposing enemy sites and operations and to minimize enemy surprise attacks through improved visibility. It was also used to destroy selected food crops in Viet Cong controlled areas of Vietnam in order to deny vital foodstuff to the enemy. The program was primarily a Government of Vietnam operation which was supported by the U. S. Government.¹

The President approved the following military action at the National Council meeting of 29 April 1961: "Assist the G.V.N. armed forces to increase their border patrol and insurgency suppression capabilities by ... applying modern technological area-denial techniques ..."² Aerial spraying operations began in 1962.

Sensitivity of the mission dictated that the program be classified Secret and minor portions classified Confidential. Due to time-phase down-grading or down-grading by the initiator, all correspondence has not yet been down-graded.

Herbicides used.

The basic three liquid herbicide agents used in Vietnam were:

Orange - NSN 6840-00-926-9095

White - NSN 6840-00-926-9093

Blue - NSN 6840-00-926-9094

Orange is a 50-50 mixture of two esters - normal butyl ester (N-Butyl) of 2,4 dichlorophenoxyacetic acid and normal butyl ester (N-Butyl) of 2,4,5 trichlorophenoxyacetic acid. This oil soluble mixture derived its designation "Orange" from its dark color.

A modified Orange designated as Orange II also was produced to a limited extent. This agent consists of 50 percent by volume of N-Butyl 2,4 dichlorophenoxyacetate and 50 percent iso-octyl, 2,4,5 trichlorophenoxyacetate. The effectiveness of this mixture was the same as Orange.

Blue was a clear water-soluble mixture of sodium cacodylate and dimethylarsenic acid with a 5 percent surfactant. The contractor designation for this product was Phytar 560G.

The active ingredients of White were 4 amino - 3,5,6 trichloropicolinic acid and 2,4 dichlorophenoxyacetic acid. This agent was a dark-colored water-soluble mixture which was color coded with a white band around the center of each drum. It is called Tordon 101, a registered trade name of Dow Chemical Co.

Herbicides are classified as contact or desiccants that kill primarily by contact with the plant tissue and systemic or translocated herbicides, which are absorbed by the plant and moved within the plant. Blue falls within the contact group and Orange and White within the systemic group. Soil-applied or residual herbicides (soil sterilants used in pellet form) kill germinating seeds and established plants by uptake of the chemical from the soil. Bromacil, Tandex, and Monuron are examples of residual herbicides capable of control of perennial grasses.⁴ The use of residual herbicides was done on a limited and experimental basis in the perimeter areas.

Orange and White were systemic growth regulators, hormone type, and killed the plant by disrupting the food system.

Blue was a rapid-acting desiccant contact herbicide that caused browning and dehydration of treated portions of plants, but did not necessarily kill the plant. Discoloration was evident in one day and maximum defoliation occurred within two to four weeks. Regrowth occurred after the leaves had fallen off.

Orange was the preferred agent because it provided a rapid response visible in a few days, could be used for both defoliation and crop control, and because it was insoluble in water it was effective during the rainy season. White was

an alternate for Orange but it was slower acting, taking about four weeks to produce visible plant response and affected less plant species. Also it could be washed off the leaves by rain.

White was considered non-volatile and was used to obtain longer lasting defoliation and to defoliate areas where vapor from Orange created unacceptable damage to adjacent vegetation. It was used in areas next to rubber plantations and other sensitive areas where vapors from Orange were carried by the wind onto adjacent foliage.

Blue was used for control of rice crops and grasses such as elephant grass.

Orange, Blue and White were all characterized by low toxicity to man, fish and wildlife and presented no hazard to animal life. Further discussion of the pros and cons will be given later.

The manufacturers experienced problems in the production of herbicides. The major factor bearing on the problem was the rate at which the Air Force's herbicide requirements grew outstripped the total U.S. chemical industry's capability to produce.

The critical ingredient in the manufacture of the preferred herbicide, Orange was tetrachlorobenzene. The Hooker Chemical Company (primary source) and the Dow Chemical

Company were the only significant producers of the item. Other herbicide producers depended on Hooker Chemical Company for this ingredient, and several of the suppliers proposed alternates in the ester form 2,4,5T acid. Thompson-Hayward developed a modified Orange designated as Orange II. It substituted the iso-octyl 2,4,5T for the N-butyl 2,4,5T. Thompson-Hayward produced only the Orange II and was the sole producer of the item.

Herbicide Management

The management of herbicides was the responsibility of MAAMA (Olmsted AFB PA) until it transferred to SAAMA* (Kelly AFB TX) in August 1966. The procurement responsibility remained at the Defense General Supply Center at Richmond VA.

The supply responsibility for herbicides transferred from Det 29, Aerospace Fuels Petroleum Supply Office, Cameron Station, VA (OM) to the Chemicals and Gases Division (OR) effective 2 Feb 1966, while still at MAAMA.⁵

On 11 Mar 69 SAAMA was assigned the management responsibility for requirements computation and procurement of all herbicides used in Southeast Asia. On 21 Apr 69 responsibility for ordering herbicides was shifted from SAAMA to 7th AF Hq with MILSTRIP requisition submission by that SEA activity authorizing shipment action.⁶

*Prior to redesignation as SA/ALC.

Research and Development (R&D) responsibilities were assigned to Fort Detrick Biological Laboratory of the U.S. Army while Eglin AFB AFATL Chemistry Biology Division was assigned the R&D equipment support testing.

In 1968 the Army coded in as a user of herbicides. Beginning in 1969 there was conflict between the Air Force and Army as to who should manage the herbicide Orange. The Army maintained that the proper Federal Supply Classification (FSC) was 1380, a vegetable control agent, managed by the Army. The Air Force maintained that it should remain assigned to FSC 6840, a herbicide, managed by the Air Force. Multiple assignment of FSNs (assigned by DGSC) to Orange existed. SAAMA requested herbicides be coded "mission essential" under Criterion 10 of the DOD Inventory Management Code Manual. On 8 August 1969 full management responsibility (excluding coordinated procurement) was returned to the Air Force by the Assistant Secretary of Defense as a "mission essential" item.⁷

Two of the three herbicides (FSNs 6840-926-9093 and 6840-926-9094) were formally transferred from DGSC to SAAMA for service management under FSC 6840 on 22 Jan 1970. The effective date of transfer was 1 June 1970. The third item (FSN 6840-926-9095) was to be transferred later during 1970.⁷ Because of the termination of the program this item never officially transferred, but was still managed by SAAMA. SAAMA (SF) responsibilities were to

acquire material, distribute, declare excesses, provide service engineering and technical support. SAAMA (DS) responsibilities were to receive, store, ship, provide transportation, inventory count, and redistribution and marketing. The latter responsibility was transferred to DSA, 1 Jul 73. ⁸

On 2 June 1971 all Orange stock was transferred in place by DD Form 695-7 to Redistribution & Marketing (R&M) for disposal and all Blue stock was turned in on base to the DSA Property Disposal Officer on 26 Oct 73. Disposition actions will be discussed later.

User management responsibilities dictated a monthly inventory including: open inventory, receipts, disposition, usage, closing inventory. This information was reported monthly to SAAMA.

Procurement, Authorization, Funding, Contracting

The herbicide program was one of explosive growth and drastic reduction. An idea of the size of the program can be obtained by the quantity of herbicides procured, delivered, and consumed.

Procured and Delivered⁹

<u>Fiscal Year</u>	<u>Awards* (gals)</u>	<u>Delivered (gals)</u>	<u>Total Cost</u>	<u>Avg Price per gal</u>
64	270,000	not avail.	\$1,700,000	\$6.30
65	330,000	not avail.	\$1,900,000	\$5.76
66	1,600,000	1,612,774	\$8,800,000	\$5.50
67	5,300,000	4,719,000	\$32,200,000	\$6.08
68	8,691,000	9,800,000	\$57,693,000	\$6.64
69	5,804,000	4,073,000	\$41,765,000	\$7.08
70	756,000	459,000	\$1,097,000	\$2.39**
71	161,000	534,105***	\$2,085,000	\$7.58

*Figures higher than shown on p. 2 because of subsequent cancellation of contracts. Rounded to nearest thousand.

**Average price of Blue decreased from \$7.08 to \$2.39.

***Includes FY71 contract for White and delivery of Blue from FY70 contract.

Consumed¹⁰

<u>Fiscal Year</u>	<u>Gallons Used*</u>
64 July 63 - June 64	265,000
65 July 64 - July 65	330,000
66	1,650,000
67	4,151,000
68	5,960,000
69	4,980,000
70	2,846,000
71	302,000**
72	0

*Figures are rounded to the nearest thousand.

**Included only Blue and White for use around perimeters of base camps and supply areas.

In 1967 the program requirements were not fully procured although quantities of agents Blue and White were substituted for the preferred Orange. FY1968 requirements were supported by supplements of Blue and White. The 1968 usage was considerably lower than originally projected and reductions were made to the FY69 requirements. The FY70 requirements drastic reduction was attributed to the temporary suspension on the use of herbicide Orange in Southeast Asia directed by the Assistant Secretary of Defense (ASD) on 15 April 1970. This will be discussed more fully later. As a result of this action the CSAF advised AFLC and SAAMA on 17 Apr 1970 that the suspension included new procurement, acceptance of product on terminated procurement contracts, transfer of product from Gulfport storage and ocean shipping operations.

Another factor in reducing procurement was that previous to the suspension of the use of Orange a restriction was placed on its use as directed by ASD, 29 Oct 1969. Orange was to be used only for targets in areas remote from population. ASD

permitted normal use of Blue and White to be continued at that time.

Requirements for herbicides, used in SEA, were developed by the Army's Chemical Operations Division, J-3, Military Assistance Command, Vietnam (MACV); passed to 7th Air Force of PACAF for coordination; to CINCPAC for review as required; to JCS and HQ USAF for approval and budgetary processing; and then to AFLC and SAAMA. SAAMA related these requirements to the capability of Ranch Hand, determined the quantity to be procured, secured the necessary budget allotment, prepared the MIPRs for procurement by the DGSC and arranged for the products to be delivered to Vietnam. ¹¹

During the FY-67 expansion period of herbicide procurement, when requirements were greater than the industries' ability to produce, it became necessary for CSAF and JCS to actively get into the herbicide program, as actions were required to divert all production from commercial to military use, and to deal directly with the DOD on the problems involving herbicide procurement and production. They performed this function until the program was greatly reduced during the last half of FY-69. On 27 Feb 1969, JCS decided to let the Air Force be responsible for herbicide consumption and procurement requirements and advised they would no longer validate requirements to HQ USAF. ¹¹

HQ USAF, on 3 Mar 1969, requested HQ AFLC assume this responsibility. HQ AFLC, on 11 Mar 1969, passed the full responsibility on down to SAAMA. Requirements then followed the flow as described above, except they were no longer sent from CINCPAC to JCS and HQ USAF, but were sent directly to SAAMA. The flow of requirements returned to the system in use before requirements outstripped the industries' capability.¹¹

SAAMA, during FY-68, based the supply support of herbicides to SEA on a 180-day (six month) lead time. This was computed as follows: 60-day supply in Vietnam (30-day supply at each of two storage points -- Saigon and Da Nang), 30-day safety level in depot supply, 30 days to process the Military Interdepartmental Procurement Request (MIPR), 15 days production time and 45 days in pipeline.¹¹ Previously a 30-day supply and 60-day safety level were used in computation.

Prior to 1 Apr 1966, funds for herbicides used in Vietnam were funded through the Fuels Division, Air Force Stock Fund, with reimbursement to this fund made through the Military Assistance Program (MAP) by the recipient.¹²

Effective 1 Apr 1966, fund project 436, "Logistic Support of Republic of Vietnam Air Force and Allied Forces, Vietnam" was established to identify costs previously included in MAP which were applicable to logistic support of Republic of Vietnam Air Force (RVAF) and Allied Forces, Vietnam. Funding of herbicides used in Vietnam then became an Air Force requirements. SAAMA's Directorate of Aerospace Fuels performed this function after 1 Jul 1966.¹²

In October 1967, HQ USAF directed that the point at which the Operation and Maintenance (O&M) appropriations for herbic was reimbursed be changed. Instead of reimbursement upon del at the point of delivery, FOB origin (product costs only) as was previously done, the O&M fund was to be reimbursed after 1 Apr 1968 for product costs, costs of transportation to first destination and losses incurred enroute to the initial unload at Port of Embarkation (POE). 12

The change in the point of sale expanded SAAMA's responsibility from a limited financial record for Operations and Maintenance funds to a full inventory and capital control system and included financing the first destination transportation of the cost of CONUS stored inventories and in-transit inventories from storage to POE. The new management concept also required development of standard prices for sale of herbicides and the preparation of Operating Programs and Budgets by SAAMA. 12

All MIPRs were forwarded to Defense General Supply Center (DGSC) for contracting. In FY67 when industrial production could no longer supply both non-military (mainly agriculture) and military requirements, DGSC with the aid of SAAMA, took the following action: attempted to accelerate production and deliveries on existing contracts, encouraged commercial prod

and held new plants and self-

Although some of the herbicide suppliers were willing and did expand their production capacity to some extent at their own expense, they were reluctant to take extraordinary measures to increase capacity without a long term contract. 13

The Department of Commerce authorized and DGSC placed Directed Orders and contracts on herbicide manufacturers for 75 percent of industry's Orange production through 30 Jun 1967. The Department of Commerce established monthly quotas for each supplier. 13

In an effort to meet FY68 requirements, the Department of Commerce denied other DOD agencies procurement of any of these products during FY68. Herbicide producers allocated 100 percent production of the products to the Air Force in FY68. 13

The Office of the Secretary of Defense directed the Department of the Army to begin herbicide production during FY69; however, this never materialized because of the sudden de-escalation of the program. 13

As a result of the de-escalation, contracts for Orange were terminated. On 30 Dec 1968, SAAMA authorized DGSC to accept all drummed products and products in contractors' blending tanks, on specification, that were ready for drumming at the moment termination order was issued (16 Dec 1968). When the order was received by SAAMA in Nov 1970 to stop Blue shipments to Vietnam, the FY70 Blue contract had not been fully drawn down; however, the undelivered quantity was in the final stages and

and no purpose could be served by stopping delivery to the Air Force. There were no existing contracts. All termination action on Orange was finalized during FY71.¹⁴

Packaging and Transportation¹⁵

Herbicides were packed in new ICG 17C 55-gallon 18-gauge* steel drums for shipment to Southeast Asia because lighter weight drums were not strong enough to protect the product. Herbicides weighed about 10 pounds per gallon.

Until 1967, lined drums were used only for shipment of Blue (Phytar 560G). Based upon compatibility tests conducted at the Air Force Materials Laboratory, it was determined lined drums were needed to ship White (Tordon 101) as well as Blue. Tests of container linings by the laboratory showed most epoxy-type linings to be satisfactory. Zinc and bare steel were unsatisfactory as container linings.

Contracts awarded for herbicides subsequent to March 1967, therefore, specified lined drums for White and Blue as follows:

White - Ault and Weyburg 4A phenolic lined drums

Blue - Phenolic lined drums as specified in MIPR FD2050-7-28059.

Orange did not require the use of lined drums as long as it was on specification (free acid content was 0.5 percent or less).

*SAAMA history made reference to 16-gauge drums; however, 18-gauge were utilized. (Shipment could not be made by air because a heavier drum "16-gauge" was required IAW government standards.)

Each herbicide drum was marked with a three-inch color-coded band around the center. The color of the band identified the herbicide agent, that is, White, Blue or Orange. This marking was initially a 12-inch band, but was changed to a 3-inch band in March 1966.

Drummed herbicides were shipped by rail from the manufacturer to the port in standard box cars, 128 drums to a car. At the port, drums were placed on pallets and taken to the pier by forklift. The ship's crane picked up the drum from the pallets and swung them aboard the ship where they were vertically stacked below deck, normally three high, for movement to Vietnam. Drums could not be stacked in railroad cars because this would have caused the cars to be overweight.

A gulf port was used for oversea movement of herbicides because cost and time-wise it was the most economical. Since herbicide suppliers were located in the eastern half of the United States, rail transportation to a west coast was greater than to a gulf port. In addition, at the crowded west coast ports, such as Seattle, there was about a 30-day waiting time at the port before departure for the oversea destination and 22 days on the water. At the gulf port, the waiting time was 5 to 15 days prior to departure and an average of 32 days on the water. Thus shipping time from the high-point port totaled 52 days versus 47 days for the gulf port.

The outpost at Mobile AL was used as the port of embarkation for herbicides bound for Vietnam. The Military Traffic Management and Terminal Service (MTMMS) issued rail routing instructions for the transportation from the herbicide supplier to the port, and the Military Sea Transportation (MSTS) arranged for the vessels to move the herbicide from the port to Vietnam.

Producers shipped to multiple oversea destinations which increased the Air Force and contractor administrative workloads associated with Export Traffic Releases, drum markings, bills of lading, receiving reports, railroad car arrival and lift information. Prior to 1967, some difficulty was experienced with excessive time lapses between the request for Export Traffic Releases and the response. SAAMA solved this problem by working out an agreement with Hq Military Traffic Management and Terminal Service (MTMMS) whereby a Blanket Export Traffic Release would be issued to cover the entire contract period. Usually, this period was one year, whereas previous Export Traffic Releases covered only two months.

About 10 out of every 10,000 drums received at the outports during 1968 were damaged or defective. This represented a damage ratio of .001 drums (one-tenth of one percent). About 50 percent of these damaged drums leaked as a result of punctures or split seams. These were caused by improper car loading and because drums were defective. Forklifts operated by stevedores also caused punctures.

Routing instructions were revised to include: "Carload Shipments will be loaded in accordance with UFC Rule 27, Sec 3." Instructions were also forwarded to the contactors concerning the method of indicating dunnage weight on the Government Bills of Lading assuring the carrier's assessment of proper transportation charges.

Liability for damaged drums was accepted by the stevedore company for drums punctured during handling by stevedores, by rail carriers for drums damaged during transit, and by herbicide suppliers for seam leakers attributed to defective drums. Redrumming was acceptable for damaged drums other than those with open punctures.

About 35 percent of the quantity shipped was allocated to Da Nang and 65 percent to Saigon Vietnam.

Storage

Storage of herbicide Orange became an item of significant importance with the temporary suspension placed on all uses of herbicide orange by the Assistant Secretary of Defense on 15 Apr 1970. Prior to that time, shipments of herbicides into Mobile Outport, Mobile AL and Gulfport MI, Naval Construction Battalion Center (CBC) and shipments from the center to SEA were handled in a routine manner.

As the herbicide inventory began to build up in Southeast Asia, SAMA discontinued shipments there from the port of embarkation to avoid exposing large quantities of herbicides to possible damage by enemy action. SAMA then had to decide what to do with the product already delivered to the port

and scheduled for delivery to the port. Rather than return the product to the manufacturer and suspend delivery to the port, SAAMA decided to arrange for the product to be temporarily placed in storage. Since the Mobile Outport, Mobile AL, was routinely used as the port of embarkation for herbicides, this was the logical place for the temporary storage. It was anticipated at that time that the storage period would be about six months.

On 18 Mar 1968, Interservice Support Agreement Z4-AA2921-0010-8 was made by and between SAAMA and the Mobile Outport, FANLETS. This agreement provided for the Mobile Detachment of the Army's Gulf Terminal Command, Mobile AL, to receive and provide temporary intransit storage for approximately 20,000, 18-gauge, 55-gallon drums of herbicide at the Mobile Outport owned by the State of Alabama. Also, the Mobile Detachment was to remove from storage and place in the transportation system quantities of drums designated by SAAMA. The agreement covered the three-year period from March 1968 to March 1971, and was effective 21 March 1968. ¹⁶

Herbicides were input to Mobile Detachment for storage between 7 April 1968 and 30 June 1968, and were removed from storage between September and December 1968 after it was determined that long term storage was necessary. Except for one shipment to SMI during September 1968, herbicides removed from this storage site were used to fill COMUS test requirements. ¹⁶

In storing, drums were placed on wooden pallets, six to a pallet (two vertical rows of three), by outport personnel, and positioned in a warehouse on the dock. It was not anticipated the storage period would exceed six months. 16

In mid-May 1968, however, a storage problem developed. Based on direction from the Chief of Staff Air Force, SAAMA notified the Outport, on 17 May 1968, to cease liftings, because the herbicide inventory in SEA was adequate for projected consumption. As a result, drums quickly stacked up so that the dock warehouse could no longer store them. Drums had to be moved from the warehouse to an outside storage area. 16

SAAMA hoped to arrange for additional outside storage at the Mobile Outport; however, this outport was unable to accommodate the maximum quantity specified in the agreement with SAAMA. Another storage site was obtained. USAF requested the Navy to make the Naval Construction Battalion Center (CBC) at Gulfport MI, available for herbicide storage and related services the request was approved, and SAAMA negotiated the agreement with the Center. 16

On 26 June 1968 Interservice Support Agreement Z3-N2604-0083-9A was made by and between SAAMA and CBC, Gulfport MI, to provide services related to receiving and storing approximately 50,000 18-gauge, 55-gallon drums of herbicide. The agreement was effective for the two-year period 1 Jul 1968 - 1 Jul 1970. It was to be reviewed annually by both parties between 1 and 15 July. 16
Input of herbicides to Gulfport began in July 1968.

Storage was considered a better alternative than to return

herbicides to the manufacturer where storage charges would have been more expensive. Shipment could be diverted from Mobile to the outport at Gulfport without increase in the transportation rate.

CBC agreed to receive and store the drums of herbicide and remove from storage quantities of drums as designated by SAAMA, while SAAMA agreed to provide 17 personnel in support of this operation. This was modified in July 1968 to reimburse CBC for material and two supervisory personnel in the estimated amount of \$1,070 per month. The 17 overhire personnel were recruited, paid, and provided other personnel services by the Civilian Personnel Officer at Keesler AFB, MI. They were assigned to the Transportation Division of the Directorate of Aerospace Fuels and detailed to the site under the supervision of Navy personnel. Except for one clerk-typist, the personnel performed manual labor involved in handling the herbicide drums.

The Gulfport outside storage area was about two miles from the docks, with convenient access to the railroad. It was fenced and isolated from public traffic. CBC provided surveillance as well as controlled access. It was planned and set up for long-term storage. To provide good drainage, 2x6-inch dunnage (creocoted lumber) was laid on a hard surface and drums, positioned horizontally with the bung closure pointed outward, were stacked in double rows, three high, in pyramidal fashion. The number of drums in each single row, bottom to top, was 55, 54, and 53.

To allow inspection of the bungs, there were 18 inches between
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each double row.

CBC personnel measured the storage area, laid dunnage, devised a drum sling to allow a crane to lift four drums at one time, provided trucks, crane, supervised the operation, scheduled railroad cars in, and accomplished transportation documents. By using the crane and the drum sling, 10 rail-
16
road cars carrying 12,800 drums could be unloaded in one day.

On 1 July 1969, responsibility for storage of herbicides transferred from the Transportation Division, Directorate of Aerospace Fuels, SAAMA, to the Management Service Division,
17
Directorate of Distribution.

Even though the Interservice Support Agreement SAAMA's Directorate of Aerospace Fuels negotiated with CBC, effective 1 July 1968, did not terminate until 30 June 1970, SAAMA's Directorate of Distribution negotiated a new agreement with CBC covering the period through 30 June 1970. This agreement, Z3-N62604-0043-0, effective 24 September 1969, differed from the previous agreement by providing a new appropriations number and authorized CBC to hire up to 14 people and pay them by citing a SAAMA appropriation number. Keesler AFB, prior to this time, had serviced the 14 SAAMA overhire spaces but this had
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not proved satisfactory to CBC.

During June 1970, SAAMA negotiated a new Interservice Support Agreement with CBC. This new agreement Z3-N62604-0048-1, effective 1 July 1970, was for the two-year period terminating

30 June 1972 and differed from the previous agreement in that it provided for the storage of herbicide Orange until a DOD decision was reached as to final disposition. It also provided for the receiving and shipping of herbicides Blue and White which were not affected by the DOD suspension placed on Orange. 17

The CBC was the only CONUS storage facility used during the last half of FY69 and FY70. The Mobile Outport intransit storage facility was not used after December 1968 when the last drums of herbicide were moved to the CBC. 17

During 1970 CBC no longer wanted any additional herbicides for storage. At the end of FY70 there were 833,855 gallons of herbicide Orange in storage at CBC. Except for a small quantity stored at Eglin AFB FL for test purposes, Gulfport was the CONUS storage point. 17

The herbicide storage agreement with CBC expired on 30 June 1972. A new Support Agreement Number Z3-N62604-0055-3 was negotiated for the period 1 July 1972 through 30 June 1975. This was renewed by Interservice Support Agreement, N62604-75182-004 for the period 1 Jul 1975 to 1 Jul 1976. 20

The basic differences between agreement ending 1975 and the previous support agreement between Kelly AFB and the CBC was that it covered a three year period in lieu of two years. Also, the Directorate of Aerospace Fuels responsibilities were omitted in the new agreement. The Directorate of Distribution was

included as storage and final disposition monitor. One of the provisions of this and the previous support agreement required quarterly on-site storage inspections of the herbicide Orange drums at the CBC by the Directorate of Distribution personnel. The responsibility for rewarehousing, redrumming or shipping was the responsibility of SAAMA Directorate of Distribution. 18

The Vietnamese handled and stored the product at the 20th Ordnance Storage Depot, Saigon, and the 511th Ordnance Storage Depot, Da Nang. Under the normal handling procedures, drums were unloaded at Da Nang and Saigon from the cargo vessel directly into semi-trailers and were placed in an upright position. The trailers were driven to the 12th Air Commando Squadron where the contents of the drums were transferred into blocked F-6 trailer tanks through a suction tube without removing the full drums from the semi-trailers. Each F-6 trailer held 4,298 gallons or about 78 drums of herbicide. As the herbicide stock built up, the blocked F-6 trailer tanks could no longer accommodate the total inventory; therefore, after drums reached the herbicide handling area, they were stacked pyramidal style until needed. 19

The transfer of the herbicides from the 55-gallon steel drums to storage tanks or aircraft tanks required some precautionary measures. Personnel handling herbicides were cautioned to treat areas contaminated by spillage by repeated flushing with diesel fuel or water and diversion of the drainage into settling basins or pits for incorporation into the soil. 19

The F-6 trailers were tied to plumbing and pumps so the product could be delivered to the aircraft without moving the trailers.

19

When the herbicide was pumped from the drums into the F-6 trailers about one-half to 1 1/2 gallons of herbicide remained in the drum. Since herbicide cost about \$7.00 per gallon, the U.S. military forces devised a stand to drain each drum to prevent the residual herbicide from being wasted. The drippings were collected from many drums in a pan-type receptacle and used for spraying base perimeter areas.

19

Orange was oil soluble, and White and Blue were water soluble. When the water and oil soluble herbicides were mixed in trailer tanks or aircraft tanks, a gummy substance formed. The F-6 trailers were therefore color-coded to correspond to the drum color-codes and used exclusively for the herbicide to which the code applied.

19

The aircraft spray tanks, positioned in the center of the airplane, and the spray system, were purged before the type of herbicide carried was changed. Particular attention had to be given to sequences involving Blue and White. A mixture of these two agents resulted in the formation of a precipitate consisting of the sodium salt of 2,4-D.

19

As a matter of information, because the shipping cost was greater than the item, empty herbicide drums were not returned to the United States. The empty drums were given

to the Military forces (Vietnam, U.S., and Free World Military Assistance Forces) for use as barriers in their defensive positions. The drums were filled with sand or concrete and made excellent bunkers and foundations for barbed wire perimeter fencing. Some were believed to have been used in runway construction and to fabricate portable showers.

Diversion of residuals to Kelly AFB TX, as well as disposition of herbicides at Gulfport, Eglin and SEA will be discussed later. 19

Redrumming

A few damaged drums were received at CBC with leaks around the bung closures because the seals had vibrated loose. In such cases the producer was notified to supply new bung closures. CBC personnel took the corrective action. Usually the leaks could be stopped by removing the cover and tightening the bung or replacing the bung gasket. 21

When leakers due to damaged drums were spotted while in storage, these were redrummed by the people on duty. It was discovered that a moist area usually appeared on the drum two or three weeks before noticeable loss occurred, and the contents could be saved by transferring it to a new drum. 21

It was found that despite the protective covering used in vertical stacking, condensation could cause moisture to collect on the drumheads and result in rust forming and contaminating the product. Since the bungs and vents were not flooded when the drums were upright, the seal could lose integrity and

result in leakage during later handling. Also, the stacks of pallets were not stable under all weather conditions, and the wooden pallets were subject to rot during long storage and could become unsafe.²¹

On 17 Aug 1969, Hurricane "Camille" hit Gulfport, Mississippi area with winds in excess of 125 miles an hour.

There were 17 railroad cars on the docks containing 1,700 drums of herbicide, valued at \$400.00 for each drum, which were withdrawn to the CBC area before the storm hit. In addition, there were 1,466 drums of Orange and Blue herbicide on the docks awaiting loading which were not returned to the storage area before the storm hit.²²

Of the 1,466 drums, 412 were recovered and shipped to Vietnam. The remainder were dredged from the Gulf by Corps of Engineers personnel and piled in the Commercial Port area at Gulfport, Mississippi. On 2 October 1969, the USAF Water Port Liaison Officer (WPLO) at New Orleans, Louisiana, requested AFLC support SAAMA in finalizing a redrumming and salvage plan to clean up the area immediately.²²

On 8 October 1969, firm arrangements were made to accomplish redrumming operation as follows:²²

1. SAAMA furnished new drums, marking and shipping instructions.
2. Defense Contract Administration Service (DCAS), Mobile, furnished a quality control man to supervise redrumming operations.

3. CBC furnished plumbing arrangements for adapting drums, bung wrenches, stencilling brushes and paint for remarking drums.
4. Eastern Area Military Traffic Management & Terminal Services (EAMTMS) furnished labor, hoses and heavy lift equipment for redrumming.
5. USAF Water Port Liaison Officer (WPLO), New Orleans made necessary booking arrangements to life redrummed herbicide from Gulfport to SEA.
6. US Army Corps of Engineers (Gulf Detachment) disposed of empty, damaged drums.

Redrumming operations were completed on 7 November 1969. Damaged drums which had been emptied were flattened with a caterpillar tractor and hauled to a hurricane Camille dumping area where they were plowed underground. Salvaged drums were placed on pallets and delivered to the pier for loading and shipment to SEA.²²

There were 809 damaged drums of herbicide Orange and Blue salvaged by the redrumming operations which produced a cost savings of \$213,492.20. Losses resulting from Hurricane Camille were 74 drums of Orange and 171 drums of Blue. This represented a loss to the government of \$57,958.55.²²

In May 1971 during an inspection of Orange by the inventory manager, it was noted that deterioration of some of the drums had required CBC personnel to redrum the product. As drums were removed from the stacks, indications of additional leaking drums became apparent. Previously, leaking had been attributed to breakdown of the bung seals used in the drum closures or an occasional seam leak. During this inspection it appeared leaking

5. Touch up with enamel paint
6. Tighten bung vent closures as necessary
7. Inventory by transportation control number (TCN) and apply corresponding Analysis Sequence Number to drum head
8. Rewarehouse onto new dunnage, three tiers high
9. Remove remains of old dunnage
10. Redrum leakers and damaged drums.

During the period 3 June through 12 November 1972, working on weekends, personnel of the 355th General Supply Company (Army Reserves) processed 4,345 drums of herbicide Orange and redrummed seven drums. The Army Reserves averaged a 25-man team each weekend. The 2954th Combat Logistic Support Squadron (CLSS) provided an 18-man team from 9 November through 18 December 1972 to complete the rewarehousing project. The 2954th CLSS team processed the remaining 11,059 drums and redrummed 10 drums of herbicide Orange during this period. ²⁴

The cost of the rewarehousing operation was \$38,273.66. ²⁴

A visit was made by a Directorate of Distribution representative to the CBC between 9-12 April 1973. The purpose of the trip was to inspect the overall storage condition and to arrange to return empty herbicide drums to Hill AFB, Utah. ²⁴

The inspection of the 15,404 drums of herbicide stored at the CBC revealed that although the rewarehousing project was completed on 18 December 1972, there was a noticeable new start of corrosion on drum surfaces. These needed no paint touch-up during the rewarehousing; however, scale rust had since developed under the new paint. Also, there were spots of rust on drums which had been on rotten dunnage next to the ground. Although the loose scales had been steel brushed at the time of the painting, exposure to

was caused by deterioration of the drum by rust from the inside. It was observed that the first indication that a drum was beginning to deteriorate by rust from the inside was a slight discoloration of the paint. At this stage only a pin-point hole in the side of the drum could be detected. As the rust progressed, the hole enlarged. When the rust broke through the paint, the rate at which the hole enlarged was quite rapid. ²³

The personnel operating the CBC site estimated that 30 percent of the drums required immediate replacement and the remainder required replacement within 12 months. The CBC personnel compiled and provided SAAMA a time/cost estimate to redrum 100 percent of the product utilizing their local resources. Using these data, SAAMA estimated redrumming cost at \$10.00 per drum for 15,290 drums. SAAMA alerted AFLC to this situation on 28 May 1971. ²³

Rewarehousing was required. SAAMA entered into an agreement with the HQ 377th Support Brigade in New Orleans, Louisiana, to rewarehouse approximately 15,000 drums of herbicide Orange on new lumber or comparable dunnage using US Army Reserve troops during weekend tours. The reserve troops began the rewarehousing during the latter part of FY-72 and as of 30 June 1972, work was progressing satisfactorily. ²⁴

Rewarehousing consisted of the following processes:

1. Lay new dunnage
2. Remove drums from storage
3. Inspect for leakage, rust and overall condition
4. Steel brush rusted areas

the salt air, rain, wind and sand had caused further corrosion on these particular spots.²⁴

No redrumming was required in 1974. However, it was determined in 1975 that further redrumming is required due to leakage and more corrosion. The 2954th Combat Logistic Support Squadron (CLSS) is to assist in this 30-day project and is scheduled to be at CBC by 31 July 1975. Initially 5,000 drums will be inspected. Representatives of the Environmental Protection Agency will be present.²⁰

Application of Herbicide in SEA ²⁵

A request for defoliation could originate either with the Americans or Vietnamese, but the Vietnamese had to approve all targets. The MACV (Military Assistance Command Vietnam) "203 Committee" administered the program and obtained U.S. Embassy's approval and other coordination prior to notification to the 12th Air Commando Squadron (ACS) of the approved target.

The process of approving targets and setting up herbicide missions was subject to review through two parallel chains of command -- one Vietnamese and the other U.S. The initial approval from the Republic of Vietnam was obtained from the District Chief within whose district the target was located. The request was then sent to specified Army of Republic of Vietnam agencies.

The U.S. approval followed a similar pattern. The request was initially approved by the District Advisor, then was sent

to the Section Advisor, Division and Corp advisors, and then to MACV.

MACV coordinated the approved requests with each of the 203 Committee organizations in turn, concluding with the U.S. Embassy. Approved requests were then forwarded to the 203 Committee's Chief of Staff for mission scheduling. Prior to the actual spraying mission, a profile mission was flown to acquaint the flight crew with the terrain to assure only the approve area would be sprayed.

Herbicides were delivered from UC-123B aircraft (modified C-123 aircraft outfitted with the A/A 45Y-1 system) at an altitude of 150 feet and an air speed of 130 to 135 knots. The equipment was calibrated to dispense the herbicide at the rate of three gallons per acre from 32 spray nozzles (12 on each wing boom and 8 on the tail boom). In four minutes, 950 gallons of herbicide could be sprayed to cover a swath 240 feet wide and 10.4 statute miles long.

The normal crew of a military herbicidal-spray plane was a pilot, co-pilot, and a technician who sat in the tail area and operated a console regulating the spray. Usually, four planes flew each sortie in formation.

In 1968, the UC-123 planes had been equipped with two gasoline burning jet engines to provide an additional source of emergency power for a quick getaway after spray dissemination.

The A/A 45Y-1 defoliant dispenser is a modular spray system for internal carriage in cargo aircraft. Essentially the dispenser consists of 1,000 gallon tank, a 20 horsepower gasoline engine and pump, and an operator's console with pump and spray release controls.

Application by aerial spray was most effective if accomplished prior to 0800 hours while inversion conditions existed, in the absence of precipitation, and while the wind was calm or not exceeding a velocity of 8 knots. This was to insure proper settling of the spray on the target area. Since Orange was insoluble in water, it was least affected by rainfall immediately after spraying.

The actual missions were flown by the 12th Air Commando Squadron, which was nicknamed Ranch Hand and began spraying operations in February 1962; operations began in Tan Son Nhut and later moved to Bien Hoa AB. The Vietnamese accompanied USAF personnel on the defoliating missions.

The number of acres sprayed annually from the beginning of the program to the end is shown below.

Approximate Aerial Destruction

<u>Year</u>	<u>Defoliated</u>	<u>Crops Destroyed</u>	<u>Total</u>
1962	4,940	741	5,681
1963	24,700	247	24,947
1964	83,468	10,374	93,842
1965	155,610	65,949	221,559
1966	741,247	101,517	842,764
1967	1,486,446	221,312	1,707,758
1968	1,267,110	63,726	1,330,836
1969	906,000**	49,200**	955,200**
1970	136,214**	-	136,214**

* The density of the foliage (single to triple canopy) determined whether one or two applications of herbicide were required.

** Estimated

During the third and fourth quarter FY68 when the mission was at its peak approximately 120 sorties were flown per aircraft. Twenty-four UC 123B aircraft were used. This averaged approximately 39 sorties per day.²⁶

Without defoliation, ground visibility was limited to 15 feet in jungle areas, and aerial observation could not detect enemy movements in areas where there were no roads. Based on pilots' reports, defoliation improved aerial visibility laterally and vertically as much as 90 percent.

Vine growth between trees in Vietnam ranged from single to triple canopy. Most areas to which herbicides were applied were triple canopy. Dense jungle growth required two applications to defoliate upper and lower layers of vegetation.

Jungle vegetation responded to herbicide treatment best during the most rapid growth period.

For crop control an effort was made to apply the chemicals during the flowering stage or prior to germination or mature stage. Since cultivated crops matured throughout the year in Vietnam and several types of rice were grown (three months, six months and so on), it was difficult to hit all targets at the right time.

The Vietnamese handled the product on the ground. Portable perimeter hand sprayers were used for areas around bases and camps and areas along the highways were sprayed by truck.⁸

The ground spraying comprised 4% of the operation while the large or remote areas sprayed by aircraft comprised 96% of the operation. Late in the program helicopters were phased into this type of action.⁸

Public Pressures in CONUS and SEA

The following excerpts from magazine and newspaper articles for the use of herbicides in SEA are summarized below:

Goodyear Industrial Progress, page undated, Vol 6, No. 3, p 3: Aerial spraying is now being used by the Air Force to save lives in Vietnam. It discourages infiltration, reduces ambushing of military and civilian vehicles, opens up helicopter landing sites and creates open perimeters around cities. It is harmless to human and animal life and opens every troop to aerial surveillance.

Bowes, D.B., St. Louis Post - Dispatch, "Weldon Spring Plant to Make Defoliants", Oct 21-22, 1967: A possible use for the defoliants could be to keep down trees and brush on the anti-infiltration barrier which the Pentagon has announced will be built between North and South Vietnam.

Bowes, D.B., St. Louis Post-Dispatch, "St Louis Firm Shares Work at Weldon Spring", Nov 8, 1967: Defoliants are used

extensively in Vietnam to reduce ambush cover along roads and canals and to destroy crops believed destined for use by the Viet Cong.

San Antonio Light, "Zone Defoliation", 11 Jan 1968: (For info only) South Korea plans to defoliate a large part of its half of the demilitarized zone so sentries will have a better chance of spotting infiltrators.

Chemical Week, "Herbicide Hassel: The Army fires Back", 13 Jan 1968; p. 67. Peaceful advantage of defoliant is that boating salesmen can see their VM prospects without scouring the underbrush. VC tunnel openings, caves and above-ground shelters were revealed to aircraft by the jungle destruction. Article stated that it is easy to distinguish village rice fields from those cultivated by VC. An Army study based on rat feedings of cacodylic acid showed that it is less dangerous than 2,4-D or 2,4,5-T.

The following excerpts from magazines and newspaper articles against the use of herbicides in SEA are summarized below:

O'Toole, T., The Houston Chronicle, "Biologists Hint Herbicide War Waged by U.S.", 13 Nov 1967: Two of the nation's foremost biologists have charged the U.S. of waging chemical warfare in Vietnam by poisoning plant and animal life for years to come. They charged that the Viet Cong did not suffer for lack of food but the food shortage caused starvation among innocent women, children, infirm and aged Vietnamese. Also, they claim the spraying has caused widespread damage to fruit and rubber trees as well as crops. They stated

that "while they may not be directly toxic to fish, they may prove toxic" by killing the microscopic animals fish feed on. Also, they stated that the "massive" use of herbicides could cause a "catastrophic upset" of the VM environment. This article also was carried in the San Antonio Evening News, 16 Nov 1967, under the bylines, "Biologists Hit Chemical Use to Kill Vietnam Plants."

Article from unidentified newspaper "Plague Predicted", 3 Dec 1967: The widespread destruction of woodland and foliage tends to bring wild rats into contact with domestic rats, thereby starting a plague cycle.

Chemical Week, "Doubts on Defoliants", 25 Nov 1967, p. 32, reiterated information given in O'Toole's article, "Biologists Hit Herbicide War Waged by U.S." Chemical Week also added that changes may include immediate harm to people and extend to serious and lasting damage to soil and agriculture. Vietnam spraying is the first use of defoliants and herbicides in warfare. Criticism was made of the use of dimethylarsenic acid sprayed for control of elephant grass and rice in which 2,4-D and 2,4,5-T are ineffective. The arsenical is toxic to humans.

San Antonio Evening News, "AAAS View on Herbicide Turned Down", 9 Aug 1968: American Assn. for the Advancement of Science (105,000 members) urged the Pentagon to stop spraying VC rice crops with a herbicide called cacodylic acid. A Pentagon

aide said the chemical which was used in the 1930s for treating syphilis is no more poisonous than aspirin.

San Antonio Express, "Defoliation 'Alters' Wildlife, Plants", 12 Feb 1968. Midwest Research Institute (MRI) in a Pentagon-commissioned report acknowledged that the use of defoliants over the past 5 years is not calamitous but could be disrupting VN balance of nature. A lack of leaves and upper branches to live in means death for the monkeys. Four other species of wildlife were listed for likely extinction through defoliation. The temperature of the defoliated jungle will be elevated, winds increase and rainfall declines. The soil may change from lateritic soil to laterite rocks.

San Antonio Express, "U.S. to Use More Crop Killing Poison in Vietnam War", 15 May 1968: The AF is preparing to dump 10 million gallons of vegetable and crop killing poison over South Vietnam in the year beginning this July. It may result in a shortage of lawn and garden weed-killers used by American home owners. Its use may lead to more deadly chemical warfare or have enduring, nature-upsetting effects on South Vietnam.

Above are examples of pros and cons in the use of herbicides in SEA. Other articles follow these lines and the majority were against its use. These articles discussed the ecological consequences of the defoliation program in Vietnam and at home; its disruptive effect on and the direct health hazards to human life. Only one of these articles made reference to

the essential prerequisites in the selection of herbicides for defoliation and anti-crop programs; that of a low mammalian toxicity. Herbicides Orange, Blue and White are all characterized by a low toxicity to man, fish and wildlife and presented no hazard to animal life in target areas during or after spray applications. The articles presented the sensational side of the subject with emphasis on the effects which resulted when relatively large oral doses were administered to mice. No mention was made of the fact that a number of US servicemen are alive today because of the herbicide program in Vietnam. 27

Unfavorable publicity spurred investigation into the matter. A team was sent from Fort Detrick, Maryland to Vietnam 15 Aug-2 Sep 1969 to assess herbicide damage on vegetable crops, tree fruits and rubber. It was suggested that many of the damage claims are Viet Cong inspired as evidenced by the fact that a VC-sponsored school for filling out claim forms had been discovered. It was also mentioned that the increase in claims appears to be inspired by the knowledge that claimants are receiving money from the RVN government for claims whether they are valid or not. It was also found that empty herbicide drums were indiscriminately used and improperly stored. Volatile fumes from empty drums were causing damage to shade trees and other desirable vegetation in Da Nang and Bien Hoa. Investigation of sprayed areas (aerial and ground) showed no permanent herbicide damage. 28

A continuous review was made of the resulting effects of herbicide spraying.

Pressure to cease the mission was even received by the Secretary of Defense from members of Congress. He received a letter from a U.S. Senator, 14 Aug 1970, in which the Senator and thirteen of his colleagues requested that the crop destruction program in Vietnam cease and the entire military defoliation program be terminated. In reply to the Senator, the Deputy Assistant Secretary listed the advantages of herbicidal spraying which far outweighed any temporary damages done. His summary of the situation is quoted, "In summary, premature termination of herbicide operations could significantly increase the number of US and Vietnamese casualties, seriously retard the Vietnamization process by requiring increased forces for security and reconnaissance missions, and raise the costs of assisting the people of South Vietnam in determining their own future free from outside interference." 29

Reduction/Cancellation of Herbicide Program

The decline in herbicide consumption can most likely be attributed to several factors: the national publicity herbicides received during the late 1960's, the Deputy Secretary of Defense's decision to suspend the use of the most widely used herbicide, Orange, during FY-70 and the discontinued use of Blue ordered by DOD during FY-71, and President Nixon's

Vietnamization Program which greatly reduced the number of US ground forces in Vietnam and left the active ground fighting to the South Vietnamese. 30

On 4 November 1969, the JCS advised CINCPAC that the Assistant Secretary of Defense had placed a restriction on the use of herbicide Orange. The decision to place herbicide Orange on restricted use was based on a report, prepared for the National Institute of Health, which presented evidence that the byproduct dioxin present in 2,4,5-T, could cause malformation of off-spring and stillbirths in mice when administered in relatively high doses. The Assistant Secretary of Defense restricted the use of Orange, for targets only in areas remote from population, until a decision could be reached by the appropriate governmental agency whether it could remain on the domestic market. ASD permitted normal use of Blue and White to be continued, but large scale substitution of Blue for Orange was not permitted. 31

The Secretaries of HEW, Interior and Agriculture, on 15 Apr 1970, announced the suspension of the use of herbicides containing 2,4,5-T for domestic uses around homes, agricultural areas, lakes, rivers, ponds and ditch banks, but permitted its use for control of weeds and brush on range lands, pastures, forests, and right of ways. The Department of Defense, on 15 April 1970, also temporarily suspended the use of herbicide Orange in all military operations pending a more thorough evaluation of the situation. 31

As previously mentioned, CSAF advised AFLC and SAAMA on 17 April 1970, that the suspension included new procurement, acceptance of product on terminated procurement contracts, transfer of product from the CBC site at Gulfport, Mississippi, and ocean shipping operations pending a more thorough evaluation of the situation. Blue shipments to SEA were stopped in Nov 1970. The requirement for White was eliminated since it no longer was used as a substitute item. 31

Due to the underflying of missions in SEA and the buildup of stock, termination of Orange contracts had already been initiated at the end of the 2nd Qtr of FY69. The value of contracts cancelled was \$12,832,606.52. 31

When the program was discontinued, some assets were relocated to storage areas where they could be held until disposition instructions were received. All of the herbicides within the United States were stored at three locations: Gulfport Mississippi, Eglin AFB, Florida, and Kelly AFB, Texas. The Orange and Blue herbicide at Eglin AFB, Florida had been obtained during previous years for test purpose. To avoid unnecessary transportation cost, SAAMA made arrangements with Eglin to retain the Orange in storage until DOD guidance for disposal was received. Contractor herbicide residuals and Blue were diverted to Kelly AFB. On 8 Dec 1970, SAAMA recosigned the remainder of Blue on Contract DSA 400-70-D-0042 at the manufacturer's plant (Ansul) from its original destination to

Kelly AFB, Texas. ³² The herbicide ingredients 2,4-D and 2,4,5-T were stored at Kelly AFB by Jan 1971. These ingredients were brought to Kelly for storage to finalize the FY-68 contract for Orange with Hoffman-Taft, Incorporated, Verona, Missouri; Hercules, Inc., Wilmington, Delaware; Thompson Hayward Chemical Co., Kansas City, Missouri, and Thompson Chemicals, St Louis, Missouri. The residuals and Blue were stored in Yard 62 at Kelly AFB, Texas, pyramidal style. ³⁰

Throughout FY-70, SAAMA personnel had attempted, unsuccessfully, to negotiate an agreement with a DOD installation in the midwestern section of the US to store these residual ingredients. Since the ingredients were located at plants in Missouri, Delaware and Michigan, movement to a storage site in the general vicinity was desirable from the standpoint of transportation cost. Although SAAMA attempted to negotiate an agreement with 13 DOD installation none were willing to accept the herbicide components, because of the adverse herbicide publicity. ³²

Further, SAAMA was unable to lease commercial storage facilities because compliance with the provisions of AFR 67-73 required clearance from all Services to certify Government storage was not available. Since Government storage was available, the clearance could not be obtained. ³²

Herbicide Orange, at the end of FY-71, was located at various locations in Southeast Asia. Because its use was prohibited, and to reduce SEA storage, PACAF wanted it moved from the area

and obtained permission to move it to Johnston Island for storage. CSAF authorized the move and Project Pacer Ivy was the nickname assigned for actions pertaining to the movement. PACAF/Seventh Air Force had all Orange collected at three bases: Da Nang, Phu Cat, and Bien Hoa in Vietnam. Redrumming was accomplished as necessary. Orange was shipped from Da Nang on 15 March, from Phu Cat on 30 March, and from Bien Hoa on 1 April 1972. The entire 1,361,826 gallons was moved on one ship, the SS Transpacific. The ship arrived at Johnston Island on 18 April 1972 and took 10 days to unload. Unloading was accomplished without incident and completed on 28 April 1972. The movement of herbicide Orange only changed its physical location because PACAF retained control and accountability. The Orange will remain at Johnston Island until the best method for disposal has been determined. 30

The inventory of herbicides and residual ingredients in gallons during FY71 is shown below:

INVENTORY* BY TYPE AND LOCATION 33
PRIOR TO ANY DISPERSAL ACTION

<u>Location</u>	<u>Orange</u>	<u>Blue</u>	<u>White</u>	<u>2,4D</u>	<u>2,4,5T</u>
Gulfport Mississippi	831,975	-----	-----	-----	-----
Johnston Island	1,361,826	-----	-----	-----	-----
Eglin AFB, Florida	14,025	3,520	-----	-----	-----
Kelly AFB, Texas	-----	173,910	-----	106,260	38,940
SEA	-----	285,753	131,311	-----	-----
Total	2,207,826	463,183	131,311	106,260	38,940

*In Gallons

Dispersal of Herbicides and Residuals

SAAMA requested permission from higher headquarters to sell herbicides to interested concerns; however, permission was denied.

The Director, Plant Sciences Laboratory, Ft Detrick, Maryland, suggested the possibility of transferring herbicides to the US Agency for International Development (AID) for use in vegetable control in the underdeveloped nations. This presented interesting possibilities for range improvement, to increase beef production in South America and for aquatic weed control in the rivers of Africa, which seriously hampered navigation in affected rivers. The plan was never developed because contract terminations on Orange procurement did not permit the large surplus to become a reality. 34

Possible domestic and other possible uses for the Orange was considered. Various companies, universities and Air Force laboratories requested samples to analyze ways to neutralize Orange for domestic and commercial use.

The samples were also used in testing methods of disposing of Orange to determine the exact parameters which would permit the destruction without contributing to environmental pollution and for pilot test burn. With higher headquarters approval, Orange was shipped from CBC, Gulfport facility. Among these activities receiving the product were Dow Chemical Company, Chemical Pollution Services, Inc., Kansas State Agricultural Experimental Station, University of California, Mississippi State University, and USAF Environmental Health Lab at Kelly AFB, Texas. 35

Approximately 100 drums were supplied for testing.

Because of the restrictions on the use of Orange, the Commander Eglin AFB wanted to have it removed from the base. 36 It was later transferred overland to CBC by truck. The Blue herbicide at Eglin was also transferred overland by truck, but to Kelly AFB TX.

Kelly dispersed all Blue in storage to requesting government agencies to be used around bases. The 2,4D and 2,4,5T residual ingredients were distributed to various US Department of Agriculture (USDA) stations, Bureau of Indian Affairs in New Mexico, and Colorado, Federal Aeronautical Administration, Naval Air Stations, National Aeronautic Space Administration in Alabama, City of Galveston, Health, Education and Welfare activities in Des Moines, Oklahoma City and San Antonio and other organizations. 36 A list "Activities and Quantities to which Herbicide Transferred" prepared by Mr. Jack Burton/SA/ALC/SFRR, is attached for information. None of the residuals remained in storage.

The Blue and White in storage in Southeast Asia was given to the Vietnamese.

Disposal Proposals

One of SA/ALC's main efforts in managing the herbicide program is directed towards providing technical support to determine the best method for disposing of the herbicide Orange still on hand at Gulfport, Mississippi and Johnston Island.

Proposed methods which were considered are contained in the Final Environmental Statement, November 1974, prepared jointly by the Kelly AFB Environmental Health Lab and SF. These proposals are:

INCINERATION AT SEA OR ON JOHNSTON ISLAND: It is proposed destruction be accomplished by incineration on a ship at sea. The Environmental Protection Agency must first issue a permit IAW the Marine Protection, Research and Sanctuaries Act of 1972. If this is not approved, then AF will pursue the principal alternative of incineration in a facility on Johnston Island. The potential impact on the delicate ecosystem of Johnston Atoll and lengthy project duration (approximately 200 burn days) make this alternative less desirable than the proposed action, which requires approximately 90 burn days. This will encompass one shipload from Gulfport and two from Johnston Island.

ALTERNATIVES CONSIDERED - INCINERATION IN THE CONUS:

Conventional type incineration systems using a "flame" concept of combustion were discussed. Although these systems can handle waste volumes from 1,000 to 10,000 pounds per hour, the size of the units and type of construction are not conducive to transportation and construction on a portable or semi-permanent basis. Also discussed were incineration systems such as located at the US Army Rocky Mountain Arsenal (RMA), Colorado. (RMA facility itself was not reviewed by US Army, nor has any action been taken to contract the RMA for Orange incinerations.) Although it appears to be capable of

incinerating the Orange in an environmentally safe manner, its waste feed rate is only two gallons per minute. It would take approximately 27 months to destroy the Orange. Also similar units are located near centers of population and industry, where local and state governments would be opposed to this alternative.

USE ON RANCLANDS AND REFORESTRATION: It was proposed that a portion of Orange stock be EPA registered and used to control undesirable weed and brush species. Presently 100,000 acres are being treated each year. A 5-year field study showed that there are no significant permanent effects on soil and vegetation attributed to exposure to herbicides.

RETURN TO MANUFACTURERS: Manufacturers of herbicide were contacted regarding the possibility of chemically reprocessing Orange herbicide whereby all impurities would be extracted. None felt capable of reprocessing the product; extensive investment in equipment and new processes would be required.

DEEP WELL INJECTION: This involves injection of the herbicide into a deep sub-surface formation through a casing cemented into place. A packer tool prevents fluid from returning to the surface. This process has not been approved by state agencies or EPA and is not considered environmentally safe.

BURIAL IN UNDERGROUND NUCLEAR TEST CAVITIES: The Atomic Energy Commission advised that a major research, development and experimentation effort would be required to prove this method

practical. In view of the time required for this effort, it is not considered feasible.

SLUDGE BURIAL: This process involves destroying Orange through bacterial action. It was proposed that trenches be dug on isolated government land. The drums would then be placed in the trenches and then surrounded by secondary sewage plant sludge, which would provide a growth medium for the bacteria. A controlled release of Orange would be allowed through the tops of the drums. The process is not considered acceptable because it would require possibly as long as 10 to 25 years to completely destroy the herbicide.

MICROBIAL REDUCTION: This involves the biological degradation of the herbicide through fermentation, using a microorganism to "feed" on the herbicide. This is complicated by the fact that Orange is insoluble in water and by its chemical structure, thus making it less available for microbial degradation. The environmental aspects cannot be evaluated until more data is developed.

FRACTIONATION: This process converts Orange into its acid ingredients by means of distillation. It separates its components 2,4-D, 2,4,5-T and its contaminant dioxin (TCDD). TCDD would then be destroyed. Fractionation is not acceptable because the fate of the dioxin was not demonstrated, 3% of the Orange could not be accounted for, and standards to control emissions into the environment have not been identified.

CHLORINOLYSIS: This process breaks down the molecule and adds a chlorine molecule to produce carbon tetrachloride, phosgene, and anhydrous hydrogen chloride, all of which have established commercial value. This method of disposing of Orange was evaluated over a period of two years. About 170 million pounds of chlorine would be required and a plant to house quartz lined reactors of the size needed would have to be designed and constructed. Owing to the uncertainties associated with developing this technique to a full scale plant capable of processing 2.2 million gallons of Orange, chlorinolysis was not selected as the method of disposal even though it is satisfactory from an environmental point of view.

SOIL BIODEGRADATION: This process is a soil incorporation technique based on the premise that high concentrations of Orange and dioxin will be degraded to innocuous products by the combined action of soil microorganisms and soil chemical hydrolysis. The most significant impact would be the denial of a 1,000-2,000 acre tract of land for reclamation or recreation use for a 3-5 year period during biodegradation.

³⁷
The summary statement of the total impact is quoted:

"The environmental impact is discussed in the following paragraphs for the proposed action of incineration at sea and the principal alternative of incineration on Johnston Island. In either case the incineration operation will destroy 99.9 to 99.999 percent of the herbicide. These efficiencies will insure that any unburned or pyrolyzates of herbicide and its TCDD content will not have any significant impact upon the environment. Since the herbicide will be essentially destroyed, the environmental impact of the following major combustion products have been considered: water, heat, carbon dioxide, carbon monoxide,

carbon particulates, and hydrogen chloride. These combustion products will be discharged directly into the atmosphere toward the west of Johnston Island over the open tropical ocean. Incineration in either case can be accomplished with minimal environmental impact which will be transient and not significant. Incineration at sea has an advantage in that the beneficial uses of the environment in which the incineration takes place, i.e., tropical ocean, are limited. Under the principal alternative, incineration on Johnston Island, the beneficial usages of the atoll are more numerous and must receive considerations of potential impact - particularly the drinking water source, reef and aquatic community, and bird refuge."

One of the major problems encountered had been to find a suitable method to destroy Orange with a dioxin content of more than .5 parts per million (PPM) without contributing to environmental pollution.

Dioxin is an impurity contained in 2,4,5T identified as 2,3,6,7 tetrachlorodibenzo-p-dioxin. It appeared to be the ecologist's main concern because tests determined it to cause the teratogenic results equivalent to that attributed to 2,4,5T. Subsequent tests have shown that both the dioxin compound and the 2,4,5T caused teratogenic or fetotoxic results on experimental animals of various species.³⁸ The plan now is to destroy all Orange, regardless of dioxin content.

Joint military/civilian review conducted by Council on Environmental Quality coordinated, approved and accepted the Final Environmental Statement in November 1974.

A request for ocean dumping (incineration term at sea) application was prepared by SA/ALC and forwarded through channels to HQ USAF. HQ USAF forwarded the request to the Environmental Protection Agency, 9 Jan 1975. ³⁹

In February 1975 the Environmental Protection Agency began investigation necessary to grant the AF request for an ocean dumping permit. The law requires that before the permit can be granted, public hearings be held. Hearings began 25 April 1975, ³⁹ and have already been held in San Francisco, Hawaii and Washington, D.C. It is anticipated that two more hearings will be held in Washington, D.C. These should be completed by the end of 1975.

As a matter of information, in July 1974, Ocean Combustion Service BV of Rotterdam, owner of the M.V. Vulcanus, began readying the ship to meet US Coast Guard specifications. The modifications were necessary to load and transport in US waters the Air Force cargo of Orange and the chlorinated hydrocarbons for incineration. ⁴⁰ Modifications have been completed.

The estimated cost of the use of the incineration ship to destroy 2.2 million gallons of Orange herbicide is approximately \$1,500,000.00.

Current Herbicide Picture

The following quantity of Orange herbicide remains in storage awaiting destruction:

HERBICIDE INVENTORY
As of 1 July 1975

<u>LOCATION</u>	<u>ORANGE*</u>	<u>APPROXIMATE COST**</u>
Gulfport MS	847,385	6,135,067.40
Johnston Island	1,355,860	9,816,426.40
	2,203,245	15,951,493.80

* In gallons

** The current market value is three times this amount.

The table on page 43 shows that prior to dispersal action Gulfport had 831,975 gallons on hand. About 100 drums, 5,500 gallons, were dispersed for testing. Gallons of Orange acquired from Eglin were 14,025,255 drums. Calculations should reflect 840,500 gallons (minus a minimal amount for seepage and redrumming) at Gulfport. However, the 1 July 1975 inventory report shows 847,385 gallons, 15,407 drums on hand. This represents a difference of approximately 125 drums. This overage can only be accounted for by failure to fill drums to capacity when redrumming and/or an incorrect inventory.

Mr. Sam Heaton, HQ AFLC/DSTMT, advised Lt Col Dorothy Craig by telephone on 28 Jul 1975, that the on hand quantity at Johnston Island is 24,652 drums, 1,355,860 gallons, as of 26 June 1975. In comparison with the table on page 43, this shows a loss of 5,966 gallons, approximately 108 drums. The difference represents a loss of .018 gallons through seepage and redrumming, which is a continual process.

Until all Orange is destroyed, the herbicide storage problem will be an expensive one to the Air Force.

1 Atch
Dispersal of Residual Ingredients

KELLY AFB TX
 (DISPERSAL OF RESIDUAL INGREDIENTS)
 ACTIVITIES AND QUANTITIES TO WHICH HERBICIDE TRANSFERRED

MONITE 2,4D - 55 Gal Drum

Quantity	Agency
10	NAS Corpus Christi TX
3	NAS Gaines GA
2	NAS Kingsville TX
10	USDA Clay Center NE
1	USDA Tombstone AZ
8	USDA Temple TX
4	USDA Mission TX
33	US Field Sta, Woodward OK
4	Fed Re. Laboratory, El Reno OK
20	Bureau of Reclamation, McCook NE
3	Bureau of Indian Affairs CO
50	Bureau of Indian Affairs CO
15	Bureau of Indian Affairs NM
2	Bureau of Indian Affairs NM
2	NASA Huntsville AL
6	FVA, Tonawanda NJ
6	Nason Hanger, Amarillo TX
10	NAS Kingsville TX
10	ZIA Co, Los Alamos NM
1	Naval Comm Sta MA
3	Naval Research Lab MA
20	Bureau of Indian Affairs, Sisseton SD
6	USDA Bushland TX
24	Nason Hanger, Amarillo TX
200	Surplus Prop Agency, Baton Rouge LA
24	US Dept of Agriculture, Gulfport MS
60	Texas Surp Prop Agency, San Antonio TX
82	US Coast Guard
50	Oklahoma State Surp Prop, Oklahoma City
50	Alabama HEW, Gadsden AL
60	Texas Surp Prop, San Antonio TX
55	Iowa DHEW, Des Moines IA
15	Miss SASP, New Brighton Minn
60	Fed Surp Prop, Lansing MI
150	Fed Ext Ser, Texas A&M
200	Mississippi Surp Prop, Jackson MS
60	Louisiana Surp Prop, Baton Rouge LA
513	Louisiana Surp Prop, Baton Rouge LA
40	West Virginia HEW, Dunbar WV
50	Oklahoma State HEW, Oklahoma City
73	Oklahoma State HEW, Oklahoma City
10	Texas HEW, San Antonio TX

2,4,5T - 55 Gal. Drum

Quantity	Agency
55	H&B AFB UT
10	NAS Corpus Christi TX
3	NAS Glyco GA
1	USDA Tombstone AZ
1	USDA Mission TX
16	Red Reformatory, El Reno OK
25	USDA Stillwater OK
10	USDA Stillwater OK
11	US Forest Svc Etowah TN
2	NASA Huntsville AL
10	NAS Kingsville TX
75	City of Galveston TX
400	Texas A&M University
20	City of Galveston TX
50	La Surp Prop Agency
20	City of Galveston TX

55
10
3
1
1
16
25
10
11
2
10
75
400
20
50
20

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