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Seven tests were also conducted at Refugio, Victoria, Carlos, and Livingston from October 3, 1963 through June 15, 1966 with similar herbicides and rates. Twelve scientists with the Agricultural Research Service were responsibly for designing, conducting, and evaluating the research plots. Additional personnel from the Agricultural Research Service provided the support for the treatments and mixing of the herbicides. The two tactical herbicides, Herbicide Orange and Herbicide White (picloram-2,4-D), were provided by Fort Detrick, Frederick, Maryland.

Sources: [redacted] 1964): Proceedings of the First Defoliation Conference, 29-30 July 1963. United States Army Chemical Corps' Biological Laboratories, Fort Detrick, Frederick, Maryland. *Document is unclassified but subject to export control. Available from the Defense Documentation Center, Accession Number AD0427874.*

[redacted] 965): Proceedings of the Second Defoliation Conference, 5-6 August 1964. United States Army Chemical Corps' Biological Laboratories, Fort Detrick, Frederick, Maryland. *Document is unclassified but subject to export control. Available from the Defense Documentation Center, Accession Number AD0329567.*

[redacted] 1966): Proceedings of the Third Defoliation Conference, 10-11 August 1965. United States Army Chemical Corps' Biological Laboratories, Fort Detrick, Maryland. *Document is unclassified but subject to export control. Available from the Defense Documentation Center, Accession Number AD898001.*

[redacted] 1968): Herbicide Combinations for Woody Plant Control. *Weed Science* 16 (3): 332-335.

[redacted] 968): Research Report...Response of Tropical and Subtropical Woody Plants to Chemical Treatments. Report Number CR-13-67. Agricultural Research Service, US Department of Agriculture Under ARPA Order No. 424, Advanced Research Projects Agency, US Department of Defense.

[redacted] 1971): Effects of Aerially-Applied Herbicides on Texas and Puerto Rico Forests. *Weed Science* 18 (1): 164-168.

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DOD TACTICAL HERBICIDE SITES

Site 20

Location: Seven Locations in Puerto Rico, including Mayaguez, Maricao, Guajataca, Guanica, Toro Negro, El Verde, and Jimenez

Date → June 1963 – October 1967

Activity Description: The importance of obscuring vegetation is particularly important in tropical areas. The Luquillo National Forest of Northeastern Puerto Rico resembled the evergreen forests of Southeast Asia. Precipitation is high and the constant high humidity and abundant soil moisture contribute to the development of lush plant growth. Numerous short trees, slender vines, and stout lianes obstruct horizontal visibility. Heavy foliage in the contiguous crowns of top story hampers vertical visibility. Vegetation in swamps or marshlands is a characteristic feature that was similar in Puerto Rico and Southeast Asia. Another feature of the vegetation in Puerto Rico and Southeast Asia was the contrast between lowland and mountain flora. The Department of Army personnel at Fort Detrick, Frederick, Maryland recognized that defoliation of such tropical vegetation similar to that found in Southeast Asia would reduce the amount of obscuring vegetation. Thus, in Southeast Asia the possibility of ambush would be reduced, and the movement of enemy equipment and personnel could be more easily observed. It was concluded that research on tactical and commercial herbicides in Puerto Rico would contribute to the understanding and use of such herbicides in Southeast Asia.

The research in Puerto Rico on the use of tactical and commercial herbicides was sponsored the Advanced Research Projects Agency (ARPA), Department of Defense. Reports of the research were reported at all three of the Defoliation Conferences (1963, 1964, and 1965). Personnel of the Agricultural Research Service, United States Department of Agriculture, were responsible for the conduct of the research. The objectives of the research in Puerto Rico were to "conduct advanced evaluation of promising herbicides for tropical and subtropical killing vegetation; and, determine optimum times and rates of application, distribution parameters, formulations and mixtures for most effective use of herbicides."

The treatments and studies in Puerto Rico were conducted at seven locations providing a wide spectrum of vegetative and environmental variability. The site at Mayaguez represented a moist coastal forest habitat; the site at Maricao was in the Lower Cordillea Forest habitat; the Guajataca site was located in a most limestone forest habitat; the Guanica site was on the southern, dry side of Puerto Rico and excluded many of the tree

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species found on the north side of Puerto Rico; the Toro Negro site was located in the Upper Cordillera Forest and was characterized by lower temperatures and higher rainfall than the Lower Cordillera Forests; the El Verde and Jimenez sites were in the Luquillo National Forests in areas that represented the best developed forests in Puerto Rico. The lands were the sites were located were provided by either private individuals, companies, the Federal Experiment Station in Puerto Rico, or the Commonwealth Division of Forestry of the Commonwealth of Puerto Rico.

Assessment: Herbicides treatments were made by two different methods. Ground applications were made with a telescoping pole sprayer designed to cover a 40-foot diameter circle. The sprayer was calibrated to spray 10 gallons of liquid per acre. Aerial applications were accomplished with a Hughes 300 helicopter delivering 1.5 or 3.0 gallons per acre in a 35-foot swath at 45 miles per hour. All applications were made near tree-top level. The herbicides applied in the various Puerto Rico sites included the isooctyl esters of picloram (Fort Detrick formulation M-3142); a 2:2:1 mixture of the isooctyl esters of 2,4-D:2,4,5-T:picloram (Fort Detrick formulation M-3140); a 4:1 mixture of 2,4,5-T:picloram (Fort Detrick formulation M-2993); and the tactical herbicides Orange, Purple, and White. In addition to Herbicide Blue, three other contact herbicides were evaluated, monosodium methanearsonate (MSMA), paraquat, and diquat. The rates varied from 3 lbs/A (White), to 6 lbs/A (Blue), and up to 24 lbs/A (Orange).

A randomized block design with one or two replications was used in each test site. Land availability, topography, number of treatments, and application equipment determined the number of replications and plot size. For aerial applications, two replications of 1-acre plots (175 by 249 feet) were treated with a helicopter calibrated for delivering 10 gallons of liquid per acre; thus rate calculations were based upon that volume. Ester formulations were sprayed in diesel oil, while amine and sodium salt formulations were sprayed in water.

Twelve scientists with the Agricultural Research Service were responsibly for designing, conducting, and evaluating the research plots. Additional personnel from the Agricultural Research Service provided the support for the treatments and mixing of the herbicides. The three tactical herbicides, Herbicides Orange, White, and Blue and the proposed candidates M-2993, M-3140, and M-3142 were provided by Fort Detrick, Frederick Maryland.

Sources: [redacted] (1964): Proceedings of the First Defoliation Conference, 29-30 July 1963. United States Army Chemical Corps' Biological Laboratories, Fort Detrick, Frederick, Maryland. *Document is unclassified but subject to export control. Available from the Defense Technical Information Center, Accession Number AD0427874.*

[redacted] 965): Proceedings of the Second Defoliation Conference, 5-6 August 1964. United States Army Chemical Corps' Biological Laboratories, Fort Detrick, Frederick, Maryland. *Document is unclassified but subject to export control. Available from the Defense Documentation Center, Accession Number AD0329567.*

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[redacted]1966): Proceedings of the Third Defoliation Conference, 10-11 August 1965. United States Army Chemical Corps' Biological Laboratories, Fort Detrick, Maryland. *Document is unclassified but subject to export control. Available from the Defense Documentation Center, Accession Number AD898001.*

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[redacted]1968): Herbicide Combinations for Woody Plant Control. *Weed Science* 16 (3): 332-335.

b6
[redacted]1968): Research Report...Response of Tropical and Subtropical Woody Plants to Chemical Treatments. Report Number CR-13-67. Agricultural Research Service, US Department of Agriculture Under ARPA Order No. 424, Advanced Research Projects Agency, US Department of Defense.

b6
[redacted]1969): Response of Tropical Vegetation to Herbicides. *Weed Science* 17 (3): 285-290.

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[redacted](1970): Effects of Aerially-Applied Herbicides on Texas and Puerto Rico Forests. *Weed Science* 18 (1): 164-168.

DOD TACTICAL HERBICIDE SITES

Site 21

Location: Fort Gordon, Augusta, Georgia
Fort Chaffee, Fort Smith, Arkansas
Apalachicola National Forest, Sopchoppy, Florida

Date → July 1967 – October 1967

Activity Description: During the period December 1966 to October 1967, the newly named "Plant Science Laboratories" at Fort Detrick initiated a comprehensive short-term project to evaluate desiccants and herbicidal mixtures as rapid-acting defoliants. The objectives of this study were to evaluate rapid-acting desiccants as defoliants and to assess the defoliation response of woody vegetation to mixtures of herbicides and/or desiccants. The criteria for assessment was based principally on rapidity of action, but included other features such as safety and ease of handling, compatibility with dissemination systems, and low toxicity to man and wildlife.

The approach to the objective of an improved rapid-acting defoliant involved three phases: (1) evaluation of commercially available rapid desiccants or contact herbicides; (2) evaluation of improved formulations of rapid desiccants developed under industry contacts and by in-house effort; (3) development and evaluation of desiccant-herbicide mixtures containing the rapid defoliant characteristics with the sustained long-term effects of Orange and other Tactical Herbicides. The project required an immediate access to a diversity of woody vegetation. Accordingly, Fort Detrick arranged for test locations at Fort Gordon near Augusta, Georgia; Fort Chaffee near Fort Smith, Arkansas, and Apalachicola National Forest near Sopchoppy, Florida.

The Georgia site was described as a warm temperate, humid, moderate rainfall climate with deep, well-drained sands in rolling topography. The vegetation type was an oak-hickory-pine forest. The Arkansas site was described as a temperate continental, moderate rainfall climate with fine sandy loam soils in rolling topography. The vegetation type was an oak-hickory forest. The Apalachicola National Forest site was described as a subtropical, humid, moderate precipitation climate with sandy soils in a flat poorly drained topography. The vegetation type was described as a Southern mixed forest. All sites were selected because of their isolation from any local human populations, e.g., in Florida, the site was a ridge located in a swamp forest.

Assessment: The desiccants selected for evaluation included Herbicide Blue (a tactical herbicide), and the commercial desiccants diquat, paraquat, dinitrobutylphenol

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(DNBP), pentachlorophenol (PCP), hexachloroacetone (HCA), and monosodium methanearsonate (MSMA), pentachloro-pentenoic acid (AP-20), endothall, and various mixed formulations of these desiccants. The systemic herbicides included the two tactical herbicides Orange and White; the potassium salt, triisopropanolamine salts, and the isooctyl ester of picloram; and, a ethylhexyl ester of 2,4,5-T mixed with HCA. Mixtures of propanil, nitrophenol, linuron, and silvex were also evaluated. All chemicals were furnished by Fort Detrick.

Aerial application at these three sites were made with a Bell G-2 helicopter equipped with two 40-gallon tanks and a 26-foot boom with 6-inch nozzle positions adaptable for volume deliveries of 3, 6, or 10 gallons per acre in a 50-foot swath. Spray equipment, pilot, and support were furnished under contract with Allied Helicopter Service of Tulsa, Oklahoma. Aerial applications were made on duplicate 3-acre plots, 200 by 660 feet in dimension. A sampling and evaluation trail was established in each plot on a diagonal beginning at 100 feet from one corner. Major species were marked along 500 feet of this transect and individual plants were identified by combinations of colored plastic ribbons. A minimum of 10 individuals of each species was marked unless fewer were present. Evaluations were made at 1-, 5-, 10-, 30-, and 60-day intervals by experienced Fort Detrick personnel. At each evaluation period the identical marked individuals of the major species were rated for defoliation and desiccation. At each location, approximately 475 gallons (~10 drums) of Herbicide Blue, 95 gallons (~2 drums) of Herbicide Orange, and 6 gallons of Herbicide White were expended.

The assistance of Department of Army forestry personnel at Fort Gordon, Fort Chaffee, and the 3rd and 4th Army Headquarters were acknowledged in the report for their support in the selection and preparation of sites in Georgia and Arkansas. The land and facilities for the Florida tests were provided by the Supervisor, Apalachicola National Forest, Tallahassee, Florida. Personnel from the Physical Sciences Division, Fort Detrick assisted in the development of formulations and preparations of field test mixtures. They also provided the data on the physical characteristics of the candidate tactical defoliants and mixtures.

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Sources: [redacted]): Field Evaluation of Desiccants and Herbicide Mixtures as Rapid Defoliants. Technical Report 114, Plant Sciences Laboratories, Fort Detrick, Frederick, Maryland. *Document unclassified but subject to special export control. Available from the Defense Documentation Center, Accession Number AD 880685.*

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DOD TACTICAL HERBICIDE SITES

Site 22

Location: Adjacent to the Demilitarized Zone, Korea

Date → 20 March 1968 – 1 July 1968

Activity Description: In early 1967, as part of a general review of the Demilitarized Zone (DMZ) defenses, the United Nations Command (UNC) and the United States Forces Korea (USFK) found that dense vegetation within the DMZ and contiguous areas provided cover for North Korean infiltration or raiding parties. The vegetation in these areas had grown unencumbered since the Armistice and was an important part of the DMZ defensive problem. In March 1967, representatives of the Plant Sciences Laboratory, US Army Biological Laboratories, Fort Detrick, Maryland visited Korea and inspected typical vegetation growth in selected areas contiguous to the DMZ. Based upon this evaluation, the Plant Sciences Laboratory recommended the use of tactical herbicides, specifically Herbicides Orange and Blue, and a commercially available soil applied herbicide (Monuron UROX 22) to control general and specific vegetation growth adjacent to the DMZ.

The decision to use tactical herbicides required obtaining approval of the United States Department of State. Numerous messages were dispatched during the period May through September 1967. In early September, the US Secretary of State authorized discussion of the program with the Republic of Korea (ROK) Government. These discussions provided the acceptance of the program by the ROK Prime Minister and on 20 September 1967 both governments (ROK and US) granted permission for the use of the tactical herbicides to be sprayed in the area between the DMZ South tape and the Civilian Control Line.

Following a series of planning conferences a comprehensive vegetation control program was developed. On 4 March 1968, the Commander, US Forces in Korea (COMUKOREA) was authorized to deploy tactical herbicides as part of the vegetation control program in Korea. To preclude the possibility of unfavorable propaganda and to ensure that defoliants would be properly employed with a margin of safety, the following constraints were placed upon the vegetation control program: (a) Defoliants were not be employed North of the Southern boundary of the DMZ; (b) During application, care was to be taken to ensure that there was neither run-off nor spray drift into areas North of the Southern boundary of the DMZ; (c) Defoliants would not be applied during precipitation or when rain was expected within 12 hours after application; (d) Extreme caution was to be exercised to avoid damage to food crops; (e) Defoliants would note be dispensed from aircraft of any kind; and (f) a Korean Military Assistance Group (KMAG) Representative

(a Chemical Corps Officer assigned to this subordinate element of the Eighth US Army) would be physically present whenever defoliants were deployed. By 20 March 1968, the first herbicide (Monuron) and equipment arrived in country. On 31 March, implementation of the Vegetation Control Program CY 68 (for Calendar Year 1968) was ordered to begin on or about 15 April 1968. On 10 April 1968 supplies of Herbicides Orange and Blue were on-hand in forward locations near the DMZ.

Assessment: Soldiers from the First Republic of Korea Army (FROKA) were assigned the task of applying the herbicides. Monuron UROX 22 was spread by hand or mechanical broadcast beginning on 15 April 1968 and through 28 April 1968. The usual technique involved dividing a selected area into several lanes and each soldier walked along his assigned lane spreading the Monuron pellets along an area of 5 meters on each side of his marked lane. Supplies of Monuron were spotted throughout the area to facilitate individual re-supply along assigned lanes. In this manner, approximately 7,800 drums (397,800 pounds) of palletized herbicide were applied on 1,560 acres or at a rate of 255 lbs/A.

Applications of the tactical herbicides Orange and Blue began on 15 May 1968 upon the emergence of foliage, and terminated on 15 July 1968, The Orange herbicide was mixed with diesel oil at a ratio of 3 gallons of Orange to 50 gallons of diesel. Since many application areas selected for spraying with Orange were relatively inaccessible for use of the modified M8A2 Decontamination Trailer, 22 liquid defoliant spray sets were employed. These units were insecticide sprayers commonly used in Engineer Entomological Services and consisted of a portable lightweight hypro-type pump with a standard gasoline engine. The Republic of Korea Army (ROKA) also had available ten M106 "Mitey Mite" dispensers that were used to supplement liquid spray capabilities. The M106 was a commercial, backpack sprayer that consisted of a compact two-cycle gasoline engine that dispersed the herbicide through a 6-foot hose. The tank contained 3 gallons of liquid. The modified M8A2 Decontamination Trailers were used for spraying both Orange and Blue. The unit consisted of a 200 gallon capacity tank and a 25 HP GED pump mounted on a 1 ½ ton trailer. A single hose reel allowed the operator to move approximately 50 feet from the trailer and direct a liquid spray through the adjustable Beam type spray gun at a rate of 20 gallons per minute.

Approximately 380 drums of Orange (20,900 gallons) were applied on 6,966 acres (3 gallons/acre). Herbicide Blue was applied as a liquid spray mixed with water at a ratio of 3 gallons of Blue to 50 gallons of water for application on one acre. Approximately 625 drums of Blue (34,375 gallons) were applied on 11,458 acres (3 gallons/acre). As noted, all applications were done by ground-based spray systems. The use of masks and handling precautions were mandatory. The report noted that 3,345 FROKA soldiers were involved in the actual spray operations. No US military personnel were used to spray the tactical herbicides, or were involved in any of the spray operations, e.g., mixing of the herbicides and diluents. US military personnel (Chemical Corps Officers) were used to monitor and report on the activities of the ROKA Forces.

Sources: [redacted] anuary 1969): Final Report, Vegetation Control Plan CY 68. United States Army Advisory Group, Korea, APO San Francisco 96302. *Document 203-C69, Declassified from Confidential, source or date not legible.*

[redacted] 04): Korea DMZ Vets & Agent Orange. VFW Magazine, January 2004, page 44.

Additional Comment: The Sypko article noted that Agent Orange was used from April 1968 through July 1969. The Buckner Report confirmed only that Orange and Blue were used from 15 May through 15 July 1968 (three months). There was no record found of the use of Orange or Blue Herbicides being applied in CY 1969. The Sypko article confirmed correctly that **all of the defoliants were applied by South Korean Troops**. The Buckner Report noted that all ROKA personnel who participated in the project were well trained, prepared, and that the operation was adequately organized and followed the planned schedule in an orderly manner.

DOD TACTICAL HERBICIDE SITES

Site 23

Location: The Outport, Gulfport, Mississippi

Date → 17 August – 7 November 1969

Activity Description: In August 1966, the United States Department of the Air Force consolidated the responsibility for the management of all tactical herbicides (used in Vietnam) under the Directorate of Air Force Aerospace Fuels, San Antonio Air Materiel Area (SAAMA), San Antonio, Texas. One action that resulted from this consolidation was the selection of the Port of Mobile, Mobile, Alabama for the port of embarkation of all tactical herbicides procured and shipped to Vietnam. Thus, all of the producers of Herbicide Orange, Herbicide White, and Herbicide Blue were instructed by the Defense Supply Agency (the procuring agency) to ship the tactical herbicides in 55-gallon drums and by rail to the Port of Mobile. As the tactical herbicide inventory began to build up in Vietnam (primarily at the Air Bases at Bien Hoa and Da Nang) in 1968, SAAMA temporarily discontinued shipment from the Port of Mobile in order "to avoid exposing large quantities of herbicides to possible damage by enemy action." Since the Port of Mobile was routinely used as the port of embarkation, SAAMA arranged for the tactical herbicides to be temporarily placed in storage at the Port. However, it was recognized that additional temporary shortage would be needed.

On 26 June 1968, SAAMA negotiated with the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi to receive and store additional drums of tactical herbicides, Moreover, the NCBC outside storage area was about two miles from the Gulfport Outport Docks. By December 1968, 66,700 drums had been moved to NCBC. Over the next eight months (in 1969) drums were again being shipped to Vietnam out of both the Outport at Gulfport and from the Port of Mobile. On 17 August 1969, Hurricane "Camille" hit the Gulfport, Mississippi area with winds in excess of 200 miles per hour. There were 17 railroad cars on the Gulfport Docks containing 1,700 drums of herbicide that were withdrawn to NCBC area before the storm hit. However, there were 1,466 drums of Orange and Blue in the berthing area awaiting loading and shipment to Vietnam. These drums were scattered throughout the port area and into the water by the hurricane.

Assessment: Of the 1,466 drums, 412 were recovered and shipped to Vietnam. The remainder were dredged from the Gulf by the personnel of the Army Corps of Engineers and piled in the Commercial Port Area at Gulfport. On 2 October 1969, the Air Force Logistics Command directed the Eastern Area Military Traffic Management and

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Terminal Services to furnish labor, hoses, and heavy equipment for the redrumming of the remaining inventory. SAAMA furnished new drums, marking and shipping instructions. The Army Corps of Engineers (Gulf Detachment) disposed of the contaminated soil and empty damaged drums.

The redrumming operations were completed on 7 November 1969. Contaminated soil and the damaged drums that had been flattened were hauled to a Hurricane Camille "dumping area" where they were plowed underground. Salvaged drums were placed on pallets and delivered to the Gulfport Docks for loading and shipment to Vietnam. After the completion of the operation, Port Officials and Air Force Logistic Command personnel determined that 171 drums of Herbicide Blue and 74 drums of Herbicide Orange/Orange II were missing from the inventory and despite recovery efforts, they were never found. The issue of these "lost drums" was the subject of a Freedom of Information Request to the Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio, and a subsequent newspaper article in The Sun/The Daily Herald, Biloxi, Mississippi, 11 March 1985.

Sources: b6 [redacted] 1975): Use of Herbicides in Southeast Asia. A History Prepared for the Directorate of Energy Management, San Antonio Air Logistics Center, Kelly Air Force Base, Texas.

b6 [redacted] 1980): The Disposal of Herbicide Orange, 1971-1979. Office of History, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

b6 [redacted] 1985): Freedom of Information Act, Case 85-325. Headquarters United States Air Force, Department of the Air Force, Washington, DC. (dated 9 April 1985)

DOD TACTICAL HERBICIDE SITES

Site 24

Location: Soil Biodegradation Studies of Herbicide Orange, in Five Locations- Florida, Kansas, Utah, Oregon, and Washington

Date → April 1972 – March 1979

Activity Description: One method selected for the potential disposal of the surplus 2.3 million gallons of Herbicide Orange remaining after the Vietnam War was subsurface injection or soil incorporation of the herbicide at massive concentrations. The premise for such studies was that high concentrations of the herbicides and TCDD would be degraded to innocuous products by the combined action of soil microorganism and soil hydrolysis. In order to field test this concept, biodegradation plots were established in five climatically and environmentally different areas of the United States: Northwest Florida at Eglin Air Force Base (AFB); Western Kansas at the Kansas State University Experimental Station, Garden City; Northwestern Utah on the Air Force Logistics Command (AFLC) Test Range Complex near the Dugway Proving Grounds; A Pesticide Waste Disposal Site established by the Department of Entomology, Oregon State University in Eastern Oregon; and the Agronomy Farm, Washington State University, Pullman, Washington. The project was initiated in April 1972. Drums of Herbicide Orange were available at Eglin AFB for the plots established on Test Area C-52A of the Eglin Reservation. However for the other locations drums of Herbicide Orange were shipped from the Naval Construction Battalion Center, Gulfport, Mississippi to Garden City, Kansas (one 55-gallon drum), Dugway Proving Ground, Utah (two 55-gallon drums), Department of Entomology, Oregon State University (one 55-gallon drum), and Department of Agronomy and Soils, Washington State University (one 55-gallon drum).

Assessment: The amount of Herbicide Orange incorporated into field plots varied by location. On Test Area C-52A, Eglin AFB, Florida, the herbicide was placed (simulated subsurface injection) in 5 replicated 10 x 10-foot plots, 6 inches below the soil surface at concentrations of 4,000 pounds per acre (initial concentration in 6-inch profile was 5,000 parts-per-million). The 10 plots were periodically samples over a period of six years (Apirl 1972 – April 1978). At the Garden City Kansas Experiment Station, Herbicide Orange was pre-plant incorporated into one-acre plots via a rototiller at concentrations of 2,000 and 4,000 pounds per acre. The site was sampled and monitored for three years (June 1972 – June 1975). At the AFLC Test Range Complex, Herbicide Orange was placed (simulated subsurface injection) into replicated 10 x 15-foot plots, 6 inches below the soil surface at concentrations of 1,000, 2,000 and 4,000 pounds per acre. The site was

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sampled and monitored for six years (May 1972 – May 1977). At the Pesticide Waste Disposal Site in Eastern Oregon, herbicide was subsurface injected at 1,000 pounds per area (on one acre). At the Agronomy Farm at Washington State University, Herbicide Orange was incorporated into 42 field lysimeters at concentrations of either 1,000 or 5,000 pounds per acre. The lysimeters were established in December 1976 and were terminated in March 1979.

At Eglin AFB, Florida, 2 civilians and 2 military officers were involved in the treatment and monitoring of the plots. At Garden City Kansas, one civilian with the Kansas State Experiment Station was involved in the sampling and monitoring of the plots. At the AFLC Test Range, 2 military officers were involved in the sampling and monitoring of the plots. At the Pesticide Waste Disposal site in Eastern Oregon, personnel from the Department of Entomology were involved in sampling and monitoring. At Washington State University, the research was the focus of a Ph.D. Thesis, and thus a graduate student and his Major Professor were involved in the project.

The United States Air Force Scientific Advisory Board's Ad Hoc Committee for the Disposal of Herbicide Orange felt that this method was promising, but that more data and evidence were needed to ensure environmental safety. Moreover, the permission to use Federal lands for this disposal option would require not only an appropriate Environmental Impact Statement, but also the approval of State and Federal Authorities, with likely many legal challenges.

Sources:

b6 [redacted] (1976): Fate of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in the Environment. Summary and Decontamination Recommendations. Technical Report USAFA-TR-76-18, Department of Chemistry and Biological Sciences, United States Air Force Academy, Colorado.

b6 [redacted] (1975): Soil Incorporation/Biodegradation of Herbicide Orange. Volume I. Microbial and Baseline Ecological Study of the US Air Force Logistics Command Test Range, Hill AFB, Utah. Document No. DPG-FR-C615, US Army Dugway Proving Ground, Dugway, Utah. *Unclassified, limited to US Government Agencies only.*

b6 [redacted]: Soil Incorporation/Biodegradation of Herbicide Orange. Volume II. Meteorological and Chemical Studies of a Proposed Test Site on the AFLC Test Range, Hill AFB, Utah. Document No. TECOM-5-CO-213-000-015, US Army Dugway Proving Ground, Dugway, Utah. *Unclassified, limited to US Government Agencies only.*

b6 [redacted] (1973): Waste Pesticide Management. Final Narrative Report. US Environmental Protection Agency Demonstration Grant No. 5-G06-EC-00222, Department of Entomology, Oregon State University, Corvallis, Oregon.

b6 [redacted] (1982): Dissipation of Massive Quantities of 2,4-D and 2,4,5-T n-Butyl Esters in Field Mini-Lysimeters. J Environ Qual 11 (4): 645-649.

b6
[redacted] Mobility of 2,4-D and 2,4,5-T n-Butyl Esters in Soils Following Massive Applications to Field Mini-Lysimeters. J Environ Qual 11 (4): 650-655.

b6
[redacted]989): Final Decision Document for Herbicide Orange Test Area, Utah Test and Training Range, North Range, Utah. US Air Force Installation Restoration Program, Hill Air Force Base, Utah. Prepared Under Interagency Agreement No 40-1760-86 by Science Applications International Corporation, McLean, Virginia. Submitted to US Air Force Logistics Command, Wright-Patterson AFB, Ohio. *Unclassified, available for public distribution.*

DOD TACTICAL HERBICIDE SITES

Site 25

Location: Reformulation of Herbicide Orange for Domestic or Foreign Use, Bound-Brook, New Jersey

Date → April 1972 – January 1973

Activity Description: One method selected for the potential disposal of the surplus 2.3 million gallons of Herbicide Orange remaining after the Vietnam War was the option of donating or selling the herbicide to private industry, or to another United States Government Agency. For example, a significant portion of the total land area of the United States was used for pasture and grazing purposes, and weeds and brush presented a major problem on these lands. Various species of undesirable brush and trees and numerous noxious (foreign) weeds dominated some 320 million acres of US rangeland and pastures, and the application of phenoxy herbicides, such as found in Herbicide Orange, could be an economical method of increasing the quality and grazing capacity of these lands. Moreover, in April 1972 representatives from the Blue Spruce Company, Bound-Brook, New Jersey and from the International Research Institute, a Rockefeller Foundation affiliate, contacted the Air Force Logistics Command proposing to reformulate Herbicide Orange and sell or donate it to a number of South American Governments, including Brazil, Colombia, Venezuela, and Surinam. The basic plan was to have the Air Force donate the herbicide for use to improve rangelands in the upper Amazon Basins of South America. The Herbicide Orange would be reformulated (diluted) and repackaged for ground application under controlled conditions. AFLC advised the Blue Spruce Company that "*it had no objection, but recommended that the proposed governments that would be involved would employ Blue Spruce Company to reformulate and repackage the Herbicide Orange.*" From May 1972 through January 1973, 121 drums (6,655) gallons of Herbicide Orange were shipped to the Blue Spruce Company.

Assessment: As a "Tactical Herbicide", Herbicide Orange was not an EPA (US Environmental Protection Agency) registered pesticide, and as such could not be domestically used or sold. However, the 2.3 million gallons of surplus represented a resource of considerable monetary value. Beginning in May 1972 the Blue Spruce Company experimented on reformulating and diluting the Herbicide Orange. Simultaneously, the Company (with the assistance of the International Research Institute) initiated discussions with the Brazilian Government and with the US EPA. After more than one year negotiating with US and South American Government Agencies, letters of support for the proposal were not forthcoming. Accordingly, after a great deal of

discussion, the United States Air Force Scientific Advisory Board's Ad Hoc Committee on the Disposal of Herbicide Orange rejected this alternative for the following reasons: "*Once sold or donated, the United States could not assure that the herbicide would be handled with the proper technical and environmental controls. In addition, the widespread publicity on the use of the herbicide in Southeast Asia had created an "anti-people" image for the material that would probably result in adverse public opinion and political reactions in the event the herbicide was sold to another country. In view of these considerations, the Board felt that the herbicide's sale or donation to a foreign country would be against the best interests of the United States.*"

No record could be found of how the Blue Spruce Company disposed of the reformulated herbicide. The use of 2,4,5-T herbicide was not formally suspended until 1978.

Sources: Department of the Air Force (1974): Final Environmental Statement on the Disposition of Orange Herbicide by Incineration. November 1974, Department of the Air Force, Washington, DC, *Unclassified, available for public distribution*

Air Force Logistics Command (1976): Historical Records – Project on the Disposition of Herbicide Orange. Office of History, Air Force Logistics Command Archives, Wright-Patterson Air Force Base, Ohio, *Unclassified*

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DOD TACTICAL HERBICIDE SITES

Site 26

Location: Destruction of Herbicide Orange by Chlorinolysis, Painsville, Ohio

Date → September 1972 – July 1974

Activity Description: One method selected for the potential disposal of the surplus 2.3 million gallons of Herbicide Orange remaining after the Vietnam War was the option of chlorinolysis. From the theoretical engineering point of view, chlorinolysis offered an efficient, controlled, and safe method for the disposal of Herbicide Orange. The concept was that the chlorinolysis process would breakdown the molecules of herbicides and add a chlorine molecule to produce carbon tetrachloride, phosgene, and anhydrous hydrogen chloride, each of which had established commercial value. In July 1972, discussions and correspondence with the US Environmental Protection Agency (EPA) committed the Air Force Logistics Command (AFLC) to pursue the testing and research necessary to determine the feasibility of converting Herbicide Orange to salable products by chlorinolysis. In September 1972 a Memorandum of Agreement between the EPA and AFLC was initiated. The objective of the agreement was the development of a laboratory program to evaluate the practicality of the application of chlorinolysis for the disposal of Herbicide Orange. It was agreed that the EPA would manage the research and provide a report containing all data collected, together with conclusions and recommendations. AFLC agreed to fund the research. Three drums (165 gallons) of Herbicide Orange containing 14 ppm TCDD were provided to the Diamond Shamrock Corporation Laboratory in Painsville, Ohio.

Assessment: Chlorinolysis as a means to dispose of Herbicide Orange was evaluated over a period of almost two years. Reports received in early 1973 confirmed that no dioxin was detected (sensitivity level of 10 parts-per-trillion). Moreover, the 2,4-D that was fractionally distilled from Herbicide Orange by the Diamond Shamrock laboratory contained less than 1 part-per-billion dioxin. The material remaining after distillation was predominantly the dioxin-contaminated 2,4,5-T herbicide, which was then subjected to the chlorinolyis process. EPA estimated that to convert 26.5 millions pounds of Herbicide Orange to carbon tetrachloride, phosgene, and hydrogen chloride would require about 170 million pounds of chlorine. To undertake such a large industrial operation, Diamond Shamrock estimated that it would take from 36 to 90 months to build and evaluate a plant large enough to handle the volume of Herbicide Orange available. In the Final EPA Report, the Diamond Shamrock scientists concluded that chlorinolysis could be an effective means of disposing of the surplus Herbicide Orange. Destruction of the dioxin

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(TCDD) was complete, and preliminary toxicology tests of the recovered carbon tetrachloride on rabbits show no evidence of TCDD contamination, i.e., the rabbit ear test for chloracne was negative.

Owing to the uncertainties associated with developing this technique to a full-scale plant capable of safely processing 2.3 million gallons of Herbicide Orange in a timely and economic manner, chlorinolysis was not accepted as the method of disposal even though it was shown to be satisfactory from an environmental point of view. The EPA Final Report did not provide any information on the personnel involved in the laboratory research, nor on the fate of any remaining Herbicide Orange or subsequent products from the chlorinolysis process.

Sources: US Environmental Protection Agency (1974): Study of Feasibility of Herbicide Orange Chlorinolysis. Technical Report EPA-600/2-74-006, July 1974, US Environmental Protection Agency, Washington, DC. *Unclassified, available for public distribution.*

Department of the Air Force (1974): Final Environmental Statement on the Disposition of Orange Herbicide by Incineration. November 1974, Department of the Air Force, Washington, DC. *Unclassified, available for public distribution.*

b([redacted] 80): The Disposal of Herbicide Orange, 1971-1979. Office of History, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

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DOD TACTICAL HERBICIDE SITES

Site 27

Location: Fractionation of Herbicide Orange for Commercial Use, Jacksonville, Arkansas

Date →14 March 1972 – January 1973

Activity Description: One method selected for the potential disposal of the surplus 2.3 million gallons of Herbicide Orange remaining after the Vietnam War was the option of fractionation (chemical distillation). Fractionation was the proposed process of converting Herbicide Orange into its acid ingredients by means of high temperature distillation. The concept was to separate the normal butyl esters of 2,4-D and 2,4,5-T herbicides from the dioxin (TCDD) contaminant. The 2,4-D and 2,4,5-T was then to be reformulated for commercial use. The dioxin (TCDD) would then be destroyed by chemical, biological, or incineration techniques. Actual distillation efficiencies theoretically could approach 90% to 95%. In February 1972, Transvaal, Inc., a chemical company in Jacksonville, Arkansas approached the Air Force Logistic Command (AFLC) with a proposal to dispose of Herbicide Orange through a process of fractional distillation. On 3 March 1972, a team of Bio-environmental Engineers from the AFLC's United States Air Force Environmental Health Laboratory, Kelly Air Force Base, Texas visited the Transvaal Facilities in Jacksonville, Arkansas. On 14 March 1972, AFLC shipped one drum (55 gallons) of Herbicide Orange from the inventory at the Naval Construction Battalion Center, Gulfport, Mississippi to the Transvaal Inc. laboratory in Jacksonville, Arkansas.

Assessment: Immediately after the visit by personnel from Kelly AFB, Transvaal, Inc. undertook a small-scale feasibility study funded by AFLC and with the Herbicide Orange from Gulfport. The Kelly AFB personnel had informed Transvaal that their Herbicide Orange disposal option must contain a feasible monitoring capability that would establish what concentrations of 2,4-D and 2,4,5-T esters, and the TCDD contaminant would be released to the environment during the re-distillation process. Although the Transvaal research laboratory was very limited in instrumentation, they were able to separate Herbicide Orange into its original ingredients. The Transvaal Engineers stated that the TCDD residue would be isolated and destroyed during the fractionation process. However, subsequent research did not demonstrate adequately the fate of the TCDD. In addition, standards to control and monitor vapor and fluid emissions into the environment were not adequately identified. In January 1973, the Air Force Scientific Advisory Board recommended that further research into fractionation not be supported, and that this option not be considered for the disposal of Herbicide Orange.

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No records could be found of how the Transvaal, Incorporated disposed of the separated and reformulated herbicides, nor of any remaining Herbicide Orange. The use of 2,4,5-T herbicide was not formally suspended by EPA until 1978.

Sources: [redacted]): Trip Report to Transvaal Inc., Jacksonville, Arkansas. Prepared for the Commander, USAF Environmental Health Laboratory, Kelly Air Force Base, Texas (copy in the Alvin L. Young Agent Orange Collection, National Agricultural Library – see Sources Page).

Department of the Air Force (1974): Final Environmental Statement on the Disposition of Orange Herbicide by Incineration. November 1974, Department of the Air Force, Washington, DC. *Unclassified, available for public distribution.*

[redacted]1980): The Disposal of Herbicide Orange, 1971-1979. Office of History, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

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DOD TACTICAL HERBICIDE SITES

Site 28

Location: Reforestation Tests in Western Oregon

Date → 15 May 1973 – 1 June 1974

Activity Description: One method selected for the potential disposal of the surplus 2.3 million gallons of Herbicide Orange remaining after the Vietnam War was the option using it in reforestation programs in the Western United States. Forest surveys taken in 1972 indicated that there were some 4.7 million acres of commercial forest lands in Western Oregon and Washington that were either non-stocked or poorly stocked with conifers (e.g., Douglas fir). Virtually all such lands were occupied by vegetation whose presence precluded reestablishment of conifers. Concepts of selective brush control had been developed for reforestation with the aid of commercial formulations of 2,4-D and 2,4,5-T. In 1972, more than 100,000 acres were being treated each year with various formulations of these materials, all as low-volatile esters. Success had been good, especially in "release" operations where the newly planted conifer species would have the opportunity of out-growing the brush species that had been treated with the herbicides. There were three general approaches to the use of phenoxy brushkillers in reforestation, with the differences tied to season of application. Dormant sprays were applied in spring, between the onset of plant growth activity in early spring and conifer bud busting. Summer and fall foliage sprays were used when brush species were typically resistant to dormant treatment. Summer treatments were the least selective in a Douglas fir community, but tended to have the greatest systemic activity on sensitive species.

In May 1972, a Professor of Forestry with the Oregon State School of Forestry, Corvallis, Oregon submitted a proposal to the Air Force Logistics Command (AFLC) titled: "Field Tests of Herbicide Orange for Brushfield Rehabilitation and Conifer Release." The objectives of this proposed research were: (1) to evaluate the impact of high-volatile brushkiller on brush-dominated forest ecosystems, (2) to determine whether Herbicide Orange could be used effectively in the re-establishment of conifers in Western Oregon brushfields, (3) to evaluate the difficulties of using a technical grade ester without adjuvants for field use, and, (4) to obtain a crude estimate of whether drift problems from the high-volatile butyl esters were manageable. On 20 October 1972, after reviewing the proposal with other Federal agencies, AFLC authorized the shipping of 5 drums of Herbicide Orange from the inventory at the Naval Construction Battalion Center, Gulfport, Mississippi to the School of Forestry, Oregon State University, Corvallis, Oregon.

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Assessment: A total of 358 acres of test plots in Western Oregon were treated with Herbicide Orange on 10-11 May 1973. The plots on which Herbicide Orange was applied were selected among sites available on the ownership of three industrial cooperators, all of whom had on-going chemical brush control programs. The cooperators provided the cost of application by helicopter and secured application permits from the Oregon State Forestry Department. Tall brush plots were treated with 4.3 pounds per acre acid equivalent (one-half gallon of Orange in 15 total gallons of diesel fuel), while low brush plots received 2.1 pounds per acre acid equivalent (one quart per acre in ten gallons total spray). The treatments were made by a commercial applicator. Oregon State University School of Forestry personnel conducted the field flagging, field observations, and evaluations of the effectiveness of Herbicide Orange.

Although the brush control and conifer release with Herbicide Orange was excellent, the resulting negative publicity, and concerns expressed by the US Environmental Protection Agency over the transport and use of a non-registered pesticide caused AFLC to reject this method of disposing of the surplus Herbicide Orange. The remaining Herbicide Orange (2 drums) was subsequently returned to the Naval Construction Battalion Center.

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Sources: [redacted] October 1972): Field Tests of Herbicide Orange for Brushfield Rehabilitation and Conifer Release. Oregon State University School of Forestry Research Project F882A. Submitted to Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

Gazette Telegraph (1973): Weed Killer Banned in Vietnam Being Tested in Five States. Sunday, June 10, 1973, Colorado Springs, Colorado.

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[redacted] 975): Environmental Impact of "Agent Orange" Used in Reforestation Tests in Western Oregon. Abstract 144, pages 52-53, Proceedings of the Weed Science Society of America, 1975 Annual Meeting held in Washington, DC.

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DOD TACTICAL HERBICIDE SITES

Site 29

Location: Incineration Tests on Herbicide Orange, Van Nuys, California

Date → October 1973 – April 1974

Activity Description: One method selected for the potential disposal of the surplus 2.3 million gallons of Herbicide Orange remaining after the Vietnam War was the option of destroying the herbicide in a land-based commercial incinerator. Personnel from the United States Air Force (USAF) Environmental Health Laboratory (EHL), Kelly Air Force Base, San Antonio, Texas were directed in August 1971 by the Air Force Logistics Command (AFLC) to prepare a statement of work for the disposal of Herbicide Orange by incineration. The tasks involved first conducting in-house bench-sized incinerations tests to determine feasibility of monitoring the emissions of incinerators burning Herbicide Orange, and secondly, in identifying an appropriate commercial incinerator capable of destroying the large quantity of surplus herbicide. The in-house tests were augmented by studies conducted at Mississippi State University and at the Rocket Propulsion Laboratory at Edwards Air Force Base, California. The EHL personnel made trips to Monsanto Company's Krummrich Plant, Sauget, Illinois; and to the Rollins Purle Commercial Incinerator near Philadelphia, Pennsylvania. The outcome of these trips was the recognition that additional engineering studies were required to fully understand the requirements that a commercial incinerator would need to undertake the project. In 1973, AFLC contracted with the Air Force-Marquardt Jet Laboratory, at Van Nuys, California to conduct the required tests. Twenty-eight drums (1,540 gallons) were shipped from the Herbicide Orange Inventory at the Naval Construction Battalion Center, Gulfport, Mississippi to the Marquardt Company in Van Nuys, California. The mean concentration of the dioxin (TCDD) in the Herbicide Orange was 13.3 ppm (parts-per-million).

The tests objectives were to: (1) determine the capability of an incinerator system to destruct the Herbicide Orange over a range of selected incinerator conditions; (2) obtain the necessary engineering data to adequately monitor, control, and document the incinerator operation during the project; (3) evaluate the test burns' effects and project the long-term effects of the combustion gases on the material of the incinerator unit; and, (4) determine the combustion gas, scrubbed effluent gas, and "spent" scrubber water discharge mass rates of herbicide constituents and any other organic compounds that may be detected.

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Assessment: On 8 October 1973, tests were initiated with the Marquardt incinerator system to evaluate the incineration of Herbicide Orange in a commercial incinerator over a range of selected conditions. Particular emphasis was placed on the ability of the incinerator to destroy the parts-per-million quantities (11-16 mg/kg) of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) present in the herbicide. A total of 30.5 hours of burn time on undiluted Herbicide Orange fuel was accumulated during eight record burn periods. Test data demonstrated that the incineration system operated very satisfactorily using undiluted "Orange" Herbicide as a fuel and that the herbicide and TCDD was effectively and safely destroyed in the combustion process.

The tests were accomplished between 8 October 1973 and 21 December 1973 at the Air Force-Marquardt Jet Laboratory, Van Nuys, California. During the conduct of the tests, twelve military personnel from the USAF Environmental Health Laboratories at Kelly Air Force Base, Texas and McClellan Air Force Base, California performed the gas sampling, scrubber water sampling, biomonitoring, noise testing, drum cleaning experiments, and the combustion and scrubbed effluent gas monitoring.

With the success of the Marquardt studies, the Under Secretary of the Air Force (Installations and Environment) recommended that the site location for a commerical incinerator was probably the most important factor for the disposal of Herbicide Orange. In 1976, the Air Force selected at-sea incineration aboard the *M/T Vulcanus*, a Dutch-owned incinerator ship, to destroy the herbicide in Operation PACER HO (to be described in the leaflets for the Naval Construction Battalion Center, Gulfport, Mississippi, and Johnston Island, Central Pacific Ocean).

Sources: Department of the Air Force (1974): Final Environmental Statement on the Disposition of Orange Herbicide by Incineration. November 1974, Department of the Air Force, Washington, DC. *Unclassified, available for public distribution.*

Air Force Logistics Command (1976): Historical Records – Project on the Disposition of Herbicide Orange. Office of History, Air Force Logistics Command Archives, Wright-Patterson Air Force Base, Ohio.

[redacted] b6

The Disposal of Herbicide Orange, 1971-1979. Office of History, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

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DOD TACTICAL HERBICIDE SITES

Site 30

Location: Reprocessing of Herbicide Orange, Gulfport, Mississippi

Date → May 1975 – March 1977

Activity Description: In December 1974, the Department of the Air Force filed a final environmental impact statement with the Council on Environmental Quality on the disposition of Herbicide Orange by destruction aboard a specially designed incinerator ship in a remote area of the Central Pacific Ocean west of Johnston Island. The US Environmental Protection Agency (EPA) held a public meeting in February 1975 to consider the Air Force's request for a permit for ocean incineration of Herbicide Orange. During that meeting, public testimony was presented that suggested that Herbicide Orange could indeed be reprocessed and the material commercially used. The EPA requested that the Air Force Logistics Command (AFLC) again investigate the feasibility of reprocessing the herbicide as a means of disposition prior to making a decision on the permit of ocean incineration. In March 1975, a private company, Agent Chemical Inc., (ACI) submitted a proposal to AFLC proposing that a new process had been developed to remove the TCDD from the herbicide, thus making it available to be reformulated, registered with EPA, and sold in commercial channels.

From May 1975 to March 1977, ACI, the Defense Supply Agency, and AFLC worked on tests and pilot plant research to determine if the reprocessing of the Herbicide Orange stocks could be preformed safely. During the period, the Defense Supply Agency took the lead in managing the reprocessing program. The AFLC's Occupational and Environmental Health Laboratory at Brooks Air Force Base, Texas provided the technical expertise. AFLC retained responsibility for all project and environmental safety programs. In August 1975, ACI received permission from the Mississippi Air and Water Pollution Control Commission to construct a pilot reprocessing plant at the Naval Construction Battalion Center (NCBC) in Gulfport, Mississippi. The NCBC was the storage site for 860,000 gallons of Herbicide Orange. The Naval authorities worked closely with AFLC and the Defense Supply Agency in their reprocessing efforts. If the pilot plant proved successful, NCBC would be the site for the reprocessing operation.

Assessment: In October 1975, ACI received a permit to construct and operate the pilot plant. The plans called for reprocessing the herbicide at both Gulfport and Johnston Island. The process consisted of heating the herbicide and then passing it through carbon absorption cylinders to remove the TCDD. To reprocess all of the Herbicide Orange

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would require about 1,000 steel cylinders, each 10 feet long and 30 inches in diameter, 642 tons of activated charcoal. In a series of tests, ACI processed 354 gallons (6.5 drums) of Herbicide Orange (taken from the NCBC Inventory). On 7 July 1976 ACI submitted its report to EPA, the Defense Supply Agency, Under Secretary of Defense for Installations and Environment, Air Force Logistics Command, and to the Occupational and Environmental Health Laboratory. ACI's process was judged successful, and the Defense Supply Agency began negotiating a contract. Complications subsequently emerged related to disposal of the TCDD-loaded steel cartridges, and with concerns by the Navy over the construction of a major facility at NCBC, and from Environmental Groups over the reprocessing of the 2,4,5-T herbicide. In March 1977, the Department of Defense recommended that all reprocessing efforts be discontinued in favor of incineration at sea. Since the incinerator ship *MT Vulcanus* was expected to be available in April 1977, DoD requested EPA immediately grant the permit for the at-sea incineration of the entire Herbicide Inventories at NCBC and Johnston Island.

Active duty Air Force personnel with the Occupational and Environmental Health Laboratory, Brooks Air Force Base, Texas were intimately involved in all phases of the pilot plant construction, the handling of the Herbicide Orange, the on-site environmental monitoring, the oversight of the pilot plant operations, and the health and environmental safety programs. In addition, active duty Navy personnel with the Naval Construction Battalion Center provided additional oversight of the activities occurring on the Naval installation.

Sources: Department of the Air Force (1974): Final Environmental Statement on the Disposition of Orange Herbicide by Incineration. November 1974, Department of the Air Force, Washington, DC. *Unclassified, available for public distribution.*

Air Force Logistics Command (1976): Historical Records – Project on the Disposition of Herbicide Orange. Office of History, Air Force Logistics Command Archives, Wright-Patterson Air Force Base, Ohio.

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[redacted]76): Report of Plant Operation and Proposed Reprocessing of Herbicide Orange, 24 May – 8 July 1976. Agent Chemical Company, Houstong, Texas.

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[redacted] The Disposal of Herbicide Orange, 1971-1979. Office of History, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

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DOD TACTICAL HERBICIDE SITES

Site 31

Location: Storage and Operation PACER HO, Naval Construction Battalion Center, Gulfport, Mississippi

Date → December 1968 – February 1989

Activity Description: After August 1966, the Port of Embarkation for the "Tactical Herbicides Orange, White, and Blue" was the Port of Mobile, Mobile, Alabama. As the tactical herbicide inventory began to build up in Vietnam in 1968, the San Antonio Air Materiel Area (SAAMA), a component of the Air Force Logistics Command (AFLC), temporarily discontinued shipment from the Port of Mobile Outport in order "to avoid exposing large quantities of herbicides to possible damage by enemy action." Since the Port of Mobile was routinely used as the port of embarkation, SAAMA arranged for the excess tactical herbicides to be temporarily placed in storage at the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. About 10 out of every 10,000 drums received at the Outports during 1968 were damaged or defective. Most of the leakage occurred as a result of punctures (from forklifts) or split seams. Thus, when NCBC agreed to temporarily store the herbicide, it required SAAMA to provide funds and 17 personnel (civilian, contract) to perform storage and warehousing functions associated with the herbicide program.

The NCBC outside storage area was about two miles from the Gulfport Outport Docks, with convenient access to the railroad. It was fenced and isolated from public traffic. The NCBC provided surveillance as well as controlled access. The outside storage was planned and set up for long-term storage. To provide good drainage, 2 x 6-inch dunnage (creosoted lumber) was laid on a hard surface and drums, positioned horizontally with the bung closure point outward, were stacked in double rows, three high, in pyramidal fashion. With the decrease use of tactical herbicides in Vietnam in 1969, the inventory of Herbicide Orange at NCBC began to increase. On 4 November 1969, the Assistant Secretary of Defense placed a restriction on the use of Herbicide Orange in Vietnam. However, all Herbicide Blue and Herbicide White continued to be sent to Vietnam. On 15 April 1970, the Department of Defense issued a total suspension of the use of Herbicide Orange in all military operations in Southeast Asia. These actions left approximately 832,000 gallons of Herbicide Orange in storage at the NCBC that had to

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be continually maintained while the Air Force sought a final solution for the disposition of the surplus.

After 1970, the Herbicide Orange inventory at NCBC was augmented by receipt of shipment of surplus Herbicide Orange that had been in temporary storage at Eglin Air Force Base, Florida, and by receipt of shipment of surplus Herbicide Pink (n-butyl 2,4,5-T) that had been in storage at Kelly Air Force Base, Texas. The research efforts to develop a viable option for the disposal of Herbicide Orange expended approximately 180 drums of herbicide, leaving the inventory in April 1977 at 15,470 drums (850,850 gallons). Immediately after the US Environmental Protection Agency issued the permit for the at-sea incineration of Herbicide Orange, Operation PACER HO (pacer an Air Force term for movement, and HO for Herbicide Orange) was implemented at NCBC on 29 April 1977.

Assessment: Operation PACER HO required the dedication and coordination of military and civilian personnel from numerous state and federal agencies and from the military installations in Texas, Mississippi, Alabama, Florida, Ohio, Hawaii, Utah, Georgia, Oklahoma, and California. The Programming Plan detailed requirements for (1) de-drumming operations at Gulfport, Mississippi and Johnston Island; (2) environmental monitoring at Gulfport and Johnston Island; and (3) disposal by at-sea incineration in a remote area off Johnston Island. The plan also included personnel requirements, medical and environmental surveillance, emergency protocols, public relations coordination, and technical guidance for all of the engineering and transportation requirements. The active duty military at the AFLC Occupational and Environmental Laboratory, Brooks Air Force Base, Texas played key roles in the oversight of all activities during Operation PACER HO. The physical operation for PACER HO commenced on 2 May 1977 at NCBC. The schedule called for all actions to be completed at Gulfport within 38 days at which time the operation would shift to Johnston Island, with final activities including at-sea incineration to be completed by day 123 (5 September 1977).

The need for Operation PACER HO personnel for the NCBC portion of the operation was met by issuing a call for active duty military volunteers from the Air Force Logistics Command's five Combat Logistics Support Squadrons (CLSS). More than 200 men volunteered from Robins Air Force Base Georgia (the 2955th CLSS), Hill Air Force Base, Utah (the 2952nd CLSS), Kelly Air Force Base, Texas (the 2954th CLSS), Tinker Air Force Base, Oklahoma (2953rd CLSS) and McClellan Air Force Base, California (2951st CLSS). Additional civilian and military personnel came from Andrews Air Force Base, Maryland, Wright-Patterson Air Force Base, Ohio, and the United States Air Force Academy, Colorado.

The members of CLSS teams were responsible for carrying out all phases of PACER HO including empting drums, loading tank cars, pumping the herbicide onboard the *M/T Vulcanus* at the Gulfport Outport Dock, and crushing and stacking the emptied 55-gallon drums. The uniform of the day for all CLSS members in the processing of the herbicide included protective clothing, masks with respirators and goggles, and personal monitoring devices that were checked at regular intervals. The medical staff from the

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Aerospace Medical Division at Brooks Air Force Base, Texas provided pre- and post-exposure physical examinations to all active duty members of the CLSS units and other active duty military participating in PACER HO. The operation was completed at NCBC on 10 June 1977.

Following the completion of Operation PACER HO at NCBC, military from the Occupational and Environmental Health Laboratory, Brooks Air Force, Texas supervised the initial clean up of the NCBC storage site including disposal of dunnage, contaminated protective clothing, and other waste materials. These were subsequently disposed of in an approved landfill at the National Space and Technology Laboratory in Bay Saint Louis, Mississippi. The crushed 55-gallon drums were sold to a smelter. In August 1977, a soil, sediment, and biological monitor program was put into place to track the fate of TCDD and residues of Herbicide Orange in the NCBC environment. This monitoring program was conducted by Active duty Air Force officers from the Occupational and Environmental Health Laboratory, San Antonio, TX and from the Engineering and Services Laboratory, Air Force Engineering and Services Center, Tyndall Air Force Base, Florida, conducted the monitoring program. In February 1989, the Air Force in accordance with the Defense Environmental Restoration Program completed a final site cleanup at NCBC by incinerating all remaining TCDD-contaminated soil.

Sources: Department of the Air Force (1974): Final Environmental Statement on the Disposition of Orange Herbicide by Incineration. November 1974, Department of the Air Force, Washington, DC. *Unclassified, available for public distribution.*

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Young AL, [redacted] (1978): The Toxicology, Environmental Fate, and Human Risk of Herbicide Orange and Its Associated Dioxin. Technical Report OEHL-TR-92, USAF Occupational and Environmental Health Laboratory, Aerospace Medical Division, Brooks Air Force Base, Texas. *Approved for public release, distribution unlimited.*

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[redacted] (1980): The Disposal of Herbicide Orange, 1971-1979. Office of History, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

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[redacted] 984): Herbicide Orange Monitoring Program. Technical Report ESL-TR-83-56, Engineering & Services Laboratory, Air Engineering & Services Center, Tyndall AFB, Florida. *Approved for public release, distribution unlimited.*

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[redacted] (1990): Full-scale Incineration Demonstration at the Naval Construction Battalion Center, Gulfport, Mississippi. Final Report prepared by EG&G Idaho, Inc., Idaho Falls, Idaho, Technical Report ESL-TR-89-39, Engineering & Services Laboratory, Air Force Engineering & Services Center, Tyndall AFB, Florida. *Approved for public release, distribution unlimited.*

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DOD TACTICAL HERBICIDE SITES

Site 32

Location: Storage and Operation PACER HO, Johnston Island, Central Pacific Ocean

Date → April 1972 – June 2004

Activity Description: On 15 April 1970, the Assistant Secretary of the Defense suspended the use of Herbicide Orange in Vietnam. The suspension lasted from 15 April 1970 to 13 September 1971. On 13 September 1971, the Secretary of Defense directed the Chairman, Joint Chiefs of Staff that "*all stocks of Herbicide Orange in Vietnam will be returned to the Continental United States as quickly as practicable for disposition. A Joint State/Defense message has been prepared requesting the US Embassy negotiate with the Government of Vietnam for the return to US control of all stocks of Herbicide Orange in the Republic of Vietnam.*" Based on this directive, the 7th Air Force in Vietnam initiated Operation PACER IVY, the removal of all Herbicide Orange in Vietnam to Johnston Island. In mid-April 1972, the cargo ship, the *M/T TransPacific*, arrived at Johnston Island, Central Pacific Ocean, and off-loaded 25,200 55-gallon drums (1,386,000 gallons) of Herbicide Orange. From mid-April 1972 until mid-July when Operation PACER HO commenced, the Johnston inventory of Herbicide Orange required continual maintenance because of the deteriorating condition of the drums. The Pacific Test Division of Holmes and Narver, Inc., a civilian contractor, was responsible for the maintenance of the storage site and drums.

Assessment: When the Herbicide Orange stocks arrived at Johnston Island, the entire inventory was placed in the northwest corner of the Island and immediately fenced to restrict access to the storage area by civilians and Army personnel stationed on the Island, i.e., the inventory storage area was identified as an area "off limits" to military and civilian employees. The location of the storage area was important because it was located in an area where the prevailing winds would blow any vapors (and hence odor) away from the Island and away from where the temporary personnel or semi-permanent residents were quartered and messed.

The Johnston Island component of Operation PACER HO required the dedication and coordination of military and civilian personnel from State and Federal agencies and from many military installations. The Programming Plan detailed requirements for (1) de-

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drumming operations at the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi and Johnston Island; (2) environmental monitoring at Gulfport and Johnston Island; and (3) disposal by at-sea incineration in a remote area off Johnston Island. The plan also included personnel requirements, medical and environmental surveillance, emergency protocols, public relations coordination, and technical guidance for all of the engineering and transportation requirements. The active duty military at the AFLC Occupational and Environmental Laboratory (OEHL), Brooks Air Force Base, Texas played key roles in the oversight of all activities during Operation PACER HO. The physical operation for PACER HO at Johnston Island commenced on 27 July 1977.

On Johnston Island civilian employees were hired by a contractor to perform the de-drumming operations. USAF officers from OEHL monitored all operations. Two 10-hour shifts of approximately 50 men each were used. All workers were provided daily changes of freshly laundered work cloths, and men working within the de-drum facility wore protective clothing consisting of cartridge respirators, face shields, rubber aprons, gloves, and boots. Men on each crew remained in the same job through the de-drumming and transfer operations. A requirement for employment was pre- and post-operational physical examinations similar to those given to the active during military at NCBC.

In the actual de-drumming operation, the drums were handled using techniques similar to those at the NCBC. The herbicide and rinsing liquids from the drums were pumped into modified fuel tankers and transported to the Johnston Island Dock where the material was pumped aboard the *M/T Vulcanus*. A total of 24,795 drums of Herbicide Orange were processed between 27 July and 23 August 1977. Both environmental and occupational monitoring was accomplished on land and aboard the *M/T Vulcanus*. All sampling on Johnston Island was conducted by Battelle Columbus Laboratories, Columbus, Ohio. Personnel from TRW, Inc., Redondo Beach, California, and military officers from OEHL did the shipboard sampling.

Following the completion of Operation PACER HO at Johnston Island, military personnel from OEHL supervised the initial clean up of the storage site including disposal of dunnage, contaminated protective clothing, and other waste materials. These were subsequently disposed of in an approved burn site on the island. Afterward the residue was buried, and the remaining 36,000-plus crushed 55-gallon drums were sold to a smelter. In August 1977, a soil, sediment, and biological monitor program was put into place to track the fate of TCDD and residues of Herbicide Orange in the Johnston Island environment. This monitoring program was conducted by active duty Air Force officers from OEHL, the Department of Chemistry and Biological Sciences at the United States Air Force Academy, and from the Engineering and Services Laboratory, Air Force Engineering and Services Center, Tyndall Air Force Base, Florida. In February 1989, the Air Force, in accordance with the Defense Environmental Restoration Program, completed a final site cleanup at Johnston Island by destroying all remaining TCDD-contaminated soil by the use of an on-site thermal desorption system employing low-temperature thermal desorption technology. The site was covered by approximately 6 inches of topsoil and planted with vegetative species native to the region.

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Sources: Department of the Air Force (1974): Final Environmental Statement on the Disposition of Orange Herbicide by Incineration. November 1974, Department of the Air Force, Washington, DC. *Unclassified, available for public distribution.*

Young AL, [redacted] b6 8): The Toxicology, Environmental Fate, and Human Risk of Herbicide Orange and Its Associated Dioxin. Technical Report OEHL-TR-92, USAF Occupational and Environmental Health Laboratory, Aerospace Medical Division, Brooks Air Force Base, Texas. *Approved for public release, distribution unlimited.*

[redacted] b6 : Land Based Environmental Monitoring at Johnston Island – Disposal of Herbicide Orange. Technical Report USAF OEHL TR-78-87. Prepared by Battelle Columbus for the US Air Force Occupational and Environmental Health Laboratory, Brooks AFB, Texas. *Distribution Unlimited.*

[redacted] b6 he Disposal of Herbicide Orange, 1971-1979. Office of History, Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

[redacted] b6 Herbicide Orange Monitoring Program. Technical Report ESL-TR-83-56, Engineering & Services Laboratory, Air Engineering & Services Center, Tyndall AFB, Florida. *Approved for public release, distribution unlimited.*

[redacted] b6 Final Corrective Measures Implementation Report, Solid Waste Management Unit No.2, Johnston Atoll. Prepared for the United States Air Force 15th Airlift Wing Environmental Restoration Program. Available at the following web site: http://projects.ch2m.com/johnston_atoll/JA17_Public.htm

Summary of Assessment of Site Exposure

The issue of "meaningful exposure" to Tactical Herbicides is a subject of debate in the scientific literature. The most reliable information has shown that the esters of the herbicides, 2,4-D and 2,4,5-T, that made up Herbicide Orange, and its associated dioxin contaminant (2,3,7,8-tetrachlorodibenzo-p-dioxin, TCDD) rapidly dried within minutes of being sprayed on vegetation, rendering them unavailable for absorption. The process of drying involved the chemicals being absorbed within the waxy layer of the plant cuticle, where they were not readily dislodged [1]. Studies of Herbicide Orange and the associated TCDD on both leaf and soil surface demonstrated that photolysis rapidly decreased the concentration of TCDD (within hours), and this process even continued in shade [2]. Studies of 'dislodgeable foliar residues' (the fraction of a substance that is available for cutaneous uptake from the plant leaves) showed that only 8% of were present 1 hour after application. This dropped to 1% 24 hours after application [3]. Moreover, studies in human volunteers confirmed that after 2 hours of saturated contact with bare skin, only 0.15-0.46% of 2,4,5-T entered the body and was eliminated in the urine [4]. The implications of these studies and observations are that individuals who entered a sprayed area one day after application of Herbicide Purple, Herbicide Green, Herbicide Pink and Herbicide Orange received essentially no "meaningful exposure." These are important findings because military and civilian personnel from Fort Detrick, United States Department of Agriculture (in Puerto Rico and Texas), and the Air Force Logistics Command that participated in the evaluation of the spray and monitoring operations were not likely to have been exposed. Certainly, any local civilians who entered the spray area days after spraying were at no risk of exposure.

What is meant by a "measurable" human exposure to Tactical Herbicides is difficult to estimate for personnel who were not monitored by non-evasive blood or urine techniques. In the years before and during Vietnam, these techniques were not available [5]. The components of the Tactical Herbicides, 2,4-D, 2,4,5-T, cacodylic acid and picloram can now be measured in the urine. The excellent studies by Lavy [5] and Hood [6] have provided convincing evidence that in forestry and brush control programs mixers and applicators of the phenoxy herbicides, picloram or cacodylic acid would have had "measurable", albeit generally very low, levels in their urine. However, these studies also indicated that individuals who walked through the sprayed areas even 2 hours after application did NOT have measurable levels of herbicides in their urine. Thus, it was unlikely that either short term or prolonged time spent in sprayed areas 24 hours after spraying would have resulted in any "measurable" levels of exposure.

Testing of serum dioxin levels has been widely regarded as the gold standard for epidemiological studies of TCDD from Herbicide Orange since its development in the late 1980s [7]. Studies conducted on the men that actually handled the liquid Herbicide Orange showed measurable levels of TCDD in their blood serum [8,9]. Moreover, the major industrial studies since the 1980's have relied upon it to validate estimation of exposure [7]. The significance of these studies and observations is that those Active Duty military personnel who mixed, loaded, and participated in the actual spray programs during the development of the tactical phenoxy-related herbicides and spray equipment,

and those who participated in Operation PACER HO, may have received a "measureable exposure" to TCDD. This was most likely true even though participants were generally instructed to use face shields or respirators, rubber gloves, and aprons. Many of these studies were conducted in subtropical and tropical climates; the wearing of protective clothing was very uncomfortable. In Operation PACER HO great care was taken to monitor the safety of the hundreds of men who participated in the de-drumming and transfer of the liquid Herbicide Orange and rinse, but the process was not free of minor spills and accidents.

Although most of the studies on the disposal options for Herbicide Orange involved Active Duty military, the use of safety protocols was an important part of the studies, and they were less likely to be exposed to the liquid Herbicide Orange. Safety protocols were also required in the site monitoring and remediation programs that followed PACER HO at the Naval Construction and Battalion Center and at Johnston Island. Active Duty military personnel handled contaminated soil. Studies of the binding of TCDD to soil particles likely minimized the cutaneous availability to naked skin (e.g., hands) and to many biological organisms associated with that soil [10,11]. Moreover, The handling of these soils generally occurred many months to years after the soil had been contaminated and most the residues would have been degraded by chemical and biological mechanisms [12]. Nevertheless, it cannot be concluded that "no measurable exposure" occurred. Indeed, three of the individuals who had participated in these monitoring programs did have analyses of their adipose tissue performed in 1978, and levels of 5-7 parts-per-trillion (ppt) TCDD were measured [10]. RANCH HAND personnel who handled the liquid Herbicide Orange a decade before the above individuals still had in 1986 levels that were orders of magnitude greater than those involved in the monitoring programs [8].

References

[1] Young AL, [redacted] (2004): Environmental Fate and Bioavailability of Agent Orange and Its Associated Dioxin During the Vietnam War. ESPR – Environ Sci & Pollut Res 11 (6): 359-370

[2] [redacted] Environmental Degradation of 2,3,7,8-Tetrachloro-dibenzo-*p*-dioxin (TCDD). Science 195: 1337-1338

[3] [redacted] (1992): Percutaneous Penetration of 2,4-Dichlorophenoxy-acetic Acid and 2,4-Dimethylamine Salt in Human Volunteers. J Toxicol Environ Health 36 (3): 233-240

[4] [redacted] 1): Potential Exposure of Humans to 2,4,5-T and TCDD in Oregon Coast Range. Fund Appl Toxicol 1: 339-346

[5] [redacted] 987): Human Exposure to Phenoxy Herbicides. VA Monograph, May 1987, Agent Orange Projects Office, Department of Medicine and Surgery, Veterans Administration Central Office, Washington, DC, 128 pages

[6] [redacted] 1985): Cacodylic Acid: Agricultural Uses, Biologic Effects, and Environmental Fate. VA Monograph, December 1985, Agent Orange Projects Office, Department of Medicine and Surgery, Veterans Administration Central Office, Washington, DC, 171 pages

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[7] Young AL (2004): TCDD Biomonitoring and Exposure to Agent Orange: Still the Gold Standard. ESPR – Environ Sci & Pollut Res 11 (3): 143-146
[8] The Air Force Health Study – Final Report (200): Chapter 2. Dioxin Assay. Prepared by SAIC for the Air Force Research Laboratory, Brooks City-Base, Texas. Available at: http://www.brooks.af.mil/AFRL/HED/hedb.afhs/afhs.html b6
[9] [redacted] (2006): Health Status of Army Chemical Corps Vietnam Veterans Who Sprayed Defoliant in Vietnam. Am J Ind Med 49: 875-884
[10] Young AL, [redacted] b6 (2005): Long Overlooked Historical Information on Agent Orange and TCDD Following Massive Applications of 2,4,5-T –Containing Herbicides, Eglin Air Force Base, Florida. ESPR – Environ Sci & Pollut Res 11 (4): 209-221
[11] Young AL (2002): The Volunteers: The First Human Biopsy Studies from Agent Orange Exposure. ESPR – Environ Sci & Pollut Res 9 (3): 157
[12] Young AL (2006): Enhanced Co-Metabolism of TCDD in the Presence of High Concentrations of Phenoxy Herbicides. ESPR – Environ Sci & Pollut Research 13 (3): 149-150

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US Advisory Gp Korea
APO SF 96302

DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY ADVISORY GROUP, KOREA
APO SAN FRANCISCO 96302

2 JAN 1969

EAAKORD/CML

SUBJECT: Final Report, Vegetation Control Plan CY 68 (U)

Commanding Officer
Combat Developments Command
Chemical-Biological-Radiological Agency
ATTN: CSGCB-MT
Fort McClellan, Alabama 36201

1. The inclosed subject report is furnished with the understanding that it is to be used for information purposes only as it is currently being staffed at higher headquarters to obtain approval and implementation of recommendations.

2. In addition you may find it beneficial to interview MAJ [redacted] b6 who will be attending the Chemical Officer Advanced Course during the period January through October 1969. MAJ [redacted] b6 was previously assigned as Assistant Chemical Officer VI ROK Corps and was instrumental in developing defoliation plans in that area of the DMZ.

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ANNEX C
FINAL INVESTIGATION
ENCL 5 TO ENCL 5
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ABSTRACTED

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FINAL REPORT, VEGETATION CONTROL PROGRAM CY 68 (U)

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VEGETATION CONTROL PROGRAM CY1968 (U)

I. (C) INTRODUCTION

a. BACKGROUND:

1. In 1963, CG I US Corps (GP) proposed the use of herbicides in the DMZ to improve observation and fields of fire and to deny hostile forces the concealment provided by vegetation. A feasibility study was requested and ultimately provided by the U. S. Army Biological Laboratories, Fort Detrick, Maryland. The study recommended that applications of herbicides be made using C-123 aircraft. Due to the possibility of accusations of armistice violations, and a resulting potential propaganda harvest by the Communist world, approval was denied by CINCUNC. However, the then ROK VI Corps Chemical Officer has reported that in late 1963 a small quantity of a commercial herbicide (2,4,D) was used in selected areas such as observation posts and guard posts to clear fields of fire. Lacking specific technical guidance, ROKA forces applied 2,4,D to grassy areas unaware that 2,4,D is specific for broad leaf vegetation and has little or no effect upon annual and perennial grasses.

2. In October 1965, the 2nd U. S. Infantry Division requested that herbicides be investigated for use in controlling growth within the anti-infiltration barrier. It was pointed out that certain chemicals, i.e. Post Engineer R&U herbicides and TO/E equipment were already on-hand and capable of employment. The request was staffed and once again denied due to possible adverse North Korean or third-country reactions.

3. In early 1967, as part of a general review of the DMZ defenses, UNC/USFK found that cover, provided North Korean infiltration or raiding parties by the vegetation within the DMZ and contiguous areas, had grown unencumbered since the Armistice and was an important part of the DMZ defensive problem. Dense uncontrolled growth significantly hampers UNC defensive operations while enemy infiltration operations are enhanced.

Effective use of night vision devices was affected by dense foliage and frequently movements of UN Forces into defensive positions were being hampered. It was decided to study how best to control vegetation, provide selected cleared areas and yet stay within the Armistice agreement. Various means including hand clearing, mechanical clearing, and use of herbicides were studied with regards to effectiveness, initial and recurring costs, and other pertinent factors to include adverse Communist and third-country reactions. As part of this evaluation, tests of herbicides were conducted in small selected areas near, but South of, the DMZ South tape to establish the parameters for vegetation control in Korea. Based on test results, plans were to be prepared for future full scale application in the area between the DMZ South tape and the Civilian Control Line.

4. The planning for the herbicide testing in Korea revealed the desirability of obtaining State Department approval of the program. This approval was requested by a Country team message. Numerous messages were dispatched during the period May through September 1967. During this period, the political implications were carefully analyzed and the U. S. Mission to the United Nations (USUN) was contacted for comment. Based on USUN support and Country team assurance that political implications were manageable, Secretary of State, in September 1967, authorized discussion of the program with the ROK Government. These discussions provided the acceptance of the program by the ROK Prime Minister and on 20 September 1967, permission for herbicide testing in Korea was granted.

5. As a result of the 20 September 1967 State Department Authority to implement herbicide testing plans, HQ Eighth U.S. Army (EUSA) issued implementing instructions to First ROK Army (FROKA) and I US Corps (GP) to make test applications of available herbicides Monuron (Telvar) and 2,4,D on flat terrain (2nd US Inf Div) and in the mountains (21st ROK Inf Div). Despite the lateness of the growing season, it was decided that these applications were necessary in order to train personnel, evaluate available dispensing equipment, test North Korean, ROK and third-country reactions. A summary of test results is attached as Annex A.

6. Based on the assumption that Secretaries of State and Defense would approve a herbicide program in Korea and I US Corps (GP) were alerted on 16 January 1968 to initiate planning for a comprehensive vegetation control program.

7. On 4 March 1968, COMUSKOREA was authorized to employ herbicides as part of the vegetation control program in Korea. To preclude the possibility of unfavorable propaganda and to insure that defoliants would be properly employed with a margin of safety, CG EUSA directed that the following restraints be placed on the vegetation control program (Annex B, appendix 1):

(a) Defoliants will not be employed North of the Southern boundary of the DMZ.

(b) During application, care will be taken to insure that there is neither run-off nor spray drift into areas North of the Southern boundary of the DMZ.

(c) Defoliants should not be applied during precipitation or when rain is expected within 12 hours after application.

(d) Extreme caution will be exercised to avoid damage to food crops.

(e) Defoliants will not be dispensed from aircraft of any type.

(f) A KMAG representative will be physically present whenever and wherever defoliants are employed.

8. Planning Conferences were held on 3-4 March 1968 in the Engineer Operations Division EUSA to review FROKA and I US Corps (GP) plans and to coordinate details for anticipated implementation. Action personnel from EUSA G-3, G-4, and Engineer, HQ KMAG, Det L KMAG, HQ FROKA, HQ 1 US Corps (GP) and HQ 2nd US Inf Division attended the conference.

As a result of the planning conferences, detailed plans were approved and on 10 March 1968, the EUSA directive for the Vegetation Control Program CY68(U) was released with instructions to implement on order (Annex B, appendix 1).

9. By 20 March 1968, material and equipment began to arrive in the country and in an orderly manner was distributed forward to using units. At this point, confusing information was received from supply agencies in CONUS concerning the soil-applied herbicide, Monuron. The original CIGCOREP requirement requested UROX 22, however, EUSA G-4 was informed that Monuron (Telvar) was being shipped. Since there is a vast difference in the amount of active ingredient in Telvar and UROX 22, different application rates are used; therefore, 250 lbs of UROX 22 per acre as compared with 50 lbs of Telvar per acre. Accordingly, plans and allocations were quickly changed. However, on 8 April 1968, supplies of Monuron arrived in Korea and were confirmed as UROX 22, a pelletized form of Monuron.

10. In mid March, comprehensive briefings on vegetation control including technical information on herbicides, means of application, and expected results were presented to key personnel of HQ I US Corps (GP) and 2nd US Inf Division by Senior Chemical Advisor, Headquarters, KMAG. These briefings specifically presented the restraints and controls directed by JCS and CINC/UNC. The Chemical Advisor, Detachment L, KMAG presented identical briefings in bilingual format to key personnel of HQ FROKA, each ROK Corps HQ, and KMAG Detachments West, Center, and East.

11. On 31 March 1968, CG EUSA ordered implementation of the Vegetation Control Program CY68 to be initiated on or about 15 April 1968 (Annex B, appendix 2).

b. GENERAL:

1a. In March 1967, at the direction of the CG EUSA, a study group was organized for the purpose of conducting a study

to determine the requirements for clearing vegetation and foliage in areas contiguous to and immediately south of the southern boundary of the DMZ. The EUSA Engineer was assigned responsibility for this task and was assisted as required by representatives from EUSA G-3, G-4, and KMAG. As defoliation was included as a part of the CIGOCOREP plan which was actioned prior to completion of the study groups findings, a formal documented study was never staffed nor published. The decision to employ defoliants overtook the need for staffing the study; however, it has been retained in the Operations Division, EUSA Engineer Section for historical value in two complete copies. It has been used as a reference document in the preparation of certain portions of this report.

1b. Although the EUSA Engineer Study was neither staffed nor published, its primary conclusion was that the use of chemical control of vegetation along the DMZ, in conjunction with manual and mechanical means, is practical, manageable, politically acceptable, and if appropriate chemicals are supplied is within the current capability of EUSA and the Republic of Korea Army. The comparison of techniques and resultant estimated costs in funds and manpower revealed the following comparison: (Annex C, Comparison and Estimated Costing of Clearing Techniques.)

Technique of Clearing	Cost per Acre	Man-hours per Acre
Manual	$467	227
Mechanical	$160	20
Chemical	$408	25

2. The planning responsibility for vegetation control was delegated to EUSA Engineers rather than to a staff agency within EUSA headquarters where a staff chemical officer was assigned. However, technical advice and assistance was provided by the Senior Chemical Advisor, KMAG and efforts were closely coordinated between EUSA Engineer, Nuclear-CB Division G-3, and Chemical Advisory Section, Headquarters, KMAG.

c. WEATHER, VEGETATION, SOIL AND TERRAIN:

A summary analysis of weather, vegetation, soil and terrain extracted from the EUSA Engineer Study "Clearance of Vegetation and Foliage in the DMZ Area" (U), 31 January 1968 is attached as Annex D.

d. CHARACTERISTICS OF HERBICIDES:

1. In March 1967, representatives of the Plant Sciences Laboratory, U.S. Army Biological Laboratories, Fort Detrick, Maryland visited Korea and inspected typical vegetation growth in selected areas contiguous to the DMZ. Based upon this evaluation, the Plant Sciences Laboratory recommended the use of Agents Orange and Blue and a soil applied herbicide to control general and specific vegetation growth in Korea.

2. Considering both the field evaluation conducted in October 1967 and the recommendation of the Plant Sciences Laboratory, requirements for Agents Orange and Blue, and Monuron were included in the CIGCOREP Plan. A discussion of the technical characteristics of the recommended herbicides is attached as Annex E.

e. EQUIPMENT AND MATERIEL:

1. Requirements for equipment and materiel to support the Vegetation Control Program were established by the CIGCOREP Plan of which portions were approved and funded in early January 1968. A summary of vegetation control equipment and materiel requirements is attached as Annex F.

2. Discussion:

(a) As Monuron UROX 22 is spread by hand or mechanical broadcast, no particular problem was anticipated in its application. 50 Mechanical BORAX weed killer dispensers were received to be used in mechanical broadcast of this agent. A photograph of this dispenser is attached as Figure F-1.

(b) Both agents Orange and Blue are applied as a liquid spray. In addition, it had been anticipated that Monuron Telvar, which is applied in a liquid suspension, would be used in Korea. Accordingly, a requirement was established for a portable light-weight hypro-type pump spray apparatus with the capability of dispersing a liquid spray and a wettable powder suspension. The actual equipment received were 22 standard gasoline engine-driven insecticide sprayers commonly used in Engineer Entomotogial Services. Upon test operation of the sprayer, it was determined that it was satisfactory for spraying agents Orange and Blue, but not capable of spraying a wettable powder suspension. Ultimately, this problem was solved by the receipt of pelletized Monuron UROX rather than Monuron Telvar. A photograph of this sprayer is attached as Figure F-2.

(c) Based on the limited herbicide testing conducted in October 1967, FROKA recommended the use of hand-held insecticide sprayers for small area spraying of liquid agents. 200 of these 2 and 3 gallon sprayers were provided for this purpose. A photograph of these sprayers is attached as Figure F-3.

(d) In addition to the equipment provided by the CIGCOREP Plan, within ROKA and U.S. units there were available several types of TOE and TA equipment which were used for application of liquid defoliants as follows:

(1) ROKA had available 48 ea M8A2 Decontamination Trailers which were used to spray Agents Orange and Blue and to supplement storage and transportation of water for mixing and application. The M8A2 Decontamination Trailer consists of a 200 gallon capacity tank and a 25 HP GED pump unit mounted on a 1 1/2 ton trailer. A single hose reel allows the operator to move approximately 50 feet from the trailer and direct a liquid spray through the adjustable Beam type spray gun at a rate of 20 gallons per minute. A photograph of this equipment is attached at Figure F-4.

(2) ROKA had available 10 ea M106 "Mitey Mite" dispensers which were used to supplement liquid spray capabilities. The M106 Dispenser is a commercial, back-pack, agricultural duster-sprayer that has been adapted for military use. It consists of a compact two-cycle gasoline engine which powers a blower to disperse liquid or powdered defoliants or riot control agents through a six foot flexible hose. A self contained tank provides the capability of dispersing 3 gallons of liquid agent, total weight of the disperser is 25 lbs less fuel or agent. A photograph of this disperser is attached as Figure F-5.

(3) For liquid application of Agents Orange and Blue to small areas, the FROKA Chemical Officer devised a field expedient consisting of crimping a perforated metal cap to the end of a flexible nozzle, then by attaching the flexible nozzle to a 5 gallon "GI" gasoline can, the liquid agent was literally poured over vegetation similar to the manner a garden watering can is used. A photograph of this expedient is attached as Figure F-6.

II. (C) DEFOLIANT OPERATIONS

a. GENERAL

1. Prior to initiation of defoliant operations, a comprehensive briefing was prepared to inform commanders and staffs of the technical aspects of defoliant operations and to specifically delineate controls and restraints pertaining to application of defoliants. The Senior Chemical Advisor, HQ KMAG, assisted by EUSA Engineer Project Officer, briefed the commanders and staff personnel of HQ 2nd U.S. Inf Division and I US Corps (GP) on 21 and 22 March 1968. Senior Chemical Advisor, Detachment L, KMAG presented this same briefing in bi-lingual format to the commanders and staffs of Headquarters FROKA, each ROK Corps, and Detachments East, West, and Center in early April.

2. To insure a coordinated effort in planning defoliant operations, a series of planning conferences were held in late March 1968 in the EUSA Engineer Operations Division. Those in attendance were representatives of EUSA Engineer, G-3, and G-4, Headquarters and Detachment L KMAG, I US Corps (GP), 2nd US Inf Div., FROKA and ROKA. For guidance in planning operations, conferees were instructed to prepare plans for defoliant operations along the following guidelines:

(a) Defoliant applications will be made only in the area north of the Civilian Control Line (CCL) and south of the southern boundary of the DMZ (South Tape).

(b) Priorities of applications were established as follows:

(1) Priority 1: A 100 meter strip on each side of the DMZ Security Fence System.

(2) Priority 2: Tactically significant areas in the vicinity of OP's, CP's and other vital areas. In order to preserve natural camouflage, manual clearing would be accomplished first and then defoliants would be applied to improve firing lanes and to deny concealment to would be infiltrators.

(3) Priority 3: A 30 meter strip on each side of tactically significant roads in the forward areas.

(c) Based upon planning guidance, FROKA and I US Corps (GP) submitted plans for implementation listing quantities required by priority. See attached Annex G. Plans submitted were based on the planned receipt of Monuron Telvar (80% active ingredient) which required an application rate of 50 pounds per acre. The Eighth Army execution order informed appropriate action officers of the change in type of material and application rate and advised that quantities of Agent Orange and Blue be shifted into Priority 1 requirements to fill in the shortfall of 6,340 acres caused by the change in types of defoliant.

(d) By 10 April, supplies of defoliants and material for vegetation control were on-hand in forward locations in preparation of planned implementation date of 15 April 1968. A summary of material allocations is attached at Annex H.

b. OBSERVATIONS

1. Defoliant applications were initiated on 15 April 1968 with the application of Monuron in Priority 1 areas (see Annex L for photographic coverage). No particular difficulties were found in dispensing Monuron as it is spread by hand similar to the manner by which Korean farmers spread seeds or fertilizer. The usual technique involved was that an area selected for Monuron application was divided into several lanes and each man walked along his assigned lane spreading Monuron by hand or the mechanical spreader along approximately 5 meters on each side of his marked lane. Supplies of Monuron were spotted throughout the area to facilitate individual resupply along assigned lanes.

2. As of 28 April 1968, Monuron applications were completed in I US Corps (GP) area. In I US Corps (GP) area, the terrain is generally flat with some rolling hills along the DMZ Security Fence System and is relatively accessible by vehicular traffic; however, in the FROKA area the terrain becomes increasingly difficult moving eastward from the CHORWON Valley. In the extreme eastern area of the DMZ in the III ROK Corps area, some application sites were a four hour foot march from the nearest road. Work in these inaccessible areas progressed very slowly but improved when materiel and men were flown in by helicopter when available.

3. The action of Monuron is dependent upon rainfall to soak the active ingredient into the soil and penetrate the plant root zone. Almost coincidental with the application of Monuron, there was a minor drought in most of the areas which resulted in an unusually delayed response time to the defoliant. Once absorbed into the plants, the initial response to Monuron is very

similar to reaction to fertilizer and very little visible evidence is exhibited except a slight yellowing is apparent and then slowly foliage begins to turn brown and eventually defoliates completely as if the vegetation had been struck by a killing frost. In those areas where annual and perennial grasses appear, most vegetation did not even emerge leaving a strip almost devoid of all plants.

4. As Monuron is an all-purpose defoliant rather than a selective defoliant it effectively kills annual and perennial grasses which may lead to soil erosion problems in future years in those areas where it was applied along the DMZ Security System Trace. To counter this problem a soil erosion program has been planned in which sheep fescue and white dutch clover will be planted in susceptible areas to prevent serious erosion problem. This plan is being carefully coordinated at the working level to insure that seed and fertilizer will not be applied to areas that have been previously treated with Monuron. In this respect, it would appear that in future defoliant programs the use of a selective defoliant to control broadleaf vegetation and not affect grasses has merit. There are several off the shelf commercial herbicides that are specific for use against broadleaf vegetation but do not affect grasses. Agent WHITE, known commercially as TORDON 101, has been used in Vietnam for specific problem areas in which it was desired to preserve grasses. The use of liquid WHITE or pelletized formulation such as Tordon 10K along the DMZ Security System Trace should be more satisfactory than the use of Monuron in that annual and perennial grasses would not be affected and once the bushy woody growth is reduced grasses would remain to prevent serious erosion problems. The remaining grasses could then be controlled through manual or mechanical means utilizing the jeep and tractor drawn mowers and other equipment provided by the CIGCOREP Plan.

5. Application of the liquid Agents Blue and Orange began in mid May 1968 upon the emergence of foliage.

(a) Agent Orange:

(1) Agent Orange was mixed with diesel oil at a ratio of 3 gallons of Orange to 50 gallons of diesel which was recommended as the application rate per acre to preclude regrowth of resistant vegetation. The only significant problem area involved was the lack of adequate spray equipment. Most application areas were relatively inaccessible to vehicular traffic which precluded the use of the M8A2 Decontamination Trailer. As only 22 liquid defoliant spray sets were available, expedient means of applying Orange were devised. Generally speaking, the expedient devices to apply liquid defoliants were ineffective in that they resulted in a waste of materiel as there is no way, other than by visual estimation, of accurately measuring an application rate per acre. In applying liquid defoliants, the most critical factor is liquid particle size. In aerial application, as employed in Vietnam, undiluted Agent Orange is sprayed from aircraft through specifically designed equipment to produce an aerial spray of the optimum particle size to facilitate absorption through the leaf surfaces of foliage. There is no visible evidence of plant damage for a period of several weeks as the agent is being translocated throughout the plant. Then, dramatically and vividly, the systemic herbicide exhibits its effect of defoliation and killing of the plant. Both methods of liquid dissemination used in Korea produced large droplets of liquid, in fact, the expedient methods of Orange application resulting in literally pouring the agent/oil mixture on foliage. The high concentration of diesel oil in the mixture immediately caused a browning of foliage which, in most cases, prevented the absorption of Agent Orange and its subsequent translocation. As a result of this "drenching" vegetation was defoliated and most of it eventually died; however, in some cases where controlled burning was not used to clear defoliated areas, there was some regrowth by mid July. In the opinion of Dr. [redacted] Plant Sciences Laboratory, U. S. Army Biological Laboratories, Fort Detrick, Maryland, the diesel oil was primarily responsible for defoliation and retarded growth rather than the Agent Orange. In an attempt to achieve optimum particle size from ground spraying operations, units were

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advised to spray Orange in a fine mist and to direct the spray high into the air allowing the mist to settle on foliage. Although this procedure increased the risk of undesired spray drift, the effectiveness of Orange was increased. In regard to spray drift, it was realized that under certain conditions when the windspeed exceeds 5 knots per hour, that there was the possibility of spray being carried downwind and damaging sensitive vegetation. In the 2nd US Infantry Division area, the "fine spray" technique was employed successfully between the Imjin River and the South Tape where no farming is allowed. This technique was used only when distance and wind speed and direction precluded drift into the DMZ, and it was noted that sensitive foliage (primarily locust trees) within 100 to 200 meters downwind of the application area were frequently effected by spray drift.

(2) Although in advisory visits and briefings to key ROKA personnel, it was stressed that Agent Orange is a specific systemic herbicide for broadleaf plants and is ineffective against most annual and perennial grasses, a large quantity of Agent Orange was applied to grassy areas with the result that the growth of grass was retarded by the effect of diesel oil and within two to three weeks the grass began to grow again. This procedure in effect was a waste of time, manpower, and materiel in that although the application sites were tactically important, vegetation could have best been controlled by manual clearance or controlled burning.

(3) Used properly, Agent Orange produces excellent results and in those areas covered with woody growth, broad leaved plants, vines, and trees, produced good results within a minimum period of time and required less effort than would be required by manual methods.

(4) There were no serious problem areas in maintaining the equipment used to apply Agent Orange. Spray equipment was thoroughly cleaned and flushed at the end of each day's operations; therefore, deterioration of rubber components, as expected, from the Orange/oil mixture was minimized. There were some cases reported of checking and

cracking of rubber gaskets in the 2 or 3 gallon hand-held insecticide sprayer. In some instances, the 180 GPH Insecticide Sprayers were damaged by rough handling in which the pressure value indicator glass was broken and the carrying frame bent. In mid June, 3 of the 22 sprayers were deadlined because of engine failure and there were no repair parts available in Korea. Five new engine assemblies were procured from CONUS and direct exchange of engines was performed by 2nd S&T Battalion, 2nd U. S. Infantry Division. For future operations, a supply of repair parts and direct exchange parts should be stocked in-country to facilitate maintenance.

(b) Agent Blue:

(1) Agent Blue was mixed with water at the ratio of three gallons of Blue to 50 gallons of water for spray application. The majority of locations sprayed with Agent Blue were located along roadsides and areas easily reached by vehicles; consequently, the M8A2 Decontamination Trailers were used extensively for spraying Blue. As Agent Blue is particularly effective against rice and other cereal grain crops, precautions were taken to avoid damaging adjacent crop areas.

(2) Agent Blue was particularly effective against wild rice and a tall grass commonly referred to as "Buffalo Grass" which grows in abundance in abandoned rice paddies and along rivers and streams. It was highly effective in drying out these grasses with a high water content and preparing them for controlled burning. In general, Agent Blue causes dessication of broad leaf and narrow leaf vegetation ultimately causing effective defoliation, but it does not necessarily cause plant kill in all cases. In those areas where applications of Blue were followed up by controlled burning, vegetation clearance was complete; in those areas not burned off, there has been considerable regrowth.

6. (a) Not all plant species react similarily to defoliants. The differential susceptibility may be a function of time of treatment, nature of the leaf surface, variable capacity for

absorption and translocation of the defoliant, plant chemistry, or the nature of the defoliant itself. Thus one can expect different reactions of vegetative types, some will be easily defoliated and killed while others will be comparatively resistant to the defoliant. Locust trees and scrub oak appeared to be extremely sensitive to Agent Orange. However, some grasses exhibited regrowth after the initial application of Agent Blue requiring a second application of the agent by mid summer.

(b) In general, all three defoliants produced the expected results with the exception that regrowth following Blue and Orange application was greater than anticipated. In measuring the overall tactical effectiveness of the defoliation project, one must consider the priorities that were directed by higher headquarters. Application of all three agents along the DMZ Security System fence line (Priority one) was tactically the most sound as it provided a clear area for observation and fields of fire and to a certain degree improved the effectiveness of night vision devices by producing an area of high contrast. When applied in Priority 2 areas around OP's and CP's, frequently an entire area was cleared thus exposing these installations to enemy observation. Applications in Priority 3 areas were not too effective because the width of the area covered was usually less than 30 meters on each side of the road. This distance is not adequate to afford protection from ambush.

7. There were no serious major accidents or incidents as a result of defoliant application nor were there any safety problems in handling any of the material. The most serious accident occurred immediately prior to the application phase of the program when the Chemical Officer, 6th ROK Infantry Div was accidentally killed by a booby trap as he was returning from a reconnaissance of planned application areas.

(a) There were several minor incidents in which ROKA personnel detonated uncharted mines and booby traps, but no serious injuries were sustained.

(b) There were no problems encountered in the handling, storage or application of defoliant materials. It had been anticipated that some of the defoliants could possibly cause eye, nose, throat, and skin irritation; however, this effect was minimized by the wearing of gauze masks and gloves when handling the material and by washing upon completion of application.

8. Ground application of defoliants requires extensive manpower and time. In addition to manpower actively employed in application, overhead is required to provide security and to provide mixing, filling and transportation of defoliant material to application sites. Use of relatively unsophisticated spray equipment results in estimated application rates, further, Agent Orange applied by ground spray means is not as effective as it could be. Use of an aerial spray system such as the AGRINAUTIC system developed for the UH-1 series helicopter would result in a more efficient plant response, require less time in application, and require considerably less manpower support than ground application means. The AGRINAUTRIC spray apparatus is not limited to liquid spray but can also be used to disperse pelletized solid herbicides such as Monuron UROX 22, BROMACIL, and TORDON 10 K which are soil-applied defoliants. The average application rate for ground applied liquid agents was approximately 200 acres per week depending upon the ruggedness of the terrain. By contrast, one UH-1 helicopter equipped with the AGRINAUTIC sprayer, flying at a height varying from 12 feet to 50 feet at 90 knots per hour, could spray a swath 100 feet wide with Agent Blue at an application rate of 3 gallons per acre for a total area coverage of 65 acres in approximately 2 1/2 minutes in one sortie. A minimum of four sorties per working day would thus yield an area coverage of 250 acres which would require more than seven working days by ground application means. Swath width can be adjusted by varying the flight heights and more positive control of spray drift can be accomplished by flying at low altitudes but at a reduced swath width. Nozzles can be calibrated and adjusted to spray optimum particle sizes. The AGRINAUTICS sprayer is designed for rapid installation in the UH-1 B/D helicopter and can easily

be removed in the field within a minimum of time should the helicopter be required for another type of mission. A technical description of the AGRINAUTICS, Model 3090, is attached as Annex I.

9. The Chemical Officer, FROKA, monitored the entire program in the FROKA area in an outstanding professional manner. The corps and division Chemical Officers, along with the regimental Chemical Officers, actively supervised defoliant applications. The overall staff planning and the initial plans submitted were complete and thorough in every detail. Initially, all commanders including corps, division and regimental displayed a great deal of interest and enthusiasm in the program; unfortunately, this enthusiasm was the result of the concept that defoliants would be applied in those areas considered to be most tactically significant, i.e. north of the South Tape within the DMZ. In initial plans for application, FROKA had planned to apply defoliants to extensive areas within the DMZ and adjacent to the MDL. The FROKA Chemical Officer was repeatedly briefed on the restraints and controls directed by CG EUSA but his efforts to prepare plans based on application only in the area between the South Tape and the Civilian Control Line were thwarted by the fact that the corps and division commanders involved in the project chose to make their own interpretation of directives. Thus, from the outset of planning, the division Chemical Officers prepared their plans based on guidelines received from the division commander which were contrary to the published guidelines. At this point, it was detected that corps commanders were exerting pressure and using personal influence to FROKA and ROKA Headquarters to lift the restrictions. It was only after positive statements were made by the CG FROKA to the effect that he was a soldier and was duty-bound to obey directives from higher headquarters and that he expected the same from his subordinate commanders that it became apparent to all commanders that violations would be reported and appropriate command action taken. Once commanders accepted the fact that they were bound to obey the restraints and control, planning proceeded in an orderly manner in accordance with Eighth U. S. Army guidance. However, it was readily apparent that once the commanders were finally convinced that

restrictions on the use of defoliants within the DMZ would not be relaxed, they lost all interest in the program and shifted their interest to projects which they considered more important. In an advisory visit to a ROK Corps headquarters, the commander openly stated to the Senior Chemical Advisor, KMAG that he could not understand why the United States would spend such a large amount of money for expensive defoliants and then waste them by not allowing him to use them in the DMZ where they were needed and desired. However, in almost the same breath, he stated he was impressed with the results of Monuron and desired to use additional quantities of Monuron in future defoliant operations.

10. (a) In spite of the apparent loss of interest by commanders, the Chemical Officers in the field were highly motivated and enthusiastic concerning the use of defoliants. For them it was an opportunity to prove that a technical service was capable of providing operational support in a tactical mission. During the planning period, an outstanding training program was conducted on the use of defoliants and the equipment provided for the operation. Personnel turbulence during the five month application phase necessitated repetition of training, consequently, all ROKA personnel who participated in the project were well trained and prepared.

(b) Initially, the main battle area (MBA) divisions experienced difficulty in defoliant application in that a lack of organization was evident. This was no doubt due to last minute changes in the plans, the lack of command interest when it was finally realized the defoliants could not be utilized as desired, and a reluctance on the part of lower unit commanders to detail their troops to this project when they had so many other high priority projects confronting them. However, within a short period following the initial shaky start, the operation was adequately organized and, in general, followed the planned schedule in an orderly manner.

(c) The physical stamina of the individual Korean soldier was remarkably demonstrated by the tedious and hard labor performed by troops in applying defoliants. Working in

1957

difficult terrain for long hours, and transporting their equipment and materiel on their backs, they diligently performed their job in the face of many dangers such as uncharted minefields and even friendly booby traps literally under the noses of observing North Korean troops.

c. OPERATIONAL CONSIDERATIONS

1. Command, Control, and Coordination:

(a) General

(1) Chief, KMAG was assigned responsibility for technical assistance and supervision of the vegetation control program by CG EUSA. This responsibility required KMAG to assume an operational mission, yet it is organized and staffed only to provide an advisory mission. As of April 1968, there were only four Chemical Corps Officers assigned to KMAG, two in the Chemical Advisory Section, HQ KMAG, one assigned to Det L, KMAG and one assigned to Det F, KMAG. The Chemical Advisory Det F KMAG is assigned specific logistical advisory duties and due to distance and travel limitations did not participate in the mission.

(2) As stated previously, responsibility for planning defoliant operations was delegated to the Engineer EUSA since that section had been originally tasked to make the feasibility study. At the time that the CG EUSA authorized the application of defoliants and stipulated that ROKA troops apply defoliants, the decision was made to task KMAG with supervision of the program. This was done for several reasons; BG James H. Batte, Senior Logistics Advisor, KMAG, as a Chemical Corps Officer, has had extensive experience in many technical fields of chemical operations; further, KMAG is a subordinate element of Eighth U. S. Army, thus reducing administratively the span of control. Execution orders and implementing instructions of a directive nature were released by P&P Div., G-3 EUSA. Other matters of an informative nature were released through Senior Chemical Advisor, HQ KMAG for the Chief, KMAG.

b6 b6

ANNEXES:

1959

ANNEX A: HERBICIDE FIELD EVALUATION, 21st ROK INF DIV (U)

1. (U) The only materials available for field evaluation were Monuron Telvar, an 80% active ingredient wettable powder formulation and a commercial weedkiller (2,4,D) which was released from Post Engineer assets for testing purposes.

2. (U) No special equipment was provided for testing as one objective of the test was to determine if the defoliants could be applied using TOE and TA equipment normally available to both US and ROKA units.

3. (C) Testing commenced on 9 October 1967 and was completed in approximately 10 working days.

4. (C) A summary of test findings are as follows:

(a) Applications were made at far from ideal conditions; the growing season was over and in the 21st ROK Division area, some killing frosts had been experienced.

(b) No visible reaction was noted in areas where Monuron was applied; this was anticipated. As of 8 June 1968, there was visible evidence that Monuron persisted in the soil over the winter season and is retarding growth effectively.

(c) Vegetation sprayed with 2,4,D began to react within 7 to 10 days as noted by discoloration and wilting.

(d) M106 dispenser (Mitey Mites) did not effectively dispense wettable powder. Hand sprayers (standard 2 gallon insecticide sprayers) worked adequately but the M8A2 decontamination trailer worked best and is the recommended equipment to be used in a ground applied herbicide program.

(e) Equipment application capabilities and operation requirements were determined to be:

(1) Hand sprayer, 2 men, 0.15 acres per hour

(2) M106, 3 men, 0.63 acres per hour

(3) M8A2 decon trailer, 5 men, 1.26 acres per hour

(f) There were no safety problems encountered and material in no way appeared to be injurious to rubber components of equipment.

1960

(b) KMAG Supervision

(1) Guidance from CG EUSA directed that whenever and wherever ROKA troops applied defoliants, a KMAG representative would be physically present to provide technical assistance and guidance. KMAG supervisory responsibilities were discharged in the following manner:

a In the I US Corps (GP), direct supervision of ROKA working teams was provided by Chemical Corps Officers and enlisted personnel assigned to the U. S. 54th CBRE Detachment and the Chemical Section, 2d U. S. Infantry Division. The Deputy Chemical Advisor, HQ KMAG was placed on TDY to HQ I US Corps (GP) and maintained daily contact with working teams applying defoliants.

b In the FROKA area, KMAG supervisors were detailed from advisory personnel assigned to the subordinate detachments of Detachment L, Detachments East, West, and Center.

(2) To provide guidance for KMAG personnel assigned supervision duties in defoliant application and to provide further guidance to ROK application teams, a comprehensive Standing Operating Procedure for vegetation control was published in bi-lingual format and distributed in sufficient quantities to be issued to working personnel. A copy of the SOP is attached as Annex J.

(3) There were some problem areas concerning KMAG supervision at the onset of defoliant applications which can be attributed to last minute changes in plans and the fact that U. S. personnel monitoring a ROKA operation was not entirely palatable to ROKA commanders. Initially when it was learned by ROKA commanders that KMAG supervision would be present throughout the entire operation, a considerable number of questions were tactfully asked by ROKA personnel as to why. When it was finally realized that the KMAG personnel were assigned by higher headquarters to assist and guide the defoliation

program, they were quickly accepted as members of the defoliation team and excellent relationships were developed at the working level. This, plus the fact that there was no serious injuries, accidents or incidents involving KMAG supervisors, indicates that the supervisory role of the operation was a success.

(4) As a parallel it was equally unpalatable to U.S. personnel in I US Corps that ROKA personnel only would make actual application of defoliants, a mission that U. S. Chemical Corps personnel are trained in and fully qualified to perform. However, as with ROKA personnel, when it was realized that this was a mandatory requirement it was accepted as such. Only one significant problem developed. In the 2d U.S. Inf Div area defoliant application was conducted by personnel of the 98th ROK Regimental Combat Team. Administrative delays due to clearance and access into areas north of the Imjin River plus the time consumed traveling to and from application areas significantly increased the time required to complete operations in the division area. Use of U. S. troops whose compounds are located north of the Imjin River could have reduced the time required to apply defoliants.

(5) The task of KMAG supervision did, however, exert its toll on the overall advisory function of Detachment L, KMAG. During the height of the defoliant operations, 15 June through 1 July when a massive effort was mounted to apply defoliants prior to the beginning of the rainy season, it was estimated by Detachment L, that its advisory function was reduced by 70% in order to accomplish its supervisory mission over FROKA defoliant operations.

2. Intelligence Implications:

(a) It has been assumed that the North Koreans would use any vegetation control program in or adjacent to the DMZ as the basis on which to charge the UNC with violating the Armistice Agreement and further would probably charge that the use of defoliants would be either "chemical" or "germ" warfare similar to charges by North Vietnam resulting from

the employment of defoliants in Vietnam. On 12 January 1968, news releases originating from the ROK Ministry of National Defense openly indicated the ROK Government's intention to employ defoliants in the DMZ area (Fig II-1). Though not acknowledged by the United Nations Command, these releases provided a factual test of ROK, North Korean, and third-country reaction. As of this date, the only reaction that has been registered was at a meeting of the Military Armistice Commission as discussed in the 22 January 1968 Stars and Stripes news release (Fig II-2).

(b) Within ROKA, all information concerning defoliation plans and operations were classified as "SECRET" with a limited distribution on a need-to-know basis. Defoliant application teams employed deceptive measures in those areas under observation from North Korean outposts by labeling equipment and supplies with the code words "CORN" for Monuron, "RICE" for Agent Blue, and "BEANS" for Agent Orange to give the impression that the working teams were planting crops.

(c) In mid-July, one EM of a FROKA unit that had been assigned to a defoliant application team defected to North Korea, however, there has been no information which would indicate that he revealed defoliation plans to the North Koreans.

(d) As of this date, there has been no reported indication that North Korea is aware of the testing and subsequent application of defoliants. Present indications are that the North Koreans have not exploited the use of defoliants in the vicinity of the DMZ by UNC personnel.

3. Coverage Accomplished (see Annex K): Although the total requirement of priority application totaled 24,115 acres. The quantities of defoliant materials received provided a coverage capability of only 19,984 acres. Based on reports submitted from I US Corps (GP) and FROKA, a total of 18,150 acres were reported covered which reflects a shortfall of 1,834 acres. This discrepancy in reported coverage can be explained by several considerations as follow:

(a) Field expedient methods of mixing and applying defoliants resulted in rough approximation. For example, in FROKA it appears that the average actual application rate varied for each agent as follows:

Agent	Recommended Application Rate	Average Application Rate
Monuron	250 lbs per acre	95 lbs per acre
Orange	3 gallons per acre	3.3 gallons per acre
Blue	3 gallons per acre	5.5 gallons per acre

(b) Areas treated with defoliants were not measured or approximated as acre plots but were visually estimated as 100 meter or 30 meter wide strips based on the priority designation of the area.

(c) In the case of Monuron applications, the low average application rate could be responsible along with the lack of rain for the delayed response time seen in Monuron treated areas. In the case of Orange and Blue, it appears that there were slightly heavy applications which may account for the extremely rapid responses gained from these agents.

4. Cost Estimation and Comparison on Techniques:

(a) Cost estimates of defoliation operations were developed from statistics obtained in actual defoliant applications in a 44 day period in which 3,345 ROKA personnel were engaged in applying defoliants over an area of 1,658 acres.

(b) Cost estimates of manual clearing were developed from data obtained by FROKA from manual clearing operations in the summer of 1967 in which 425 square kilometers were cleared at the expense of approximately 600,000 man days over a 30 day period.

(c) Estimates of both funded and unfunded costs indicate that clearing vegetation by the application of defoliants can be accomplished at a total cost of $165 per acre. If the cost of troop labor is funded on the assumption that the labor force

is always available and will be used as the requirement dictates, then the average cost of defoliants is estimated as $63 and 710 manhours per acre.

(d) A comparison of techniques and resultant costs and manpower per acre reveal the following comparison (See Annex M).

(1) Funded and unfunded cost estimates:

Technique	Cost Per Acre	Man Hours Expended
Manual	$0.12 (105,019 acres)	4,800,000
Defoliants	$165 (1,658 acres)	1,177,440

(2) Funded Costs Only:

Technique	Cost Per Acre	Man Hours Per Acre
Manual	None	4.6
Defoliants	$63 (average)	710

(e) Regardless of which method of vegetation clearance is employed, the most critical factor is the use of manpower rather than costs in that ROKA Forces are faced with many high priority projects such as Main Battle Area construction and hardening of defensive positions which require a staggering amount of manpower to accomplish; consequently, the use of military labor results in a significant decrease in military operations due to the impact of committing troop labor to such tasks.

(f) The conditions in Korea pertaining to accessibility, working hazards (due to minefields, and obstacles), vegetation and practicability (due to cost, labor and management) appear to dictate that no one method of clearing vegetation is best. A proper amalgamation of three methods: manual, mechanical and defoliants appear to be the best technique of vegetation clearance.

1965

III. (C) FINDINGS:

a. That cleared areas to improve visibility, increase contrast for night vision devices, and the reduction of cover and concealment for infiltration are an essential requirement in the DMZ Security System.

b. Monuron applications in the vicinity of the DMZ Security System fence contributed significantly to the strengthening of the defensive capability along the fence line. However, removal of vegetation cover may cause erosion problems in the future.

c. That the effects of Agents Blue and Orange were negated by regrowth of vegetation in those areas that defoliation was not followed up by controlled burning. The application of these agents in areas other than the DMZ fence trace was of doubtful tactical value. In addition, the drenching of vegetation with Agent Orange/oil mixture and the use of Orange on grassy areas were a waste of time and effort.

d. That the use of defoliants was a costly program of marginal success because:

1. Restraints and controls precluded the application of defoliants north of the southern boundary of the DMZ along the most logical approach routes and clearly the most desirable location for their use from the tactical point of view. As a result, a resource that could have had a very favorable impact from a tactical viewpoint was expended at considerable time and effort in far less critical areas.

2. The political value of the project was negated when, after providing the defoliants and selling the program to ROKA, the use of defoliants was restricted to the point where commanders lost interest in the project and turned their support and interest to other priority projects. Additionally, U. S. military personnel were used to monitor and report on the activities of the ROKA Forces. Although it is felt that the rapport of the advisor-counterpart relationship did not suffer under this arrangement, there were some minor feelings of mistrust at times.

That due to a last minute change in the type of defoliant allocated, there exists a requirement to continue control of vegetation by the use of a soil applied defoliant to the remaining 6,240 acres along the DMZ Security System trace.

f. That KMAG supervision of the defoliation program severly tasked the overall advisory mission to the point that the Detachment L advisory effort was reduced by 70% during the peak of the operation.

g. That the ground application of defoliants requires a massive amount of manpower and time. In addition, in the case of Agents Orange and Blue, the dilution, mixing, and liquid spray reduced the overall effectiveness of the defoliants and led to significant regrowth of vegetation.

h. That there has been no reported indication that North Korea is aware of the use of defoliants and there have been no attempts by North Korea to make a political harvest of propaganda by accusing the UNC of Armistice violations or the accusations of employing "chemical" or "biological" warfare as was anticipated.

i. That the aerial application of defoliants, particularly pelletized defoliants, is feasible and desirable for use in those areas adjacent to the DMZ Security System fence under carefully controlled conditions and under the proper meteorological conditions.

j. That the estimated cost of defoliant operations is $63 and 710 man hours per acre.

k. That insofar as a combination of practicability and costs are concerned, neither clearing by the use of defoliants nor the clearing by manual means can stand alone due to the consideration of weather, terrain, vegetation, and enemy and friendly capabilities. A careful combination of the two methods using the best one for specific problem areas appear to be practical, reasonably expensive, yet within the current capability of the United Nations Command in men and equipment.

l. That the stipulation that ROKA Armed Forces only could make actual application of defoliants considerably slowed down application progress in the U. S. 2nd Infantry Div. area.

m. That supervision and monitoring of the operational aspects of defoliant applications should be conducted by a headquarters adequately staffed to perform an operational mission with the technical guidance of qualified staff chemical officers.

IV. (C) CONCLUSIONS:

a. There is a need to continue the control of vegetation along the DMZ Security System fence and to extend this control beyond the southern boundary to include the most logical approach routes and other locations within the DMZ to deny enemy infiltrators the use of vegetation for cover and concealment.

b. The use of defoliants in conjunction with manual and mechanical clearing means in practicable, manageable and politically acceptable and if appropriate defoliant materials are again provided, is within the current capability of this command.

c. The use of Monuron significantly contributed to the strengthening of defensive capabilities along the DMZ Security System trace.

d. The use of Agents Orange and Blue in areas other than the DMZ fence line located to the rear of the South tape contributed very little to improving defensive positions.

e. The application of defoliants by ground means is difficult, expensive and requires a staggering amount of manpower. Carefully controlled aerial application would reduce the time and manpower required and in the case of Agents Orange and Blue would result in a more effective response.

f. Although it is probable that North Korea has concluded that defoliants have been used in Korea by UN Forces, there has been no reported indication of adverse propoganda or complaints of armistice violations.

g. ROKA Forces have shown that they have the technical competence and capability to conduct defoliant operations on a massive scale. Although this was accomplished under KMAG supervision, it is believed that future operations could be conducted with a minimum of supervision by U. S. personnel.

V. (C) RECOMMENDATIONS:

a. That defoliant applications in conjunction with manual and mechanical clearing be continued to provide positive extended control of vegetation.

b. That future defoliation plans be based on the use of a soil-applied selective herbicide to control bushy growth and not affect grasses in order to prevent soil erosion problems. First priority of applications should be established as the 7,800-acre along the DMZ Security System Fence.

c. That future defoliation plans include the controlled use of aerial spray systems for application of liquid and dry defoliants along the DMZ Security System trace and that the use of ground applied means of application be extended to include the use of defoliants in areas of tactical significance south of the MDL within the DMZ.

d. That action be initiated to expedite procurement and insure delivery in-country of the following defoliants prior to May 1969:

Defoliant	Quantity	Expected Area Coverage
TORDON 10K Pellets	624,000 lbs.	6,240 acres
Agent Orange	10,500 gals.	3,500 acres
Agent Blue	3,000 gals.	1,000 acres

1969

e. That action be initiated to procure three each AGRINAUTICS Aerial Spray Systems (FSN 3740-866-4481). Equipment should be delivered ASAP so that necessary training can be conducted prior to actual application operations. It is further recommended that spray equipment be allocated on the following basis:

FROKA - 1 Unit

I US Corps (Gp) - 1 Unit

Reserve - 1 Unit

f. That future defoliation projects be supervised by a headquarters staffed to support an operational mission with the guidance of staff chemical personnel.

g. That ROKA units be authorized to apply defoliants without the direct supervision of U. S. personnel and that U. S. units be allowed to make applications as required.

(g) The greatest problem area encountered was the resupply of mixing water to prepare a wettable powder suspension of Monuron. Using units recommended the use of granular or pelletized Monuron (UROX 22) which could be spread by hand, or mechanical broadcaster.

(h) As of this date, there have been no indications of adverse political reactions from North Korea or in the ROK itself.

(i) Based on a hypothetical 10-year program and using funded and unfunded costs, it is estimated that effective chemical control of vegetation can be conducted at an average cost of $408 and 25 man hours per acre.

5. (C) Figure A-1 illustrates a portion of the DMZ Security System fence trail along which Monuron Telvar was applied during testing in October 1967. As killing frosts had been experienced in this area, vegetation was dormant. Figure A-2 illustrates this same area as of July 1968. Note that some of the short grass is still active but in general, the area resembles that of typical vegetation in the dormant growing season.

ANNEX C: COMPARISON AND ESTIMATED COSTING OF CLEARING TECHNIQUES (U)

I. (C) INTRODUCTION: Estimated costing data for the three clearing techniques has been extracted and summarized from the data contained in Annexes G, H, and I to the study, "Clearance of Vegetation and Foliage in the DMZ Area (U)", EUSA Engineer 31 January 1968.

1. Clearing vegetation by the use of manual and mechanical techniques in both I US Corps (GP) and FROKA areas has been accomplished in the past and will probably continue in the future. In the FROKA area there are areas where steep slopes and rough terrain preclude the use of mechanical equipment. Conversely, there are areas in FROKA that could be more expeditiously and efficiently cleared by mechanical means. The use of defoliants in clearing and maintaining vegetation control in inaccessible areas due to minefields and trafficability appears to have merit.

2. The slow laborious technique of manual clearing of vegetation along the DMZ, includes the use of civilian and military personnel equipped with saws, axes, brush hooks and sickles.

3. Although cutting by hand is normally the accepted means in Korea, certain areas, such as minefields, cannot be cleared by this method without subjecting personnel to undue hazards. Any clearing operations near the DMZ also draw down on tropp strength as well as subjecting personnel to possible enemy attack.

4. The mechanical method of clearing vegetation is defined as an effort expended by either civilian (contract labor) or military personnel using equipment such as chain saws, bulldozers, road graders, etc. which increases the clearing rate per acre beyond what would be achieved by manual labor.

II. (C) COSTING ESTIMATES:

1. Assumptions: The model area for computation purposes consists of a corps area of 20,000 acres (38 miles long and 0.8 miles deep) which requires manual, mechanical, or herbicidal clearance over a 10 year period.

a. Estimated costs are based on current prices:

b. Where labor or operator wages are required, the average ROK wage of $1.50 per day will be used.

c. The model area will be covered with vegetation ranging from old Field to Forest Community with topography ranging from flat plains to steep mountains.

2. Manual Clearing:

a. Using data obtained from FM 5-34 manual clearing of undergrowth and trees less than 12 inches in diameter can be accomplished at the rate of 0.36 acres per 8 hour work day. Based on that rate, the sample area would require a 1,550 man work force each day of the year (4,526,000 man hours per year) to clear the area one time. It has been assumed that manual clearance once a year is adequate.

b. Utilizing the estimated prices for Korean hand tools and labor the 1,550 man work force, considering tool replacement, and a ten year period, the following estimate of funded and unfunded costs is provided:

(1) Equipment:

Tool	Unit Cost	1st Year Requirement	Life (Yrs)	Supply Frequency	Total Req'd	Total Cost
Saw	$7.00	1,500	2	1	1,500	$10,500
Axe	2.00	800	2-3	5	4,000	8,000
Sickle	1.20	800	2	5	4,000	4,800

1973

Tool	Unit Cost	1st Year Requirement	Life (Yrs)	Supply Frequency	Total Req'd	Total Cost
Brush Hook	$2.00	400	2	5	2,000	4,800
File	.40	10,000	2	2	20,000	8,000
Sharpening Stone	.25	400	2	4	1,600	400

(2) Labor 1,550 men; $1.50/day; 365 days/year; 10 years = $8,486,250.

(3) Transportation: 50 trucks; $1.50/truck hour; 3 hours/day, 365 days/year; 10 years = $821,250.

(4) Grand total $9,344,000.

(5) Based on the toal cost and the 20,000 acre requirement, the manual clearing cost per acre would be $467 and 229 man hours per acre over a 10 year period.

5. Mechanical Clearing:

a. Data presented is based on experience of the end US Inf Division in clearing the anti-infiltration barrier trace in 1966 and is as follows:

Item	Estimated Capability
Dozer w/blade	0.13 acre per hour
Chain saws	0.17 acre per hour
Mower w/tractor	2.00 acres per hour

b. The model area has been costed on a reasonable utilization of equipment; based on a 20% grass land and 80% scrub-forest vegetation. The use of chain saws has been costed based on a requirement to assist in the 80% area with a 4 hour day.

1974

c. Total Equipment:

(1) Chain saws at 0.17 acre/day for .80 X 20,000 acres, working 5 each four hour equipment days per week equals 23,275 equipment days or 4,655 equipment weeks, or 90 equipment years. For purposes of cost, estimate 150 chain saws will be used.

(2) Mower at 2 acres per hour for 2 X 20,000 acres, working 5 each 8 hour equipment days per week equals 2,000 equipment days or 400 equipment weeks or 8 equipment years. For purposes of cost estimate 12 mowers will be used.

(3) Bulldozer with angle blade at 0.13 acres per hour for .80 X 20,000 acres working 5 each 8 hour equipment days per week equals 15,400 equipment days or 3,080 equipment weeks or 60 equipment years. For purposes of cost estimate 60 bulldozers will be used.

(4) 10 Year Cost (Funded and Unfunded):

Item	Qty	Cost/ hour	1 Year Cost	Application Frequency	10 Yr Cost	Daily Cost
Mower	12	$2.00	$ 54,600	10	$ 546,000	$17.50
Bulldozer	60	4.00	$546,000	4	$ 2,184,000	$ 35.00
Chain Saw	150	.20	345	2	690	$ 2.30
Transportation					$ 468,000	
			GRAND TOTAL		$ 3,198,690	

*40 Vehicles: $1.50/vehicle hour, 3 hours/day, 260 days for 10 years.

(5) First year manhours:

1975

(a) The total manhours, based on equipment operation for the first year of the proposed program, is based on the following total by piece of equipment:

1 Mowers: 12 X 260 X 8 = 24,960 hours

2 Chain Saws: 150 X 260 X 4 = 156,000 hours

3 Bulldozers: 60 X 260 X 8 = 124,800 hours

4 Support: 40 X 260 X 8 = 83,200 hours (not costed)

(6) Based on the noted total cost and the 20,000 acres requirement, the mechanical clearing cost would be $160 and 20 man hours per acre over a ten year period.

4. Clearing with Defoliants: Data presented is based on the field herbicide evaluation conducted in September and October 1967 (Annex A).

a. Capability of an augmented chemical Combat Support Company, based on field evaluation, is computed to be 110 acres per day. Assuming that defoliants must be placed on the 20,000 acres in the model corps area in 90 days, it would require 2 chemical Combat Support Companies to accomplish the job.

b. 10 Year Cost for Model Area per Acre:

Item	1 Yr Cost	Supply Frequency	10 Yr Cost
Equipment (20 Co's)	$ 40,000	2	$ 80,000
Agent Blue	70,000	10	700,000
Agent Orange	131,250	10	1,312,500
UROX 22	1,080,000	5	5,400,000
Personnel (2 Co's 350 men)	49,250	10	492,500
Transportation (est)	18,000	10	180,000
		TOTAL	$ 8,165,000

1976

Mechanical 160 Manual HLS

Cost per acre = $\frac{\$8,165,000}{20,000 \text{ acres}}$ - $408.20/acre

Manpower = $\frac{504,000 \text{ man/hour}}{20,000 \text{ acres}}$ - 25.2 m/h per acre 20 225

1977

ANNEX D: Weather, Vegetation, Soil and Terrain (U)

1. (U) General: This analysis of weather, vegetation, soil and terrain has been summarized and extracted from Annex D to study "Clearance of Vegetation and Foliage in the DMZ area (U)", EUSA Engineer, 31 January 1968.

2. (U) The DMZ Security System Trace can be divided into three areas on the basis of topographic characteristics. The three areas include:

a. West DMZ - Extending from the mouth of the Imjin Valley to the point where the Imjin enters the ROK.

b. Center DMZ - From the point where the Imjin enters the ROK, east to the Soyang River.

c. East DMZ - From the Soyang River to the Eastern coast of the ROK.

3. (U) Weather:

a. General: The source of most of the variation in Korea's climate is the annual progression of the seasons. The cyclic alternation of the south and north monsoons of summer and winter, respectively, decisively control the climate. Due to the predominance of this monsoon control, the climate seasons are best delineated by wind flow. Within the lower layers of the atmosphere, immediately above the land surface, a persistent northerly wind flow characterizes the winter season. A persistent southerly wind flow distinguishes the summer season. In the intervening periods when the wind flow has no persistent direction, are spring and fall. Climatalogically the DMZ Security System Trace is also divided into three distinct areas. Temperatures, precipitation and winds will differ in the highground area of the Central DMZ, from the relatively low laying area of the West DMZ and the East DMZ.

b. Growing Season: Spring normally commences during the first week in April with the last frost occurring around 20 April, in the central portion of the DMZ. Broadleaf trees in Old Field, Scrub and Forest communities begin budding in late April. Flowering follows during early and mid May. Leaves begin to appear in late April and are fully developed in all species by late May. The effective cover of this foliage extends then from late May until the first severe frosts in late October. New shoots of grass species begin to emerge from the old plants in early April. Full growth is dependent on the species, the maximum height (one to one and a half meters) is reached by all species by mid June.

c. Dormant Season: Dormant season or winter season commences about the first of November, terminating about the last of March.

1978

The following data shows the mean dates of surface frost and thawing. Dates will vary, depending on the locality.

MEAN DATES, FREEZING AND THAWING OF THE SURFACE SOIL

	West DMZ	Central DMZ	East DMZ
Freezing	20 December	10 December	20 December
Thawing	20 February	1 March	20 February

4. (U) Vegetation:

a. Description of Communities along the Trace: Vegetation along the DMZ Security System Trace can be divided into four types of plant communities. The classification is based on four factors: Dominant species, soil type, water availability, and influence of man. These associations include:

(1) Old Field Community: The dominant species in an Old Field Community along the Trace include several grass species and sedges (Carex). Growth of these plants will reach height of one to one and one half meters during the growing season. Scrubs are common in the Old Field Community. Two of the most common are alder (Alnus) and willow (Salix). For a typical example see photograph, figure D-1.

(2) Scrub Community: The SCRUB community can be dominated by either needle leaf plants, mostly pine (Pinus) and juniper (juniperus) or broadleaf plants, or a mixture of the two. The broadleaf is dominated by oak (Quercus) and chestnut (Castenea). Other common species include birch (Betula), popular (Populus) and alder species. Trees vary in size between two and three meters. Though the soils of the SCRUB communities usually lack moisture and contain few nutrients, large areas along the Trace are covered by SCRUB as a result of man's influence through cutting, burning and clearing. This community occupies the larges percent of land along the Trace. For a typical example see photograph, figure D-2.

(3) Forecast Association: Trees in the FOREST community include mostly oak and chestnut. Pine is common and occasionally spruce and maple are observed. FOREST communities are limited to mountainous areas along the Trace particularly in the central DMZ. For a typical example see photograph, figure D-3.

(4) Cultivated Lands: Cultivated lands are found in the low wet areas along the rivers and streams both north and south of the DMZ beyond the limited access areas. For a typical example see photograph, figure D-4.

b. DMZ Vegetation: An analysis of the DMZ restricted area and the area to the south indicates the following percentage by type of community:

1979

(1) Old Field - 15%.

(2) Scrub - 70%.

(3) Forest - 10%.

(4) Cultivated - 5%.

5. (U) Soils: Soils along the Trace are both deep and shallow. Deep soils of finegrained clays and silts at a depth exceeding 2 feet are located at the extreme western portion of the Trace from the mouth of the Imjin River to a line connecting Kaesong and Munsan. From this line to Chorwon the soil is shallow to moderately deep and is composed of course and fine-grained sands and clays. Between Chorwon and Kumwha a third type, moderately deep fine-grained clays, is the dominant type. Finally from Kumwha to the east coast the soils are shallow and characterized by coarse and fine-grained sands and clays with rock fragments. All soils along the Trace are rated uncompacted.

6. (U) Terrain:

a. Topography:

(1) West DMZ: The area of the western part of the DMZ consists of rolling terrain and grassy plains, relatively easily accessible to vehicular traffic. The Imjin valley is the dominant feature. The eastern part of the western DMZ becomes mountainous with ragged and steep slopes up to 39 degrees, rising to an elevation of approximately 300 meters. The drainage pattern is mainly southerly.

(2) Central DMZ: Immediately south of the south tape, the western part of the Central DMZ consists of rolling terrain and grassy plains in the Chorwon area. East of Chorwon it becomes mountainous with elevations ranging excess of 350 meters. Steep slopes up to 70 degrees and ridges are characteristic. Trafficability is extremely difficult. Rivers drain south into the Han River basin.

(3) Eastern DMZ: East of the Soyang gang valley the terrain continues to be mountainous with slopes from 50 to 70 degrees and elevations in excess of 400 meters. Trafficability is extremely difficult. The terrain slopes relatively steeply towards the coast. Rivers in this area flow generally north into the Nam gang.

b. Drainage: When applying herbicides the following run-off characteristics should be considered:

(1) West DMZ: In the US sector, although there are virtually no cultivated areas north of the Imjin river, consideration should be

1980

given to possible pollution of the southern bank where rice is the predominent crop. The Yokkok Chon, originating in the Chorwon area, flows north through the DMZ into North Korea and meanders through North Korea for approximately 30 Kilometers to join the Imjin River at coordinates CT 1729. The main crop in this area is rice.

(2) Central DMZ: In the central part of the Central DMZ, a nameless stream originates at coordinates CT 8436 and drains north into the Kumsong River north of the DMZ. The Kumsong flows into the Pukhan River which in turn drains into the Hwachon resevior.

(3) Eastern DMZ: Streams and brooks along the eastern DMZ drain into the Nam Gong River. Rice fields are to be found within the Kosong area in North Korea and may become subject to pollution.

1951

ANNEX E: Technical Characteristics of Herbicides (U)

1. (U) Chemical control of vegetation and foliage has been an accepted agricultural practice for a number of years. The various chemical herbicides that are commonly used for this purpose are classified according to their effects as follows:

a. Dessicants are chemicals which rapidly dry up foliage causing the leaves to fall off of treated vegetation. Dessication can be effectively used to prepare vegetation for controlled burning during the growing season.

b. Herbicides are chemicals which are absorbed into the plant inhibiting growth and eventually killing the plant. Initial plant response is that the leaves and stems of the plant begin to die first causing the plant to be "defoliated". The second response is the eventual death of the plant which may occur two to three weeks later.

c. Soil applied herbicides are chemicals that are placed into the soil and are absorbed through the plant root system and then translocated throughout the plant causing defoliation and eventual killing of the plant.

2. (U) As a common meaningful designation and to prevent confusion the term "defoliant" rather than the term dessicant, herbicide, etc has been used throughout all briefings, correspondence and directives pertaining to the Vegetation Control Program CY 1968.

3. (U) Spraying defoliants as a means of improving both horizontal and vertical visibility where vegetation is dense has become an accepted practice in military operations in Vietnam. Research, which has been conducted for more than 20 years at the US Army Biological Laboratories, Fort Detrick, Maryland, has been confirmed for its use on a large scale, for certain defoliants by their successful use during the past six years in Vietnam. In Vietnam the military worth of herbicides as a new military weapon has been proven. The improvement of air-to-ground and ground-to-ground visibility has uncovered enemy positions, permitted observation of his movements and has been a primary factor in reducing the incidence of ambushes with a resultant saving of lives of allied military personnel.

4. (U) The defoliants that have been used in Korea have been in use in the United States for over 20 years. They are available commercially in the United States under a variety of trade names at most seed stores, garden shops and farm supply stores. In the summer of 1967 a commercial variety of 2,4 D was sold in the YONGSAN PX Garden Shop. Although the use of defoliants is recognized and is taught at agricultural colleges in Korea they are not generally used in agriculture in Korea due to the relative expense of the active ingredients and the plethora of cheap manual labor.

1982

5. (U) In order to avoid misunderstandings on what can be accomplished, by the use of defoliants on vegetation, it should be borne in mind that the utlimate effect of the chemicals will be to provide a vegetation condition similar to that of winter. With certain chemicals, the vegetation growth is completely stopped. While with others it may be temporarily defoliated and later refoliate. In any case the chemicals do not cause the vegetation to vanish. The trunks and branches of trees, for example, remain in place until removed by man or nature. In any case the chemicals do not cause the vegetation to vanish. The trunks and branches of trees, for example, remain in place until removed by man or nature. In Vietnam, it has been noted that when trees 50 to 100 feet high were defoliated by aerial spray, there was an increase of approximately 80% in vertical visibility and horizontal visibility was improved 50%.

6. (U) As a result of tests and data obtained from defoliant operations in Vietnam and field evaluation in Korea as well as recommendations from the US Army Biological Laboratories, Fort Detrick, Maryland the following defoliants were selected for use in Korea:

a. Agent Orange: A 50:50 mixture of normal butyl esters of 2,4-diphenoxyacetic acid (2,4-D) and 2,4, 5-triphenoxyacetic acid (2, 4, 5T). It is a systemic plant poison which when absorbed into the plant through foliage and translocated throughout the plant causes a rapid withering followed by death of the plant within 2 to 3 weeks. It is specific for broad leaf plants and is effective against most trees and woody brush including evergreens, locust and scrub oak. Generally speaking narrow leaf plants which include most grasses are not affected by Agent Orange. Effective defoliation and death of most susceptible vegetation can be expected from an application rate of three gallons of active agent per acre. Agent Orange was applied as a liquid spray and was mixed with No 1 diesel oil at a rate of 3 gallons of Orange to 50 gallons oil for spray of a one acre area. Agent Orange is relatively non toxic and no danger exists to warm blooded animals in connection with its handling and application. Figure E-1 illustrate the vegetation cover along a road near the DMZ. Figure E-2 illustrate the same area after treatment with Agent Orange.

b. Agent Blue: A liquid formulation of cacodylic acid known commercially as PHYTAR 560G. It is used for the rapid dessication, or drying out, of the leaves of woody and grassy growth, particularly narrow leaf growth such as annual and perennial grasses. It has an extremely fast response time of 3 to 5 days for this type of vegetation and is especially effective in preparing vegetation of a high water content for controlled burning. Rice and other cereal grain crops belonging to the narrow leaf family of plants are extremely sensitive to this agent, in fact Blue has been used in Vietnam as a specific agent to destroy Viet Cong rice crops. Agent Blue is applied as a liquid spray and is mixed with water at a ratio of 3 gallons of Blue to 50 gallons of water for application to a one acre area. Figure E-3 shown

1983

a possible ambush area adjacent to a tactical road Figure E-4 is the same area following application of Agent Blue.

c. Monuron UROX 22: This agent is a pelletized solid containing 22% Monuron trichloroacetic acid and is an all purpose semi-permanent soil applied herbicide. It is effective for the long term control of perennial and annual grasses, vines, broadleaf weeds, trees and woody plants. This agent is spread by hand or mechanical broadcast in the same fashion as pelletized fertilizer and is applied to the soil immediately prior to or at the beginning of the growing season. Once applied to the soil Monuron slowly dissolves and is absorbed into the soil where it is absorbed into the root systems of plants and is further translocated throughout the plant causing defoliation and eventual killing of the plant. Rainfall is required to dissolve the pellets and cause absorption into the soil; therefore, two to three months may be required before a visible effect of the agent may be observed. Once applied to the soil Monuron is expected to be effective for up to two growing seasons. It is comparitively non-toxic and no danger exists to man or animals in handling and application.
To illustrate the effect of Monuron UROX the tree in Figure E-5 was treated with a basal application on 10 April 1968. Figure E-6 shows that as of 3 July 1968 the leaves were browning and the tree was beginning to die in contrast to the fully developed foliage of adjacent untreated vegetation.

1984

COMPARISON OF HERBICIDE EFFECTS

AGENT:	ORANGE	BLUE	MONURON UROX 22
CLASSIFICATION:	HERBICIDE	DEFOLIANT (DESSICANT)	SOIL APPLIED HERBICIDE
CHEMICAL COMPOSITION:	50:50 MIXTURE 2,4D AND 2, 4, 5T	CACODYLIC ACID (PHYTAR 560G)	COMMERCIAL PREPARATION (ALLIED CHEMICAL CO.)
EFFECTED VEGETATION:	WOODY GROWTH, TREES BROAD LEAF WEEDS	WOODY AND GRASSY	WEEDS, TREES, WOODY PLANTS AND PERENNIAL GRASSES
METHOD OF DISSEMINATION:	LIQUID SPRAY (OIL BASE)	LIQUID SPRAY (WATER BASE)	HAND OR MECHANICAL BROAD CAST
DURATION OF EFFECTIVENESS:	ONE GROWING SEASON	MAXIMUM DEFOLIATION IN 2 TO 3 WEEKS	TWO GROWING SEASONS
RESPONSE TIME:	2 TO 3 WEEKS	3 TO 5 DAYS	2 TO 3 MONTHS
TOXICITY:	NO EFFECT ON WARM BLOODED ANIMALS	LOW (COMPARABLE TO ASPIRIN)	NON-TOXIC

1985

Annex F

SUMMARY OF EQUIPMENT AND MATERIEL FOR VEGETATION CONTROL

FSN	NOMENCLATURE	UNIT PRICE	QUANTITY	SOURCE OF SUPPLY	TOTAL COST
6840-926-9094	Agent Blue	$ 275 per drum	635 drums	AF Stocks, Vietnam	$ 174,625
6840-915-6351	Agent Orange	$ 385 per drum	380 drums	AF Stocks, Vietnam	$ 146,300
9140-274-1912	DFM Diesel Oil	$ 5.50 per drum	7,000 drums	EUSA	$ 38,500
6840-685-5449	Monuron UROX 22	$ 30 per drum	7,800 drums	CONUS	$ 234,000
NSN	Herbicide Dispenser	$ 25 each	50 each	CONUS	$ 1,250
3740-916-6462	Insecticide Sprayer GED, 180 gal per hr	$ 160 each	22 each	CONUS	$ 3,520
3740-641-4719	Insecticide Sprayer Hand-held, 2 or 3 gal capacity	$ 25 each	200 each	EUSA	$ 5,000
				TOTAL COST:	$ 603,195

20,000 G/A

1956

ANNEX G

PRIORITY, SCOPE, AND DEFOLIANT REQUIREMENTS

PRIORITY	MATERIAL	I CORPS (CP) SCOPE (ACRES)	I CORPS (CP) QUANTITY	FROKA SCOPE (ACRES)	FROKA QUANTITY	TOTAL QUANTITY	TOTAL ACRES
1 DMZ SECURITY SYSTEM FENCE	MONURON	2,200	110,000 LB	5,600	280,000 LB	390,000	7,800
	ORANGE	1,730	5,190 GAL	2,650	7,950 GAL	13,140 GAL	4,380
	BLUE	1,500	4,500 GAL	0	0	4,500 GAL	1,500
2 CP's and OP's	MONURON	0	0	0	0	0	0
	ORANGE	450	1,350 GAL	1,365	4,095 GAL	5,440 GAL	1,815
	BLUE	1,400	4,200 GAL	0	0	4,200 GAL	1,400
3 ROADSIDES	MONURON	0	0	0	0	0	0
	ORANGE	300	900	0	0	900 GAL	300
	BLUE	1,550	4,650 GAL	5,370	16,110 GAL	20,760 GAL	6,920
						TOTAL	24,115 ACRES

1967

orange=1948D 6/4

ANNEX H

ALLOCATION OF DEFOLIATION EQUIPMENT AND MATERIEL

MATERIEL	I US CORPS (CP)	CAPABILITY	FROKA	CAPABILITY	TOTAL CAPABILITY
MONURON (UROX B)	2,900 dms (145,000 lbs)	580 acres	4,900 dms (245,000 lbs)	980 acres	1,560 acres
AGENT ORANGE	135 dms (7,425 gal)	2,475 acres	245 dms (13,475 gal)	4,491 acres	6,966 acres
AGENT BLUE	274 dms (15,070 gal)	5,023 acres	351 dms (19,305 gal)	6,435 acres	11,458 acres
*DIESEL OIL	2,500 dms	N/A	4,500 dms	N/A	N/A
				TOTAL COVERAGE CAPABILITY:	19,984 acres

1584

* Used for mixing w/Agent Orange at a ratio of 50 gals per 3 gal Orange

Standard Operating Procedures for Vegetation Control (U)

식물 통제 예규 (보)

operations when required weather conditions are exceeded.

지휘관에게 작업 중지 건의.

g. Report to Detachment L all areas which are treated, identifying

살초 작용제 살포 지역 (범위와 위치)과, 사용된 화학제 (양)

the area sprayed (size and location), and agent used (amount). See Annex A.

를 포함한 작업 실시 전 지역을 "앨" 파견대에 보고. (부록 에이. 참조)

h. Observe and report agent effects on areas previously sprayed,

기 작업 실시 지역에 대한 화학 작용제의 효과와, 가능시는

to the degree possible. See Annex A.

효과의 정도도 보고. 부록 에이. 참조.

3. (C) Agnet Characteristics:

(111) 화학 작용제의 특징:

a. Monuron: Monuron is an all purpose, semi-permanent soil sterilant

머뉴론 : 머뉴론은 그 사용 목적이 다양하며 반 영구적 초토제로서

effective in the control of perennial grasses, weeds, trees, and woody

다년생 식물, 잡초, 초목 및 기타 임산 식물 통제에 효과적임.

plants. The form of Monuron to be used in Korea is Urox 22. It should

한국에서 사용될 머뉴론의 형태는 유락크스 22이며, 본 살초제는 초목

be applied to the soil just before or during the growing season so that

성장기 직전이나 성장 기간중 지면에 살포함으로서 식물의 뿌리로

it can be carried down into the root zone for absorption into the plant.

흡수토록 한다. 화학제가 일단 식물에 흡수되면 그 작용은

Once absorbed into the plant its action is slow, requiring 2 to 3 months

서서히 나타나기 시작하여 큰 식물을 죽이는데 2내지 3개월이 소요

to kill larger plants. It is non-toxic and presents no particular

된다. 본 살초제는 독성이 없고 취급과 사용에 특별한 위험성은

hazard in handling or application except that it is slightly irritating

없으나 피부나, 코 및 목구멍을 약간 자극 시킨다.

to the skin and the nose and throat.

1989

Standard Operating Procedures for Vegetation Control (U)

식물 통제 예규 (보)

operations when required weather conditions are exceeded.

지휘관에게 작업 중지 건의.

g. Report to Detachment L all areas which are treated, identifying

살초 작용제 살포 지역 (범위와 위치)과, 사용된 화학제 (양)

the area sprayed (size and location), and agent used (amount). See Annex A.

를 포함한 작업 실시 건 지역을 "앨" 파견대에 보고. (부록 에이. 참조)

h. Observe and report agent effects on areas previously sprayed,

기 작업 실시 지역에 대한 화학 작용제의 효과와, 가능시는

to the degree possible. See Annex A.

효과의 정도도 보고. 부록 에이. 참조.

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effective in the control of perennial grasses, weeds, trees, and woody

다년생 식물, 잡초, 초목 및 기타 임산 식물 통제에 효과적임.

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be applied to the soil just before or during the growing season so that

성장기 직전이나 성장 기간중 지면에 살포함으로서 식물의 뿌리로

it can be carried down into the root zone for absorption into the plant.

흡수로록 한다. 화학제가 일단 식물에 흡수되면 그 작용은

Once absorbed into the plant its action is slow, requiring 2 to 3 months

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to kill larger plants. It is non-toxic and presents no particular

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hazard in handling or application except that it is slightly irritating

없으나 피부나, 코 및 목구멍을 약간 자극 시킨다.

to the skin and the nose and throat.

1950

Standard Operating Procedures for Vegetation Control (U)
식물 통제 예규 (보)

b. Agent ORANGE: A mixture of two systemic herbicides known chemically
오렌지. 작용제: 이것은 두 개의 분류가 다른 살초제의 혼합물로서
as 2,4D and 2,4,5T, both of which are available commercially in the United
화학 분야에서는 2,4디. 와 2,4,5디. 라 부르며 이는 미국에서 상품화되어
States and are widely used by homeowners to kill weeds in lawns, along
있으며 가정에서 잔디나 집 주변의 잡초를 죽이는데 널리 이용되고
fence lines, and around borders. Agent ORANGE is a systemic plant poison
있다. 오렌지. 작용제는계획적인 초목 유독제로서 식물의 잎에 흡수되면
which, when absorbed into the leaves of plants causes rapid defoliation
신속한 낙엽 초과를 나타내어 궁극적으로는 그 식물을 죽이게 된다.
and eventual death of the plant. Agent ORANGE is effective against most
이 오렌지. 작용제는 상록수와 인동 덩굴 및 기타 덩굴과 잎이 큰
trees including evergreens, woody growth such as honeysuckle and other
식물과 같은 우거진 식물을 포함한 활엽수에 효과적임. 이 살초제는
vines, and most broadleaf plants. The agent is disseminated as a spray,
분무식으로 살포하며, 취급하는데 있어서나 사용하는데 있어서 온혈
and no danger exists to warm blooded animals in connection with its handling
동물에는 하등의 위험성이 없다. 이 살초제를 사용한후 비가 많이 나리면
or application. If there is heavy rainfall following application the
미소량의 살초제가 빗물을 따라 관개 배수로로 흘러들어갈 가능성은
possibility exists that traces of the agent may be carried in run-off water
있으며 물이 살초 지역으로부터 멀리 갈수록 살초제는 점점 희박해져
into irrigation ditches; however, the farther the water travels from the
농작물에 대한 피해 가능성은 감소된다.
sprayed area, the greater will be the dilution factor and the possibility
of crop damage will decrease.

c. Agent BLUE: Agent BLUE is a liquid solution of cacodylic acid
부루. 작용제 : 이 살초제는 일반 시장에서 싸다. 560즈..라부르는.

1971

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known commercially as Phytar 560G. It is used for rapid drying out of the
비소산 액체 용액이다. 이 작용제는 잎이 무성한 식물의 잎을 신속히
foliage of woody and grassy vegetation and is particularly effective in
건조시키는데 사용되며 다년생 식물을 장기간 통제하는데 특히
the extended control of perennial grasses. Rice is extremely sensitive to
효과적이다. 벼는 이 살초제에 극히 민감하다.
this agent. It is disseminated in a spray form and when applied during dry
이 작용제는 분무식으로 살포되며 건조기에 사용하면 신속히 흙속으로
weather there is little danger of run-off water carrying traces of Agent
흡수 분해 됨으로 동 작용제가 빗물을 따라 논답으로 흘러들어갈
BLUE into rice paddies since the agent is rapidly inactivated in the soil.
위험성은 거의 없다.
Agent BLUE is water soluble and will not be effective if applied during
부루. 살초제는 물에 용해되며 강우시에 사용하면 효과가 없으며
rain; and if rain occurs within 12 hours of application, considerable
또 사용후 12시간내에 비가 나리면 효과가 상당히 감소 된다.
degradation of effects can be expected. Additionally, rain immediately
이 외에도 사용중이나 사용 직후에 비가 나리면 빗물과 함께
after or during application will increase the possibility of crop damage
흘러가 농작물에 대한 피해 가능성이 증가된다. 독성면에서 볼때
due to run-off. As for toxicity, Agent BLUE is about as toxic as aspirin.
부루. 살초제는 아스피린. 정도의 유독성이 있다. 이 작용제를 취급
Personnel handling or applying this agent should take normal sanitary
하거나 사용했을때는 몸을 씻는것과 같은 정상적인 위생 대책을
precautions of washing after handling.
취해야 한다.

4. (C) Application restrictions:

(111) 사용상의 제한 사항 :

a. No agents will be applied within the DMZ. All areas must be
비무장 지대내에서는 살초제 사용을 금지한다. 모든 사용
south of the south Tape. Agents will NOT be applied in areas which are
지역은 반드시 남방 한계선 이남이어야한다. 다음과 같은 상황하에서는

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immediately adjacent to the South Tape if:

살초제를 남방한계선 직 부근지역에 사용함을 금한다:

(1) There is a possibility of run-off into the DMZ. Areas of

비 무장 지대안으로 흘러들어갈 가능성이 있을때.

application close to the DMZ will have a positive southward drainage

비 무장 지대에 가까운 지역에서 사용할때는 남방 한계선과 사용

between the South Tape and the application area.

지역 간에 분명히 남쪽으로 흐르는 배수로가 있어야 한다.

(2) There are winds blowing which could cause possible agent

살초제를 비 무장 지대나 건답으로 날아가게할 정도의

drift into the DMZ or into food crops. With wind speeds over 5 MPH,

바람이 불 경우. 그리고 5마일의 풍속하에서 실험한결과 살초제가

agent drift has been observed for distances up to 3 miles.

3마일 지점까지 날아간 경우가 있었다.

b. Extreme care will be taken to avoid damage to food crops. No

농작물에 대한 피해를 방지하기 위해 각별한 주의를 경주해야한다.

agent will be applied within 200 meters of food crops.

건답으로부터 200미터 이내 지역에서는 살초제의 사용을 금한다.

c. Spray operations will be conducted so as to avoid contaminating

강 물이나 물이 고인 곳에 오염되지 않도록 살포 작업을 해야

streams and standing water. Special caution will be used when cleaning

한다. 살포 장비를 세척할때는 물을 오염시키지 않도록

spray equipment to proclude gross contamination of water bodies.

각별한 주의를 경주해야 한다.

d. Spray operations with BLUE and ORANGE will not be performed when

강우시는 부루. 나 오렌지. 작용제를 살포해서는 않되며 또

it is raining, and BLUE should not be applied if rain is predicted within

12시간 이내에 강우 예보가 있을때도 부루. 작용제는 사용해서는

12 hours. Monuron can be applied during light rain but should not be

않된다. 머뉴론. 작용제는 가랑비가 나릴때 사용하여도 무방하나

applied during heavy rain or when heavy rain is predicted, since heavy

호우시나 호우 예보가 있을때는 사용해서는 않된다. 왜냐하면

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rain might carry the Monuron with the run-off water rather than working
머뉴론. 작용제가 사용지역의 식물의 뿌리로 흡수되지 않고 빗물에
it into the root zone within the area of application.
씻겨 흘러갈 가능성이 있기 때문인 것이다.

5. (C) Application Priorities:

(111) 사용상의 우선 순위 :

a. Priority 1:

우선 순위 1:

(1) A strip approximately 100 meters on either side of the fence
방책선에서 약 100미터 폭의 지역 (어느 한쪽이면 한쪽) 에다
will be treated with Monuron and ORANGE. The width of the strip will vary
머뉴론. 이나 오렌지. 작용제를 사용한다. 이 100미터 지역의 폭은 지형
some what depending on the terrain and current installations.
이나 현존 시설물에 따라 다소 차이가 있을것임.

(2) In areas where the fence is north of the South Tape, NO
방책이 남방 한계선 북방에 위치한 지역에는 여하한
agents will be applied. These areas will be cleared manually.
살초제도 사용해서는 않된다. 이러한 지역은 인력으로 초목을 제거해야한다.

(3) No agents will be used along the fence when the South Tape
남방 한계선이 방책 아래쪽으로 경사를 이루고 있을때는
is down slope from the fence. These areas will be cleared manually.
살초제를 울타리를 인해 사용해서는 않되며 인력으로 초목을 제거해야 한다.

b. Priority 2: Check Points (CP's) and observation posts (OP's).

우선 순위 2: 검문소와 관측소.

A strip approximately 100 meters wide will be cleared around the entire
이러한 시설물의 전 외곽을 따라 약 100미터 폭의 지대는 사계 청소해야
perimeter of these installations. The first 50 meters will be cleared
한다. 처음 50미터폭의 지대는 인력으로 하고 잔여 50미터는
namually and the next 50 meters will be treated with one of the three
위 제한 사항에 위배되지 않는한 위 세가지 살초제중 한가지를 사용

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agents, provided application does not result in violation of the above

사계 청소 한다.

restrictions.

c. Priority 3: Roads and MSR's between the CCL and the South Tape.

우선 순위 3: 남방 한계선과 민통선 간의 도로 및 주 보급로.

A strip 60 meters wide (30 meters on each side of the road) will be

상기 제한 사항에 위반하지 않는한 도로 양쪽 30미터씩 60미터 폭의

treated provided it does not violate the above restrictions. The actual

지역에 살초제를 사용한다. 이 지역의 실제 폭은 지형에 따라

width of the strip will vary depending on terrain and the agents may be

일정하지 않을것이며 또 살초제의 종류도 대상 식물에 따라

varied depending on the vegetation. Agents BLUE and ORANGE will be used

다를수 있다. 작용제 부루. 와 오랜지.는 대부분 우선 순위 3 지역에

for the most part on priority three areas.

사용 된다.

6. (C) Equipment:

(111) 장비 :

a. M8 trailer mounted power driven decon apparatus.

엠.8 트렉타 탑제 동력 제독기.

b. Hydro - pump defoliation sets.

고압식 살포기.

c. Hand sprayers.

수동식 살포기.

d. M106 disperser (Mity Mite).

엠.106 분무기 (마이티. 마이트.)

e. Herbicide Dispensers (granular).

살초제 유포기 (입자식).

7. (C) Equipment and Agent Handling Procedures.

(111) 장비 및 살초제 취급 절차.

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a. Agents will normally be diluted by mixing with diesel oil or water before being applied. Dilution rates can be varied depending upon the equipment being used to spray and the agent and the amount of agent desired per acre. For this operation the rate of dilution and application to be expected are:

살초제는 사용전에 디젤유 나 물과 혼합하여 농도를 희박하게하는것이 통상이다. 작용제의 농도는 분무에 사용되는 장비와 1 에이커 당 사용하는 양에 따라 다르다. 이와같은 작업을 위해 기대하는 살초제의 농도와 사용량은 아래와 같다 :

(1) Monuron - Granules are to be broadcast by hand or mechanical spreaders at the rate of 250 pounds per acre.

뮤뉴론 - 1 에이커 당 250 파운드를 손이나 기계 분무기를 사용 살포 한다.

(2) ORANGE - 3 gallons of agent with 50 gallons of diesel oil per acre.

오랜지 - 1 에이커 당 3가론의 살초제와 디젤유 60가론을 혼합 살포한다.

(3) BLUE - 3 gallons of agent with 50 gallons of water per acre.

부루 - 1 에이커 당 살초제 3가론과 물 50가론을 혼합한다.

b. Although none of the three agents being employed are toxic to humans, skin irritations may be noticed during prolonged contact. All personnel should take normal precautions to maintain personal cleanliness and to avoid ingestion or prolonged skin contact with agents.

위 세가지 종류의 살초제가 인간에게 유독성이 있는것은 아니나 장시간 접촉하면 피부를 자극시킬수도 있다. 모든 인원은 항상 몸을 청결하게 하고 살초제를 흡입하거나 장시간 피부에 접촉시키지 않도록 평상시 취하는 방비책을 취해야 한다.

c. Spray equipment should be flushed after each days operation with the material used to dilute the agent.

살포 장비는 매일 사용후에는 살초제 용해물질로 씻어야 한다.

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(1) Equipment used to apply Monuron and Agent BLUE will be

비뉴론. 과 부루. 작용제 살포에 사용된 장비는

flushed with water.

물로 씻어야 한다.

(2) Equipment used to apply Agent ORANGE will be flushed with

오렌지. 작용제 살포에 사용된. 장비는 디젤유로

diesel oil. Oil used to flush equipment will be placed in an empty

씻어야 한다. 장비를 씻는데 사용된 유류는 오렌지. 작용제가

Agent ORANGE barrel for use in the next day's mixing operations.

들어 있었던 통에 넣어 두었다가 익일 작용제 혼합작업에 사용한다.

d. When equipment is being changed over from use with Agent BLUE to

부루. 살초제 살포에 사용한 장비를 오렌지. 살초제 살포에 사용

use with Agent ORANGE, the equipment will be throughly flushed with water

하려면 해당 장비를 물로 구석구석이 세척한후 기름을 발라야 한다.

and then rinsed with oil. Oil rinse followed by water rinse will be used

그리고 오렌지. 살초제로부터 부루. 살초제 살포에 사용할때는 우선 물로

when changing from ORANGE to BLUE.

씻은후 기름을 바른다.

e. Caution must be taken to assure agents are not mixed together.

종류가 상위한 살초 작용제가 서로 혼합되지 않도록 주의해야 한다.

For example, if BLUE and ORANGE solutions were mixed, a solid material

예를들면, 만약 부루. 작용제와 오렌지. 작용제 용액이 혼합되면 단단한

would be formed which would clog equipment and would neutralize completely

물질로 화하여져서 장비의 분무 구멍이 막히게되고 또 살초제를 완전히

or partially both agents.

또는 부분적으로 중화시키게된다.

f. Empty agent barrels (BLUE and ORANGE) must not be left open

부루. 나 오렌지. 작용제가 들어 있었던 빈 통은, 통안에 잔여

until flushed to remove defoliant residue. When empty and no longer

작용제를 모두 물로 구석구석이 씻어낼때까지는 뚜껑을 열어둔채로둬서는 않된다.

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required for mixing operations they will be flushed at the application site
며 이상 살초제 혼합에 필요가 없는 빈 통은 살초제 사용장소에서 디젤이나
with diesel or water as appropriate. Intact drums will be sealed and
물로 세척한다. 사용하지 않은 통은 밀봉하고 야전군 임위로 차후
gathered intact at a centralized location for subsequent disposal and use,
처분 과 사용을 위해 일정한 장소에 모두 집결하여 촉수 엄금해 둔다.
as appropriate by FROKA.

g. Empty Monuron fiber drums will be destroyed by burning at the
빈 머뉴론. 확이바 통은 매일 작업완료후 사용 현장에서 불
end of each days operations at the application site. Under NO circum-
태워 버린다. 여하한 경우를 막론하고 머뉴론. 작용제 통의 재
stances will Monuron containers be salvaged for reuse.
사용을 위해 보관해 둬서는 않된다.

h. Oil drums will not be used to mix agents. Agent/oil mixing
살초 작용제 혼합에 유류 통을 사용해서는 않된다. 살초 작용제와
and agent/water mixing will be accomplished in agent drums, and/or drums
유류의 혼합이나, 살초 작용제와 물의 혼합은 반드시 살초제 도람통이나
provided for this purpose. Drums used for mixing purposes will be marked
이러한 혼합을 위해 마련된 통으로 혼합해야 한다. 살초제 혼합에 사용된
as Agent drums and will be disposed of as prescribed in paragraph 7f above.
도람 통은 화학 작용제 통이라 표시하고 위 7조 에프.항에 의거 처리해야한다.

8. (C) Reporting:

(iii) 보 고 :

a. Unclassified telephonic reports will be submitted daily to Det L,
살초 작업을 완료했을때마다 고문단 엘. 파견대에 매일
KMAG, following each defoliation operation conducted. Reports will be
평문으로 유선 보고 한다. 제반 보고는 보록 에이.에 명시된 보고
submitted prior to 2400 hours using the report format provided at Annex A.
양식을 사용 당일 자정 까지 보고완료해야 한다.

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b. In cases where advisors observe violations of the restrictions

상기 제 4조에 명시된 제한 사항에 위배되는것을 목격 하거나

outlined in paragraph 4 above, or observe violations about to be committed,

이를 위반할 우려가 있음을 목격한 관계 고문관은 다음과 같은 조치를

the following actions will be taken:

취한다 :

(1) Call the violation to the attention of the application team

작용제 살포조 지휘관에게 위반사항을 지적해 주는 동시에

commander, and point out the nature of the restriction being violated or

위반했거나 위반할 우려가 있는 제한 사항의 내용을 지적해 준다.

about to be violated.

(2) Advise the team commander that he should issue orders to

살포조 지휘관에게 작업중지 명령을 내리도록 건의하고

cease operations and that he should take corrective actions to assure

규정된 제한 사항을 준수토록 필요한 시정조치를 취하도록 건의

compliance with the restrictions.

한다.

(3) If advise is promptly complied with, the advisor need take

고문관의 건의를 받아드려 이를 실천하면 고문관은 이

no further action in the matter, except that the incident must be included

문제에 대해 더 이상의 조치를 취할 필요는 없으나 위반사항은 반드시

in the daily report.

일일보고에 포함시켜야 한다.

(4) If the application team persists in committing the violation

만일 살포조가 계속 위반을 하거나 살포조 지휘관이 위반

and the team commander takes no action to stop the violation, a report of

중지를 위해 하등의 조치를 취하지 않을 경우에는 이 사실을 가능한 가장

the matter must be made immediately to Detachment L through the Forward

신속한 방법으로 전방 고문단 파견대장 경유 앨. 파견대에 신속히

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Detachment Commander, by the most expeditions means available.

보고 해야 한다.

9. (C) Coordinating Instructions:

(111) 협조 지시.

a. Detailed task organization and precise scheduling information

작업 담당 부대와 정확한 작업 계획에 관해서는 관계

will be obtained from the appropriate Corps and Division headquarters.

군단이나 사단 사령부로부터 획득 할것.

Senior Advisors will coordinate weather forecasts and other operational

수석 고문관은 매일 관계 군단이나 사단 사령부와 기상 예보와 기타

matters on a daily basis with the appropriate Corps or Division headquarters

작전 문제를 협조하고 계획된 작전에 관해 군단이나 사단을 조언해

and will advise them concerning scheduled operations. In cases where

줄것. 군단과 사단 사령부에 의해 작업이 취소되었을때는

operations are cancelled by Corps and Division Headquarters, contact with

고문단 대표는 작업조와 연락 작업 취소 명령 접수 여부를

application teams will be made by the KMAG representative to verify

확인 할것.

receipt of the cancellation order.

b. Weather forecast information will be obtained from the sources

기상 예보는 작전 기간중 매일 다음 출처로 부터

indicated below on a daily basis during the duration of the operation.

획득 할것.

Detachment L G-3 will inform forward detachments immediately upon receipt

앱. 파견대 작전처는 여하한 기상 예보의 변동사항을 접수한 즉시

of any changes to weather forecasts.

전방 고문단 파견대에 전달 할것..

(1) Weather forecast transmitted by 20th Weather Squadron.

제 20 기상대로 부터의 기상 예보.