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1. Purpose of Trip:

a. To assist US and Republic of Vietnam (RVN) personnel in RVN in recognition of herbicide damage on vegetable crops, tree fruits and rubber as differentiated from insect and disease damage.

b. To become familiar at firsthand with all operational phases of the defoliation and crop destruction programs in RVN.

c. To provide technical assistance in the application and use of vegetation control agents to Chemical Operations Division personnel and other military and civilian personnel associated with the defoliation program.

d. To assess the effects of the recent policy suspension on the use of agent WHITE for defoliation.

2. Personnel Contacted:

COL H. C. Kinne, Jr., Chief, MACV, Chemical Operations Division, J-3  
LTC J. E. Adams, Deputy Chief, MACV and III Corps Chemical Operations  
MAJ G. J. Altom, IV Corps Chemical Operations  
MAJ L. E. Salomon, I Corps Chemical Operations  
MAJ C. A. H. Waller, II Corps Chemical Operations

3. Itinerary of Inspections:

a. 15 August 1969 - Arrival at Saigon, MACV J-3, Chemical Operations Division

(1) In discussions of the current defoliant program with the personnel of MACV Chemical Operations Division, J-3 Group, COL Kinne briefed the

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team concerning claim problems, the lack of qualified agriculture-oriented personnel in-country, and the sites which would be visited during our visit.

(2) Following the briefing the team met with Mr. George Anderson of the US Embassy staff. He suggested that many of the damage claims are Viet Cong (VC) inspired as evidenced by the fact that a VC-sponsored school for filling out claim forms has been discovered. He also mentioned that the increase in claims appears to be inspired by the knowledge that claimants are receiving money from the RVN government for claims whether they are valid or not.

(3) Mr. Marvin D. Davis, Chief of the Agronomy and Research Branch of the United States Agency for International Development (USAID), informed us that only a few personnel qualified to determine chemical damage are in RVN at this time. His major responsibility is in the area of rice production but he has been called in to assess damage claims on various crops and tree fruits throughout the country. The major claims he has heard about are damaged rubber and fruit trees. Some rice claims have been processed in the Delta region near Can Tho.

b. 16 August 1969 - Trip made by staff car from Saigon to Bien Hoa, Long Binh and return with COL Kinne and LTC Adams. Primary purpose of the trip was to inspect facilities and operations of the 12th Special Operations Squadron in Operation RANCH HAND at Bien Hoa.

(1) A briefing was held with the group leader, LTC Rex Stoner, and MAJ Buck Trott who reviewed preparation and application techniques. With MAJ Trott the team observed the chemical storage areas, loading areas and the UC-123K aircraft which are used in the spray program.

(2) The team met briefly with LTC Del Payne, Chemical Corps Officer, at II Field Force Headquarters at Long Binh. We then visited LTC Julian Ewell, II Field Force Commander and discussed the defoliation program briefly. LTC Ewell stressed the need in III CTZ to reduce defoliation targets in heavily populated areas.

c. 17 August 1969 - Trip by helicopter to Cu Chi, Headquarters 25th Division; Lai Khe, Headquarters 1st Division, and Phuoc Vinh, Headquarters 1st Cavalry Division, with COL Kinne and LTC Adams.

(1) Cu Chi - Briefing of 25th Division defoliation activities by CPT Ray Bills.

(a) We flew a UH-1/D reconnaissance across the Hobo Woods, Boi Loi Woods along the Saigon River near Tri Tam, returning over Go Dau Ha and Trang Bang to Cu Chi. During this flight we observed results of

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helicopter spraying (AGRINAUTICS system) with ORANGE on woody vegetation along river banks. Some additional areas were observed which had been sprayed from a Navy boat using a bilge pump and hose sprayer. Extensive areas were observed which had been sprayed by a UC-123. The results of these three types of applications appeared to give excellent defoliation results.

(b) At Cu Chi we met with personnel from Tay Ninh Province including Mr. Robinson, Deputy Province Senior Advisor of Civil Operations and Revolutionary Development Support (CORDS), CPT Kiernan and CPT Hansen from the 25th Division in Tay Ninh city. Mr. Robinson mentioned that a great deal of the area which had been Rome-plowed is regrowing and will require additional plowing or defoliation. Recovery of the plowed area is very rapid in most areas during the wet season. Mr. Robinson also mentioned that some damage has been reported on IR-8 rice which was accidentally sprayed with ORANGE along the Oriental River. Some helicopter spraying of diesel fuel for grass control is being done in areas in Tay Ninh Province.

(2) Lai Khe - Briefing on defoliation activities of 1st Infantry Division by LTC Herbert Jeo, Chemical Officer.

(a) LTC Jeo said that additional information was needed for chemical officers concerning herbicides and their effects on various plant types than is available in the Chemical Corps orientation booklet available from Fort McClellan.

(b) On a tour of the base perimeter several types of grass were found including: Napier grass or elephant grass (Pennisetum purpureum), wild sugarcane (Saccharum spontaneum), and Guinea grass (Panicum maximum). The base area is almost entirely within a rubber plantation. Some areas outside the base were sprayed with ORANGE during April 1969 with ground spray equipment. The treatments drifted toward the base causing the defoliation of a large number of rubber trees. These trees were recovering at the time of the visit. The team recommended that BLUE could be sprayed under rubber trees to control the grass without damage to the rubber.

(3) Phuoc Vinh - Briefing on chemical activities of 1st Cavalry Division by LTC P. O. Bauer.

(a) On a tour of the base perimeter at Phuoc Vinh, LTC Bauer stated that fuel oil has been used as a ground spray because BLUE was not available.

(b) With LTC Bauer we made an aerial reconnaissance over the northern part of Tay Ninh Province. We flew over the Michelin Rubber Plantation. Portions of this plantation appeared to be dead or dying from plant

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pathogens and lack of care. We landed at LZ Grant, a forward artillery position of the 1st Cavalry Division, and toured the perimeter. Grasses noted in the perimeter area included: Pangola grass (Digitaria sp.), windmill grass (Chloris sp.), and Guinea grass (Panicum maximum). This landing zone had an urgent need for an effective method of grass control. Because of its isolated location in a forested area, the control of perennial grasses in the perimeter area could be effectively achieved for periods of 6 to 12 months by use of a soil-applied herbicide such as bromacil. Within an hour after the departure of our team from LZ Grant, the CO was shot from ambush.

d. 18 August 1969 - The team made a courtesy call to COL Tho of the Joint General Staff (JGS), RVN and MAJ Bom, the J-3 Chemical Officer at Tan Son Nhut. In the afternoon a visit was made to the Ministry of Agriculture in Saigon. Discussions were held with Mr. Thai Cong Tung, the Director of Agricultural Research, and Mr. Pham Hieu Anh, Chief Soil Scientist. These provided the team with specialized vegetation and soils maps of RVN. They were very cooperative and offered help in identification of plant specimens and in providing other information concerning agriculture.

e. 19 August 1969 - Trip by U-21 to Can Tho and Binh Thuy AFB, IV CTZ, and return with COL Kinne. Met by MAJ Gil Altom and MAJ Paul Gardner, IV Corps Chemical Advisor.

(1) During the flight to Can Tho, areas of defoliation were observed in the Delta area along canals and rivers. The observed areas showed good defoliation and yet crops in the area appeared to be undamaged.

(a) Inspection was made of the Can Tho market to review the wide variety of tree fruits, vegetables and root crops grown in the Delta area. Due to the great importance of rice and other agricultural crops in the IV CTZ as a source of food for other parts of the country, no crop destruction activity is undertaken in this Corps Zone. Defoliation targets are principally of mangrove and other woody vegetation along rivers and canals with ORANGE as the basic agent used.

(b) In a briefing by Mr. G. D. Rohlf, Chief Regional Agricultural Advisor, CORDS, progress in the agricultural assistance programs was reviewed. The new variety of rice IR-8 is being established on 109,000 hectares with a projected yield of over 5 metric tons per hectare in contrast to local variety yields of less than 2 metric tons per hectare. Seventy-five percent of the nation's rice is produced on 1.5 million hectares of rice land in the Delta region. Livestock production in Region IV dominates the local market with 75% of the chickens and hogs, 80% of the ducks, and 70% of the cattle and buffalo. These livestock

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industries are dependent on rice mill waste as the primary source of feed. Introduction of purebred swine and chickens is an important phase of the agricultural development program for the region. Prices for local poultry and hogs are high by US standards.

(2) At Binh Thuy AFB we were met by Mr. Fred Gross of PACAF and CPT Powell, USAF, who are involved with the control of vegetation on air base perimeters.

(a) Observations were made along the perimeter road on the west side of the Binh Thuy AFB of areas aerielly treated with Kenapon (Dalapon ester) and BLUE. Treated areas consisted of principally perennial grasses and reeds growing in flooded or partially flooded soils. The area east of the road in the strip between the road and the airport runway had been sprayed with 5 gal/A of Kenapon on 13 March 1969 and a subsequent treatment with 3 gal/A of Kenapon made on 13 August 1969. On the perimeter strip west of the road, it was reported that four applications of BLUE at 3 gal/A had been made in 1969, followed by a final application of Kenapon at 3 gal/A on 13 August 1969.

(b) It was reported that the initial March 1969 treatment with Kenapon had given a longer period of grass control than corresponding treatments with BLUE. At the time of our observations, both areas showed the effect of the 6-day-old Kenapon retreatment and no significant differences were noted in the areas treated with BLUE and with Kenapon.

f. 20 August 1969 - Trip by helicopter with COL Kinne and LTC Adams to Tay Ninh City, Tay Ninh Province, III CTZ for coordination meeting with District Chief and ARVN personnel on proposed defoliation targets.

(1) Personnel present at the meeting included MAJ Bom and CPT Thao of JCS, MAJ H. J. Thomas, the III Corps Chemical Advisor, and CPT McAdams, Intelligence Officer from the 12th SOS group at Bein Hoa.

(2) Discussions of the proposed target pointed up the restrictions in UC-123 defoliation missions due to the proximity of cultivated crops. A portion of the proposed target could be sprayed by UC-123's and remaining localized areas would be completed by helicopter spraying.

g. 21 August 1969 - Tour of perimeter of Tan Son Nhut Air Base with Mr. Fred Gross of PACAF and CPT Palmer of the civil engineering group.

(1) BLUE has been used to control grass along the perimeter but rice crops have been planted up to the fence. A small test which had been conducted with BLUE and Kenapon in 1968 was observed. This test area was not clearly defined because of the spillage of fuel oil or other contaminants in the area.

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(2) Extensive damage to shade trees and fruit trees was observed outside the perimeter caused by an ARVN ground spray application of ORANGE on 29 July 1969. Application of 17 drums of undiluted ORANGE was made by Buffalo turbine during a high wind and thus the chemical drifted outside the fence.

h. 22 August 1969 - Trip by staff car to Bien Hoa with COL Kinne and LTC Adams, and by jeep from Bien Hoa to Xuan Loc and Headquarters, 199th Brigade and return trip to Bien Hoa was to attend coordination meeting at Xuan Loc on proposed defoliation targets in Long Khanh Province. Personnel at the coordination meeting in Xuan Loc included MAJ H. J. Thomas, III CTZ Chemical Officer, CPT Thao of JGS and MAJ J. Calvert, 199th Brigade Chemical Officer.

(1) At 199th Brigade Headquarters no inspection of base camp perimeter or other chemical activities was possible because of heavy rains.

(2) Observations were made enroute from Bien Hoa to Xuan Loc of low stature crops including rice, beans, melons and peanuts which had been planted by local farmers in the 200- to 300-meter wide Rome-plowed strips on both sides of Highway 1. This practice of maintaining a low stature cover along roadsides is compatible with current military requirements and can be expected to play an important role in agricultural development in the projected pacification program.

i. 23 August 1969 - RANCH HAND defoliation mission flights in Phuoc Long Province III CTZ. Return to Saigon by Staff car with COL Kinne and LTC Adams.

j. 24-26 August 1969 - Trip to I and II CTZ with COL Kinne and MAJ Salomon; by U-21 from Saigon to Chu Lai, Headquarters Americal Division; by helicopter to Tam Ky and LZ Bronco and return to Chu Lai; 25 August - by UC-123 RANCH HAND plane in reconnaissance in I CTZ including Sa Duc District, Hue, DMZ, Khe Sanh, A Shau Valley and Da Nang; then to Qui Nhon; 26 August - by helicopter from Qui Nhon to An Khe, Headquarters, 1st Brigade, 4th Division; return to Saigon by U-21.

(1) Chu Lai - Americal Division Headquarters

(a) Personnel contacted included: MG James Ramsey; BG Powell; COL Donaldson, Chief of Staff; LTC W. C. Gibbons, Chemical Officer, Americal Division.

(b) Following an orientation on chemical activities by LTC Gibbons we were briefed by COL Donaldson on general division actions.

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(c) BG Powell stressed the urgency of securing replacement parts for the three AGRINAUTICS spray systems of the Americal Division. Only one unit was functional due to delays in securing replacement parts for the windmill pumps. An active program of helicopter defoliation had been carried on by the Americal Division and a continued high level of defoliation and crop destruction effort was projected in planned programs.

(d) MG Ramsey spoke highly of the defoliation program, indicating its advantages in the divisional operations.

(2) Tam Ky - Brief meeting with MAJ Rothrock and MAJ John W. Kelly, the leader and Chemical Corps Advisor of the Province Advisory Group. MAJ Kelly had earlier experience in Thailand with defoliation tests conducted there by Fort Detrick.

(3) LZ Bronco - We then flew south to LZ Bronco where we picked up CPT Grady, Chemical Corps Officer, with whom an aerial reconnaissance was made of 1969 defoliation on San Juan Hill, west of Duc Pho, Quang Ngai Province. Evidence indicated that the VC were putting in small rice fields in deep valleys and on hillsides. We then flew over Duc Pho and down "Ambush Alley" along Highway 1 in extreme south Quang Ngai Province and observed the results of helicopter spraying. Areas which had been sprayed by helicopter 2 and 4 weeks previous showed excellent defoliation. The rugged topography of this localized site pointed up the necessity of spraying by helicopter in such critical areas. We flew over LZ Charlie Brown and returned north to LZ Bronco and after a short stop returned to Chu Lai.

(4) Reconnaissance flight from Chu Lai to Da Nang and Qui Nhon - The team left Chu Lai on 25 August and flew with MAJ Vergene Ford of the RANCH HAND group at Da Nang. We flew the UC-123 over an area in the Hau Duc district near Nong Son in which claims had been received for damaged crops and dead animals. The chemical damage from agent ORANGE all fell within the target area. Sensitive plants such as banana adjacent to the target area were not damaged. Small areas located northeast of the target area had been burned by fire. Additional crop targets were observed in the Tien Phuoc District and on Co Noi Island west of Hoi An. Both areas showed effective control.

(a) The UC-123 reconnaissance flight was continued north of Da Nang to Hue, Quang Tri and the Demilitarized Zone. Overflights were made of Khe Sanh, A Shau Valley and other defoliation targets in Thua Thien Province. Effective defoliation had been secured by UC-123 flights over rugged topography on lower valley slopes and in clearing ridge tops peripheral to fire support bases and observation posts.

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Although defoliation targets were widely scattered in this mountainous part of I Corps, their military value in protection of landing zones and fire support bases in advanced positions of friendly troops was readily apparent. Extensive areas of new road construction in the A Shau Valley were provided security by defoliation on both sides of the new right-of-way.

(b) After lunch at Da Nang the UC-123 flight was continued with termination at Qui Nhon.

(5) Qui Nhon, Binh Dinh Province, II CTZ

(a) Personnel Contacted: MAJ C. A. H. Waller, II Corps, MACV, Chemical Operations Division and W. B. McCully, Agricultural Advisor, CORDS.

(b) Trip was made by staff car to the village of An Nhon, north of Qui Nhon and to a demonstration planting of improved agricultural crops several kilometers west of Qui Nhon on Highway 19 to An Khe.

(c) In discussions of the agriculture of the area, Mr. McCully stated that 12,000 hectares of the new IR-8 rice were to be planted in 1969.

(d) Improved crops seen at the demonstration farm included IR-8 rice, sweet corn, sorghum, sweet potatoes, squash and peanuts.

(e) Observations were made along Highway 19 of extensive damage of rice due to leakage of diesel fuel from the surface pipeline between Qui Nhon and Pleiku.

(6) An Khe - Headquarters, 1st Brigade, 4th Division

(a) Personnel Contacted: MAJ Charles Roberts, Chemical Officer, 4th Division, Pleiku and CPT Bailey, Chemical Advisor, An Khe.

(b) At the An Tuc District office, the District Chief and CPT Bailey reviewed recent claims of crop damage alleged to be due to herbicides or defoliants. A brief visit by jeep was made to one farm in which damage was reported on peanuts. The peanuts had been harvested but a few residual plants remained in the field. Extensive insect damage was noted on these plants but no chemical damage was observed. Sweet potatoes growing in an adjacent field did not have any chemical injury even though they were closer to the target area. Other sensitive plants in the area were completely healthy.

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k. 27 August 1969 - Reviewed the following reports available in the files of Industry Division, USAID at Building B, 45 Nguyen Khac Nhu, Saigon.

(1) Vakili, N. G. Response of cultivated plants to herbicide incidence. Report to Victor I Prasisto, Agriculture Branch Director, III CTZ. SECRET. Report dated 18 July 1968. 10 pp, plus 32 photographs. A general report with detailed photographs of herbicide effect on crops and tree fruits based on observations at Bien Hoa and in Binh Long and Phuoc Tuy provinces.

(2) Flamm, Barry R. A partial evaluation of herbicidal effects to natural forest stands principally in Tay Ninh Province. Unclassified Report, USAID, dated 15 April 1968. Detailed vegetational composition studies of defoliated and nondefoliated forest areas based on on-site reconnaissance of areas in the vicinity of Special Forces camps at Thien Ngon, Katum, Tong Le Chon, and Bu Dop. It was pointed out that single defoliation treatments, as at Tong Le Chon was not detrimental to timber tree reproduction and that a high percentage of trees showed regrowth. Repeat application of herbicides in 1966 and 1967 as at Katum had severely damaged sawtimber size trees and timber reproduction with an accompanying increase in grasses.

l. 28 August 1969 - Review was made of the damage claims which have been reported to the MACV office during 1968 and 1969. The team flew by UC-123 to Bien Hoa for an awards ceremony for personnel of the 12th SOS group. LTC Stoner, Commanding Officer of the RANCH HAND group was presented the Army Commendation Medal by COL Kinne. Following return to Saigon in early afternoon, a second visit was made to the Ministry of Agriculture to obtain vegetation type maps and literature on the vegetation of Vietnam.

m. 29-30 August 1969 - Trip by U-21 from Saigon to Da Nang and return with COL Kinne and MAJ Solomon to inspect herbicide damage on trees and vegetable crops.

(1) Personnel contacted: Mr. John Woodward, Agricultural Advisor for Quang Nam Province; Mr. E. M. Stickney, Agricultural Advisor for Region I (CORDS); Mr. Alvin Adams, District Senior Advisor (CORDS), District 3 (South of Da Nang City); Mr. David Chen, Leader of a Chinese vegetable team sponsored by USAID, and MAJ Vergene Ford, USAF group leader of RANCH HAND based at Da Nang.

(2) The entire group visited areas which had reported damage from herbicides. The first site was east of the city in Hoa Chong Hamlet,

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a rice growing area. Extensive damage was observed caused by plant pathogens and stem borer insects. No herbicide damage was observed.

(3) The group then visited a Catholic church in the hamlet Cam He. The priest claimed that their crops were killed by herbicide spray planes. His description of the planes as silver indicated that he had seen the insecticide spray planes used for mosquito control. Careful inspection showed that slight herbicide damage was in evidence on papaya and mango trees. This damage was probably caused by fumes from empty drums of agent ORANGE which were kept less than 20 feet from the damaged plants. Sensitive weeds in close proximity also had herbicide symptoms. No evidence of damage caused by aerial application of herbicides was noted.

(4) The group then visited a village west of Da Nang. At this site there was evidence of herbicide damage on mango and other fruit trees. This damage was scattered and thus appeared to be caused by a leaky valve on a herbicide spray plane. The plants were recovering.

(5) The group then visited a village south of Da Nang City which claimed that herbicides had damaged their trees. The trees and crops in the area were suffering from severe drought symptoms. Two jackfruit trees had died during the year but other sensitive species such as Casuarina or Australian pine showed no herbicide damage. No definite implication of herbicide damage could be established.

(6) The group then returned to Da Nang City to meet with LTC James Corey of CORDS. During the briefing session, LTC Corey stated that he has taken steps to have the tops and bottoms of all empty herbicide drums punctured, so they will not be suitable for any other use. Empty herbicide drums were noted in all parts of the city; more than a dozen drums were seen within a block of the CORDS office.

(7) On 30 August the group visited a vegetable growing area at An Hai, east of Da Nang City. The growers were washing off all of the vegetable plants to prevent herbicide damage. This procedure was instituted after the people had seen a silver spray plane fly over, supposedly spraying herbicide. The plane was the mosquito control spray plane which was spraying the insecticide malathion. Several small beds of seedling lettuce were damaged by a damping off plant pathogen but no herbicide damage was observed on any of the vegetable crops in the area. Outside of the area some fruit trees were slightly damaged by herbicide which may have been caused by defective valves on the UC-123 herbicide spray planes.

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#### 4. Discussion:

##### a. RANCH HAND Defoliation Program

###### (1) Selection of Targets

(a) Requests for defoliation targets originated from a Province Chief, US Field Commander or an ARVN Commander and are staffed from the Province or District level to the ARVN Joint General Staff (JGS), COMUSMACV and the US Ambassador under procedures outlined in MACV Directive 525-1, Herbicide Operations, dated 12 August 1969. Approved defoliation projects are given a final review at a coordination meeting convened at the province capital by the JGS and attended by the MACV J-3, Chemical Operations Division action officer.

(b) The two coordination meetings attended in III CTZ (Tay Ninh and Xuan Loc) were good illustrations of the completeness of review and discussion of selected targets by the Province or District Chief and by the US and ARVN representatives concerned with the defoliation program. The targets considered appeared to be of high priority from a military standpoint.

###### (2) Spray Mission Operation

(a) In the two defoliation spray missions in which the team participated as observers, the 12th Special Operations Squadron members showed effective coordination and performance. Some delay was experienced in achieving coordination on target with the fighter plane support furnished by another USAF group. General orbiting in formation was carried out in waiting for fighter support.

(b) Execution of a defoliation spray mission requires simultaneous positioning of the Forward Air Controller (FAC), two fighter planes and the UC-123 spray planes at the target coordinates. After the three groups have assembled, the FAC marks with a smoke grenade the target position or initial point at which the spray is to be released. If ground fire is received by any of the UC-123's while spraying, a smoke signal is dropped by the crew chief to position air strikes by the fighter aircraft. Close coordination of the three aircraft units is thus essential in the accomplishment of the missions.

(c) On the return trip from the second mission, leaking spray nozzles were observed on the tail booms of two spray planes, following pull-out at the end of the spray run. In spite of a rigorous program of maintenance of the spray systems including frequent replacement of the nozzle diaphragms, leaking nozzles may occur due to trapped sediment or rapid

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deterioration of nozzle diaphragms from the action of the chemical. Following the drop in pressure at spray cutoff, the residual herbicide in the spray boom may be disseminated at high altitudes, causing wide-spread injury to sensitive plants. A system of reverse valves creating suction at the nozzles has been suggested as a method of elimination of this "leaker" problem. It is our understanding that the Hayes Company, engineers for the original spray system, have included such engineering in the latest modification of the A/A45-Y/1 system.

b. Defoliation by Helicopter Spraying

(1) Under MACV Directive 525-1, corps and divisional commanders are delegated authority to carry out defoliation operations with US helicopter and the AGRINAUTICS spraying systems which have been issued to each corps and to the field force divisions. These defoliation operations are carried out by divisional chemical officers to reduce ambush possibilities and maintain defensive fields of fire around base camps, fire support bases, landing zones, observation posts, and for localized strip spraying along highways, Rome-plowed areas, river and canal banks and other lines of communication. The divisional chemical officers may also utilize ground-based equipment such as PDDA's, Buffalo turbines and other power or hand-operated sprayers for perimeter spray applications.

(2) No observations were made by the team of actual spray operations by divisional chemical officers in any of the four corps zones. Aerial reconnaissance of areas sprayed in 1969 made in I, II and III Corps Zones, showed effective results with this highly maneuverable equipment.

(3) All divisional chemical officers contacted were strongly in favor of the use of helicopter spray systems and had heavy demands for the use of the AGRINAUTICS equipment on hand. Some of the deficiencies in the equipment were pointed out such as the inability to use a full tank of chemical, reduction of pressure from the wind-driven pump at low speeds, inadequate spray coverage on turns, leaking booms and pipe connections due to vibration and rapid decline in efficiency of the windmill pumps. Lack of replacement parts in some divisions was seriously hampering the effective operation of the spray systems.

(4) In general there appeared to be a need for improved engineering of a spray system of more rugged structure and designed to better conform to available space in the UH-1B/D aircraft in relation to center of gravity and weight-and-balance relations.

(5) Observations of the defoliation effects of helicopter spraying in the rugged mountain topography of I CTZ strongly emphasized the military advantage of this type of chemical application in providing

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protection to friendly troops. Helicopters were invaluable in conducting spray applications in critical highway areas such as "Ambush Alley" in southern Quang Nai Province and at innumerable landing zones and fire support bases in the advanced positions of friendly troops.

c. Availability and Use of Agents ORANGE and WHITE

(1) At the time of the team inspection, herbicides available in-country were ORANGE and WHITE for defoliation and BLUE for use in crop destruction and grass control. Prior to April 1969 agent WHITE had been used exclusively on defoliation targets near active rubber plantations. Following suspension of this practice in April 1969, ORANGE has been used for all defoliation targets and supplies of WHITE conserved until further notice. At the time of this change, ample supplies of ORANGE were available and no additional procurement of WHITE was anticipated.

(2) Review of the rubber and crop damage claim files at MACV J-3 for the years 1968 and 1969 showed that there was no appreciable difference in the number or nature of damage claims which could be related to the exclusive use of ORANGE near active rubber plantations. From the evidence at hand, either ORANGE or WHITE can be safely used near rubber plantations under procedures outlined in MACV Directive 525-1. Alternative use of WHITE to utilize in-country stocks would thus appear to be justified.

d. Need for Effective Agent(s) for Perennial Grass Control

(1) One of the major problems encountered in visits to various division areas was the need for an effective agent for control of large perennial grasses. Tall grasses, commonly called elephant grass because of their height (6 to 12 or more feet), often form dense stands following tree clearing around base camps, installation perimeters, minefields, etc. Weedy grasses grow rapidly under monsoon conditions and create excellent ambush sites and protective cover for enemy infiltration of base camps and other installations.

(2) During the inspection tour, three types of area were observed in which control of perennial grasses presented a major problem.

(a) Tall reeds and marshy grasses growing under more or less permanently flooded conditions. Example: Binh Thuy Air Base perimeter near Can Tho, IV CTZ. This situation involving perimeter areas of low marshy or poorly drained land occurs in the Delta region and to some extent in coastal low-land areas or along major drainages. Collection and identification of the

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major grasses was not possible at Binh Thuy Air Base because of the flooded condition in the wide perimeter strip. At least three species attained heights of 10 to 12 feet or more including: Common reed (Phragmites karka), wild cane (Saccharum spontaneum), and Napier grass (Pennisetum purpureum). Intermediate height grasses (4 to 8 ft) included: Sorghum (Sorghum sp.), Guinea grass (Panicum maximum) and cup grass (Eriochloa sp.).

(b) Upland or well drained sites in perimeters of landing zones, fire support bases, Special Forces camps, etc. in nonagricultural areas or cleared forest. Example: LZ Grant, 1st Cavalry Division, Tay Ninh Province. Areas of this type would include most of the forward positions, artillery and fire support bases in upland or mountainous areas in I, II, and III CTZ in which there are no rubber plantations, tree fruits or cultivated crops in close proximity to military installations. Portions of the Demilitarized Zone would be considered in this category. Grasses observed in these locations included:

Guinea grass	<u>Panicum maximum</u>
Sorghum, Johnson grass	<u>Sorghum halepense</u>
Sorghum	<u>Sorghum affine</u>
Napier grass, elephant grass	<u>Pennisetum purpureum</u>
Goosegrass	<u>Eleusine indica</u>
Crowfoot grass	<u>Dactyloctenium aegyptium</u>
Paragrass	<u>Brachiaria mutica</u>
Bermuda grass	<u>Cynodon dactylon</u>
Jungle-rice	<u>Echinochloa colonum</u>

(c) Upland or well-drained sites in base perimeters or installations in close proximity to rubber, tree fruits, crops and other desirable vegetation. Examples: Tan Son Nhut Air Base, Long Binh, Headquarters of 1st Division at Lai Khe in Binh Duong Province. This category would include the permanent type installations in which crop or agricultural land adjoins the perimeter area and in which shade trees, rubber trees, tree fruits and other cultivated plants are maintained within the base. This type would occur in all four Corps Tactical Zones. Grasses and other vegetation in the base or camp perimeter areas are similar to those in the previous category. Additional species identified at specific locations include:

<u>Tan Son Nhut</u>	
Crabgrass	<u>Digitaria</u> sp.
Lovegrass	<u>Eragrostis gangetica</u>
Plumegrass	<u>Erianthus fastigiata</u>

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Lai Khe

Vetiver

Bristlegrass

Vetiveria sp.Setaria sp.

(3) Currently agent BLUE is the only chemical available in-country which may be used for control of grasses in the three situations outlined. Experience has shown most perennial grasses (including all of the larger forms called elephant grass) show rapid regrowth following helicopter or ground spray application of BLUE. Under conditions in which BLUE has been unavailable and in base camp perimeters with crops or desirable vegetation in close proximity, diesel fuel has been effectively applied for short-term kill back of grasses.

(4) Two additional types of chemicals, available commercially but not designated as military vegetation control agents, are effective in the control of perennial grasses. These are grass herbicides and soil-applied herbicides for total vegetation control.

(a) Grass herbicides, such as dalapon, are systemic herbicides selectively more effective on grasses than on broadleaf vegetation. Kenapon a liquid ester formulation of dalapon containing 5 pounds active ingredient per gallon, has been experimentally applied at Tan Son Nhut Air Base in 1968 and at Binh Thuy Air Base in 1968 and 1969, in comparative tests with agent BLUE. Kenapon was reported to have given some systemic root kill of grasses in contrast to the "burn" or topkill by BLUE, with a delay in regrowth for 2 months or more. From the limited tests in Vietnam, Kenapon offers some promise as a chemical for grass control and further trials and research and development are warranted. An initial treatment at 20 to 25 lb/A (4 to 5 gal/A) with follow-up or maintenance applications at 15 lb/A (3 gal/A) at 4- to 6-month intervals appear to be needed. Under the flooded conditions at Binh Thuy Air Base, the larger reeds and grasses growing in deeper water were not as effectively controlled by either Kenapon or BLUE as the intermediate grasses on better drained sites.

(b) Soil-applied herbicides are residual herbicides that are absorbed through the root system and may give control for periods of 4 to 12 months. Bromacil, Tandex, and monuron are representative chemicals in this group. Bromacil or Hyvar and Tandex, commercially available as 80% wettable powders, are broad spectrum soil-applied herbicides effective in the control of grasses and broadleaf herbaceous and woody plants. Under temperate zone conditions applications of 12 to 25 lb/A give effective control of most grasses. On the basis of limited tests in Hawaii and Puerto Rico under tropical conditions, 30 lb/A or more of bromacil or Tandex may be required for control of the larger grasses

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such as Guinea grass, Napier grass, etc. There is an urgent need for reevaluation of these two chemicals under Vietnam conditions. Bromacil is also available in liquid formulation and as a 10% pellet for hand or aerial broadcast. Tandex may be made available in granular formulations. Monuron or Telvar has been used extensively in temperate areas. It is effective for control of grasses at rates of 50 lb/A or more. For tropical situations bromacil or Tandex are preferred over monuron on the basis of lower cost and rates of application.

e. Suggested Improvements in Methods of Grass Control in Perimeter Areas

(1) In perimeter areas subject to flooding under monsoon conditions, the taller reed-type grasses are often so dense that the vegetation may remain standing after topkill by aerial application of BLUE. The dead vegetation may remain erect for some time and is resistant to removal by burning under the high moisture conditions. On such areas or portions of perimeters without fences or mine installations, the excess top growth should be removed by bulldozing and/or burning during the dry season. Subsequent repeated applications of BLUE or Kenapon may be made to keep down regrowth. At permanent military installations, landfill to eliminate the flooded areas might be feasible so that periodic bulldozing or Rome-plowing could be used for vegetation control.

(2) In perimeters of temporary bases and landing zones in nonagricultural areas, soil-applied or residual herbicides such as bromacil and Tandex are strongly recommended to provide longer periods of grass control without repeat applications as required with agent BLUE or diesel fuel. These materials can be applied in liquid sprays or dry granular or pellet formulations. The residual action of these herbicides is dependent upon soil type, rate of application, and the amount and distribution of rainfall influencing leaching. Effective control can be obtained for periods of one year under tropical conditions. A limited use program under approval authority of MACV J-3 Chemical Operations Division would ensure proper use and restriction of the suggested agents to nonagricultural areas.

(3) R&D tests in both CONUS and tropical OCONUS locations have shown that various kinds of grass such as Napier or elephant grass, Guinea grass and wild cane show selectivity in control with agents such as Kenapon, bromacil and Tandex. Rates of application of bromacil, for example, effective for control of wild cane may not be sufficient to control Guinea grass. Experience has shown that BLUE may be effective in control of some short-lived grasses but repeat applications are needed for most perennials under tropical conditions. It is suggested

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that divisional chemical officers make comparative tests of several rates of application of BLUE and of Kenapon or the soil-applied herbicides on an experimental basis to determine suitable control measures for the specific mixture of grasses present at their respective locations.

f. Herbicide Damage on Crops, Fruit Trees and Shade Trees

(1) Inspections were made of several cases of alleged herbicide damage in the Da Nang and An Khe areas in company with CORDS agricultural advisors, US chemical officers and RVN district or village chiefs or their representatives. In addition aerial reconnaissance was made of the Sa Duc area in which alleged herbicide damage occurred in cropland from direct spray application beyond the river marking the terminus of the UC-123 defoliation target. Herbicide damage on shade trees was also observed in the general vicinity of Bien Hoa.

(2) A review of possible causes of herbicide damage on crops and other desirable vegetation on nontarget areas shows the following assessment for the conditions observed:

(a) Direct spray application due to navigational errors or incorrect mapping coordinates. The chances of herbicide damage from direct RANCH HAND or helicopter spray application are extremely small. The position of RANCH HAND targets is marked by the FAC who is thoroughly knowledgeable of the area and the location of crops and other nontarget vegetation. In most RANCH HAND missions the two lead planes have navigators who check accurately on the position of the target coordinates. In the case of helicopter applications by divisional chemical officers, preliminary ground and aerial reconnaissance made of proposed target areas prior to spraying insures lack of error in placement of spray. One instance was reported to the team of crop damage from helicopter spray application by an ARVN group in IV CTZ due to navigational error. In this particular case the US advisor did not accompany the spray mission.

(b) Direct application of herbicide caused by emergency dumps of chemical from UC-123 while in flight. Under extreme situations such as engine failure due to enemy fire or other malfunctioning, emergency dumping of the entire 1000-gallon tankload may be required for the safety of the plane and crew. Examination of Chemical Operations Division files at MACV showed that five such emergency dumps from RANCH HAND planes had occurred in the period since 1 December 1968. One of these dumps had been made at a location 10 kilometers offshore over the South China Sea, south of Bac Lieu Province. The remaining four were within a general radius of 20 to 25 kilometers from Bien Hoa and had been made from elevations of 2000 to 3500 feet. Inspection of one dump location 20

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kilometers up the Song Guai by Marvin Davis, USAID, showed damage to broadleaf fruit trees, palms, and ornamentals and considerable crop loss over an area 1 kilometer long and 1 kilometer wide. At another location near My Quoi village in Bien Hoa Province on which ORANGE was dumped from 2500 feet altitude, the area of damage was 1 kilometer wide and 2 to 3 kilometers long as reported by Marvin Davis, USAID. Citrus, mango bananas, coconut and betelnut were most severely damaged. However, annual crops planted within six weeks after the incident showed no herbicide effect. Severe herbicide damage caused by emergency dumps thus appears to be limited in area affected although lesser damage occurs over a wider area under conditions conducive to drift of spray released at these altitudes. Undoubtedly spray from the emergency dumps that have occurred in the immediate vicinity of Bien Hoa may account for some of the damage to shade trees observed east of that city.

(c) Direct application of herbicide from leaking nozzles during over-flight of UC-123 or helicopter spray aircraft to or from target area. As stated in the earlier discussion of RANCH HAND operations, leaking nozzles may occur despite a rigorous maintenance and inspection schedule on the UC-123 spray systems. Leaking nozzles are most likely to occur in the return flight following the spray mission due to clogging of the diaphragms and gravity release of the small amount of residual chemical in the booms after pump pressure has been cut back. The extent of herbicide damage by the UC-123 systems on crops and other nontarget vegetation from this cause is not known but it is believed to be of a low order of magnitude, due to the small quantities of herbicide involved and its further dilution with the great altitude of release. Helicopter spray systems are subject to close surveillance before and after spray operations and the incidence of crop damage from this source should be negligible.

(d) Spray drift during application to designated defoliation targets. If aerial or ground-based spray operations are conducted in conformance with the procedures outlined in MACV Directive 525-1, the possibilities of damage to crops and desirable vegetation in proximity to targets by drift are negative or extremely negligible. The restrictions in distance to crops, wind velocity and air temperature at the time of spray application and recommended height of spray release from aircraft are all designed with safety factors that should eliminate damage attributable to drift. Spraying under high wind, high temperatures, and/or lapse conditions probably accounts for most of the cases in which damage to crops occurs due to spray drift.

(e) Volatility of herbicide vapor from sprayed areas. A detailed discussion of the possible effects of volatility from ORANGE and WHITE is available in Appendix D of the US Embassy-MACV Policy Review of

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August 1968. As discussed under the previous section (d) on spray drift, adherence to the procedures outlined in MACV Directive 525-1 should preclude any incidence of damage to crop plants or desirable vegetation in proximity to sprayed areas. The incidents of damage to shade plants on the Tan Son Nhut Air Base perimeters and to rubber trees at Lai Khe caused by perimeter spraying with ORANGE were attributable to direct drift of chemical applied under wind and temperature conditions other than those delineated under the MACV directive and not to volatility from sprayed areas subsequent to application. Thus, under proper application procedures, volatility of herbicides is a negligible factor in causing crop damage.

(f) Indiscriminate distribution and use of empty defoliant barrels. Widespread distribution of empty herbicide drums containing residues of as much as 2 to 3 gallons of chemicals has taken place from the two principal RANCH HAND loading sites at Bien Hoa and Da Nang. The transport of these empty drums throughout the cities and adjoining areas and the consequent leakage and volatilization of the residual herbicide has undoubtedly caused considerable damage to shade trees, fruit trees, and other desirable vegetation in the area of dispersal of these drums. Recognition of this problem in Da Nang was given in a report dated 25 March 1969 "Defoliant Damage in Da Nang City" from LTC Jim Corey, Deputy Chief, CORDS/NLD/I CTZ to R. M. Urguhart, Chief, CORDS/NLD/I CTZ, from files of Chemical Operations Division, MACV J3-09. As cited in this report and observed by the team members in the Da Nang area, empty defoliant barrels are widely and abundantly scattered throughout the city and environs. Drums are used as containers for gasoline, diesel fuel and water without complete removal of residual chemical. The widespread use of herbicide-contaminated gasoline in motorcycles and other vehicles has undoubtedly contributed substantially to the herbicide damage caused by volatilization from promiscuous storage of empty drums. The magnitude of the damage problem in the city of Da Nang has led to restrictive measures in the distribution of the drums. A procedure for burial or safe disposal of the contaminated empty drums is needed to prevent continuation of this problem.

(3) There is an evident need for well trained agricultural advisors in the CORDS program with backgrounds in entomology, horticulture and pathology qualified to differentiate between herbicide damage and the effects of insects, plant diseases and improper crop culture and management. Such qualified personnel could provide technical assistance in handling claims from Vietnamese residents for alleged herbicide damage and in differentiating between valid herbicide damage and the effects of insects, plant diseases and other conditions causing abnormal growth of crops or desirable vegetation. During the brief inspection tour in the An Khe and Da Nang areas, the team found the following cases of insect or disease damage which the local Vietnamese farmers were

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attributing to herbicide damage:

- (a) Leaf roller insect damage on peanuts near An Khe.
  - (b) Stem borer damage causing sterile grain in paddy rice in Hoa Chong near Da Nang.
  - (c) Oriental sheath and leaf spot (Corticium) in paddy and broadcast rice in Hoa Chong near Da Nang.
  - (d) Leaf curl and damage caused by mites on manioc near Catholic church in Cam He, near Da Nang.
  - (e) Damping-off disease of seedling lettuce in vegetable crop area at An Hai near Da Nang.
- (4) The mistaken identity of the "silver" plane which sprayed malathion for malaria control with the defoliation spray program encountered among the Vietnamese farmers in the Da Nang area pointed up the far-reaching effects of VC propaganda and the need for an intensive public information program explaining the nature and purposes of the two spray programs.
- (5) On the basis of the limited field observations of the team, it was evident that several species of plants susceptible to the defoliants ORANGE and WHITE could be used as indicators of herbicide damage. Among the tree fruits, jackfruit, papaya, and star apple, showed marked damage by defoliation, topkill and loss of fruit yield. Other trees sensitive to herbicides included kapok, Australian pine or Casuarina and rain tree or monkeypod tree. No vegetable crop damage was observed by the team. Annual crops grown in RVN which are known to be highly susceptible to herbicide damage include tomatoes, soybeans, beans, and sweet potatoes. In general rice and grain crops are more resistant to the systemic herbicides used as defoliants. An information manual for recognition of herbicide responses of the major crops and tree fruits and shade trees would be of considerable value to agricultural advisors and other CORDS personnel.

#### 7. Recommendations:

- a. Regular semiannual meetings should be held in Saigon and at Fort Detrick to keep all personnel directly involved in the defoliation program informed of operational problems and procedures and the general state-of-the-art. The desirability of these meetings has also been expressed by MACV J-3 and CINCPAC personnel.

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b. All US Army chemical officers and USAF pilots assigned to the defoliation program should visit Fort Detrick for an orientation program of at least one week duration concerning the handling of herbicides and their effects on plants.

c. A continuing effort should be made to have at least one qualified botanist or plant scientist familiar with herbicides on the staff of MACV J-3 Chemical Operations Division at all times.

d. More effective measures are needed for the disposition of empty herbicide drums to avoid the hazards of volatilization and spillage of residual herbicides and the indiscriminate use of contaminated drums as storage containers for gasoline, diesel fuel and water. Widespread herbicide damage to shade trees and other desirable vegetation has been caused in Saigon, Da Nang and Bien Hoa by volatile fumes from empty drums and from contaminated gasoline or fuel used in private motorcycles and other vehicles. A disposal program is needed to eliminate this continuing source of vegetation damage. Personnel involved in this program should be thoroughly briefed in the hazards of improper use of herbicides.

e. A public information program should be initiated to stress the reason for the antimalarial insecticide spray program. Emphasis could be given to inform vegetable producers that the malathion would give them an added benefit by killing the insects on plants.

f. In certain base perimeter situations the team recognized a definite need for a soil-applied herbicide to control grass for periods of 3 to 6 months or more. This type of compound is used routinely by the US Army and US Air Force for control of vegetation at military installations throughout the United States and other areas of the world. In situations where inadequate grass control leads to the enemy infiltration of bases with the resultant loss of personnel and materials, the use of soil-applied herbicides to provide these installations with the most desirable agent is amply justified.

g. Based on the recent operational experience with ORANGE on defoliation targets in proximity to active rubber plantations, the alternative use of ORANGE or WHITE for such targets is recommended under the limitations set forth in MACV Directive 525-1.

h. The need for a positive valve shut off or other system for the spray systems of the UC-123 spray planes is desirable to eliminate leaking nozzles. A reverse pump which would draw the herbicide out of the spray booms and into the spray tank following a spray mission might be a satisfactory answer. It appears that damage caused by these leaky booms could be totally eliminated.

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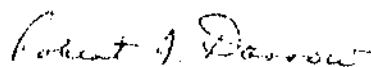
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i. The AGRINAUTICS spray systems currently used in helicopter spray operations need engineering modification for improvement in efficiency of operation under field conditions. Major problems have been experienced with the fan windmill system used for driving the pump in maintaining adequate pressure. Redesigning the tank in a contoured form to provide proper weight and balance in relation to center of gravity would permit loads of 200 gallons instead of the present 150 gallon capacity. A more effective method of providing replacement parts is needed.

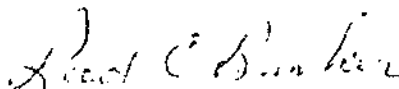
8. Significant Attitudes:

a. All of the military personnel contacted in the field consider defoliation a major contribution to the war effort. This was emphasized at the division level by the increase in number and area of proposed targets suggested for the divisional areas of operation. With the increase in defoliated area the enemy is being denied a place he can hide his men and materials. Another major advantage is that the US personnel can operate in zones of relative safety because areas along roads and waterways have been defoliated to prevent ambush.

b. The team was impressed by the excellent morale of the men involved in the chemical program. The men of the MACV J-3 Chemical Operations Division, the chemical personnel in the field and the members of the USAF 12th Special Operations Squadron are doing an outstanding job to carry out all of the many facets of an extremely difficult program. It should be noted that this has been accomplished despite extensive opposition to military use of defoliation from various groups in the United States and other parts of the world.



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