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Agent Orange Investigative Report Series, No. 15

Contract: VA-101-12-C-0006

Investigative Report:

Assessment of New Information on the Former UC-123Ks

Post-Vietnam Issue

Compensation Service

Department of Veterans Affairs

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March 2014

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April 10, 2014

Mr. Michael Pharr
Contract Officer's Representative
Compensation Service
Department of Veterans Affairs
810 Vermont Ave., NW
Washington, DC 20420

Dear Mr. Pharr,

Please find attached to this letter the Investigative Report: **Assessment of New Information on the Former UC-123Ks Post-Vietnam Issue.** This report is the fifteenth (15th) of many reports that will be prepared in fulfillment of Contract 101-12-C-0006, Development of an Archival Directory of Agent Orange Documents. The investigative reports are supported by the archival research. The goal of developing the Directory is to search and identify the thousands of documents, reports, and correspondence located within our National Archives and Records Administration and other document repositories that relate to the use of "Tactical Herbicides", including Agent Orange, outside of Vietnam. Using documents from the repositories, reports are prepared on topics requested by the Compensation Service.

In the case of this topic, the Compensation Service has previously received two submissions; a report in November 2012 and a brief in August 2013. The disclaimer to those reports emphasized that if *additional authenticated documents or records are found that address the topic of this report, a re-evaluation of the conclusions may be necessary.* This report is in response to an article published in the April 2014 issue of **Environmental Research** titled: **Post-Vietnam military herbicide exposures in UC-123 Agent Orange spray aircraft.** The authors, Drs. Peter A Lurker, Fred Berman, Richard W. Clapp, and Jeanne Mager Stellman, alleged that since sparse monitoring data were available for analysis, it was appropriate to use three complementary models and various assumptions to determine concentrations of herbicide and TCDD likely to have occurred via inhalation, ingestion, and skin absorption in aircrew and maintainers during post-Vietnam use of the aircraft the aircraft.

Despite the very sophisticated modeling efforts, omission of key data, and questionable assumptions, the article represented an interesting "academic exercise"; the results must be seriously questioned. Noting that Air Force Reservists averaged only 42 days per year in the reconditioned aircraft, the true test of the validity of the Lurker et al. article is in comparison with the men of Operation RANCH HAND. Did the men of Operation RANCH HAND who flew the same UC-123Ks in more than 250 sorties per year spraying Agent Orange and other tactical herbicide in Vietnam have evidence of disease caused by their measured elevated levels of exposure to Agent Orange and its associated TCDD contaminant? During the six examinations conducted over 20 years, the Air Force Health Study (AFHS) investigated more than 300 health endpoints on multiple occasions. **The results of the AFHS did not provide evidence of disease in the RANCH HAND veterans caused by their elevated levels of exposure to Agent Orange and its associated dioxin contaminant.** Thus, it must be concluded that the Air Force Reserve personnel have no valid supporting evidence from the 2013 published article to seek presumptive compensation from the Department of Veterans Affairs.

Sincerely,

Alvin L. Young, PhD
Professor of Environmental Toxicology
Colonel, USAF (Retired)

DISCLAIMER FOR VA REPORTS

The conclusions reached in this report are based upon a comprehensive review of the historical records maintained in the publicly available files of the National Archives and Records Administration, and other archival repositories. However, the conclusions reached do not necessarily represent those of the Department of Veterans Affairs or any other Department or Agency of the United States Government.

This report is part of the Agent Orange Investigative Report Series, and should be considered as an amendable or living document. If additional authenticated documents or records are found that address the topic of this report, a re-evaluation of the conclusions may be necessary.

INVESTIGATIVE REPORT: ASSESSMENT OF NEW INFORMATION ON THE FORMER UC-123Ks POST-VIETNAM ISSUE

EXECUTIVE SUMMARY

The controversy continues on the issue of whether United States Air Force Reservists experienced adverse health outcomes as a result of serving as flight and maintenance crews in former UC-123K RANCH HAND aircraft post-Vietnam, 1971 – 1982. The Air Force Reserve veterans have sought an automatic presumption for exposure to Agent Orange, thus bypassing the requirements to provide evidence of a relationship between disease and a prolonged occupational exposure during military service.

Four reports have been prepared by Compensation Service (2012, 2013) and the United States Air Force School of Aerospace Medicine (2012). All four reports supported the conclusion that it was unlikely for Air Force Reserve individuals to have had exposures to Agent Orange that exceeded acceptable regulatory standards or to be predisposed to experience future adverse health outcomes. The latest efforts to establish such evidence to the contrary comes in the form of an article published in the April 2014 issue of **Environmental Research** titled: ***Post-Vietnam military herbicide exposures in UC-123 Agent Orange spray aircraft.*** The authors, Drs. Peter A. Lurker, Fred Berman, Richard W. Clapp, and Jeanne Mager Stellman, henceforth referred to as Lurker et al., alleged that since sparse monitoring data were available for analysis, it was appropriate to use three complementary models and various assumptions to determine the concentrations of herbicide and TCDD that were likely to have occurred via inhalation, ingestion, and skin absorption in aircrew and maintainers during post-Vietnam use of the aircraft. Indeed, the results of the models indicated that "*Aircraft occupants would have been exposed to airborne dioxin-contaminated dust as well as come into direct skin contact, and our models show that the level of exposure is likely to have exceeded several available exposure guidelines*."

The failure of the article to support the conclusions began with the failure of the authors to study the history of the former RANCH HAND aircraft. Only 26 UC-123K aircraft (of 46 UC-123B/K) returned to CONUS after the termination of the

defoliation/crop denial/insecticide operations in Vietnam, with only 19 reassigned to the three Air Force Reserve units. Lurker et al. assumed that all former UC-123K (34 by their number) returned directly to the Air Force Reserve units highly contaminated with Agent Orange and its associated dioxin (TCDD). This assumption was incorrect, as all 26 aircraft were initially assigned to the Military Aircraft and Storage Disposal Center (MASDC), later the 309th Aerospace Maintenance and Regeneration Group (AMARG), Davis-Monthan Air Force Base, Arizona as they returned from Vietnam, 1970 -1972. At AMARG, the aircraft underwent removal of all armor, and any remaining spray apparatus with the exception of those 4 aircraft destined to join the Aerial Spray Flight, Rickenbacker ANG Base, Ohio. Three of the remaining 22 aircraft were destined for transfer to other nations under the Military Assistance Plan.

The remaining 19 aircraft were temporarily assigned to the Air Force Logistics Command for depot level maintenance at the Hayes Aircraft facility at Napier Field, Dothan, Alabama, where they underwent restoration prior to reassignment to selected USAF Air Reserve units in 1971-1972. At the Hayes Aircraft facilities, new heaters, windshield defrosting system, new oxygen systems, new stanchions, and new seats for the navigator, pilot, and copilot. Repairs and updates were made to the instrument panels, flooring plates, side panels and other areas damaged during the War in Vietnam. The engines and operating systems were reconditioned as necessary, and following cleaning of the interiors and exterior of the aircraft, they were painted as appropriate for their new assignments with the Air Force Reserves. These aircraft were no longer the “heavily contaminated” aircraft described in the article by Lurker et al. Nevertheless, for their models they determined that during any single mission aircrews at the Air Reserve units had a 46% probability of flying in a formerly contaminated RANCH HAND aircraft. However, examination of the tail numbers for the C-123K aircraft assigned to the units, revealed that only a 30% probability of that occurring.

Recognizing that the results and conclusions from the models are only as good as the assumptions that are made, Lurker et al. maximized the data inputs to ensure the worst case scenarios. For example, the authors selected exceedingly high values of 13 ppm and 45 ppm TCDD for Orange and Purple, when the average based upon more that 525 samples of Agent Orange and 557 samples of 2,4,5-T spanning the years from 1963 through 1969 were 1.88 ppm and 6.10 ppm for

Orange and Purple, respectively. The authors used data from 19 surface wipe samples for TCDD from three aircraft including “Patches” in 1994 and two aircraft sampled at AMARG in 2009 giving an average value of 285 ng/m^2. However, the authors ignored data collected from 45 samples that averaged 45 ng/m^2 in ‘Patches” in 1995, and 19 wipe samples with low to non-detect samples values collected from two additional former RANCH HAND aircraft at AMARG. Moreover, the three highest value wipe samples were from ‘Patches” in 1994, and were collected from locations somewhat protective of routine crew movement and routine historical maintenance and were not indicative of the surface contamination throughout the entire cargo area. Clearly, the value of 285 ng/m^2 used in the models for TCDD concentration would have been significantly lower had all available sampling data from 1995 and 2009 been used, and the final results would have been significantly different.

Lurker at al. made the decision to model air samples based upon imputed data, rather than acknowledge the three air samples that were collected from “Patches” in 1979 and from the eight air samples collected from the four former RANCH HAND aircraft sampled at AMARG in 2009. The conclusions of the actual air samples from 1979 and 2009 were the same, the values were considered to be below possible health hazards. However, the two models for inhalation exposure, based upon saturated vapor pressures of the herbicides, found that flight crews and maintainers were likely to have been exposed to airborne concentrations of TCDD that exceeded worker standards. The approach to determine concentrations of TCDD in dust samples was even more intriguing. Lurker et al. selectively used the air sampling data collected in 1979 as the basis for their whole dust sorption theory. They hypothesized that since the 1979 air sample concentrations exceeded theoretical air concentrations based upon vapor pressure, there must have been some additional herbicide associated with dust that collected in the air samples. They then extrapolated this theoretical mechanism to dioxins and concluded that the dioxin-laden dust presented a significant health hazard. For Lurker et al. to describe continual contamination through airborne dust ignored the role of the Air Reserve aircraft maintenance personnel and the frequent and necessary cleaning to maintain an appropriate environment needed for “aero-medical evacuations”, the stated use of the C-123K aircraft.

Numerous other issues have been addressed in this report that did not support the conclusions of the Lurker et al. article. It was apparent that their analysis was seriously flawed due to omission of key data. Despite the very sophisticated modeling efforts, omission of key data, and questionable assumptions, the article represented an interesting "academic exercise." Noting that Air Force Reservists averaged only 42 days per year in the aircraft, the true test of the validity of the Lurker et al. article can only be addressed by the question they did not ask, namely: "Did the men of Operation RANCH HAND who flew the same UC-123Ks in more than 250 sorties per year spraying Agent Orange and other tactical herbicide in Vietnam have evidence of disease caused by their measured elevated levels of exposure to Agent Orange and its associated TCDD contaminant?" During the six examinations conducted over 20 years, the Air Force Health Study (AFHS) investigated more than 300 health endpoints on multiple occasions. **The results of the AFHS did not provide evidence of disease in the RANCH HAND veterans caused by their elevated levels of exposure to Agent Orange and its associated dioxin contaminant**. Thus, it must be concluded that the Air Force Reserve personnel have no valid supporting evidence from the 2014 published article to seek presumptive compensation from the Department of Veterans Affairs.

INTRODUCTION

The controversy continues on the issue of whether Air Force Reservists experienced adverse health outcomes as a result of exposure to Agent Orange and its associated TCDD when they served as flight and maintenance crews in former UC-123K aircraft post-Vietnam, 1971 – 1982. A previous report on this issue was prepared for Compensation Service in November 2012: ***Investigations into the Allegations of Agent Orange/Dioxin Exposure from Former RANCH HAND Aircraft*** [1].The conclusion of that investigation was that: "*The historical records and analytical and scientific studies continue to provide ample evidence that the diseases reported by Air Force Reserve aircrews and maintenance personnel assigned to UC-123K aircraft post-Vietnam are not likely related to exposure to Agent Orange, its associated dioxin contaminant, or from the other tactical herbicides used in Vietnam*" [1]. In August 2013, Compensation Service requested an Agent Orange Brief on "***Discussion Points Supporting Compensation Service's Position on the UC-123K Claims***" [2]. As with the earlier report, the same conclusion was expressed with the addition that aircrews "*were highly*

unlikely to have been exposed to the minute tightly-bound residues of Agent Orange and its dioxin contaminant" [2]. The policy described in the disclaimers to both reports stated, "*If additional authenticated documents or records are found that address the topic of this report, a re-evaluation of the conclusions may be necessary*" [1, 2].

CURRENT AGENT ORANGE POLICY

Current Agent Orange policy is shaped in part by overall VA veteran disability compensation policies [3]. By law, disability compensation "*means monetary benefits paid each month to a veteran determined to be disabled by an injury or a disease that was caused, suffered or aggravated during active military service*" [3]. Generally, disability compensation can be readily assessed through a "direct service connection", e.g., a bullet or shrapnel wound. However, establishing a direct service connection for an environmental exposure can be very challenging. There are three key items a veteran must demonstrate to establish a direct service connection between a current disease and a claimed environmental or occupational exposure [3]. These are:

1. Evidence, medical or lay, of a current disability;
2. Evidence of an injury, disease, or occupational or environmental exposure during active military service; and,
3. Evidence of a medical or scientific nexus between the current disability and the in-service event [3].

In the case of Agent Orange, the Institute of Medicine (IOM) published in 1994 the initial report **Veterans and Agent Orange** with eight updates through 2012. The Department of Veterans Affairs considers the evidence presented and recommendations made by the IOM when establishing presumptions of service connections for veterans who served in Vietnam and the Korean Demilitarized Zone during the Vietnam War. Veterans who served in other locations or during other periods and propose to have Agent Orange-related health conditions must file a claim, which is reviewed on a case-by-case basis, and the evidence listed above must be provided. Contrary to popular belief, no IOM report has ever reported an actual causal relationship between a disease and herbicide/TCDD exposure, i.e., a consistent, coherent, and credible evidence of a causal connection between

exposure and dose to a disease [3]. The US Environmental Protection Agency has spent more than 35 years trying to assess the impacts of environmental levels of dioxins, especially the 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, on human health [4]. The Agency continues to use highly controversial assumptions to address the uncertainties in establishing such relationships [4].

NEW EVIDENCE IN REGARD TO UC-123K VETERAN CLAIMS

The Air Force Reserve veterans have sought an automatic presumption for exposure to Agent Orange, thus bypassing the requirements to provide evidence of a relationship between disease and a prolonged occupational exposure during military service. The latest efforts to establish such evidence comes in the form of an article published in the April 2014 issue of **Environmental Research** titled: ***Post-Vietnam military herbicide exposures in UC-123 Agent Orange spray aircraft*** [5]. The purpose of the paper was to refute the statement: "*Current Air Force and Department of Veterans Affairs policies stipulate that "dried residues" of chemical herbicides and dioxin had not lead to meaningful exposures to flight crew and maintenance personnel, who are thus ineligible for Agent Orange-related benefits or medical examinations and treatment"* [5]. The authors alleged that since sparse monitoring data were available for analysis, it was appropriate to use three complementary models to determine the concentrations of herbicide and TCDD that were likely to have occurred via inhalation, ingestion, and skin absorption in aircrew and maintainers during post-Vietnam use of the aircraft. Indeed, the results of the models indicated that "*Aircraft occupants would have been exposed to airborne dioxin-contaminated dust as well as come into direct skin contact, and our models show that the level of exposure is likely to have exceeded several available exposure guidelines*" [5].

Recognizing that the conclusions from models are only as good as the assumptions that are made, it was necessary to carefully dissect the paper to determine the accuracy of the history, the completeness of the available sampling data, the validity of the variables, factors and assumptions that constituted the models, and the final results.

HISTORICAL CONTEXT

Listing of Former UC-123B and UC-123K Aircraft Used in Vietnam

The authors correctly note that there is no official Air Force listing of the UC-123B and UC-123K aircraft used in Operation RANCH HAND, 1962 – 1972. However, a careful review of the 1982 book by William Buckingham (Office of Air History) [6], and the 1986 book by Paul Cecil (former Historian for the RANCH HAND Vietnam Association) [7], indicated that a total of 46 C-123 aircraft were modified for spray operations under Operation RANCH HAND in the ten years of herbicide and insecticide operations in Vietnam, 1962-1972. The C-123B had a standard crew of three personnel. The aircraft had twin Pratt & Whitney 18-cylinder radial piston engines that were held inboard under the wings. The C-123B was further augmented by the use of twin General Electric J85-GE-17 turbojet engines held outboard under the wings, and was re-designated a C-123K [7]. In 1962, 4 UC-123Bs were operational. In 1965, an additional 3 aircraft arrived and by August 1966, there were 10 UC-123Bs operational (in November 1965, these and the other C-123-Bs were all designated UC-123Bs indicating modification to spray operations [7].) By June 1967, 19 UC-123B aircraft were operational. In April 1968, the first UC-123K arrived at Bien Hoa Air Base, Vietnam. The RANCH HAND squadron was the last of the five units in the 315th Tactical Airlift Wing to receive the "K" models. The modified UC-123Ks continued to arrive in the squadron in May 1968, and a program was established to return "B" models to the United States for conversion. In November 1968, an additional 14 UC-123Ks arrived. In January 1969, the last UC-123B model aircraft left Vietnam leaving only the safer "K" models. In November 1969, RANCH HAND reached its peak of 33 assigned aircraft. Nine RANCH HAND aircraft were lost to crashes, including one UC-123K insecticide aircraft in February 1971(Tail No. 56-4373) [6, 7].

In December 1969, 14 UC-123K were reassigned to airlift units in Vietnam or returned to the United States. In March 1970, another 11 UC-123Ks were reassigned to other units including Air America, South Vietnam's Air Force and to Thailand's Air Force [8]. On 31 March 1970, RANCH HAND had 6 herbicide UC-123K aircraft and 2 insecticide aircraft remaining. On 15 April 1970, the use of Agent Orange was suspended. Six aircraft were designated for spraying either the tactical herbicides White or Blue; and, since the two tactical herbicides were not

compatible with each other, washing of the aircraft and tanks was required before changing herbicides. Additionally, in order to use an insecticide, the aircraft and the entire spray system were washed and new nozzles installed. The last mission involving Agent White occurred on 9 May 1970, and last missions involving Agent Blue occurred on 7 January 1971. RANCH HAND continued flying two aircraft on insecticide missions, terminating Operation FLYSWATTER on 31 December 1971 [6, 7, 9]. A listing, collected by a hobby historian of C-123K aircraft, including the UC-123K is available on the Internet [10].

In summary, a total of 46 aircraft were modified for RANCH HAND operations in Vietnam in the ten years from 9 January 1962 to 2 February 1972. This included 12 UC-123B aircraft that were never modified as "K" models, and 33 UC-123K. One of the UC-123K insecticide aircraft was lost in February 1971. A total of 9 RANCH HAND aircraft were lost to crashes. Only 26 UC-123Ks were returned to the United States for use by USAF, with the remaining being transferred to Air America or to Air Force units belonging to South Vietnam, Thailand, and Cambodia. All UC-123K aircraft returning to the United States were initially assigned to the Military Aircraft and Storage and Disposal Center (MASDC), later the 309th Aerospace Maintenance and Regeneration Group (AMARG), Davis-Monthan Air Force Base (DM AFB), Arizona prior to reconfiguration, restoration, and return to service.

Misinformation on Former UC-123B/UC-123K Sorties

Data in Table 1, page 35 of Lurker et al. indicated 19,887 sorties [5]. The authors concluded that each RANCH HAND UC-123B or K conducted 6,000 sorties and became heavily contaminated with chemical residues during loading, maintenance, fueling, and while on missions. The tactical herbicides Orange, Blue, and White were primarily sprayed during the years 1965 to 1970, noting that Orange was first introduced in March 1965, White in December 1965, and Blue in January 1966 [11]. The available data indicated that if an average of 13 to 14 aircraft were operational during the period 1965 to 1970, then the number of sorties per aircraft was ~250 per year, or 1,500 over the six years in Southeast Asia (not 6,000 sorties). These numbers correspond with the actual number of sorties and with the gallons of herbicide sprayed over those six years.

Another correction to the historical information in Lurker et al. has to do with the configuration of the aircraft during the spraying of the defoliant [5]. Lurker et al. stated "*Planes were usually flown with pilot and co-pilot cockpit windows and aft cargo door open*" and cited an unpublished master's thesis as the source of this information. In fact, the C-123 had 2 "troop doors" in the cargo compartment of the aircraft. In the mode of spraying, the cockpit windows were open, the troop doors were always open, and the ramp door was always closed, creating an airflow pattern within the aircraft that tended to vent out of the fuselage through the cockpit windows [7]. As noted by Cecil (page 103):

> *When ground fire was taken at low-level, the copilot would order "smoke – out," while the pilot notified the Forward Air Controller and support fighters with an appropriate radio call, for example, "Alpha three, automatic weapons fire on the right." The flight mechanic's job was to take one of the colored smoke grenades (usually red) hanging along the front of his armored box, pull the pin, and throw the grenade out one of the rear troop doors, which were secured open for the purpose. When done properly, the grenade provided a distinctly visible smoke mark about 300 meters downtrack from the enemy weapons position, so fighters could attack the site after the spray run was complete. If, however, the flight mechanic missed the open door, the spewing grenade could roll around the cargo-compartment floor, filling the aircraft with dense, colored smoke. The airflow pattern in the plane caused most of the smoke to exit through the open cockpit windows, forcing the nearly blinded pilots to abruptly pull up off target with colored smoke streaming from various openings in the fuselage. This maneuver was known as a "Smoky the Bear," and led more than one aircrew to experience one of those "moments of sheer, stark terror" that are a characteristic of flying* [7]"

The authors of the Lurker et al. article apparently assumed that the aircraft in Operation RANCH HAND were always involved in spray operations [5]. However, that is not the correct history of these aircraft. For example in August 1964, the RANCH HAND squadron received the metal frame-mounted pallet with the A/A 45Y-1 Internal Defoliant Dispenser. This roll-on/roll-off spray system allowed the crew to quickly convert the aircraft to a transport mode [6, 7]. During the Tet Offensive, sixteen of the RANCH HAND aircraft switched from spray

configuration to a transport role. Between 9 February and 15 March 1968 the sixteen aircraft flew 2,866 airlift sorties transporting troops, ammunition, fuel, and even local farmers with livestock [6, 7]. On 29 September through 14 November 1969, eight UC-123Ks were modified for transport duty and moved more than 4,300 tons of cargo [7]. On 16 May 1970, the six remaining herbicide aircraft were converted to a mission of dropping psywar leaflets and flares. From 16 May through 6 July 1970, the six aircraft dropped 2,271 flares and 108.6 million leaflets, flying over 300 sorties [7].

Prior to and after these operational actions, the maintenance crews frequently washed out the aircraft, certainly before an aircraft could be converted to spraying the insecticide or a different defoliant [7]. The smell of Blue, the water soluble organic arsenical, proved to be an irritant to the crewmembers and any spills in the aircraft were frequently washed down with water [7]. Equally important to "cleansing" the aircraft was the role of the weather which included frequent rainfall, high humidity and intense sunlight. As one crew member of a C-123B (not a RANCH HAND aircraft) noted:

> *It was monsoon season, and we had to fly in heavy rain for nearly all of the 4-hour trip. It was raining so hard in the back that the passengers sitting under the heaters had to spread ponchos over the static lines to keep dry. As the water accumulated to several inches deep on the floor and began to slosh fore and aft, the plane became slowly more and more uncontrollable in pitch. Eventually, it took full elevator deflection just to keep the plane more or less level. It felt like we were rowing the bird along. I slowed to about 115 knots and had the Load Master open the ramp. The next time the nose pitched up, I let it stay there to let the water escape out the back. Then we closed it up and continued. It took a total of three "flushes" before we got to Bangkok* [12].

Reconfiguration of UC-123B/K for Vietnam and Return

The first six aircraft assigned to RANCH HAND were originally stationed at Pope AFB, North Carolina. On 9 November 1961, the six C-123Bs were modified at Olmstead AFB, Pennsylvania with the removal of all unnecessary equipment including Medevac stanchions, navigator moveable seats, etc. At the same

location, the aircraft were retrofitted with the MC-1 “Hourglass” 1,000-gallon tank system. The six aircraft returned to Pope AFB for fabricating and fitting new armor plating and were ferried to South Vietnam. When the aircraft arrived in Vietnam, the spray booms and nozzles were installed. Between August and November 1965, additional modifications were made to the aircraft in Vietnam. This included removing heaters, windshield defrost capabilities, deactivation and removal of oxygen systems, and other items to reduce weight. At the same time major modifications were made to the seats in the cockpit. The seats consisted of metal plating on the back and underneath, and special ceramic plates i.e., Doron armor, were placed on both sides of the seats. In addition, “half-moon” cut-outs of Doron armor were installed in front of the instrument panels to provide limited “head-on” protection for the cockpit area. In the back of the aircraft an open-topped box, three feet on each side, constructed of two ½-inch thick sheets of Doron armor was installed at the spray operator’s, i.e., the flight mechanic’s position to afford protection from ground fire. Modifications were also done to the helmets and flak jackets of the pilots and navigators to provide extra protection from flying shrapnel and glass [6, 7].

After 1965, as additional aircraft were assigned to RANCH HAND, most modifications occurred at the Fairchild-Hiller plant at Crestview, Florida. Beginning in 1968, RANCH HAND C-123B aircraft were rotated to the Fairchild Aircraft Company in Hagerstown, Maryland for modification with the addition of the J-85-17 jet engines, thus becoming “K” models. Additionally, each “K” model assigned to RANCH HAND received improved engine armor plating, a strengthened windshield to reduce shattering, and a larger spray pump and flowmeter [7].

The records show that 26 UC-123Ks returned to CONUS throughout 1970-1972 with 22 of these aircraft initially assigned to AMARG, DM AFB, Arizona [7, 11, 13]. The remaining 4 aircraft were directly assigned to the 907th Tactical Airlift Group, Rickenbacker ANG Base, Ohio, and subsequently underwent limited restoration. These four aircraft retained their special configuration for aerial spraying [13]. The 22 aircraft at DM AFB underwent removal of all remaining spray apparatus and armor. Three of the 22 were subsequently transferred to other nations under the Military Assistance Plan [11]. The remaining 19 aircraft were temporarily assigned to the Air Force Logistics Command for depot level

maintenance at the Hayes Aircraft facility at Napier Field, Dothan, Alabama, where they underwent extensive restoration prior to reassignment to selected USAF Air Reserve units in 1971-1972 [10, 13, 14].

When the 19 aircraft were at the Hayes Aircraft facility, it was necessary to install new heaters, windshield defrosting systems, new stanchions and litters, new oxygen systems, etc. They also had to remove the protective seats that had been modified for the RANCH HAND pilot and copilot. The protective materials were removed and new seats and clean-up of the instrument panels were part of the reconditioning. Areas in the aircraft damaged from ground fire and heavy use were repaired and replaced, including flooring and side panels. The interior of the aircraft were cleaned of dust and waste materials. The engines and operating systems were reconditioned as necessary, and exterior and interior painting was done as appropriate for their new assignments with the Air Force Reserve units. **Figure 1** is a photograph of the former UC-664 after it had been reconditioned and restored [15].

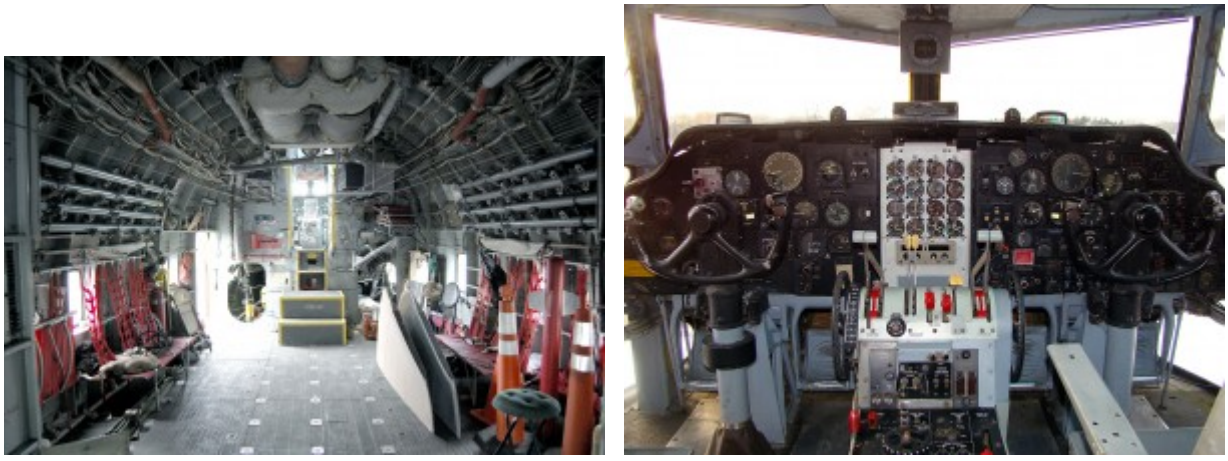

Figure 1. Photographs of the interior of UC-664, serial number 54-664, following restoration in September 1971 at the Hayes Aircraft facility, Napier Field, Alabama [15].

The Lurker et al. article does not acknowledge this reconditioning and restoration [5]. Clearly, this reconditioning and restoration would have significantly reduced remaining contamination. The painting of the interior would have likely covered and entrapped the majority of any remaining chemical residues on interior aircraft surfaces, leaving primarily crevices, cracks and small holes that held contaminated

dry residue of Agent Orange, hence the low-level contamination detected by surface wipe samples.

CONTAMINATION AS AN ISSUE

Detailed History related to "Patches"

The impression of the authors of the Lurker et al. article was that "Patches" was typical of the UC-123K assigned to RANCH HAND. The men of Operation RANCH HAND have a strong symbolic attachment to "Patches", hence it is in the United States Air Force Museum, Wright-Patterson AFB, Ohio. The history of "Patches" is informative as to the types of potential residues that could be present within its air frame. "Patches" was one of the original six C-123Bs located at Pope AFB, North Carolina that was modified for aerial spraying and was sent to South Vietnam, arriving in January 1962. However, before it was involved in defoliation missions, it was diverted at the request of the Department of State to the Middle East for locust control. It departed 2 May 1962 from Saigon to Tehran, Iran where it sprayed over 17,000 acres in Iran and Afghanistan with the insecticide Lindane [7] returning to Langley AFB, Virginia on 10 June 1962. On 14 June 1962, it was redeployed to Eglin AFB, Florida to participate in a 30-day test of aerial spray equipment on Test Range C-52A of the Eglin Military Reservation [7]. While at Eglin, it sprayed the tactical herbicide "Purple" in the first tests of the modified aerial spray equipment [7]. Following its return to Vietnam, it was immediately dispatched to treat locust infestations with 57% Malathion [7]. From January through May 1963, it was temporarily converted to supporting logistical operations delivering ammunition, general cargo including maintenance supplies, and personnel [7].

From June 1963 through most of 1966, "Patches" supported RANCH HAND operations in both defoliation and crop destruction missions. However, on 14 October 1966, "Patches" was reconfigured and dispatched again to treat locust infestations in Thailand with 95% Malathion [7]. In April 1967, "Patches" was ordered permanently assigned to mosquito control duty under the direction of the MACV (Military Assistance Command, Vietnam) Surgeon General's Office and in support of Operation FLYSWATTER [9]. In June 1968, "Patches" left the insecticide flight to return to the United States for modification as a K model. In

October 1968, “Patches”, now a UC-123K, returned to Vietnam and temporarily returned to flying defoliation missions. In late November 1968, it was returned to mosquito control duty. “Patches” returned to CONUS in February 1972 and underwent reconditioning and restoration at AMARG, DMAFB and Napier Field in September 1972 then served in the Air Force Reserves with both the 901st Tactical Airlift Group and the 731st Tactical Airlift Squadron until it was retired to the USAF Museum in 1980 [14].

Of course “Patches” was only one of the former RANCH HAND aircraft that was reassigned to Air Force Reserve units. Lurker et al. used this information in their exposure modeling to estimate the chance that reserve air crew members were serving on a former RANCH HAND aircraft. They used anecdotal evidence from “experienced personnel” to estimate that 11 of 24 aircraft (46%) assigned to the 731st Tactical Airlift Squadron at Westover AFB MA were former RANCH HAND and then extrapolate this estimate to assume that “*the remaining twenty-two RANCH HAND aircraft were evenly divided between the two other twenty-four plane squadrons at Pittsburgh International Airport Air Reserve Station and Rickenbacker Air Force Base.*” This 46% is a key component to their exposure model [5].

Analysis of the assumptions used by Lurker et al. to develop the 46% probability of being on a RANCH HAND aircraft reveals a significant error. They assumed that there were a total of 33 aircraft distributed among the reserve units when records show, as previously discussed in the history section, that only 19 of the 72 aircraft in the three squadrons could have been from RANCH HAND, then the appropriate probability used in the model should have been 26% , not 46%. This percentage is consistent with the records of aircraft assigned to the 731st Tactical Airlift Squadron, Westover AFB shown in Table 1 (7, 13, 14, 16) which indicates that 8 of the 27 aircraft (30%) were former RANCH HAND. The tail number for “Patches” was 56-4362 (14). It should be noted that analysis of actual flying records of aircraft assigned to the 731st TAS between 1973 and 1981 also resulted in a finding of 6 of 23 aircraft or 26% being former RANCH HAND aircraft [from FOIA requested information by C-123 Veterans Association received from Robin AFB Georgia in 2011, see www.c123agentorange.com.]

Table 1. Former UC-123K Aircraft Assigned to the 731st Tactical Airlift Squadron, Westover AFB Massachusetts, with former RANCH HAND aircraft shown in bold [6, 7, 10, 14, 16].

Tail Number	Description	Disposition after Vietnam	To AMARG
54-581	C-123K	No record of service in Vietnam	
54-583	**UC-123K**	**MASDC, 6 June 1970, Napier Field**	**13/09/1982**
54-586	**UC-123K**	**MASDC, 22 May 1970, Napier Field**	**20/09/1982**
54-592	C-123K	No record of service in Vietnam	
54-606	C-123K	Transferred to El Salvador Air Force	
54-607	**UC-123K**	**MASDC, 1970, Napier Field**	**16/02/1982**
54-610	C-123K	On Display Hill AFB, UT	
54-629	C-123K	On Display McGuire AFB, NJ	
54-631	C-123K	No record of service in Vietnam	
54-633	**UC-123K**	**MASDC, 1970, Napier Field, to AMARC 4/28/1982, To on Display, Robins AFB, GA**	
54-635	**UC-123K**	**MASDC, 1970, Napier Field**	**13/09/1982**
54-656	C-123K	No record of service in Vietnam	
54-661	C-123K	No record of service in Vietnam	
54-663	C-123K	On Display Howard AFB, Canal Zone	
54-669	C-123K	On Display Pope AFB, NC	
54-680	C-123K	Transferred to Royal Thai Air Force	
54-681	C-123K	No record of service in Vietnam	
54-683	C-123K	On Display Edwards AFB, CA	
54-693	**UC-123K**	**MASDC 6 July 1970, Napier Field**	**15/07/1982**
54-695	C-123K	US Department of State	
54-703	C-123K	Transferred to El Salvador Air Force	
54-706	C-123K	Military Aircraft Restoration, Anaheim, CA	
54-707	C-123K	No record of service in Vietnam	
55-4565	C-123K	No record of service in Vietnam	
55-4571	**UC-123K**	**MASDC, July 1971, Napier Field**	**11/06/1986**
56-4361	C-123K	Military Aircraft Restoration, Anaheim, CA	
56-4362	**UC-123K**	**MASDC, February 1972, Napier Field to United States Air Force Museum, Dayton, OH**	

***All UC-123K were sent to AMARG for initial restoration, and then ferried to Hayes Aircraft, Napier Field, Dothan, Alabama for major restoration (see text). Following restoration the aircraft were sent to United States Air Force Reserves [7, 13, 14].**

RANCH HAND Crews versus Air Force Reserve Crews:

In addition to green fatigues, that were seldom washed, crew members of RANCH HAND operations found it necessary to wear flak vests/groin protectors and unwashed purple scarves on each mission. The head gear, goggles, gloves, and

other items of equipment were handed down (re-issued) as replacement crews arrived in the squadron, without any cleaning/disinfectant during a RANCH HAND tour, other than hosing off any blood accumulations. All of the gear that was issued to a crew member was hung on a peg rack among all the other unit personnel issued items. Because of the lack of air conditioning, the only items worn by the crews next to the flak vests were cotton tee shirts, as the tops of fatigues were removed while on missions. None of the equipment storage locations had the benefit of air conditioning or filtered air. When the crews returned to base, the opportunities of showering and changing clothes were frequently limited [6, 7].

Air Force Reservists were issued Nomex flight suits and gloves, especially in winter at Westover AFB. All of the other gear was new and replaced as necessary. When the aircraft arrived or returned to a military base, the crew members were provided the opportunity for daily showers and clean clothes. Since Reservists generally flew only 42 days per year, their flight suits were likely cleaned after each programmed mission [5]. The Air Force Reserve Unit maintenance personnel were known to be top notch at keeping their aircraft in a high state of readiness. The Maintenance Technical Orders required inspection and cleaning of cargo aircraft on return to home station [17]. This was especially important if the aircraft were to be used for “aero-medical” evacuation missions as noted by Lurker et al. and Carter [5, 16]. For Lurker et al. to describe continual contamination through airborne dust ignores the role of the Aircraft Maintenance Supervisor and the frequent and necessary cleaning to maintain an appropriate environment needed for “aero-medical” evacuations [5, 16, 17].

Dioxin Concentrations Used in the Models

The Lurker et al. article referenced the 2003 article by Stellman et al. as the source of dioxin concentrations for the models [5]. Stellman et al. cited 13 ppm as the average dioxin concentration in Agent Orange. The basis for the 13 ppm was 28 samples described in the 1974 **Air Force Final Environmental Statement for the Disposition of Orange Herbicide by Incineration** [18]. The 28 samples came from twenty-eight 55-gallon drums of Agent Orange that were from the USAF stocks in storage at the Naval Construction Battalion Center (NCBC) Gulfport Mississippi, and used in the demonstration of the incineration technology. Indeed, the 28 drums were selected because the high dioxin content allowed better

assessment of the efficiency of incineration. Clearly, the 13 ppm was not the norm. The actual concentration of TCDD in Agent Orange was determined to be a mean of 1.88 ppm with a 95% upper bound of 2.14 ppm [11]. These data were based on the analysis of 525 drums of Orange Herbicide from the stocks in storage at NCBC and Johnston Island, and 557 samples of 2,4,5-T spanning the years from 1963 through 1969 and reported by National Institute of Occupational Safety and Health (NIOSH) [11]. The mean concentration for Agent Purple was 6.1 ppm not 45 ppm as described in the article [5, 11]. Therefore, Lurker et al. selected biased values for the concentrations of TCDD for the models.

Use of Wipe Sampling Data

Lurker et al. used surface wipe data collected from three different aircraft including "Patches" at the United States Air Force Museum in 1994, and two aircraft in 2009 at AMARG [5]. These surface wipe data were used to estimate an interior dioxin surface concentration of 285 ng/m^2, and were subsequently used in the TCDD dermal-oral exposure model. The authors selected the TCDD concentrations of 3 wipe samples collected in 1994 (1400, 250, and 200 ng/m^2). The three samples were described by the authors as "interior surface wipes" implying that former crewmembers were exposed to these sampling sites. However, in the report prepared by the Air Force in December 1994, the three wipe samples "*were…collected from locations somewhat protective of routine crew movement and routine historical maintenance … and are not indicative of the surface contamination throughout the entire cargo area of the aircraft"* [19]. Thus, the data from the three samples should not have been used in the risk scenario.

In 1995, a total of 49 wipe samples were collected in the interior of "Patches", and the TCDD data averaged 45 ng/m^2 TEQ, however, these data were NOT included in the Lurker et al. article [5, 20]. The authors of the report of the 1995 samples concluded "the *C-123 exterior and the majority of the interior was not contaminated with PCDDs or PCDFs above detectable levels, and that the contamination was confined to a very small area of the plane's interior and to the inside of the rear inspection ports"* [20]. Nevertheless, Lurker et al. selected the entire aircraft interior surface (280 m^2) as contaminated for their model, being unaware that the interior of the aircraft had been cleaned and painted at Napier Field before being assigned to an Air Force Reserve Unit. As noted earlier, the

painting of the interior would have likely covered and entrapped the majority of any remaining chemical residues on interior aircraft surfaces, leaving primarily crevices, cracks and small holes that held contaminated dry residue of Agent Orange components, hence the low-level contamination detected by surface wipe samples in "Patches", averaging 45 ng/m^2, rather than 285 ng/m^2 TEQ for dioxins and furans.

From 1986 through 2010, there were 18 UC-123K aircraft in storage at AMARG. Four of the 18 were sampled for residual Agent Orange components (2,4-D, 2,4,5-T, and the associated TCDD) in 2009 [21]. Although at the time of the 2009 sampling, it was thought that one of the four aircraft had not been used in Vietnam. Further review of the history of the aircraft in question indicated that they had actually all been deployed in RANCH HAND missions in Vietnam, and subsequently were assigned to Air Force Reserve units (Tail Nos. 55-4571, 55-4532, 55-4544, and 54-0585) [10, 13, 21]. A total of 138 samples were collected and analyzed from the four aircraft. More importantly, a comprehensive sampling protocol ensured that all key internal and external surfaces were sampled in replicate for all four aircraft. Indeed, 16 samples were collected for each analytical class (dioxins/furans or chlorinated herbicides). Lurker et al. ignored the results of two of the RANCH HAND aircraft, Tail Nos. 55-4544 and 54-0585, that had only trace levels of contamination [5, 21]. The conclusions of sampling the four aircraft applicable to the Lurker et al. article but not cited in the article were:

- There were no detectable levels of Agent Orange constituents found in any of the samples collected on the exterior of the four aircraft;
- There were no detectable levels of Agent Orange constituents found in any of the air samples collected within the four aircraft that were sampled;
- Two of the four aircraft (Tail Nos. 55-4544 and 54-0585) had trace levels (near the detection limit) of Agent Orange constituents on interior floor locations with non-detectable levels on other interior aircraft surfaces. The trace levels were a maximum of 3.9 ng/m^2 as TEQ for dioxins/furans, 230 µg/m^2 for 2,4,5-T, and 250 µg/m^2 for 2,4-D on interior floors; and,
- Two of the four aircraft (Tail Nos. 55-4571 and 55-4532) had low levels of Agent Orange constituents on interior surfaces sampled. The average interior levels were 15.0 and 18.2 ng/m^2 TEQ for dioxin/furans, 518 and 502 µg/m^2

2,4,5-T, and 587 and 453 µg/m^2 2,4-D for aircraft 55-4571 and 55-4532, respectively [21].

The Hill AFB Industrial Engineers conducted an extensive risk characterization of the data [21]. They determined that the acceptable screening level value for surface concentrations of dioxins/furans was 23 ng/m^2, based on 2,3,7,8-TCDD (this was similar to the 25 ng/m^2 action level for the "Patches" decontamination project [20]). The acceptable levels of 2,4-D and 2,4,5-T were calculated to be much higher at 100,000 µg/m^2 (these were concentration levels based on industrial exposure scenario with a duration of one year) [21].

As noted, the Hill AFB study did not detect levels of Orange constituents in any of the air samples. There were 8 air samples taken in the aircraft (4 for herbicides, and 4 for dioxins). Air samples for herbicides were collected according to the sampling method of NIOSH [21]. Samples were collected within the fuselage of each aircraft on a binderless glass fiber filter at a rate of approximately 2 liters/minute for 60 minutes. Air samples for dioxins/furans were collected according to an EPA method that collects the air sample on a polyurethane foam (PUF) plug. Samples were collected at a flow rate of approximately 4 liters/minute for approximately 4 hours. Air samples were intended to represent typical exposure levels for any unprotected worker who may enter the aircraft in efforts to clean out debris [21]. The air samples included particulates, although the particulate collection efficiency was not known.

In 1979 (30 years before the Hill samples were collected), the Air Force Occupational and Environmental Health Laboratory (OEHL), Brooks AFB, Texas was tasked to collect and measure air samples from a C-123K, serial number 56-4362 ("Patches") at Westover AFB [22]. Air samples were taken over a 5-hour period from three positions inside the aircraft, using MSA Model "S" personnel samples and chromosorb tubes, at a flow rate of 740 cc/minute. Levels of herbicides ranged from 0.243 mg/m^3 to 0.428 mg/m^3 (combined 2,4-D + 2,4,5T). Levels of Malathion insecticide ranged from1.7 mg/m^3 to 3.0 mg/m^3. The threshold limit value (TLV) of 10 mg/m^3 for 2,4-D, 2,4,5-T and Malathion is the level to which it is believed a worker can be exposed day after day for a working lifetime without adverse health effects as determined by the American Conference of Governmental Industrial Hygienists (ACGIH). USAF OEHL concluded that levels

found in ‘Patches” indicated no health hazard from either Agent Orange or Malathion [21]. The analysis of samples of a brown material removed from two cargo tiedown rings contained < 60 µg/kg (ppb) 2,4-D butyl ester, ~92 ppb 2,4-D isooctyl ester, ~ 149 ppb 2,4,5-T butyl ester, < 60 2,4,5T isooctyl ester, and ~145 ppb Malathion [21]. The results of these levels were considered to be below possible health hazards [21].

It should be noted that the butyl esters were from Agent Orange, and the isoocytl esters were from Orange II [11]. Note also that the levels in air samples taken by USAF OEHL 30 years earlier in “Patches” reached the same conclusion as the samples collected in similar former UC-123K aircraft in 2009, namely, no health hazard [21, 22]. Lurker et al. selectively used the sampling data collected by USAF OEHL in 1979 as the basis for their whole dust sorption theory. They hypothesized that since the 1979 air sample concentrations exceeded theoretical air concentrations based on vapor pressure, there must have been some additional herbicide associated with dust that collected in the air samples. They then extrapolated this theoretical mechanism to dioxins. In their article, Lurker et al. never mentioned the third air sample collected in 1979 that was non-detected for herbicide. If their hypothesis was correct, why didn’t the third sample show herbicide laden dust? It can only be concluded that Lurker et al. ignored any data by USAF OEHL or by the Hill AFB Industrial Engineers that did not fit the desired results, and instead used a model with imputed data, and therefore questionable interpretation [5].

Lurker et al. repeatedly emphasized that the data collected in 2009 represented significantly lower levels of contamination, and that the Air Force Reserve crew members were exposed to higher levels, consistent with the results from their models. However, Lurker et al. again failed to evaluate all the available data. In 1996, an Industrial Hygiene Survey was conducted of 17 of the 18 former UC-123 aircraft in storage at AMARG, DM AFB Arizona [23]. A detailed comparison of the 1996 and 2009 UC-123 herbicide data are presented in Appendix I [21, 23]. These data were evaluated by an Industrial Engineer at Hill AFB [24]:

> *Comparison of the 1996 and 2009 data sets does not indicate that significant degradation or volatilization of chemical residuals occurred over 13 years of storage as Lurker et al. postulate. In fact, aircraft that had detectable*

levels of herbicides in the single sample taken in 1996 had similar levels of herbicides in the replicate samples analyzed in 2009, and the 1996 data fell within the 95% confidence interval of the 2009 data in three out of four cases (e.g., the 1996 2,4,5-T concentration from the single floor sample taken in aircraft 55-4532 was 431 ug/m^2 while the average concentration of four samples from the same floor taken in 2009 was 610 ug/m^2 with an upper 95% confidence limit of 1426 ug/m^2). Based on the apparent stability of the herbicide residues, it is likely that dioxin residues were even more stable since the TCDD vapor pressure is several orders of magnitude less than the vapor pressures of 2,4,5-T and 2,4-D. These data do not support the assertion of Lurker et al. that chemical residuals were subject to significant loss mechanisms in the interior of the aircraft. In fact, they support the concept that the residuals were highly stable and immobile over a significant time period [24].

Additional Questionable Factors in the Models

Lurker et al. programmed in the model that 6% of the TCDD was removed when hands contacted the dry residue. They estimated that both hands of the crew made contact with the residue 3 times a day during each of the 42 days per year when the aircraft was deployed [5]. This of course ignored the fact that the aircraft did not have autopilot and that the crew generally flew wearing gloves. In 1981, Newton and Norris critically examined potential exposures of humans to 2,4,5-T and its associated TCDD [25]. They found that the phenoxy herbicide 2,4,5-T, and presumably their lipophilic contaminants, penetrated human skin very poorly. TCDD was less likely to be carried through skin than 2,4,5-T because of its strong adsorption coefficient, a property that made it difficult to work with in the laboratory since it stuck to the glassware and went out of solution [25]. If dry, as a residue, it is much more likely to adsorb tightly to metallic surfaces than to skin; if dry residues were dislodged by skin contact, the behavior of the substance would have undoubtedly remained on the outside of skin surface. This suggests that the 6% programmed in the model by Lurker et al. was exaggerated [5].

In addition, Kimbrough et al. found that the transfer of TCDD from the handling of soil was <1% [26]. Stevens described the efficiency of TCDD transfer from the environment into an individual body receiving the liquid mist of Agent Orange to

be 0.05% [27]. This low efficiency of transfer resulted from clothing protecting most of the skin, and from very little of the TCDD being transferred to the lips where it might be ingested [27]. Lurker et al. used a factor of 1 for the transfer of the TCDD to the mouth, meaning that 100% of the TCDD residue assumed to be transferred from the aircraft surface to the hands went into the digestive system [5]. Despite comments from other papers that only a small portion of the aircraft was contaminated, Lurker et al. assumed the entire interior of the fuselage was contaminated [5, 19, 20], thus no matter where the hands contacted the fuselage, both were contaminated.

The assumption by Lurker et al., that volatile 2,4-D and 2,4,5-T monitored in air samples contained levels of TCDD consistent with mean levels of TCDD in Agent Orange is not substantiated by an understanding of physical chemistry [5]. Vapor pressure is an important physicochemical parameter for predicting the atmospheric concentrations of given compounds. Practically, it can be used to determine the transport and fate of contaminants in the environment and to characterize exposure in the context of modeling a risk assessment (as done by Lurker et al. [5]. However, the precise measurement of the vapor pressure of low-volatile substances is an experimental challenge. This is true in the case of dioxins and more specifically 2,3,7,8-TCDD, in which a range of values of vapor pressure found in the literature indicate it was spread over several orders of magnitude [1, 2]. At ambient temperature (around 25° C, perhaps close to the temperature in the cockpit of a former UC-123K, 77°F) TCDD is still in a solid state, e.g., dry residue, and its vapor pressure is about 9 to 11 orders of magnitude lower than that of liquid water. The temperatures in the closed aircraft at AMARG likely exceeded 54° C or >130° F, and hence could only be detected in hexane wipe samples, but not air samples. Numerous studies have shown that 2,3,7,8-TCDD will only melt around 420°C [1]. Contrary to Lurker et al. conclusions, vapor exposures to TCDD at or near ambient temperatures are extremely unlikely to result in a significant dose [1, 2].

DISCUSSION

From the examination of all of the available data, not just selective portions of the data, and the evaluations of questionable assumptions used in the models, the Lurker et al. article failed to refute the exposure assessments conducted by the Air Force School of Aerospace Medicine and the Compensation Service of the

Department of Veterans Affairs that concluded: **It was unlikely for Air Force Reserve individuals to have had exposures to Agent Orange that exceeded acceptable regulatory standards or to be predisposed to experience future adverse health outcomes** [28, 29].

Despite the very sophisticated modeling efforts and the omission of key data and questionable assumptions, as noted above throughout the text, the Lurker et al. article represents an interesting "academic exercise." Noting that Air Force Reservists averaged only 42 days per year in the aircraft, the true test of the validity of the Lurker et al. article can only be addressed by the question they did not ask, namely: "Did the men of Operation RANCH HAND who flew the same UC-123Ks in more than 250 sorties per year spraying Agent Orange and other tactical herbicide in Vietnam have evidence of disease caused by their measured elevated levels of exposure to Agent Orange and its associated TCDD contaminant?" During the six examinations conducted over 20 years, the Air Force Health Study (AFHS) investigated more than 300 health endpoints on multiple occasions. **The results of the AFHS did not provide evidence of disease in the RANCH HAND veterans caused by their elevated levels of exposure to Agent Orange and its associated dioxin contaminant**. Thus, it must be concluded that the Air Force Reserve personnel have no valid supporting evidence from the 2014 published article to seek presumptive compensation from the Department of Veterans Affairs.

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BRIEF BIOGRAPHY OF THE AUTHORS

For more than 40 years, Dr. Alvin L. Young has been involved in issues surrounding the use of Agent Orange and other tactical herbicides in Vietnam. He completed his PhD in Herbicide Physiology and Environmental Toxicology at Kansas State University in 1968. In his 21 years with the USAF (obtaining the rank of Colonel), he was involved with the testing and evaluation of the equipment used in Operation RANCH HAND, Vietnam, and with the environmental and human health studies with the School of Aerospace Medicine and the Department of Veterans Affairs. He served as a Science Advisor on environmental issues including Agent Orange with the President's Office of Science and Technology Policy. He was the Director of the Department of Energy's Center for Risk Excellence. He was a Visiting Professor at the University of Oklahoma, 2001-2007, and has served as the Senior Consultant on Agent Orange for the Office of the Deputy Under Secretary of Defense (Installations and Environment). He has more than 350 publications in the scientific literature, including five books on issues related to Agent Orange and/or dioxins and furans. From 2000 to 2012, He was the Editor of the international journal *Environmental Science and Pollution Research*.

For the past ten years, Kristian L. Young has been the Principal Researcher for A.L. Young Consulting. He received his Bachelor of Arts in Political Science from DePaul University, Chicago (Magna Cum Laude, Phi Kappa Phi, and Pi Sigma Alpha). He received the Master of Arts in International Relations in 2010 through Webster University's Global Program having studied in Europe and China. He has provided support to the company in areas of public policy, technical issues, archival research, and the coordination of national and international projects.

APPENDIX 1

Comparison of 1996 and 2009 UC-123 herbicide data

Background:

1- Herbicide testing for 2,4,5-T and 2,4-D was conducted on 17 of the 18 UC-123 aircraft in storage at AMARG in 1996

a) One wipe sample per aircraft was collected over an approximately 6"x 6" (0.0232 m^2) area on the interior floor under one of the spray hose connections.
b) One wipe sample per aircraft was taken from the interior of the spray hose connection itself. This sample would not be representative of personnel exposure.
c) Two wipe samples were analyzed for dioxins/furans in 1996. Neither the aircraft nor the exact locations of the samples were recorded.

2- Herbicide and dioxin/furan testing was conducted in four of the 18 UC-123 aircraft in 2009

a) A total of 138 samples were collected, including surface wipe samples on interior and exterior surfaces and air samples.
b) Four wipe samples were collected in random locations on the interior floor of each aircraft and tested for 2,4,5-T and 2,4-D.
c) These are the only known samples that would be comparable to the 1996 data to give an indication of contaminant persistence
and potential degradation rates over the 13 year period between sampling events

Conclusion:

The available data is poor, however based on the comparisons below it is not apparent that significant degradation or volatilization occurred over 13 years of storage in the extreme heat of the Tucson environment. Aircraft that had non-detectable levels of herbicide in 1996 still had non-detectable levels in 2009 and aircraft that had detectable levels of herbicides in 1996 had similar levels of herbicides in 2009 (1996 data generally fell within the 95% confidence range of the 2009 data).

Based on the apparent stability of the herbicide residues, it is likely that dioxin residues were similarly or even more stable based on the lower vapor pressure of dioxin (2,3,7,8-TCDD) compared to the herbicides.

The vapor pressure for 2,3,7,8-TCDD is **7.4×10^{-10} mm Hg**
Vapor Pressure for 2,4-D: **8×10^{-6} mm Hg**
Vapor Pressure for 2,4,5-T: **2×10^{-6} mm Hg**

http://www.epa.gov/ttnatw01/hlthef/dioxin.html
http://pmep.cce.cornell.edu/profiles/extoxnet/24d-captan/24d-ext.html
http://www.chemicalbook.com/ProductMSDSDetailCB6263140_EN.htm
http://www.atsdr.cdc.gov/ToxProfiles/tp104-c3.pdf

Aircraft Tail Number: 54-0585

2009 Interior floor samples				**1996 floor sample**	
units: ug/m^2				units: ug/m^2	
Sample #		**2,4,5-T**	**2,4-D**	**2,4,5-T**	**2,4-D**
	21	51	ND (<82)	ND (<95)	ND (<82)
	22	92	ND (<82)		
	23	ND(<17)	ND (<82)		
	24	230	ND (<82)		

Aircraft Tail Number: 55-4571

2009 Interior floor samples				**1996 floor sample**	
units: ug/m^2				units: ug/m^2	
Sample #		**2,4,5-T**	**2,4-D**	**2,4,5-T**	**2,4-D**
	53	490	540	646	603
	54	100	110	(15 ug/wipe)	(14 ug/wipe)
	55	360	520		
	56	310	250		
	average	**315**	**355**		
	95% conf. int.	**57-573**	**21-689**		

Aircraft Tail Number: 55-4544

2009 Interior floor samples				**1996 floor sample**	
units: ug/m^2				units: ug/m^2	
Sample #		**2,4,5-T**	**2,4-D**	**2,4,5-T**	**2,4-D**
	119	ND(<17)	ND (<82)	ND (<95)	ND (<82)
	120	ND(<17)	ND (<82)		
	121	ND(<17)	ND (<82)		
	122	22	ND (<82)		

Aircraft Tail Number: 55-4532

2009 Interior floor samples				**1996 floor sample**	
units: ug/m^2				units: ug/m^2	
Sample #		**2,4,5-T**	**2,4-D**	**2,4,5-T**	**2,4-D**
	87	1000	810	431	646
	88	100	ND (<82)	(10 ug/wipe)	(15 ug/wipe)
	89	240	140		
	90	1100	1200		
	average	**610**	**548***		
	95% conf. int.	**0-1426**	**0-1427**		

*used 1/2 of detection limit for calcs with ND data