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Description Notes	Item includes report and cover letter. Cover letter is from Stephen L. Meek, to Alvin L. Young. Article mentioned in cover letter is missing.

Dear Al,

Enclosed is the article from the KC paper. I thought it would be of interwst to you.

I have also enclosed a copy of my report to Dr Lathrop. I don't believe I had previously sent you a copy.

Things are going alomg fine (other than my typing) down here at Whiteman. I was glad to hear your school and other projects were going well for you.

I want to thank you again, Al, for all your help and support.

Keep in touch!

Steve

PRELIMINARY REPORT

SUBJECT: "Aerosol Dispersion and Internal Airflow Studies on UC-123K Aircraft"- An Exposure Estimate"

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DATES: 14-16 Apr 80 and 12-14 May 80

WRITTEN FOR: GEORGE LATHROP, Col, USAF, MC
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I. INTRODUCTION.

In October of 1979 I contacted USAFSAM/EK (Col Lathrop) offering to participate in the study of aircrews exposed to Herbicide Orange during Operation Ranch Hand in Vietnam. Being a veteran of Ranch Hand and an Environmental Health graduate student, I was in a position to both contribute and benefit from such participation. Over the following months, with the cooperation of Major Alvin Young and Lt. Col. William Wolfe of USAFSAM/EK, it was determined that an estimated exposure study would best support the Herbicide Orange epidemiological investigation and meet my graduate research requirements.

I first considered an approach involving actual spraying using Herbicide (Agent) Orange Simulant (a glycerin and sodium thiosulfate solution previously developed by the USAF for spray equipment testing). However, practical considerations dictated a revised approach. The need was for a compact, portable system to dispense an aerosol within the aircraft to simulate pressurized leaks and spills and some means of collecting, analyzing, and quantifying the dispersed material. The approach selected was to internally release a dilute Agent Orange Simulant marked with sodium fluorescein and to collect samples at selected locations. The purpose being to assess the relative exposure of the pilots in the cockpit versus the flight mechanic in the cargo compartment.

Additionally, the airflow patterns in the aircraft were to be determined. These data would be useful for verifying an impression of forward airflow, in predicting dispersal patterns, and might be used in subsequent modeling studies if the experimental results were equivocal.

II. EXPERIMENTAL.

Ranch Hand aircraft were commonly configured with the pilots' side windows cracked open for ventilation. On target, the left rear troop door was open (allowing the flight mechanic to throw out smoke grenades marking sources of ground fire.) It was my impression that this configuration created, or increased, a forward airflow in the cabin. Discussions with an aeronautical engineer lent validity to the impression. However, I felt it important to demonstrate the direction of air movement from the cargo compartment into the cockpit and to measure it. Had there been no, or rearward, air movement, the dispersal experiment would have been superfluous.

Two flights were conducted on 15 Apr 80 in a UC-123K. Cabin air and internal surface temperatures were taken with a Tele-Thermometer. Relative humidity was measured with a Weksler psychometer. Air velocity at selected points in the cargo compartment and at the hatchway to the cockpit was

measured with an Alnor Series 6000-P Velometer equipped with a 6070-P Probe. Physical dimensions of the aircraft were also acquired.

A portable system was developed and tested for generating an aerosol. It consisted of an oxygen cylinder, size D containing 360 liters of medical oxygen, with Puritan valve, regulator, and flowmeter equipment. This provided a pressure source for aerosol production by a Bard-Parker Model u-mid/hi Jet Nebulizer. On the aircraft the system was positioned just aft of the herbicide tank near the pump and hosing apparatus.

A variety of solutions were tested for aerosol production, including Herbicide Orange Simulant. However, a more dilute solution of 10% glycerin in distilled water proved most acceptable. The solution contained sodium fluorescein as a marker to facilitate analysis. With oxygen flow set at seven (7) liters/minute and the nebulizer providing, by an adjustable air valve, 50% dilution with cabin air, the solution nebulized at the rate of .6 ml/minute.

Sampling included surface wipes, static skin deposition patches, and breathing zone air sampling. The surface wipes and skin deposition patches were of Whatman #1 filter paper. The breathing zone air samples were collected using DuPont Model P-4000 Multi-Range High Flow Sampler Pumps drawing air through .8 um Millipore filters in holders.

The surface wipe locations were the copilot's arm rest and the flight mechanic's panel. The skin deposition patches were securely attached to the copilot's and flight mechanic's left forearms. The air samples were taken by placing the pumps in the copilot's and flight mechanic's laps, draping the hoses around their necks, and positioning the filter holders just under their chins. During the mission the copilot remained in his cockpit seat; the flight mechanic remained at the spray panel during the simulated spraying period of ten (10) minutes, then was free to move around.

Aerosol generation time was ten (10) minutes, simulating usual mission spray time or that time during which the spray system was pressurized. The air sampling pumps were preset for fifteen (15) minutes of operation to bracket the aerosol generation time. The wipes and patches were collected immediately after the aerosol dispensing was complete. They were cleanly handled and bottled. The filter holders were collected and capped.

Initially, an attempt was made to use a Welch ChemAnal Fluorimeter for the analyses. However, it became apparent that the sample concentrations of fluorescein were not within the acceptable detection range of this equipment. So, I con-

tracted out the analyses to Langston Laboratories, Inc., Leawood, Kansas. The analyses were performed on a Turner Model 111 Fluorometer with excitation wavelength at 365 mu and emission at 510 mu. The statistical correlation of the standard curve was .9981.

An apparent problem was encountered with fluorescence of the blanks. To rule out contamination as a cause, at my request Langston Lab analyzed samples of their own stock of Whatman #1 filter paper. These samples showed similar fluorescence.

III.RESULTS.

A total of four flights were made in UC-123K aircraft. The first two on 15 Apr 80 were in an aircraft fitted with an insecticide spray system. Airflow determinations were made and later verified on the third flight on 13 May 80 in an aircraft configured with the A/A 45Y-1 herbicide spray system as used in Vietnam.

In the ventilation configuration commonly used on spray missions (pilots' side windows cracked open and troop door open) the internal airflow is strongly directional, flowing from the vicinity of the troop doors, past the console operator's (flight mechanic's) position, along the sides of the herbicide tank, forward through the cockpit hatchway, and out the cockpit windows. Airflow in the immediate vicinity of the tank, pump, piping, and console is swirling and turbulent.

Approximately 5000 cubic feet per minute (CFM) of air moves forward from the cargo compartment into the cockpit in the common ventilation configuration and at an indicated airspeed of 130 knots (spray speed). As the pilots' windows are incrementally closed the flow decreases until it becomes essentially non-directional at full closed. Closing the troop door has little effect on flow as there appears to be sufficient leakage around the door seals and ramp to supply the make-up air. In the common configuration, the cargo compartment experiences approximately two (2) air changes per minute supplied from outside, while the cockpit experiences twenty five (25) changes per minute supplied from the cargo compartment.

The fourth flight on 13 May 80 was devoted to the aerosol dispersal and sampling effort. Measured quantities of recovered fluorescein (corrected for background/blank values) were:

Skin Deposition - Copilot	Negligible
Skin Deposition - Flt Mech	6.06 ug
Surface Wipe - Copilot	Negligible
Surface Wipe - Flt Mech	.11 ug
Breathing Zone - Copilot	1.07 ug
Breathing Zone - Flt Mech	.61 ug

IV. CONCLUSIONS.

An aerosol generated in the vicinity of the spray tank will be dispersed forward through the aircraft by the high volume, directional airflow. The dispersal is not uniform. The results indicate that the flight mechanic receives substantially greater exposure, via skin deposition and subsequent absorption, than do the pilots.

The breathing zone figures present something of an anomaly, for which I have no immediate explanation. I would theorize, though, that in the turbulent airflow around the flight mechanic larger particles quickly impact on surfaces, while the smaller particles are entrained in the directional flow and carried forward. A much more extensive investigation would be required to adequately assess the many variables involved.

Exposure due to skin and/or clothing deposition is likely to continue, via absorption, throughout the flight mechanic's duty day. In contrast, the pilot's inhalation exposure only occurs during the flight. If absorption and inhalation exposures are comparable enough to be simply additive, then I conclude that the flight mechanic experiences a total exposure at least six (6) times that of the pilots.

ACKNOWLEDGEMENT: I would like to thank Colonel (Dr) George Lathrop for allowing me to participate in this study, Major Alvin Young for his eager and invaluable assistance, and the 355th TAS/Spray Branch for their unstinting cooperation.

S. L. Meek

APPENDIX F

EQUIPMENT LIST

Aerosol Generator
- Burnidge Oxygen Distributing Co., Size D Cylinder, Oxygen USP, Lot No. 4-14 1896.
- Puritan Valve and Adapter.
- Puritan Pressure Regulator, Type 128-P, 50 PSI Preset.
- Puritan Flowmeter, Pressure Compensated Series B, Calibrated 4-17-80 by Professional Medical Equipment Service.
- Bard-Parker u-mid/hi Jet Nebulizer, Stock No. H8294-005007.

Air Sampler
- Dupont Constant Flow Sampler Kit, SN886.
- Dupont P-4000 Multi-Range High Flow Sampler Pumps, SN887 and SN888, Calibrated 5-13-80 by Stephen L. Meek.

Psychrometer
- Weksler Instrument Psychrometer, Princo Slide Rule.

Thermometer
- Yellow Springs Instrument Co. Tele-Thermometer, Model 44TC, SN OEHL-00617, Calibrated 2-4-80 by OEHL 101.

Velometer
- Alnor Instrument Co. Series 6000-P Velometer with 6070-P Probe, SN OEHL-01295, Calibrated 11-9-79 by OEHL 128.

Key:
- OEHL = U.S. Air Force Occupational and Environmental Health Laboratory.