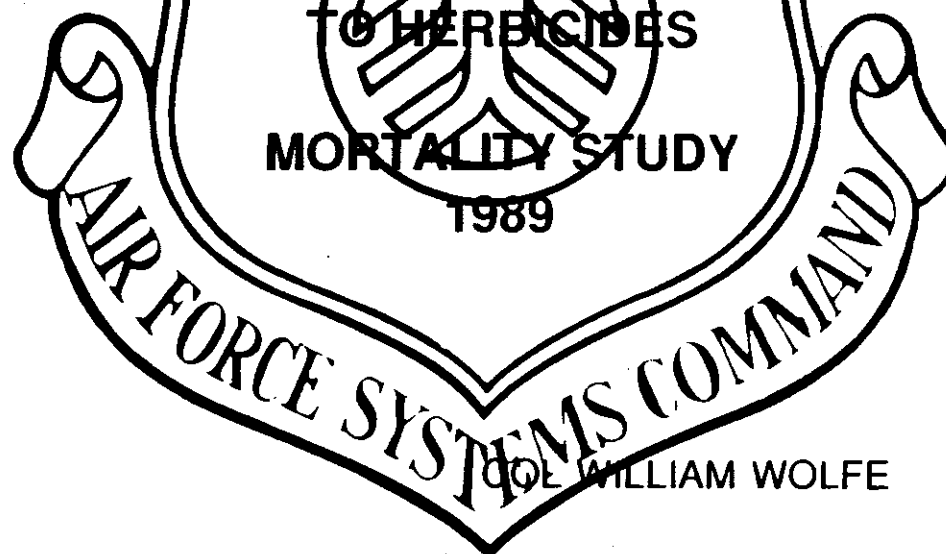


**AIR FORCE HEALTH STUDY  
AN EPIDEMIOLOGIC INVESTIGATION OF HEALTH EFFECTS  
IN AIR FORCE PERSONNEL FOLLOWING EXPOSURE  
TO HERBICIDES**

**MORTALITY STUDY**

**1989**



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USAF SCHOOL OF AEROSPACE MEDICINE  
HUMAN SYSTEMS DIVISION (AFSC)**



## OVERVIEW

- BASED ON MORTALITY DATA THROUGH 31 DECEMBER 1987
- 1,261 RANCH HANDS AND 19,101 COMPARISONS
- 5.9% OF RANCH HANDS AND 5.4% OF COMPARISONS HAVE DIED
- OVERALL DEATH RATES
  - RANCH HAND            2.8 PER 1000 PERSON-YEARS
  - COMPARISON            2.9 PER 1000 PERSON-YEARS
- OVERALL ADJUSTED STANDARDIZED MORTALITY RATE (SMR) IS 1.0



## SUMMARY COUNTS OF DEATHS

### ALL PERSONNEL

| GROUP      | NUMBER<br>AT RISK | NUMBER<br>DEAD | PERSON-<br>YEARS | RATE PER 1000<br>PERSON-YEARS |
|------------|-------------------|----------------|------------------|-------------------------------|
| RANCH HAND | 1261              | 74             | 24964            | 3.0                           |
| COMPARISON | 19101             | 1039           | 413726           | 2.5                           |

### OFFICERS

| GROUP      | NUMBER<br>AT RISK | NUMBER<br>DEAD | PERSON-<br>YEARS | RATE PER 1000<br>PERSON-YEARS |
|------------|-------------------|----------------|------------------|-------------------------------|
| RANCH HAND | 467               | 26             | 9248             | 2.8                           |
| COMPARISON | 5531              | 334            | 116489           | 2.9                           |



## SUMMARY COUNTS OF DEATHS (CONT)

### ENLISTED FLYERS

| GROUP      | NUMBER<br>AT RISK | NUMBER<br>DEAD | PERSON-<br>YEARS | RATE PER 1000<br>PERSON-YEARS |
|------------|-------------------|----------------|------------------|-------------------------------|
| RANCH HAND | 207               | 12             | 4112             | 2.9                           |
| COMPARISON | 2833              | 202            | 60292            | 3.4                           |

*Not stat.  
sig*

### GROUND ENLISTED

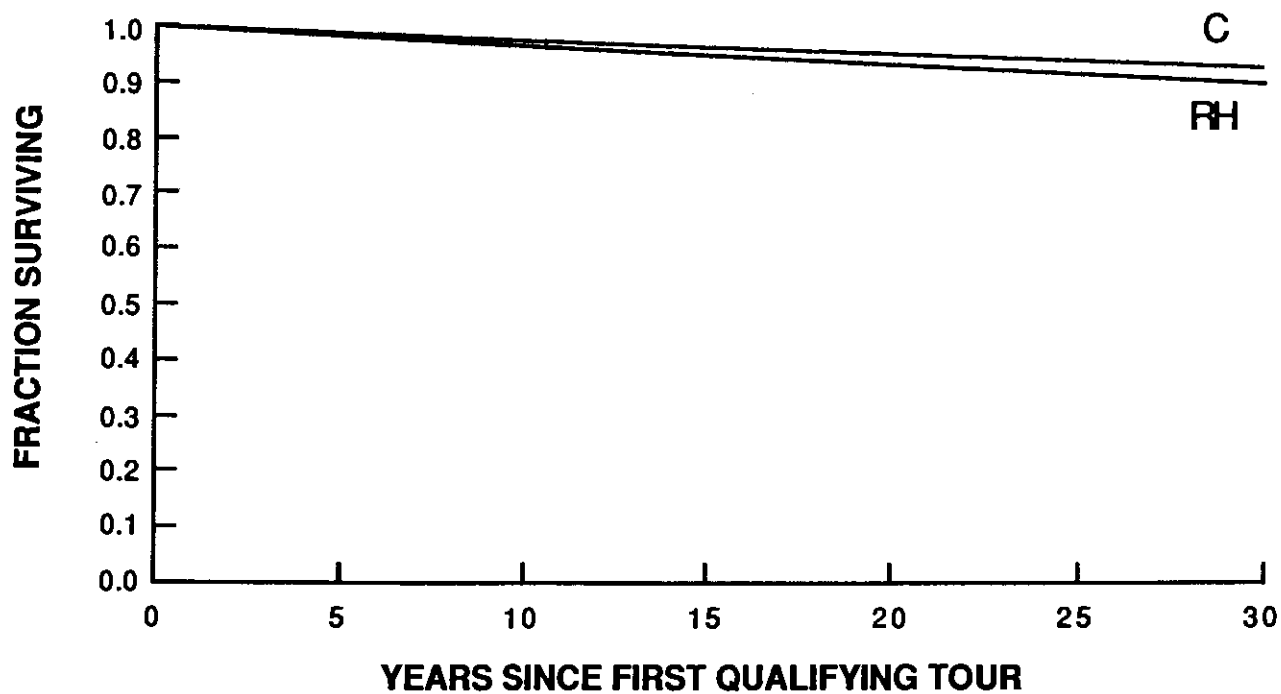
| GROUP      | NUMBER<br>AT RISK | NUMBER<br>DEAD | PERSON-<br>YEARS | RATE PER 1000<br>PERSON-YEARS |
|------------|-------------------|----------------|------------------|-------------------------------|
| RANCH HAND | 587               | 36             | 11604            | 3.1                           |
| COMPARISON | 10737             | 503            | 236945           | 2.1                           |

*Statistically  
sig - small*



## ADJUSTED SURVIVAL CURVE ESTIMATES

ALL RANCH HANDS AND ALL COMPARISONS  
SURVIVAL FROM START OF TOUR





## ADJUSTED\* ANALYSES OF CUMULATIVE DEATHS

### RANCH HANDS VERSUS ALL COMPARISONS

| STRATUM         | NUMBER<br>DEAD | EXPECTED<br>DEATHS | SMR | 95%<br>CONFIDENCE<br>INTERVAL |
|-----------------|----------------|--------------------|-----|-------------------------------|
| OFFICERS        | 26             | 27.4               | 1.0 | 0.6 - 1.3                     |
| ENLISTED        | 48             | 45.6               | 1.1 | 0.8 - 1.4                     |
| GROUND ENLISTED | 36             | 29.1               | 1.2 | 0.8 - 1.6                     |
| FLYERS          | 37             | 43.2               | 0.9 | 0.6 - 1.1                     |
| NONFLYERS       | 37             | 30.1               | 1.2 | 0.8 - 1.6                     |
| ALL PERSONNEL   | 74             | 73.6               | 1.0 | 0.8 - 1.3                     |

\* ADJUSTMENTS MADE FOR RANK, AGE AND OCCUPATION



## RANCH HAND MORTALITY FIVE-YEAR TREND

### NUMBER OF DEATHS

| YEAR | FLYING<br>OFFICERS | OTHER<br>OFFICERS | ENLISTED<br>FLYERS | GROUND<br>ENLISTED | ALL<br>PERSONNEL |
|------|--------------------|-------------------|--------------------|--------------------|------------------|
| 1983 | 0                  | 0                 | 1                  | 2                  | 3                |
| 1984 | 1                  | 0                 | 0                  | 0                  | 1                |
| 1985 | 1                  | 0                 | 1                  | 2                  | 4                |
| 1986 | 5                  | 0                 | 1                  | 3                  | 9                |
| 1987 | 4                  | 0                 | 1                  | 1                  | 6                |



## RANCH HAND MORTALITY FIVE-YEAR TREND

### STANDARDIZED MORTALITY RATIO (SMR)

| YEAR | FLYING<br>OFFICERS | OTHER<br>OFFICERS | ENLISTED<br>FLYERS | GROUND<br>ENLISTED | ALL<br>PERSONNEL |
|------|--------------------|-------------------|--------------------|--------------------|------------------|
| 1983 | 0.0                | 0.0               | 1.0                | 1.6                | 0.8              |
| 1984 | 0.6                | 0.0               | 0.0                | 0.0                | 0.2              |
| 1985 | 0.7                | 0.0               | 1.1                | 0.9                | 0.9              |
| 1986 | 2.8                | 0.0               | 0.8                | 1.6                | 1.8              |
| 1987 | 1.8                | 0.0               | 1.4                | 0.5                | 1.2              |

TRENDS FOR FLYING OFFICERS AND FOR ALL PERSONNEL  
ARE STATISTICALLY SIGNIFICANT





## UNADJUSTED DEATHS BY CAUSE

|                    | RANCH HAND | COMPARISONS |
|--------------------|------------|-------------|
| ACCIDENTAL         | 22         | 290         |
| SUICIDE            | 3          | 74          |
| HOMICIDE           | 2          | 20          |
| CANCER             | 12         | 226         |
| CIRCULATORY SYSTEM | 25         | 309         |
| DIGESTIVE SYSTEM   | 6          | 37          |
| OTHER CAUSES       | 4          | 83          |
| TOTAL              | 74         | 1039        |



## UNADJUSTED ANALYSES BY CAUSE OF DEATH

| CAUSE              | DEAD | EXPECTED | SMR | 95%<br>CONFIDENCE<br>INTERVAL |
|--------------------|------|----------|-----|-------------------------------|
| ACCIDENTAL         | 22   | 17.5     | 1.3 | 0.7 - 1.8                     |
| CANCER             | 12   | 13.6     | 0.9 | 0.4 - 1.4                     |
| CIRCULATORY SYSTEM | 25   | 18.6     | 1.3 | 0.8 - 1.9                     |
| DIGESTIVE SYSTEM   | 6    | 2.2      | 2.7 | 1.0 - 5.8                     |



## DIGESTIVE SYSTEM MORTALITY

| TYPE OF DISEASE                    | NUMBER OF DEATHS |             |
|------------------------------------|------------------|-------------|
|                                    | RANCH HANDS      | COMPARISONS |
| ESOPHAGUS, STOMACH<br>AND DUODENUM | 0                | 4           |
| APPENDICITIS                       | 0                | 3           |
| ACUTE ALCOHOLIC HEPATITIS          | 1                | 0           |
| OTHER DISEASES                     | 5                | 30          |
| TOTAL                              | 6                | 37          |



## ADJUSTED ANALYSES OF DEATH BY CAUSE

| STRATUM       | ACCIDENTAL |          |     | CONFIDENCE<br>INTERVAL |
|---------------|------------|----------|-----|------------------------|
|               | DEAD       | EXPECTED | SMR |                        |
| OFFICERS      | 9          | 7.4      | 1.2 | 0.4 - 2.0              |
| ENLISTED      | 13         | 11.0     | 1.2 | 0.5 - 1.8              |
| FLYERS        | 13         | 11.9     | 1.1 | 0.5 - 1.7              |
| NONFLYERS     | 9          | 7.0      | 1.3 | 0.5 - 2.1              |
| ALL PERSONNEL | 22         | 18.0     | 1.2 | 0.6 - 2.4              |

| STRATUM       | MALIGNANCY |          |     | CONFIDENCE<br>INTERVAL |
|---------------|------------|----------|-----|------------------------|
|               | DEAD       | EXPECTED | SMR |                        |
| OFFICERS      | 5          | 7.0      | 0.7 | 0.1 - 1.3              |
| ENLISTED      | 7          | 9.9      | 0.7 | 0.2 - 1.2              |
| FLYERS        | 6          | 10.5     | 0.6 | 0.1 - 1.0              |
| NONFLYERS     | 6          | 6.4      | 0.9 | 0.2 - 1.7              |
| ALL PERSONNEL | 12         | 17.0     | 0.7 | 0.4 - 1.2              |



## ADJUSTED ANALYSES OF DEATH BY CAUSE (CONT)

### CIRCULATORY

| STRATUM       | DEAD | EXPECTED | SMR | CONFIDENCE<br>INTERVAL |
|---------------|------|----------|-----|------------------------|
| OFFICERS      | 8    | 8.6      | 0.9 | 0.3 - 1.6              |
| ENLISTED      | 17   | 14.6     | 1.2 | 0.6 - 1.7              |
| FLYERS        | 10   | 13.2     | 0.8 | 0.3 - 1.2              |
| NONFLYERS     | 15   | 9.8      | 1.5 | 0.8 - 2.3              |
| ALL PERSONNEL | 25   | 23.7     | 1.1 | 0.7 - 1.6              |



## CANCER MORTALITY BY SITE OF TUMOR

| SITE OF TUMOR   | NUMBER OF DEATHS |             |
|---|------------------|-------------|
|   | RANCH HANDS      | COMPARISONS |
| DIGESTIVE SYSTEM;<br>INCLUDING COLON                                      | 3                | 50          |
| RESPIRATORY SYSTEM;<br>INCLUDING LUNG                                     | 5                | 85          |
| BONE, SKIN, AND SOFT TISSUE   | 1                | 12          |
| GENITOURINARY SYSTEM;<br>INCLUDING PROSTATE AND<br>TESTICLES              | 1                | 8           |
| LYMPHATIC SYSTEM;<br>INCLUDING HODGKINS DISEASE,<br>LEUKEMIA AND LYMPHOMA | 0                | 22          |
| OTHER   | 2                | 52          |
| TOTAL   | 12               | 229         |



## SUMMARY OF ADJUSTED ANALYSES

| CAUSE OF DEATH            | SMR |
|---------------------------|-----|
| ACCIDENTAL DEATHS         | 1.2 |
| MALIGNANCY DEATHS         | 0.7 |
| CIRCULATORY SYSTEM DEATHS | 1.1 |



## CONCLUSIONS

- OVERALL CUMULATIVE MORTALITY IS INDISTINGUISHABLE
- INCREASING TREND IN RANCH HAND FLYING OFFICERS SINCE 1983
  - CUMULATIVE DEATH RATES ARE EQUIVALENT
  - IMPACT OF THIS TREND IS UNCLEAR
  - DOES NOT FIT LEVELS OF DIOXIN EXPOSURE
  - FURTHER FOLLOW-UP IS INDICATED
- INCREASE IN DIGESTIVE SYSTEM DEATHS IN THE RANCH HANDS
  - NUMBER IS SMALL; N=6
  - PATTERNS BY SITE DO NOT INDICATE A HERBICIDE EFFECT
- RANCH HANDS ARE EQUIVALENT TO COMPARISONS IN:
  - ACCIDENTAL DEATHS
  - MALIGNANCY DEATHS
  - CIRCULATORY SYSTEM DEATHS





## SERUM DIOXIN STUDIES

ASSAY DEVELOPED AT CDC TO DETECT DIOXIN IN SERUM  
AT PARTS PER TRILLION LEVEL

JOINT USAF/CDC EFFORTS:  
HALF-LIFE STUDIES (7.1 YEARS)

ASSAY OF AFHS PARTICIPANTS

PRETEST OF 200 DEMONSTRATED ASSAY VALIDITY

RANCH HAND MEAN = 48.0 PPT

COMPARISON MEAN = 4.8 PPT

EXPANDED STUDY OF 1999 PARTICIPANTS

TO BE COMPLETED IN 1989

FUNDED BY HQ AFSC WITH REIMBURSEMENT FROM

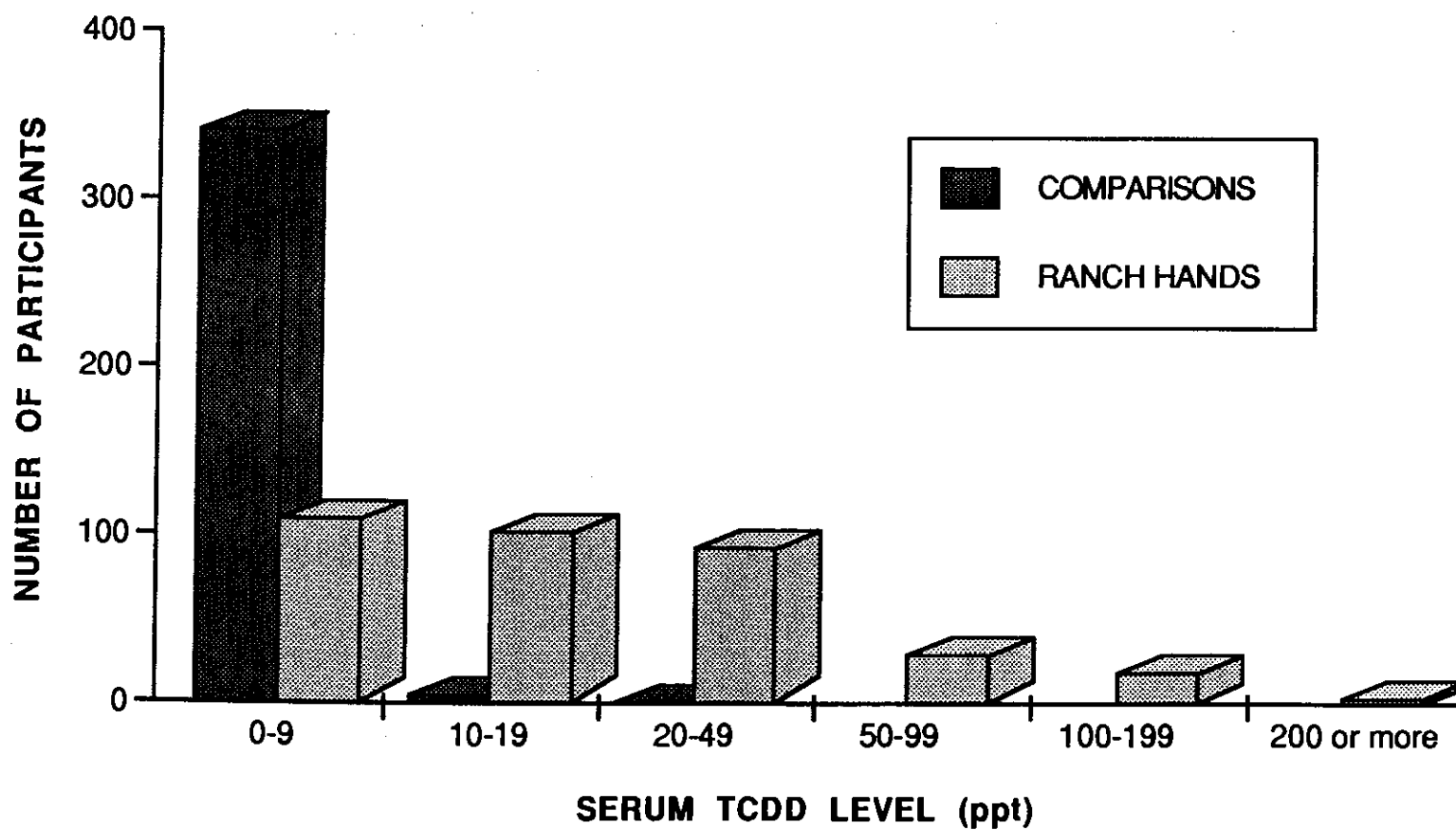
EXCESS VA FUNDS (S.11)

FUNDS TO COVER COST OF ASSAYS AND ANALYSIS

*1000 per test for dioxin  
1500 per test for PCBs*



## SERUM DIOXIN



highest  
313 ppt



## SE [REDACTED] RUM DIOXIN LEVELS

| GROUP       | NUMBER | MEAN | RANGE    |
|-------------|--------|------|----------|
| RANCH HANDS | 374    | 32.1 | 0 - 313  |
| COMPARISONS | 352    | 4.8  | 0 - 26.0 |



## SERUM DIOXIN VALUES (CONT)

| OCCUPATION      | NUMBER | MEAN | RANGE      |
|-----------------|--------|------|------------|
| PILOTS          | 72     | 9.8  | 1.6 - 41.5 |
| NAVIGATORS      | 16     | 11.2 | 2.9 - 36.0 |
| OTHER OFFICERS  | 6      | 7.1  | 3.3 - 12.6 |
| ENLISTED FLYERS | 57     | 21.6 | 3.6 - 127  |
| GROUND ENLISTED | 223    | 44.2 | 0 - 313    |



## SCHEDULE OF REPORTS

| <u>REPORT</u>  | <u>PUBLICATION DATE</u> |
|--|-------------------------|
| 1989 MORTALITY UPDATE<br>COMPARISON COHORT EXPANDED<br>(N=19, 101) | MARCH 1989              |
| BIRTH DEFECT REANALYSIS<br>BASED ON FULLY VERIFIED DATA            | FALL/WINTER 1989        |
| THIRD MORBIDITY REPORT   | FALL/WINTER 1989        |



## **FUTURE PLANS**

- 1989 COMPLETE SERUM DIOXIN ASSAYS**
- 1990 ANALYZE SERUM DIOXIN DATA AND PUBLISH REPORT**
- 1991 PREPARE FOR AWARD OF CONTRACT FOR THIRD FOLLOW-UP EXAMINATIONS**
- 1992 CONDUCT PHYSICAL EXAMINATIONS**
- 1993 ANALYZE DATA**
- 1994 PUBLISH REPORT**



## **SPIN-OFFS**

**VA MORTALITY STUDY OF TWINS**

**CDC DIOXIN VALIDATION STUDY**

**NIOSH AND CDC STUDY DESIGNS**

**AUSTRALIAN AGENT ORANGE STUDY DESIGNS**

**DATA BASE AND STATISTICAL ADVANCES**

**GENERAL EPIDEMIOLOGY**

**EPIDEMIOLOGY OF HIV INFECTION**

**ESTABLISHED QC STANDARDS IN IMMUNOLOGY**