Tasker

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE LOGISTICS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

REPLY TO ATTN OF: MCD

16 Jan 1968

SUBJECT: Palomares Broken Arrow--Report on Medical Follow-up Program.

TO:

1. Reference, Proceedings--First Annual Meeting Plutonium Deposition Registry Board, 26-28 Oct 66, Wright-Patterson AFB, Ohio 45433.

2. In accordance with recommendations of the USAF Plutonium Deposition Registry Board, the USAF Radiological Health Laboratory (AFLC), Wright-Patterson AFB, Ohio 45433, conducted follow-up bioassay studies on 26 individuals. These men were selected from the group of nearly 500 who participated in the resampling program subsequent to completion of operations at Palomares, Spain, and represented the 26 whose urine showed the highest concentrations of ^{239}plutonium. In terms of body burden, the values ranged from 7% to 57% of one body burden, systemic, with bone being the critical organ.

3. Originally, it was intended to sample at 2-month intervals until a total of six specimens were obtained from each person. However, after reviewing results of the first three samples it was obvious that little, if any, additional information could be gained by continuing the program. The attached chart gives the complete bioassay history on each of the 26 individuals.

4. Participation in this program was surprisingly good considering the fact that many had been separated from the service, and nearly all had one, and a few, two, changes of duty station during the period of the study. Had participation been complete we would have received 78 samples (67 were processed). One individual declined to cooperate; three gave only one sample; and, two provided two rather than the three specimens requested.

5. Because of the paucity of significant findings subsequent to the first meeting of the USAF Plutonium Deposition Registry Board, and there

being no new problems requiring the deliberation of the Board, the Surgeon General, Hq USAF, approved a request from the Board Chairman to cancel the meeting scheduled for calendar year 1967.

6. No further bioassay studies are planned, but tissue specimens will be analyzed for ^{239}plutonium as they become available.

7. Your help has been extremely valuable, and we would be very pleased to receive any comments you may have on this report or on any other facets of the program.

H. G. Wallace

H. G. WALLACE, Colonel, USAF, MC
Surgeon

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Bioassay results, ^{239}Pu, urine samples

Cy to: SGHW

BIOASSAY RESULTS -- ^{239}PLUTONIUM -- URINE SAMPLES

Tabulated below are results of all studies done by the USAF Radiological Health Laboratory on the 26 individuals included in the long-term follow-up program. Dates of possible exposure 17 January to approximately 15 Apr 1966:

Patient No.	Date Sample Collected	Results (as percent of one body burden)
1	30 Mar 66	LE**
	7 Oct 66	16%
	20 Jan 67	0
	17 Apr 67	0
	14 Aug 67	0
2	13 Feb 66	48%*
	13 Jun 66	9%
	19 Jan 67	3%
	24 Apr 67	0
	20 Aug 67	0
3	10 Mar 66	LE**
	22 Apr 66	41%*
	28 Jun 66	0
	20 Jul 66	8%
	28 Jan 67	0
	21 Apr 67	0
	10 Oct 67	0
4	14 Apr 66	9%*
	8 Jun 66	7%*
	20 Sep 66	7%
	21 Feb 67	3%*
	30 Apr 67	0
5	3 Mar 66	LE**
	20 May 66	18%*
	8 Sep 66	8%
	15 Jan 67	0
	10 Apr 67	0
	9 Aug 67	0

Patient No.	Date Sample Collected	Results (as percent of one body burden)
6	4 Feb 66	10%*
	22 Jun 66	16%
7	17 Feb 66	34%*
	15 Aug 66	9%
	28 Feb 67	2%
8	13 May 66	14%*
	26 Sep 66	7%
	19 Jan 67	3%
	17 Apr 67	0
	14 Sep 67	0
9	7 Mar 66	18%*
	28 Jul 66	7%
	22 Feb 67	2%
	2 May 67	0
	7 Sep 67	0
10	25 Feb 66	29%*
	8 Jun 66	7%
	21 Jan 67	2%
	25 Apr 67	0
	25 Aug 67	0
11	6 Apr 66	10%*
	4 Sep 66	7%
	13 Jan 67	2%
	8 Apr 67	2%
	4 Aug 67	0
12	28 Feb 66	25%*
	28 Jul 66	11%
	1 Sep 66	8%
	20 Jan 67	0
	17 Apr 67	0
	16 Aug 67	0
13	7 Mar 66	25%*
	26 May 66	7%
	20 Jan 67	3%
	17 Apr 67	0
	10 Aug 67	0

Patient No.	Date Sample Collected	Results (as percent of one body burden)
14	30 Aug 66	7%
	13 Jan 67	4%
	14 May 67	0
	23 Aug 67	0
15 (Army)	10 May 66	16%*
	1 Jun 66	9%
	7 Feb 67	2%
16	13 Feb 66	400%*
	8 Apr 66	20%
	29 Oct 66	10%
	13 Jul 67	0
17	17 Feb 66	17%*
	6 Jun 66	7%
	23 Jan 67	2%
	9 May 67	0
	17 Aug 67	0
18	7 Mar 66	15%*
	6 Oct 66	11%
	9 Mar 67	0
	13 Apr 67	5%
	9 Aug 67	0
19	27 Jan 66	12%*
	18 Jun 66	8%
	12 Feb 67	2%
	9 Apr 67	0
	13 Aug 67	0
20	13 Jul 66	9%*
	24 Jan 67	6%
	26 Apr 67	1%
	10 Aug 67	0
21	10 Feb 66	100%*
	3 Mar 66	10%*
	26 Apr 66	17%*
	10 Oct 66	67%
	26 Jan 67	3%
	9 May 67	0
	20 Sep 67	0

Patient No.	Date Sample Collected	Results (as percent of one body burden)
22	17 Feb 66	23%*
	8 Jun 66	7%
	19 Jan 67	3%
	17 Apr 67	0
	10 Sep 67	0
23	3 Mar 66	15%*
	1 Sep 66	7%
	2 Feb 67	0
	5 Jun 67	0
	15 Sep 67	0
24	25 Jan 66	21%*
	6 Apr 66	15%*
	26 Oct 66	11%
	19 Jan 67	1%
	5 May 67	0
	15 Aug 67	0
25	11 Feb 66	25%*
	24 Jul 66	7%
	17 Jan 67	3%
	25 May 67	0
	4 Sep 67	0
26	20 Jul 66	8%
	20 Jan 67	3%
	19 Apr 67	0

** Laboratory error in processing.

* Gross alpha determination. All other values derived by alpha spectroscopy. Chemical recovery in each sample was checked by use of ^{238}Plutonium spike. Mean recovery of the spike was 85.1% (± 17.5 S.D.).

An additional item of interest in relation to this program was the results of analysis of lung tissue from one of the participants in the Palomares Operation, who later died of acute myocardial infarction. The complete bioassay history on this individual is shown below:

BIOASSAY AND TISSUE STUDIES -- Case HPA 95-66

Material	Date Collected	Quantity	Procedure	Results (as percent of one body burden)
Urine	circa 1/20/66	400 ml	gross alpha	560%
Urine	circa 1/29/66	1650 ml	gross alpha	67%
Urine	1/31/66	4270 ml	gross alpha	54%
Urine	2/28/66	2520 ml	gross alpha	0
Lung	10/28/66	7.8 gm(wet)	^{239}Pu (alpha spec)	2.78 ± 0.16 pCi

NOTE: Probable date(s) of exposure 17-20 Jan 66.

Extrapolating to the total weight of the lungs, 950 grams, and assuming homogenous distribution of the nuclide, the total lung burden was approximately 5×10^{-4} microcuries (16×10^{-3} microcuries is considered by many to be one permissible lung burden).

DISCUSSION

Bioassay results on each individual show consistent decline as the time since probable exposures increased. Several possibilities exist to explain this finding. The USAF Radiological Health Laboratory, its glassware and equipment, could have been contaminated early during the operation, and as time went on the contamination decreased thereby

reflecting lower analytical results. We did find contamination in the laboratory early in the study; however, all glassware was replaced, the entire working area, including the ceilings, was vacuumed and scrubbed, and daily swipe samples taken to insure a radioactive-free work environment. During the resampling program and subsequently, glassware was used only once for plutonium determinations and then destroyed. By use of split-sample techniques with other laboratories, we learned that our results compared favorably with theirs, which tends to rule out contamination as the sole source for the initial positive findings.

A second possibility is contamination of the sample at the time it was obtained. We had strong evidence for this, at least, initially, because swipe samples from the exterior of the container showed alpha activity. Many of the very early high bioassay results were ascribed to sample contamination, and immediate repeat samples showed lower ^{239}plutonium content, thereby supporting the contamination hypothesis. Results of the resampling program, however, contradict the sample contamination theory as the sole source of positive findings. These specimens were obtained 3-18 months after the individuals left the site of operations, and at several dozen installations scattered around the world. It is extremely unlikely that contamination of clothing and/or skin at Palomares persisted for such long periods in sufficient amount to adulterate a urine sample gathered under conditions of the average

military home surroundings.

While the amount of autopsy material available for study was very limited, we did, in the one case, find above average levels of ^{239}plutonium in the pulmonary tissue of a participant, whose bioassay results followed a pattern similar to others studied over several months (see above Case No. HPA 95-66).

Finally, we must consider some of the excellent research that has been reported on the problem of relating urinary excretion of ^{239}plutonium to amounts of the material deposited in the body. In 1956 Langham[1] suggested that between 5-10% of an inhaled dose is rapidly solubilized and passes into the blood stream. This would tend to give higher urinary excretion rates of the isotope early after the intake. In 1967 Morrow[2] and his group reported the results of several years of study in dogs, on this problem. They showed that excretion rates, during the first 1-3 days after inhalation exposure, are virtually unrelated to administered dose and body burden. Results of these studies agree with our findings of high values noted on initial samples from individuals in the group considered above. However, the steady decline in excretion of ^{239}plutonium over a period of nearly two years, is probably more akin to the experiences of the workers at Dow Chemical Company, Rocky Flats Division, Golden, Colorado. Mann and Kirchner[3] reported the details of a fire in a plutonium fabrication plant which resulted in a large-

scale spread of plutonium oxide. Urinary excretion of the isotope showed an initial high value for about two months, and then a gradual decline during the next 3-4. However, there was considerable fluctuation in the results over this period, indicating that the excretion process is not easily described by simple mathematical relationships. The authors concluded that "on the average, 30% of material initially deposited was cleared in 2-3 months. The remaining material is clearing very slowly, with little or no measurable absorption into the blood stream".

Relating the Rocky Flats experience and other work cited to that at Palomares, we can reason that initial high levels of plutonium in the urine were the result of the rapid solubilized portion being excreted, and, in some cases, specimen contamination. The steady decline in excretion noted in the 26 cases studied for an extended period follows that of the Rocky Flats group, and probably for the same reason of insolubility of the nuclide. While the evidence is meager, autopsy material from the one individual (Case No. HPA 95-66) who displayed the highest initial systemic body burden, indicated that no significant pulmonary retention occurred.

We conclude that none of the Palomares participants studied now have a significant systemic body burden of ^{239}plutonium. We are not certain what may have been deposited and retained in pulmonary tissue, but evidence suggests that the amount is probably very small, even in

those showing initial high excretion rates. Air-sampling studies during the operation failed to disclose a significant degree of resuspension of ^{239}plutonium, even during periods of high winds. Since none of the participants were on scene during the initial event and subsequent several hours, inhalation exposures of great magnitude probably did not occur.

REFERENCES

1. Langham, W. H.: Determination of internally-deposited radioactive isotopes from excretion analysis. American Industrial Hygiene Quarterly 17, 305, 1956.
2. Morrow, P. E., et al: The retention and fate of inhaled plutonium in dogs. Health Physics 13, 113, 1967.
3. Mann, J. R., and Kirchner, R. A.: Evaluation of lung burden following acute inhalation exposure to highly insoluble PuO_2. Health Physics 13, 877, 1967.