Supplemental Digital Content for,

**HISTORY OF DOSE, RISK, AND COMPENSATION ASSESSMENTS FOR US VETERANS OF**

**THE 1966 PLUTONIUM CLEANUP IN PALOMARES, SPAIN**

Jan Beyea,

Consulting in the Public Interest, Senior Scientist, emeritus, 53 Clinton Street, Lambertville, NJ, 08530, Email: [jbeyea@cipi.com](mailto:jbeyea@cipi.com)

Frank N. von Hippel,\*

Senior Research Physicist and Professor of Public and International Affairs emeritus, Princeton University, Program on Science and Global Security, 221 Nassau St, 2nd floor, Princeton, NJ, 08544, Email: fvhippel@princeton.edu

\*Corresponding author.

**Table of contents**

Texts:

Text S-1. Quote from Wright Langham concerning protective measures at Palomares.

Text S-2. Additional details for “assigned share“ calculations.

Tables:

Table S-1. Data counts for the Palomares "High 26."

Figures:

Fig. S-1. High 26 excretion data points including non-detects, set to 0.11 mBq d-1 (0.003 pCi d-1).

Fig. S-2. Histogram of natural logarithm of 250 excretion rates above 40 mBq d-1 for Palomares veterans other than the High 26

**Texts**

Text S-1. Quote from Wright Langham concerning protective measures at Palomares.

“Most of the respirators were surgical masks, and if it did something for your psychology to wear one, you are privileged to wear one. It wouldn’t do you any good in the way of protection but if you felt better, we let you wear it. We ran into such psychological problems. The manual says you will dress up in coveralls, booties, cover your hair, wear a respirator, wear gloves. That's what the manual says. So, some people tried to do this where you could find something that resembled this type of equipment and before long you found this caused consternation in the village. They said, ‘How come you dress up like that and you let us walk around in the village with our street clothes on?’ And so even little things like that that I never even thought of before becomes a problem psychologically. Why shouldn’t we be protecting them if we were doing all of this protection in the area? So, most of the time it would hardly meet the standards of the health physics manuals the way this operation was done, and I think it’s fine because I think there was not anything wrong with this operation. I think it seems wrong with the manual.” (<https://www.documentcloud.org/documents/2797062-xxplutonium-1967-DOE-secret-briefing.html>, p. 296. Accessed 4/22/2018).[[1]](#footnote-1)

Text S-2. Additional details for “assigned share” calculations.

Doses assigned to organs play a major role in the assigned share. The 4.9 cSv dose assigned to the liver by the Air Force as listed in Table 1 of the main text looks to be a factor of ~ 2 too low. This is because the 4.9 number was generated by applying ICRP-68 dose coefficients to intakes calculated with CINDY, which relied on ICRP 30 biokinetic models. The ICRP-68 model, as used in DCAL, requires at least twice as much intake to match an excretion rate. Thus, ~ 68 nCi should have been used as the input to the ICRP-68 dose coefficients. Had that been done, the recommended maximum liver dose for Palomares veterans would also have doubled and, then, even late-onset liver cancer in a Palomares veteran would meet the criteria for compensation (62% AS/PC at 99th credibility level).

On the other hand, the liver dose level listed in Table 1 under ICRP-30 assumptions is also lower than expected, compared to the other organ doses, which means that the Air Force may have made special assumptions about liver doses.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table S-1. Data counts for the Palomares "High 26." a) | | | | | | |
| LA intake estimateb) | |  | Number of Measurement | | | |
| (Bq) | (pCi) |  |  | | | |
|  |  |  | On-sitec) | Detects | Non-detectsd) | Total |
| 1260 | 34000 |  | 0 | 2 | 1 | 3 |
| 1560 | 42000 |  | 1 | 3 | 3 | 6 |
| 1630 | 44000 |  | 1 | 3 | 2 | 5 |
| 1630 | 44001 |  | 1 | 4 | 1 | 5 |
| 2040 | 55000 |  | 1 | 4 | 1 | 5 |
| 2150 | 58000 |  | 2 | 4 | 2 | 6 |
| 2300 | 62000 |  | 2 | 4 | 1 | 5 |
| 2333 | 63000 |  | 1 | 4 | 3 | 7 |
| 2370 | 64000 |  | 1 | 4 | 1 | 5 |
| 2370 | 64001 |  | 1 | 3 | 2 | 5 |
| 2410e) | 65000e) |  | 1 | 2 | 5 | 7 |
| 2440f) | 66000f) |  | 1 | 3 | 3 | 6 |
| 2520 | 68000 |  | 0 | 2 | 2 | 4 |
| 2520 | 68001 |  | 1 | 4 | 1 | 5 |
| 2560 | 69000 |  | 1 | 3 | 2 | 5 |
| 2630 | 71000 |  | 1 | 4 | 1 | 5 |
| 2670 | 72000 |  | 0 | 3 | 1 | 4 |
| 2815 | 76000 |  | 1 | 3 | 3 | 6 |
| 3190 | 86000 |  | 1 | 3 | 2 | 5 |
| 3670 | 99000 |  | 0 | 2 | 1 | 3 |
| 12960  (3700)g) | 350000 (100000)g) |  | 1 | 4 | 2 | 6 |
| 4080 | 110000 |  | 1 | 5 | 2 | 7 |
| 5930 | 160000 |  | 1 | 3 | 0 | 3 |
| 6670 | 180000 |  | 1 | 3 | 0 | 3 |
| 7780 | 210000 |  | 1 | 4 | 1 | 5 |
| 44400  (20700)g) | 1200000 (560000)g) |  | 1 | 3 | 0 | 3 |
| 1. Extracted from Appendix C of the LA report (LA 2001). 2. Baseline intakes correspond to LA’s fits to off-site data only (alpha spectrometry). For two veterans, LA reported two values in their unpublished, Appendix C.1 (LA 2001), with only the lower value reported in the public version (LA 2001 at Table E-5). The lower values for these two veterans were obtained in both cases, because an off-site, alpha-spectrometry measurement with high value was excluded. For this Table, both values have been included. 3. Gross alpha measurements. 4. A value of 0.11 mBq d-1 (0.003 pCi d-1) was assigned to these measurements in the fits that LA made to the excretion data 5. For this veteran, the LA, Appendix-C-data lists an elapsed time of 22 days for the first off-site measurement, which does not match the date differences, which give a value of 140 days. 6. For this veteran, there was an on-site non-detect gross-alpha reading that was followed 3-days later with a reading of 3.09 pCi d-1. 7. Labat-Anderson chose to exclude one alpha-spectrometry data point, generating the intake estimate listed here. The value in the row above was obtained using all the data points. | | | | | | |

A screenshot of a cell phone

Description automatically generated

Figure S-1. Graph of high-26 excretion measurements including non-detects. Reproduced from LA report.



Fig. S-2. Histogram of the natural logarithm of the 270 excretion rates above 40 mBq d-1 (1.08 PCi d-1) for Palomares veterans including the High 26. These are almost all on-site measurements, which means a potential for contamination. Maximum value = 4500 mBq d-1. The mean was 210, median 76, and geometric mean 100 mBq d-1. As for the High 26, with the same cutoff of 40 mBq d-1, the resulting 16 values had a mean of 155, a median of 71, and a geometric mean of 88 mBq d-1. The maximum on-site value for the High 26 was 1300 mBq d-1. Two of the 26 had no valid on-site readings at all. The mean on-site value for all of the High 26 was 112 mBq d-1. The median was 61 mBq d-1, and the geometric mean was 55 mBq d-1. All figures for the High 26 are based on the numbers in the (draft) Volume 2 of the Labat-Anderson Report, Appendix C1 (LA 2001).

**Citations.**

LA. Palomares-Dose-Evaluation-Report Vol 2, (Appendix C.1,"High 26") From Yale Law Clinic (Available at: https://law.yale.edu/studying-law-yale/clinical-and-experiential-learning/our-clinics/veterans-legal-services-clinic/palomares-foia-litigation Accessed 24 July 2018). Labat-Anderson, Inc.; 2001.

LA. Palomares nuclear weapons accident: revised dose evaluation report (without Appendix C) (Available at http://www.airforcemedicine.af.mil/Portals/1/Images/About/Palomares/2001-Palomares-Dose-Evaluation-Report.pdf, Accessed 4/6/2018). McLean, VA: Labat-Anderson, Inc.; 2001.

1. provided to documentcloud.org by News Documents, The New York Times - Apr 08, 2016. [↑](#footnote-ref-1)