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Dear Harvey:

1. General and Specific Comments on Input for Bob Alvarez Briefing on Project Indalo

Page 1, first paragraph: Change text to read "558 acres of uncultivated land, farmed land, and urban-developed land."

Page 3, Table 9: Carcinoma is not synonymous with cancer. It is a type of cancer. Other types are sarcoma, adenocarcinoma, leukemia, etc. We suggest "cancers other than leukemia."

Page 3, end of first paragraph: The plutonium exposures of the 26 Manhattan Project workers studied by Voelz and Lawrence at Los Alamos National Laboratory, expressed in terms of their CEDE, ranged from 10 to 850 rem.

Page 3, item 1: "It was incorrectly alleged that a National Guardsman..."
Page 3, item 2. "It was incorrectly alleged that one of the crew of..."

Under Radiological Summary, Radiological Follow-up, the distribution of potential radiation doses in terms of CEDE is given for the 52 Palomares residents with positive bioassay results. Please note that there is much uncertainty in each of these individual dose estimates. The doses were estimated by Spanish scientists in Madrid using models and methods provided by ORNL. They used the biokinetic plutonium excretion model of Leggett and Eckerman (1987) to estimate intake, and tried to account for both the initial intake and subsequent long-term chronic exposure to airborne plutonium from a very limited amount of bioassay data. The CEDEs were then derived directly from ICRP Publication 30 Supplement tables. The method used to interpret the bioassay data and estimate intakes is conservative, and the Spanish scientists have very likely over-estimated the actual intakes and subsequent internal doses.

Rather than the term "hot spots," we suggest the term "detectable contamination."

2. Risk of Leukemia after Intakes of Plutonium

There has been no known human incidence of leukemia in any U.S. worker exposed to plutonium.

Among approximately 400 beagle dogs, used in life-span studies and exposed to insoluble plutonium oxide or soluble plutonium nitrate at Pacific Northwest Laboratory between 1960 and 1975, none have had leukemia. Intakes ranged from a few nanocuries to about 10,000 nanocuries of plutonium-239. Lung tumors were observed, increasing with exposure, in dogs exposed to plutonium-239 oxide, and bone tumors were observed in dogs exposed to plutonium-239 nitrate. Both lung tumors and bone tumors were observed in dogs exposed to plutonium-238 oxide, a form that is more easily transported because it has a higher specific activity than plutonium-239. (Complete summaries of these dog studies are given (Park 1990 and 1991).

3. Radiation Dose and Cancer Risk to Residents of Palomares

According to the International Commission on Radiological Protection (ICRP, 1986), a member of the public who receives 20 rem CEDE has 1 chance in 125 of contracting cancer. This is the highest projected CEDE among the monitored residents of Palomares. For a committed effective dose equivalent of 10 rem, the chances are 1 in 250; for 5 rem, 1 in 500; for 1 rem, 1 in 2500.

There are 3 to 4 chances in 5 that there will be zero (0) cancers caused by plutonium exposure in the 568 Palomares residents who were monitored, and 1 or 2 chances in 5 that there may be one (1) cancer caused by plutonium exposure in this population. The chances of two or more cancers being caused by plutonium exposure are slight.

Collective committed effective dose equivalent (a simple summation of everyone's) from plutonium exposure among those 516 Palomares residents whose urine results were "below detectable" can be estimated by assuming a lognormal distribution. The collective CEDE is then estimated to be about 900 person-rem.

Natural background radiation, excluding indoor radon, results in radiation doses of 0.1 rem per year, per person. A population of 600 persons would receive 900 person-rem from natural background radiation during a period of 15 years. Thus, the collective CEDE estimated from the bioassay data are comparable to the collective CEDE these same people received from natural background radiation. The most highly exposed persons are estimated to have received ten times more dose from plutonium than from natural backgroud during a 15-year period.

(Supporting documentation for the above calculations is available from PNL.)

4. Dose Estimates from Environmental Plutonium

The potential radiation doses were calculated from exposure to the environmental levels of plutonium presented in Iranzo, et al. (1987). The reported soil contamination at air sampling station 2-2 in Figure 1 of that article (which appears to be the location of the nearest house downwind) was 3.2 $\mu Ci/m^2$. This surface contamination was assumed to exist at the start of

the exposure period with no reduction from cleanup, but with reduction for leaching to lower soil depths. All of the plutonium was assumed to be finely divided Pu on the soil surface. Re-suspended Pu was assumed to be class Y, but the Pu in foods was taken to be class W (f_1 = 1E-3) as recommended by the ICRP (1986). Doses calculated were 50-year CEDE values accumulated from 50 years of intake of the plutonium. Doses were calculated using Version 1.485 of the GENII software package (Napier, et al. 1988).

The calculated cumulative radiation dose was 5 rem; and the CEDE from the first year's exposure was 3 rem. This result is in the range of some of the doses calculated from the bioassay data.

For comparison, doses were calculated based on 50 years of exposure to the average air concentration reported by Iranzo,et al. (1987) for air station 2-2 located near the 3.2 $\mu Ci/m^2$ isopleth. The reported 15-year average concentration was 5.2E-05 Bq/m^3. The calculated 50-year cumulative dose from inhalation and food was only 0.1 rem. This result is much lower than the doses based on either the soil contamination data or the bioassay data.

Very truly yours,

Paul A. Hanson for

Darrell R. Fisher, Tech Leader
Exposure, Biokinetic, and Dosimetric Modeling
HEALTH PHYSICS DEPARTMENT

DRF:dls

cc: Jack Selby

Attachment

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