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Fernald: 1969 Subcontractor Bioassay Evaluation Using Dose Reconstruction Best Estimate Methodology

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Introduction

The ORAU Team has uranium urinalysis bioassay data for 12 Fernald subcontractor workers in 1969. NIOSH has requested that these data be evaluated to determine whether the coworker study 95th percentile intakes would be bounding for these workers. Therefore, a comparison is being made of the internal dose that would be assigned based on the actual bioassay data in a best estimate dose reconstruction for these workers and that which would be assigned if the coworker study 95th percentile intakes were used. None of these 12 workers are claimants; information is not available regarding their work start/stop dates nor any information regarding the development of cancers (i.e., do not know if any of the 12 developed cancers).

In order to simplify the evaluation and compensate for the lack of information, specific organ doses are not calculated. For the same solubility type, the dose received by any particular organ is scaled directly with the magnitude of the integrated intake given the same intake period. Therefore, the comparison between the best estimate internal assessment and the use of the coworker study intakes is performed on the basis of integrated intakes rather than doses. Similarly, the comparison of fitted and missed intakes within the best estimate assessment is performed in the same manner.

For each person, fitted and/or missed intakes are calculated as appropriate for each uranium solubility type. The larger of integrated fitted or missed intake is then compared to the intake that would have been calculated if the 95th percentile coworker intake rate had been used instead.

Background Information

All 12 subcontractors were employed by either I Deutsch & Sons or M&M metals; one was employed by both companies. It is assumed that all the workers were onsite for the same project (presumed to be scrap metal recovery) and thus have the same beginning and end of employment. The first bioassay for any of the workers was on July 9, 1969, and the last was on October 13, 1969. Therefore, it is assumed that the first day of employment was July 1, 1969, and the last day was October 31, 1969 (i.e., 123 days) for all workers.

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The Fernald Internal Dosimetry TBD (ORAUT-TKBS-0017-5, Rev. 0) states to assume 2% enrichment for 1969 uranium sample results (1.616 pCi/ug). The MDA for this time period is assumed to be 14 ug/L, or 31.67 pCi/d. The bioassay data seem to indicate that the exposure was to Type F or M uranium. Type S is a poor fit to many of the positive measurements. However, this evaluation assumes that all three solubility types are possible. Data also indicate that acute intakes for several workers occurred on July 17 and/or August 26. These acute intake dates are used for all the workers whose bioassay data contain positive results shortly after these dates. This information is used in this manner in lieu of an incident write-up that would normally be expected to be included in the DOE-supplied claim information.

In addition, the constituents associated with recycled uranium would normally be assigned (plutonium-239, neptunium-237, and technicium-99) to any uranium intakes in 1969. However, since the magnitude and dose from these RU constituents scale directly with the magnitude of the uranium intake, no further discussion of these constituents is made in this comparison.

Coworker intakes at the 95th percentile are 159 pCi/d for Type F, 642 pCi/d for Type M, and 7869 pCi/d for Type S. If assigned for the entire employment period, these rates correspond to total intakes of 19,557 pCi for Type F, 78,966 pCi for Type M, and 967,887 pCi for Type S.

Employee Data

The ORAU Team has uranium urinalysis bioassay data for 12 subcontractor workers with various dates ranging from July 9, 1969 through October 13, 1969.

-[Worker 1]

[Worker 1] had three urinalysis results: all <MDA and all within one week of each other from July 21st to July 28th.

Missed dose is assigned for his entire employment.

Missed Dose Chronic Intakes

07/01/1969-07/28/1969

F missed 64.78 pCi/d

M missed 439.1 pCi/d

S missed 14480 pCi/d

-[Worker 2]

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[Worker 2] had had four urinalysis results: two positive measurements beginning August 27th followed by two <MDA in October. The data are indicative of an acute intake occurring on August 26th as discussed above.

An acute intake was assigned. Missed dose is assigned for his entire employment. The fitted intakes were determined to be larger for all solubility types.

Fitted dose Acute Intake	Missed Dose Chronic Intakes
08/26/1969	07/01/1969-10/13/1969
F fitted 8/26/69, 9.97E4 pCi	F missed – 68 pCi/d
M fitted – 8/26/69, 1.84E5 pCi	M missed – 347 pCi/d
S fitted – 8/26/69, 6.4E6 pCi	S missed – 10991 pCi/d

-[Worker 3]

[Worker 3] had six total urinalysis results: two positive measurements, one in July, and one in August. Both are assumed to have occurred the day before as discussed above. These dates provide the best fit to the bioassay data. The last two measurements are < MDA in October as are two results in July.

Two acute intakes are assigned along with missed dose for his entire employment. The fitted intakes were determined to be larger for all solubility types except F.

Fitted dose Acute Intakes	Missed Dose Chronic Intakes
07/17/1969, 08/26/1969	07/01/1969-10/13/1969
F fitted – 234, 5293 pCi	F missed – 59.7 pCi/d
M fitted – 1851, 41800 pCi	M missed – 322 pCi/d
S fitted – 61050, 1378400 pCi	S missed – 10530 pCi/d

-[Worker 4]

[Worker 4] had two urinalysis results: both <MDA in October.

Missed dose is assigned for his entire employment.

Missed Dose Chronic Intakes
07/01/1969-10/13/1969
F missed – 59.68 pCi/d

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M missed – 322.1 pCi/d
S missed – 10530 pCi/d

-[Worker 5]

[Worker 5] had seven urinalysis results: six positive and one <MDA.

Fitted dose is assigned for acute intakes on July 17th, July 28th, and August 26th. Missed dose is assigned for his entire employment. The fitted intakes were determined to be larger for all solubility types.

Fitted dose Acute Intakes	Missed Dose Chronic Intakes
07/17/1969, 07/28/1969, 08/26/1969	07/01/1969-10/13/1969
F fitted – 1365, 627.6, 16148 pCi	F missed – 64.71 pCi/d
M fitted – 10923, 6072, 122900 pCi	M missed – 438 pCi/d
S fitted – 360650, 462470, 4007700 pCi	S missed – 14450 pCi/d

-[Worker 6]

[Worker 6] had two urinalysis results: both were positive in August, indicative of an August 26th acute intake.

This acute intake is assigned. There are no <MDA measurements to use for missed dose.

Fitted dose Acute Intakes
08/26/1969
F fitted – 14830 pCi
M fitted – 116020 pCi
S fitted – 3835000 pCi

-[Worker 7]

[Worker 7] had seven total urinalysis results: four positive results, with the two largest indicative of the July 17th and August 26th acute intakes.

Acute intakes were assigned along with missed dose for his entire employment. The fitted intakes were determined to be larger for all solubility types except F.

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Fitted dose Acute Intakes	Missed Dose Chronic Intakes
07/17/1969, 08/26/1969	07/01/1969-10/13/1969
F fitted –2002, 3016 pCi	F missed –59.68 pCi/d
M fitted –16770, 25350 pCi	M missed –322.1 pCi/d
S fitted –555400, 833900 pCi	S missed –10530 pCi/d

-[Worker 8]

[Worker 8] had seven total urinalysis results: six of these were positive and the last bioassay was <MDA. The bioassay data are indicative of the July 17th and August 26th acute intakes, with another acute intake on July 24th to provide the best fit to the bioassay data.

The acute intakes were assigned along with missed dose for his entire employment. The missed dose intakes were determined to be larger for all solubility types.

Fitted dose Acute Intakes	Missed Dose Chronic Intakes
07/17/1969, 07/24/1969, 08/26/1969	07/01/1969-10/13/1969
F fitted –597.8, 576.5, 2778 pCi	F missed –59.68 pCi/d
M fitted –4887, 4664, 23840 pCi	M missed –322.1 pCi/d
S fitted –16120, 154000, 784000 pCi	S missed –10530 pCi/d

-[Worker 9]

[Worker 9] had one urinalysis result on July 9, 1969 which was <MDA.

Missed dose is assigned for his entire employment.

Missed Dose Chronic Intakes
07/01/1969-07/09/1969
F missed –74.15 pCi/d
M missed –557 pCi/d
S missed –18190 pCi/d

-[Worker 10]

[Worker 10] had two urinalysis results: one positive after the July 17th acute intake and a second <MDA measurement.

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An acute intake was assigned along with missed dose for his entire employment. The missed dose intakes were determined to be larger for all solubility types.

Fitted dose Acute Intakes	Missed Dose Chronic Intakes
07/17/1969	07/01/1969-07/28/1969
F fitted –1477 pCi	F missed –64.61 pCi/d
M fitted –11683 pCi	M missed –437.9 pCi/d
S fitted –358270 pCi	S missed –14444 pCi/d

-[Worker 11]

[Worker 11] had four total urinalysis results: three positive results and one <MDA. Although the bioassay dates are different from that for most of the workers, it was assumed he was involved in the same incidents and thus had the same acute intake dates.

Acute intakes were assigned, along with the missed dose for his entire employment. The fitted intakes were determined to be larger for all solubility types.

Fitted dose Acute Intakes	Missed Dose Chronic Intakes
07/17/1969 & 08/26/1969	07/01/1969-09/03/1969
F fitted –11950, 17200 pCi	F missed –64.61 pCi/d
M fitted –60720, 77364 pCi	M missed –437.9 pCi/d
S fitted –2057000, 2601000 pCi	S missed –14440 pCi/d

-[Worker 12]

[Worker 12] had seven total urinalysis results: six positive bioassay measurements and one <MDA, the last bioassay (10/13/1969). It appears he was involved in the July 17th and August 26th incidents.

Acute intakes were assigned along with missed dose for his entire employment. The fitted intakes were determined to be larger for all solubility types.

Fitted dose Acute Intakes	Missed Dose Chronic Intakes
07/17/1969 & 08/26/1969	07/01/1969-10/13/1969
F fitted –3853, 5936 pCi	F missed –59.68 pCi/d
M fitted –33470, 50270 pCi	M missed –322.1 pCi/d

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S fitted –1103000, 1652000 pCi S missed –10530 pCi/d

Conclusions

For each subcontractor, the missed and fitted integrated intakes were compared and the larger of the two was assigned to determine a total uranium intake for each solubility type. These integrated intakes are compared to the intakes that would have been assigned if each subcontractor had instead been assigned the 95th percentile coworker intake (shown in Figures 1-3 below). The red line represents the coworker intake and each bar represents the intake based on the best estimate assessment for each subcontractor. These data are provided in tabular form in Table 1 below.

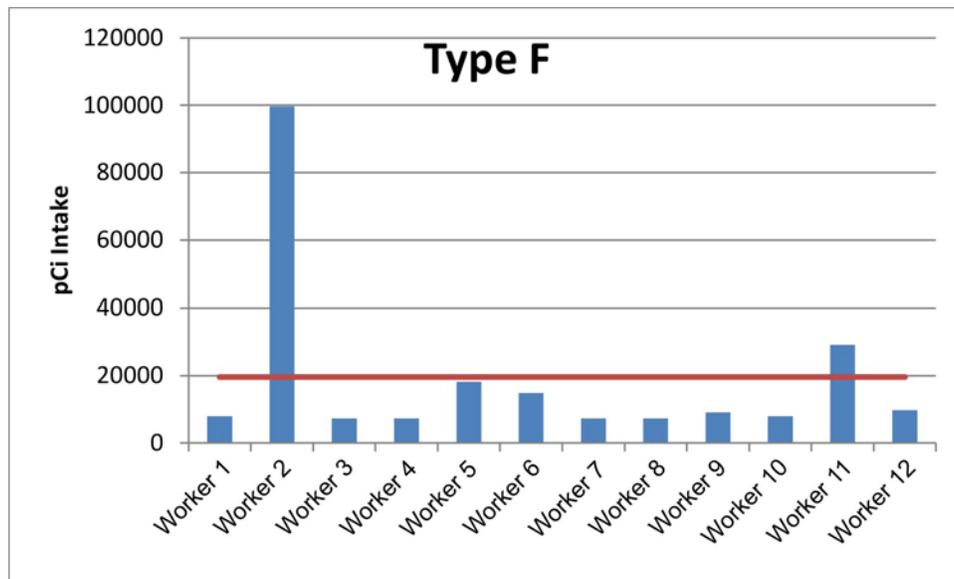


Figure 1. Type F integrated intakes.

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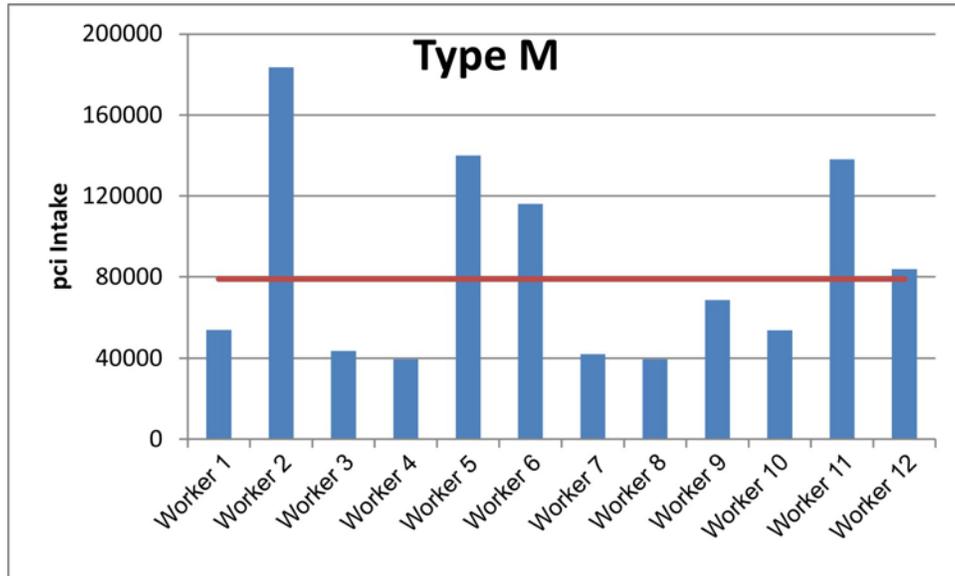


Figure 2. Type M integrated intakes.

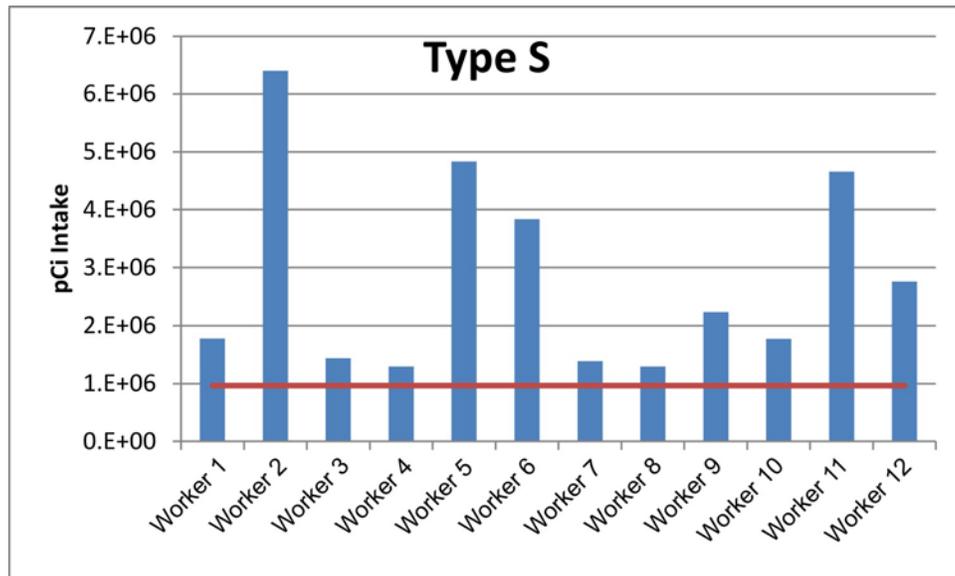


Figure 3. Type S integrated intakes.

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Table 1. Subcontractor integrated intakes.

Person	Integrated Intake, pCi		
	F	M	S
[Worker 1]	7967.94	54009.3	1781040
[Worker 2]	99688	183520	6400300
[Worker 3]	7340.64	43651	1439450
[Worker 4]	7340.64	39618.3	1295190
[Worker 5]	18140.6	139895	4830820
[Worker 6]	14830	116020	3835000
[Worker 7]	7340.64	42120	1389300
[Worker 8]	7340.64	39618.3	1295190
[Worker 9]	9120.45	68511	2237370
[Worker 10]	7947.03	53861.7	1776612
[Worker 11]	29150	138084	4658000
[Worker 12]	9789	83740	2755000
Coworker	19557	78966	967887