Office of Compensation Analysis and Support Technical Information Bulletin	Document Number: OCAS-TIB-007 Effective Date: 10/15/2007 Revision No. 1
Neutron Exposures at the Savannah River Site	**Page 1 of 6**
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RECORD OF ISSUE/REVISIONS

ISSUE AUTHORIZATION DATE	EFFECTIVE DATE	REV. NO.	DESCRIPTION
		0	New document to provide guidance on when neutron exposures should be included in SRS dose reconstructions.
10/15/07	10/15/2007	1	Clarification of locations, occupations, and time periods for which this TIB applies.

1.0 Purpose

This Technical Information Bulletin provides guidance on when neutron exposures should be included in Savannah River Site dose reconstructions. Due to changes in monitoring practices at the Savannah River Site, energy employees who worked at the site prior to the implementation of the Thermoluminescent Neutron Dosimeter (TLND) in 1971 might or might not have been adequately monitored for neutron exposure. In addition, some of the energy employees who were monitored for neutron exposure might or might not have a recorded neutron dose due to the use of Nuclear emulsion Type A (NTA) film, which generally under-responded to neutrons below 500 keV. As a result, neutron monitoring records prior to 1971 may indicate an under-reporting of neutron dose.

Starting with the use of the TLND in 1971, routine workers with significant potential for neutron exposure were adequately monitored with the TLND. Their dose and missed dose should be calculated in accordance with the External Dose Reconstruction Implementation Guideline[1]. There are some workers who depending on their job classification might have been intermittently exposed to low-level neutrons. The general criteria for neutron monitoring in the 1970s through late 1980s were determined based on being exposed to a neutron field greater than or equal to 1 mrem/hr. As a result, non routine workers might or might not have been adequately monitored for neutron exposure depending on where in the facility they were conducting their work. Starting around 1989, SRS used

the DOE criteria of the potential for 100 mrem/year as the basis for who was monitored for neutron exposure.

In the following sections, this bulletin provides general guidance on when neutron exposures should be considered in SRS Dose Reconstructions

2.0 Potential for Neutron Exposure prior to 1971

2.1 Work area is known

When exposure or work history records are sufficient to indicate that an energy employee worked in any of the following areas, neutron dose should be included in the dose reconstruction. These areas have been identified in Section 5.0 of the SRS Technical Basis Document[2] and are based on information in Brackenbush et al[3] and other site documentation.[4,5,6]

A Area (300 & 700 Areas)

- Calibration Facility (736A)
- Savannah River Laboratory (773A)

Reactor - 100 Area (C,K,L,P,R - Reactors)

- Only certain occupations involved neutron exposure, see section 2.2 for further guidance.

Separations - 200 Area (H and F Canyons)

- HB and FB Lines (221F, 221H)
- Plutonium Fuel Facility (235F)
- Production Control Laboratory (772F)

Fuel Fabrication – 300 Area

- Fuel Fabrication Facility (321M) – Only during certain time periods, see section 2.2 for further guidance.

2.2 Work area is unknown or not clear

When the work area is not known or is not clear, a Health Physicist should use the criteria outlined below to determine whether neutron exposures should be included. There is no single definitive source document that can be used to determine whether an energy employee was exposed to neutrons; however, from a weight of evidence investigation, a Health Physicist should be able to determine the neutron exposure potential. The Health Physicist should keep in mind the claimant favorable approach to dose reconstruction under EEOICPA and when there is equal evidence of potential exposure, the approach should be to include the neutron exposure. Listed below is some general guidance that can be used to assist in determining whether an individual was potentially exposed to neutrons.

2.2.1 General indications of potential neutron exposure

1. If an energy employee was monitored for neutron exposure in 1971 or later, and he or she did not change jobs or work area, the energy employee should be considered to have been exposed to neutrons prior to 1971. The monitoring for neutrons increased dramatically after the implementation of the TLND in 1971, thus contemporary monitoring is a good indicator of potential for neutron exposure.

2. External dosimetry records indicate the 17 keV calibration curve was used for interpretation of the shallow dose. This is an indication of exposure to plutonium and therefore neutrons.

3. Neutron exposure indicated in external dosimetry records between 1958-1962 (codes 32 and 33 in the external dosimetry report). This neutron dose might or might not have been separated in the HPAREH summary sheet. In addition, the dosimetry cards prior to 1958 also contained an area for fast neutrons (NF) and slow neutrons (NS) to be recorded. A close investigation of the dosimetry records should be conducted to evaluate the potential for neutron exposure.

2.2.2 Area-specific indications of potential neutron exposure

A Area (700 Area)
Indications, either through the Computer Assisted Telephone Interview (CATI), bioassay records, or other information (i.e. incident reports), that the energy employee worked with or had an exposure potential to californium or curium. An indication of work with either of these isotopes identifies individuals who have a potential for exposure to neutrons.

Reactor - 100 Area (C,K,L,P,R - Reactors)
Neutron exposures should only be considered for energy employees who might have been involved in maintenance activities in the crane wash areas of the reactors. These occupations would include maintenance crafts such as mechanics, pipefitters, electricians, carpenters, and sheetmetal workers. Note, this list is not all inclusive and is provided as an example of maintenance crafts. There is also a potential for neutron exposure for individuals responsible for radiation monitoring in the workplace. These occupations include radiological control technicians, electronics and instrumentation technicians, health physicist, and reactor operators. Monitoring for neutron exposure in 1971 or later is again a strong indicator that the energy employee performed work in the crane wash area and was potentially exposed to neutrons.

During the loading of Pu-Al targets during certain campaigns, there are other workers in the reactor areas who might have been exposed to neutrons. According to site personnel, during these operations, the individuals involved would have been monitored for neutron exposure. As a result, monitoring for neutrons in 1971 or later in the reactor areas is an indicator that an energy employee performed this type of work.

Separations - 200 Area (H and F Canyons)

Routine (i.e. more frequent than annual) plutonium (Pu) bioassay monitoring, and a relatively high shallow dose to deep dose ratio (> 2.0), and relatively little enriched uranium (EU) bioassay indicate the energy employee worked on either the FB or HB lines.

The high shallow to deep dose ratio is not always a clear indicator of neutron exposure in the 200 area. For example if there are numerous enriched uranium bioassay measurements in the 200 area, the energy employee most likely worked on the A lines and would have received little to no neutron exposure. The high shallow dose is the result of beta exposure from uranium daughter products.

Because certain occupations (crafts/trades) might have worked in both the A and B line areas of the 221-F facilities, a claimant favorable weight of the evidence approach should be used to evaluate the potential for exposure to neutrons. Clearly indications of work in the A-line or tank farm areas demonstrate a lack of potential neutron exposure and should not be included. For energy employees who worked in multiple areas, some modification to the neutron exposure distributions provided in the SRS Technical Basis Documents[2] might be necessary.

Fuel Fabrication – 300 Area
Bioassay monitoring for plutonium in 300 area. Generally this area was a uranium fuel fabrication area. There were certain campaigns (time periods), however, in which plutonium-aluminum (Pu-Al) targets were manufactured in the 321-M facility[4]. These Pu-Al targets emitted neutrons. Generally, there will also be indications that the 17 keV calibration curve was used to interpret the shallow dose. The use of this calibration curve is an indicator of potential neutron exposure. Research to date indicates that the first fabrication was conducted in 1959 (Overbeck et al., 1965), however the transplutonium program (campaigns) began in earnest in 1963 and continued until reactor operations ceased in 1992. (Harbour et al., 2000) Note this time period covers the production of californium and curium which was the purpose of the Pu-Al targets. The campaigns of these fuel elements would have been intermittent during this time period.

3.0 Potential for Neutron Exposure (1971-present)

Routine workers were adequately monitored for neutron exposures starting in 1971 and later. There is a potential for unmonitored neutron dose for non-routine (intermittent) workers who occasionally visited neutron exposure areas. The criteria for monitoring were based on entry into a neutron exposure field greater than or equal to 1 mrem/hr. Since all routine workers in facilities with this level of a field were monitored, the non-routine (intermittent) workers are expected to have received a neutron dose that was significantly less. Starting around 1989, SRS adopted the DOE criteria of monitoring workers who had a potential of exceeding 100 mrem/yr. As a result the neutron dose for unmonitored workers from 1989 to present is considered to be significantly less than 100 mrem/yr.

3.1 Non-Routine Workers (1971-1989)

For non-routine workers with photon monitoring, but no neutron monitoring, a careful evaluation of their work location, job description (classification), CATI, and photon exposure history should be conducted to determine whether neutron dose should be included in the dose reconstruction.

The following criteria should be met in determining whether neutron dose should be added.

1. Work Location – If the work location is any of the areas noted in section 2.1, then neutron exposures should be considered providing the other criteria are met.
2. Job Description (Classification) or CATI – If either the job description or the CATI indicates a type of work that could result in only intermittent exposure to neutrons in an area listed in section 2.1, then neutron exposure should be considered. An example of a job type that might result in intermittent neutron exposure would be a quality control/production inspector or inventory/accountability clerk.
3. Positive Photon Exposure - The energy employee has a measured photon dose (not missed dose).

When an energy employee has been evaluated as exposed to neutrons but not monitored, the neutron/photon ratios discussed in the SRS Technical Basis Document[2] should be applied. While these estimates will tend to overestimate the neutron dose, especially considering the ratios were developed based on routine workers, they are considered reasonable but claimant favorable.

4.0 Clarification on use of neutron to photon ratio

The neutron to photon ratio should only be applied in cases where the neutron monitoring is considered inadequate based on characteristics of measured neutron spectrum. There are some locations at SRS where the neutron monitoring was adequate and workers received a measured dose. When the measured dose is greater than the estimated dose using the neutron to photon ratio, the measured dose should be applied. For 1971 and later, the uncertainty in this measured neutron dose should be estimated using information in the SRS Technical Basis Document[2] in conjunction with the External Dose Reconstruction Implementation Guideline.[1]

5.0 Summary

A claimant favorable weight of the evidence approach with particular attention to the source information identified in section 2.2.1 (monitoring in 1971 or later, use of 17 keV calibration curve for shallow dose, and neutron monitoring identified in early dosimetry records) should be used when the work location and or activities are not clear.

6.0 References

1. NIOSH, (2002) External Dose Reconstruction Implementation Guideline, Rev 1, OCAS-IG-001, National Institute for Occupational Safety and Health, Office of Compensation Analysis and Support, Cincinnati, Ohio.

2. ORAU Team, ORAUT-TKBS-0003, Technical Basis Document for the Savannah River Site To Be Used for EEOICPA Dose Reconstructions, (2003)

3. Brackenbush, L. W., Soldat, K. L., Haggard, D. L., Faust, L. G., and Tomeraasen, P. L. *Neutron Dose and Energy Spectra Measurements at Savannah River Plant*, Richland, Washington, PNL-6301, (1987)

4. Dupont. *Progress Report: Works Technical Department - August 1965*, Savannah River Plant, DPSP 65-1-8, (1965)

5. Taylor, G. A., Crase, Kenneth W., LaBone Thomas R., and Wilkie, W. H. *A History of Personnel Radiation Dosimetry at the Savannah River Site*, Aiken, South Carolina, WSRC-RP-95-234, (1995)

6. Bebbington, W.P. *History of Du Pont at the Savannah River Plant*. E.I. du Pont de Nemours and Company, Wilmington, Delaware 0-934870-27-6 (1990).

7. Overbeck, W.P., Ice, C.H., Dessauer, G., Production of Transplutonium Elements at Savannah River. E.I. du Pont de Nemours and Company, DP-1000, Aiken, South Carolina (1965).

8. Harbour, Robert M., Ice, Clark H., Hale, William H., Lowe, John T., Development of Chemical Processes and Equipment to Recover Curium-244 and Californium-252. 50 years of Excellence in Science and Engineering at the Savannah River Site. Proceedings of the Symposium May 17, 2000. Westinghouse Savannah River Company, WSRC-MS-2000-00061 (2000).