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External Coworker Dosimetry Data for the Savannah River Site	Revision: 00 Effective Date: 05/31/2005 Type of Document: OTIB Supersedes: None

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PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
04/04/2005	00-A	New technical information bulletin to provide information to allow ORAU Team dose reconstructors to assign doses to Savannah River Site workers who have no or limited monitoring data, based on site coworker data. Initiated by Steven E. Merwin.
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05/31/2005	00	First approved issue. No training required. Initiated by Steven E. Merwin.

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1.0 PURPOSE

Technical Information Bulletins (TIBs) are general working documents that provide guidance concerning the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained. TIBs may be used to assist the National Institute for Occupational Safety and Health in the completion of individual dose reconstructions.

In this document the word "facility" is used as a general term for an area, building, or group of buildings that served a specific purpose at a site. It does not necessarily connote an "atomic weapons employer facility" or a "Department of Energy facility" as defined in the Energy Employees Occupational Illness Compensation Program Act of 2000 (42 U.S.C. § 7384l(5) and (12)).

The purpose of this TIB is to provide information to allow ORAU Team dose reconstructors to assign doses to Savannah River Site (SRS) workers who have no or limited monitoring data, based on site coworker data. The data in this TIB are to be used in conjunction with ORAUT-OTIB-0020, "Use of Coworker Dosimetry Data for External Dose Assignment."[1]

2.0 BACKGROUND

The ORAU Team is conducting a series of coworker data studies to permit dose reconstructors to complete certain cases for which external and/or internal monitoring data are unavailable or incomplete. Cases not having complete monitoring data may fall into one of several categories, including:

- The worker was unmonitored and, even by today's standards, did not need to be monitored (e.g., a non-radiological worker).
- The worker was unmonitored, but by today's standards would have been monitored.
- The worker may have been monitored but the data are not available to the dose reconstructor.
- Partial information is available, but it is insufficient to facilitate a dose reconstruction.

As described in ORAUT-OTIB-0020,[1] some cases not having complete monitoring data can be processed based on assumptions and methodologies that do not involve coworker data. For example, many cases falling in the first category above can be processed by assigning ambient external and internal doses based on information in the relevant site Technical Basis Documents (TBDs).

As described in the SRS TBD,[2] operations at the site began in 1952, and the site initially used dosimeter and processing technical support provided by the Oak Ridge National Laboratory (ORNL). SRS routine practices appear to have required assigning dosimeters to all workers who entered a controlled radiation area. There does not appear to be any significant administrative practice that would jeopardize the integrity of the recorded dose of record; however, the "adjustment to reported dose" recommended by the TBD (e.g., 1.119 for the reported deep photon dose prior to 1986) is appropriate for the coworker doses established in this TIB, since the doses are based on the SRS dosimetry data.

3.0 GENERAL APPROACH

As described in ORAUT-OTIB-0020,[1] the general approach to developing coworker data for cases without external monitoring data involves two phases. The first (Phase I) permits cases to be processed when a "best and final" estimate of dose is not required for claim determination. The second (Phase II) facilitates the assignment of "best and final estimates" of dose, when necessary. This initial revision of this TIB provides coworker external dosimetry summary statistics applicable to Phase I dose reconstructions; coworker dose distributions applicable to Phase II dose reconstructions will be made available in a subsequent revision.

4.0 APPLICATIONS AND LIMITATIONS

1. Revision 00 of this document provides SRS coworker data and information that may be used only for clearly non-compensable cases for which a higher external dose can be assigned than was likely to have actually been received, or for compensable cases on a limited basis (see Section 7.0). Revision 01 of this document will provide dose distributions and additional information based on the data presented herein to permit the processing of cases requiring a best estimate analysis.

2. Some SRS workers may have worked at one or more other major sites within the DOE complex during their employment history. Thus, the data presented herein must be used with caution to ensure that for clearly non-compensable cases, unmonitored external doses from multiple site employment have been overestimated. This will typically require the availability of External Coworker Dosimetry Data TIBs for all relevant sites.

3. Summary statistics based on SRS dosimetry data presented in this TIB do not extend beyond 1999 because at the time this TIB was drafted, sufficient data beyond that year were not available. However, the absence of these data (and the subsequent development of dose distributions) should not interfere with the processing of most SRS cases having a lack of external dosimetry data, since well before 1999 the monitoring and reporting practices at the site ensured that essentially all workers with a potential for external radiation exposure were monitored and the results are readily accessible. Should the need arise and sufficient data become available, coworker dosimetry data beyond the year 1999 will be presented in a subsequent revision to this TIB.

4. The data presented in this TIB address penetrating radiation from gamma radiation and non-penetrating radiation from beta or low-energy photon radiation. Neutron data are not presented. The site TBD[2] should be used as the basis for assigning neutron doses, when relevant, in addition to the photon and/or beta doses assigned in accordance with this TIB.

5. Prior to 1980, external on-site ambient doses should be included in addition to the coworker doses assigned in accordance with this TIB because prior to that year it is possible that such doses would not have been included in the dosimetry results reported by the site.[5]

5.0 REFERENCES

1. ORAU Team, ORAUT-OTIB-0020, Use of Coworker Dosimetry Data for External Dose Assignment, Rev 00, December 29, 2004.

2. ORAU Team, ORAUT-TKBS-0003, Technical Basis Document for the Savannah River Site to be Used for EEOICPA Dose Reconstructions, Rev 02, October 29, 2004.

3. NIOSH (National Institute for Occupational Safety and Health), External Dose Reconstruction Implementation Guideline, Rev. 0, OCAS-IG-001, Office of Compensation Analysis and Support, Cincinnati, Ohio, 2002.

4. ORAU Team, ORAUT-OTIB-0017, Interpretation of Dosimetry Data for Assignment of Shallow Dose, Rev 00, January 19, 2005.

5. ORAU Team, ORAUT-OTIB-0007, Technical Information Bulletin: Occupational Dose from Elevated Ambient Levels of External Radiation, Rev 00, November 12, 2003.

6.0 SRS COWORKER DATA DEVELOPMENT

Dosimetry data for monitored SRS workers available from the HPAREH database were evaluated. In all cases, the reported data corresponded to annual deep doses (i.e., penetrating gamma radiation) and annual shallow doses (i.e., penetrating plus non-penetrating radiation).

The annual data reported in HPAREH were prorated to account for partial years of employment based on an analysis of the length of monitored employment associated with the data (see Section 7.0 for further discussion). The data were prorated so that coworker doses representing a full year of monitored employment could be derived; this permits the dose reconstructor to assign appropriate doses based on specific employment dates and job descriptions.

The validity of the data selected for coworker dose development was confirmed by selecting a sampling of HPAREH summary data submitted by the site as part of the EEOICPA Subtitle B program and comparing it to the data described above. A review of data for two claimants with complex and extensive dosimetry records covering the years 1953 through 1999 indicated good agreement between the two data sets. Importantly, when the data did not match exactly, there was no apparent bias toward an under or overestimation of dose for either data set, suggesting that relying on the HPAREH annual data for coworker dose reconstruction would not result in a negative bias against the claimants.

Adjustment for Missed Dose

According to the External Dose Reconstruction Implementation Guideline,[3] missed doses are to be assigned for null dosimeter readings to account for the possibility that doses were received but not recorded by the dosimeter or reported by the site. Annual missed doses are calculated by multiplying the number of null badge readings by the reported dosimeter limit of detection (LOD) and summing the results. These values are used as the 95th percentile of a lognormal distribution for the purpose of calculating probability of causation which is determined by the Department of Labor; thus, in IREP the calculated missed doses are multiplied by 0.5 and entered in Parameter 1, and a value of 1.52 is entered in Parameter 2, to represent the geometric mean and geometric standard deviation, respectively.

The assignment of missed doses for monitored workers is particularly significant for SRS claimants prior to October 1957 when workers were monitored weekly. Table 1 lists the maximum annual missed dose by era and type of radiation (penetrating gamma and non-penetrating) based on information presented in the site TBD[2] and ORAUT-OTIB-0017.[4]

Special Considerations

Certain aspects of the external dosimetry practices at the SRS documented in the TBD[2] were considered in the analysis of the site data. These include:

Table 1. Missed external doses based on SRS TBD and ORAUT-OTIB-0017.

Period	Penetrating LOD (rem)	Non-penetrating LOD (rem)	Exchange frequency	Maximum annual missed dose (rem)	
				Penetrating	Non-penetrating
1951–9/1957	0.04	0.05	Weekly	2.080	2.600
10/1957–1964	0.04	0.05	Biweekly	1.040	1.300
1965	0.04	0.05	4-week	0.520	0.200
1966–1970	0.04	0.05	Monthly	0.480	0.600
1971–1983	0.015	0.025	Monthly	0.180	0.300
1984–Present	0.005	0.020	Monthly	0.060	0.240

- Although the majority of the annual doses reported were positive, many of the underlying individual badge readings were zero, and thus the reported annual doses tend to underestimate the actual doses received because of missed doses below the dosimeter LODs (see Table 1 above).

- In some cases, values less than the dosimeter LODs were reported by the site. For example, values as low as a few millirem (mrem) were reported even though the penetrating LOD was as high as 40 mrem (depending on the era).

- As discussed previously, the data available to analyze coworker doses represent annual dose summaries for individual workers. Because these data include partial work years, the average annual doses reported tend to underestimate the average annual doses received by employees who worked an entire year.

As described in Section 7.0 below, a claimant-favorable approach was adopted in the development of coworker dose summaries, and this approach should account for any underestimate of doses to radiological workers at the SRS based on the above considerations.

7.0 SRS COWORKER ANNUAL DOSE SUMMARIES

Based on the information and approaches described above, SRS coworker annual external dosimetry summaries were developed for use in the evaluation of external dose for certain claimants potentially exposed to workplace radiation, but with no or limited monitoring data provided by DOE. These summaries were developed using the following steps:

1. As described in Section 6.0 above, the reported deep and shallow doses, which represented annual summary data, were modified to account for partial years of employment. This adjustment was made by analyzing the NOCTS employment data for SRS workers and adjusting the reported doses upward by an appropriate multiplier corresponding to the average fraction of a year an employee worked at the site. For example, if in a particular calendar year the average employment period for all SRS employees in NOCTS was 11 months, the reported annual doses were multiplied by 12/11, or 1.09. This permits the dose reconstructor to assign an appropriate prorated dose to account for partial years of employment or potential exposure.

2. The 50th, 95th, and 99th percentile annual penetrating and shallow doses were derived for two scenarios: excluding and including reported zeroes.

3. For each year and percentile evaluated, the higher of the following two values was selected: 1) the percentile dose with zero results included plus one-half of the maximum annual missed dose as listed in Table 1, and 2) the percentile dose with zero results excluded.

4. Because the reported shallow doses include both penetrating and non-penetrating radiation, the percentile doses pertaining to penetrating radiation were subtracted from the percentile doses pertaining to the reported shallow doses to derive percentile doses pertaining to non-penetrating radiation.

5. The results are presented in Table 2 below. These percentile doses should be used for selected SRS workers with no or limited monitoring data, using the methodologies outlined in Section 7.0 of ORAUT-OTIB-0020.[1] Because the values include a claimant-favorable adjustment for potential missed dose, they should not be applied for cases with estimated POCs >50% without first subtracting missed dose based on the information in Table 1 and Step 3 above. Should these data prove insufficient for the completion of dose reconstructions, "best estimate" coworker dose distributions should be used as documented in Section 8.0 below and in accordance with Section 8.0 of ORAUT-OTIB-0020.[1]

Doses to organs impacted only by penetrating radiation (e.g., organs other than the skin, breast, and testes) are calculated based only on the "Gamma" columns in Table 2 combined with the appropriate organ dose conversion factors (DCFs).[3] Doses to the skin, breast, and testes (and any other cancer location potentially impacted by non-penetrating radiation) are determined based on both the "Gamma" and "Non-penetrating" columns; gamma doses are assigned as photons with an energy range consistent with information in the external dosimetry TBD for the SRS,[2] and non-penetrating doses are assigned as electrons >15 keV with corrections applied to account for clothing attenuation or other applicable considerations (or as <30 keV photons, if appropriate).[4]

8.0 SRS COWORKER ANNUAL DOSE DISTRIBUTIONS

Reserved

Table 2. Annual SRS external coworker doses modified to account for missed dose (rem).

Year	Gamma 99th%	Gamma 95th%	Gamma 50th%	Non-pen 99th%	Non-pen 95th%	Non-pen 50th%
1952	1.672	1.599	1.117	1.233	0.368	0.365
1953	1.774	1.354	1.082	2.391	1.239	0.284
1954	1.506	1.192	1.062	1.753	0.905	0.288
1955	2.994	1.885	1.087	2.609	1.716	0.297
1956	3.229	2.188	1.138	1.942	1.536	0.291
1957	3.469	2.548	1.085	1.407	0.995	0.261
1958	2.421	1.704	0.658	1.248	0.611	0.176
1959	2.727	1.836	0.689	2.321	1.665	0.314
1960	3.300	2.724	0.781	3.697	2.397	0.335
1961	2.665	2.101	0.654	6.347	3.271	0.290
1962	2.722	1.943	0.654	6.449	3.209	0.294
1963	2.937	2.168	0.637	7.283	3.091	0.283
1964	3.273	2.769	0.711	9.578	4.902	0.362
1965	2.846	2.277	0.413	8.617	4.568	0.289
1966	2.831	2.168	0.412	6.834	4.109	0.222
1967	2.897	2.443	0.429	6.285	3.191	0.264
1968	2.833	2.337	0.409	8.944	4.394	0.305
1969	2.776	2.350	0.463	7.659	4.341	0.288
1970	2.798	2.306	0.427	6.845	3.008	0.186
1971	2.609	1.925	0.411	5.483	2.152	0.183
1972	2.453	1.615	0.213	5.392	1.952	0.135
1973	2.413	1.504	0.182	5.254	1.810	0.106
1974	2.318	1.378	0.151	4.786	1.636	0.091
1975	1.775	1.093	0.137	3.236	1.255	0.096
1976	1.678	0.955	0.136	3.490	1.219	0.091
1977	1.719	0.940	0.137	3.149	1.140	0.091
1978	1.607	0.913	0.132	3.131	1.150	0.086
1979	1.601	0.905	0.122	3.271	0.889	0.092
1980	1.471	0.838	0.127	2.512	0.890	0.086
1981	1.391	0.800	0.127	2.987	1.159	0.092
1982	1.286	0.791	0.132	2.341	0.798	0.070
1983	1.239	0.739	0.128	2.531	0.845	0.082
1984	1.050	0.623	0.068	2.184	0.660	0.106
1985	1.001	0.559	0.062	1.634	0.577	0.101
1986	0.795	0.440	0.051	1.065	0.308	0.111
1987	0.780	0.425	0.047	0.994	0.285	0.123
1988	0.829	0.431	0.041	0.664	0.186	0.128
1989	0.702	0.354	0.050	0.713	0.220	0.117
1990	0.641	0.304	0.053	0.384	0.210	0.101
1991	0.397	0.193	0.030	0.265	0.092	0.090
1992	0.383	0.191	0.030	0.170	0.069	0.090
1993	0.328	0.193	0.030	0.102	0.039	0.090
1994	0.437	0.187	0.030	0.083	0.060	0.090
1995	0.491	0.260	0.030	0.130	0.062	0.090
1996	0.441	0.196	0.030	0.096	0.056	0.090
1997	0.419	0.206	0.030	0.223	0.097	0.090
1998	0.406	0.227	0.030	0.209	0.093	0.090
1999	0.276	0.161	0.030	0.243	0.115	0.090