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PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
09/22/2008	00	Approved new technical information bulletin to provide information to allow ORAU Team dose reconstructors to assign doses at the Fernald Environmental Management Project to certain workers who have no or limited monitoring data, based on site coworker data. Incorporates formal internal review comments. No changes occurred as a result of NIOSH formal review. Training required: As determined by the Task Manager. Initiated by Matthew H. Smith.

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ACRONYMS AND ABBREVIATIONS

DOE	U.S. Department of Energy
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
FEMP	Fernald Environmental Management Project
IREP	Interactive RadioEpidemiological Program
LOD	limit of detection
mrem	millirem
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
OW	open window
S	shielded
TIB	technical information bulletin
TLD	thermoluminescent dosimeter
U.S.C.	United States Code
§	section or sections

1.0 INTRODUCTION

Technical information bulletins (TIBs) are not official determinations made by the National Institute for Occupational Safety and Health (NIOSH) but are rather general working documents that provide historic background information and guidance to assist in the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). TIBs may be used to assist NIOSH staff 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 [DOE] facility" as defined in the Energy Employees Occupational Illness Compensation Program Act of 2000 [EEOICPA; 42 U.S.C. § 7384l(5) and (12)].

2.0 PURPOSE

The purpose of this TIB is to provide information to allow dose reconstructors to assign doses that are based on site coworker data to Fernald Environmental Management Project (FEMP) workers who have no or limited monitoring data. In addition, the data in this TIB should be used to assign doses for gaps in dosimetry records. The data are to be used in conjunction with ORAUT-OTIB-0020, *Use of Coworker Dosimetry Data for External Dose Assignment* (ORAUT 2005).

3.0 BACKGROUND

The Oak Ridge Associated Universities (ORAU) Team is conducting a series of coworker data studies to permit dose reconstructors to complete certain cases for which external or internal monitoring data are unavailable or incomplete. Cases that do not have complete monitoring data could fall into one of several categories:

- The worker was unmonitored and, even by today's standards, did not need to be monitored (e.g., a nonradiological worker).
- The worker was unmonitored but, by today's standards, would have been monitored.
- The worker might 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 (ORAUT 2005), some cases without complete monitoring data can be processed based on assumptions and methodologies that do not involve coworker data. For example, many cases in the first category can be processed by the assignment of ambient external and internal doses based on information in the relevant site technical basis documents.

As described in ORAUT-TKBS-0017-6, *Technical Basis Document for the Fernald Environmental Management Project* - Occupational External Dose (ORAUT 2004), operations at the site began in 1951. FEMP used film dosimeters between 1951 and 1985. Use of a multichip thermoluminescent dosimeter (TLD) was implemented in 1985. Exchange frequencies varied from quarterly to weekly dependent on the era. There does not appear to have been any significant administrative practice that would have jeopardized the integrity of the dose of record.

4.0 GENERAL APPROACH

As described in ORAUT-OTIB-0020 (ORAUT 2005), the general approach to the development of coworker data for cases without external monitoring data is to assign either 50th- or 95th-percentile doses with the intent that the assigned doses represent, but do not underestimate, the doses that would have been assigned had the worker been monitored.

5.0 APPLICATIONS AND LIMITATIONS

Some FEMP workers could have worked at one or more other major sites in the DOE complex during their employment histories. Therefore, the data in this TIB must be used with caution to ensure that, for likely noncompensable cases, unmonitored external doses from multiple site employments have been overestimated. This typically requires the availability of the recorded doses or TIBs for external coworker dosimetry data for all relevant sites.

The data in this TIB address penetrating gamma radiation and nonpenetrating electron and/or low-energy photon radiation. Neutron data are not presented separately; methods for determining neutron dose are discussed in Section 7.0.

External onsite ambient dose should be applied as specified in the latest revision of ORAUT-PROC-0060*, Occupational On-Site Ambient Dose Reconstruction for DOE Sites* (ORAUT 2006).

6.0 COWORKER DATA DEVELOPMENT

The FEMP HIS-20 database served as the data resource for coworker data analysis. The following items describe assumptions made during the analysis process:

- Different types of dosimeters were available in the HIS-20 database. Only records with a wear location of “chest” were used in the analysis.
- If a record had a blank Social Security Number, then the record was excluded.
- Deep dose and shallow dose values that were “null” were excluded and not treated as zeros. The fact that “null” records were not zero values was confirmed by comparison with DOE records from several claimants with the database.
- Dose records from 10 EEOICPA claims were compared to the database, and in all cases the results from HIS-20 data exactly matched the data from DOE under EEOICPA.
- The amount of time a badge was worn by an employee is determined in a calculated field called “WearLength” and is equal the number of days between the End_Date and the Begin_Date in the database.
    - Only records with a WearLength more than zero and less than 400 days were considered in the analysis. Relatively few records were removed from the analysis by filtering the records in this way. Of 35,795 records, 35,251 met the filter criteria of a WearLength more than zero and less than 400 days. Only 544 records did not meet the filtering criteria.
    - If the WearLength was more than 29 days then the dose was adjusted upward to represent 365 days of continuous wear. Dose values were used “as is” in the analysis if the WearLength is less than or equal to 29 days.

- The shallow dose represents the sum of the shielded (S) and open window (OW) portions of the dosimeter as discussed in Section 6.4 of ORAUT-TKBS-0017-6 (ORAUT 2004).

6.1 ADJUSTMENT FOR MISSED DOSE

According to OCAS-IG-001, *External Dose Reconstruction Implementation Guideline* (NIOSH 2007), missed doses are assigned for reported zero readings for each monitoring cycle to account for the possibility that doses were received but either not recorded by the dosimeter or not reported by the site. In addition, reported dose values less than one-half the applicable minimum detection limits are assigned as missed dose. Annual maximum potential missed doses are calculated by multiplying the number of zero or unrecorded badge readings by the reported dosimeter limit of detection (LOD) and summing the results. These values are used as the 95th-percentile values of a lognormal distribution to calculate the probability of causation, which is determined by the U.S. Department of Labor. Therefore, in the Interactive RadioEpidemiological Program (IREP), Parameter 1 is equal to the calculated maximum annual missed doses multiplied by 0.5, and Parameter 2 is equal to 1.52. These values represent the geometric mean and geometric standard deviation, respectively, for each year of analysis.

The assignment of maximum potential missed doses for monitored workers is particularly significant for FEMP workers from 1952 to 1953, when they could have been monitored weekly. Table 6-1 lists the maximum annual missed dose by monitoring period based on information in ORAUT-TKBS-0017-6 (ORAUT 2004).

Table 6-1. Missed external doses (rem) based on ORAUT-TKBS-0017-6 (ORAUT 2004).

Monitoring period	Penetrating and nonpenetrating LOD	Exchange frequency	Maximum potential annual missed penetrating and nonpenetrating dose
1952–1953	0.04	Weekly	2.080
1954–1958	0.03	Biweekly	0.780
1959–1984	0.03	Monthly	0.360
1985–2006	0.02	Quarterly	0.080

7.0 COWORKER ANNUAL DOSE SUMMARIES

Based on the described information and approaches, FEMP coworker annual external dosimetry summaries were developed for use in the evaluation of external penetrating and nonpenetrating dose for certain workers who were potentially exposed to workplace radiation but for whom there is no or limited monitoring data from DOE. These summaries were developed using the following steps:

Step 1. As described in Section 6.0, the reported penetrating dose was modified for each worker to account for partial years of employment. This permits the dose reconstructor to assign an appropriate prorated dose to account for partial years of employment or potential exposure.

Step 2. One-half of the maximum potential annual missed doses in Table 6-1 were added to the reported annual doses from Step 1 (with the exception of reported positive doses, in which case the maximum missed dose was reduced by the dose that corresponded to one badge exchange because it is not possible that all individual badge results were zero if a positive annual dose was reported).

Step 3. The 50th- and 95th-percentile annual coworker gamma doses were derived from the doses from Step 2 by ranking the data into cumulative probability curves and extracting the 50th- and 95th-percentile doses for each year.

Step 4. Table 7-1 lists the results of the coworker analysis. These percentile doses should be used for FEMP workers with no or limited monitoring data through the use of the methodologies in Section 7.0 of ORAUT-OTIB-0020 (ORAUT 2005). In general, the 50th-percentile dose can be used as a best estimate of a worker's dose when professional judgment indicates that the worker was probably exposed to intermittent low levels of external radiation. The 50th-percentile dose should generally not be used for workers who were routinely exposed. For routinely exposed workers (i.e., workers who were expected to have been monitored and routinely exposed), the 95th-percentile dose should be applied. However, other options are available through the guidance in ORAUT-OTIB-0020. For instance, for cases in which routine monitoring data exist and coworker dose is used to supplement missing quarters or years, the percentile dose should be the one that is consistent with the recorded doses unless there is reason to believe that the worker's job or location in that year differed significantly from the job or location during the years dose was recorded. For workers who are unlikely to have been exposed, external onsite ambient dose should be used rather than coworker doses.

Step 5. Table 7-2 lists penetrating dose values (as described in the steps above) that have been adjusted using the guidance in Section 8.0 of ORAUT-OTIB-0052, *Parameters to Consider When Processing Claims for Construction Trade Workers* (ORAUT 2007). This guidance is applicable for construction trade workers who meet the criteria in Section 3.0 of that TIB. Because the TIB does not provide an adjustment factor for nonpenetrating dose, this dose component is not shown in this table.

Step 6. If needed, neutron dose should be calculated using the neutron-to-photon ratios in Table 6-10 of ORAUT-TKBS-0017-6 (ORAUT 2004). These values would be applied to the penetrating dose values in Table 7-1.

Table 7-1. Annual FEMP external coworker doses modified to account for missed dose (rem).

Year	Penetrating 95th percentile	Penetrating 50th percentile	Shallow 95th percentile	Shallow 50th percentile
1952	1,520	1,120	4,320	1,220
1953	1,315	1,040	5,332	1,221
1954	776	390	6,291	676
1955	1,177	390	5,088	676
1956	475	390	5,175	675
1957	475	390	5,099	776
1958	576	390	5,990	1,077
1959	366	180	6,482	1,268
1960	565	180	6,565	1,465
1961	867	180	5,881	867
1962	1,168	265	7,094	1,168
1963	1,769	466	9,591	1,870
1964	1,465	365	7,565	1,265
1965	1,484	265	6,798	1,168
1966	967	299	5,520	967
1967	967	265	6,927	1,168
1968	865	180	5,265	665
1969	867	180	5,179	666
1970	967	265	5,580	666
1971	466	180	3,038	366
1972	765	265	4,765	565
1973	571	265	4,176	505
1974	767	265	4,908	566
1975	666	265	3,760	494
1976	665	265	4,435	465
1977	767	179	4,321	369
1978	967	256	5,470	466
1979	867	198	5,078	366
1980	925	265	5,150	465
1981	698	180	4,906	366
1982	808	186	5,542	366
1983	566	172	7,100	274
1984	665	183	6,320	392
1985	431	35	4,843	113
1986	531	36	4,845	51
1987	485	39	3,758	42
1988	289	40	1,509	40
1989	124	40	170	40
1990	96	40	106	40
1991	111	40	115	40
1992	80	40	84	40
1993	62	40	70	40
1994	59	40	61	40
1995	57	40	64	40
1996	57	40	65	40
1997	53	40	54	40
1998	49	40	49	40
1999	43	40	43	40
2000	54	40	54	40
2001	66	40	67	40
2002	88	40	93	40
2003	82	40	83	40
2004	87	40	88	40
2005	206	40	212	40

Table 7-2. Annual FEMP external coworker doses modified in accordance with ORAUT-OTIB-0052 (rem) (ORAUT 2007).

Year	Penetrating 95th percentile	Penetrating 50th percentile
1952	1,720	1,160
1953	1,433	1,040
1954	937	390
1955	1,498	390
1956	515	390
1957	515	390
1958	656	390
1959	446	180
1960	725	180
1961	1,148	180
1962	1,569	305
1963	2,411	586
1964	1,985	445
1965	2,011	305
1966	1,288	353
1967	1,288	305
1968	1,145	180
1969	1,148	180
1970	1,288	305
1971	586	180
1972	1,005	305
1973	734	305
1974	1,007	305
1975	867	305
1976	865	305
1977	1,007	184
1978	1,288	293
1979	1,148	211
1980	1,229	305
1981	912	186
1982	1,065	194
1983	727	175
1984	865	190
1985	592	37
1986	732	39
1987	667	43
1988	392	40
1989	162	40
1990	122	40
1991	143	40
1992	100	40
1993	75	40
1994	71	40
1995	67	40
1996	68	40
1997	62	40
1998	57	40
1999	48	40
2000	64	40
2001	81	40
2002	112	40
2003	103	40
2004	110	40
2005	276	40

8.0 ATTRIBUTIONS AND ANNOTATIONS

All information requiring identification was addressed via references integrated into the reference section of this document.

REFERENCES

NIOSH (National Institute for Occupational Safety and Health), 2007, *External Dose Reconstruction Implementation Guideline*, OCAS-IG-001, Rev. 3, Office of Compensation Analysis and Support, Cincinnati, Ohio, November 21.

ORAUT (Oak Ridge Associated Universities Team), 2005, *Use of Coworker Dosimetry Data for External Dose Assignment*, ORAUT-OTIB-0020, Rev. 01, Oak Ridge Tennessee, October 7.

ORAUT (Oak Ridge Associated Universities Team), 2006, *Occupational On-Site Ambient Dose Reconstruction for DOE Sites*, ORAUT-PROC-0060, Rev. 01, Oak Ridge, Tennessee, June 28.

ORAUT (Oak Ridge Associated Universities Team), 2004, *Technical Basis Document for the Fernald Environmental Management Project - Occupational External Dose*, ORAUT-TKBS-0017-6, Rev. 00, Oak Ridge, Tennessee, April 20.

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