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PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
01/10/2005	00-A	New technical information bulletin to provide information to allow ORAU Team dose reconstructors to assign doses to certain workers at the K-25 site who have no or limited monitoring data, based on site coworker data. Initiated by Steven E. Merwin.
02/25/2005	00-B	Incorporates NIOSH review comments. Initiated by Steven E. Merwin.
04/27/2005	00-C	Incorporates additional responses to NIOSH comments. Initiated by Steven E. Merwin.
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06/30/2005	00 PC-1-A	Page change initiated to incorporate recent direction from NIOSH regarding the calculation and use of coworker doses. Initiated by Steven E. Merwin.
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07/29/2005	00 PC-1	Approved page change revision. Page change incorporates recent direction from NIOSH regarding the calculation and use of coworker doses to pages 7, 8, 9, and 10. Text was modified in Sectons 6.0 and 7.0. No sections were deleted. Retraining is not required. Initiated by Steven E. Merwin. Approval: Document Owner: Signature on File 07/20/2005 Judson L. Kenoyer, Task 3 Manager Signature on File 07/26/2005 Richard E. Toohey, Projector Director Signature on File 07/29/2005 James W. Neton, Associate Director for Science

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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 Technical Information Bulletin (TIB) is to provide information to allow ORAU Team dose reconstructors to assign doses to workers at the Oak Ridge Gaseous Diffusion Plant (K-25) 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.
- the worker may have partial information, but the available information is insufficient to permit a dose reconstruction to occur.

As described in ORAUT-OTIB-0020, 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 K-25 External Dosimetry TBD,[2] dosimeters were issued to the entire workforce beginning in 1951, but only a fraction of the dosimeters were actually processed. According to the TBD, this practice continued until 1980 when all dosimeters were processed. This information is largely consistent with the data provided to NIOSH in conjunction with this program; however, the data are largely complete and sufficient for external dose reconstruction beginning in 1975, indicating that the monitoring and reporting of external doses for most workers at the site began somewhat earlier than is indicated in the TBD.

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 (Phase I) permits cases to be processed when a "best and final" estimate of dose is not required for claim determination. The second phase (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. At the Oak Ridge complex, many workers were employed at more than one of the major Oak Ridge sites (K-25, X-10 and Y-12). For some cases, employment information is provided in NOCTS as a multiple site listing such as "K-25/Y-12/X-10," and the available information such as the DOE dosimetry records and claimant interview are insufficient to determine the actual work location(s), especially on an annual basis. Similarly, workers may have worked at more than one major site at different locations across 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.

2. Summary statistics based on K-25 dosimetry data presented in this TIB do not extend beyond 1985 because at the time this TIB was drafted, data beyond 1985 were not available from the Comprehensive Epidemiologic Data Resource (CEDR). However, the absence of these data (and the subsequent development of dose distributions) should not interfere with the processing of most K-25 cases having a lack of external dosimetry data since well before 1985, 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 reliable data become available, coworker dosimetry data beyond the year 1985 will be presented in a subsequent revision to this TIB.

3. The data presented in this TIB address penetrating radiation from gamma radiation and non-penetrating radiation from beta radiation. Neutron data are not presented. However, the locations within the K-25 site at which neutron exposures were possible are limited to specific areas, and the site TBD establishes a method for assigning neutron doses when relevant.[2] Therefore, the TBD 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.

4. External on-site ambient doses should not be included in addition to the co-worker doses assigned in accordance with this TIB, because any such doses would have been included in the dosimetry results reported by the site which were used as the basis for the coworker dose distributions presented below.[4]

5. The data in this TIB supersede the occupational dose data in Tables 6-4 and 6-5 of the K-25 Occupational External Dose TBD.[2]

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-0009-6, Technical Basis Document for the K-25 Site – Occupational External Dose, Rev 00, November 24, 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-TKBS-0009-4, Technical Basis Document for the K-25 Site – Occupational Environmental Dose, Rev 00, December 29, 2004.

6.0 K-25 COWORKER DATA DEVELOPMENT

Dosimetry data for monitored K-25 workers from the CEDR databases maintained by the U.S. Department of Energy (DOE) were selected for this evaluation. The CEDR data evaluated represented quarterly or annual gamma and non-penetrating ("skin") dosimetry data provided by the K-25 site, which pertain to the shielded and open-window dosimetry readings and exclude neutron doses. As discussed in the site TBD on Occupational External Dose,[2] low-energy (<30 keV) photons are not an issue at K-25, so the penetrating doses can be assumed to be associated entirely with 30-250 keV photons, and the non-penetrating doses can be assumed to be associated entirely with > 15 keV beta particles (electrons).

The CEDR records represent annual data through 1975, after which the data are quarterly and have thus been summed and extrapolated in this analysis to derive annual doses. The year 1975 coincides with the time period in which the number of monitoring results in the database increased substantially from hundreds to thousands, indicating that the majority of personnel at the site were monitored starting in that timeframe. This is consistent with the NIOSH claimant data, which indicate that most people whose employment spanned the 1970s were not monitored (or the monitoring results were not available) until 1975 or shortly thereafter.

According to the site TBD,[2] monitoring at K-25 began in 1945 using dosimeter and processing support provided by the Oak Ridge National Laboratory (ORNL). Initially, only those workers entering controlled areas and likely to receive measurable dose received dosimeters. Starting in 1951, all workers received dosimeters as part of their security badges, but the dosimeters were not processed (by ORNL) unless the worker was deemed likely to have received measurable doses. According to the TBD, all dosimeters were processed beginning in 1980; however, as discussed in Section 2.0 above, both the CEDR and claimant data indicate that the great majority of the dosimeters were processed beginning in 1975.

Starting in 1976, the CEDR data are identified by quarter. Since, as described above, the site implemented a quarterly badge exchange cycle for essentially all workers starting in 1975,[2] these data represent directly the K-25 site monitoring results. Prior to 1976, the CEDR data appear to represent annual summary data. As shown in Table 1 below, prior to 1975 the badge exchange cycle was weekly, and most of the badges were not processed. Thus, the CEDR data in this period likely represent the summation of weekly dosimeter readings that may or may not encompass an entire year of radiation exposure.

The validity of the CEDR data was confirmed by selecting a sampling of claimant dosimetry data submitted by the site as part of the EEOICPA Subtitle B program and comparing it to the pertinent CEDR data. A review of annual data for eleven claimants covering 321 worker-years of employment at K-25 indicated excellent agreement between the two data sets. Specifically, a perfect match in the CEDR database was found for 10 of the 11 claimants for all relevant years. For one claimant, there

were no positive data through 1985, the last year for which data are present in the CEDR database, so it was not possible to identify a unique match. It is concluded that the CEDR data are acceptable for the development of coworker doses for the K-25 site, except for one quarter in 1977 which is discussed in Section 7.0 below.

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 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 K-25 claimants prior to 1975 when workers were monitored weekly. This is complicated by the fact that monitoring data are largely not available for this period because, as discussed above, the site apparently elected to have only a small fraction of the badges evaluated. Thus, it is generally not possible to obtain an accurate count of the number of null badge results prior to 1975 because the reported data reflect an annual summation of an unknown number of badge readings during the course of each year.

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] Although the TBD and a review of claimant data indicate that some workers may have been on a different cycle than is listed below, the majority of workers were on the typical schedule so the values provided in Table 1 are deemed appropriate for the adjustment of reported coworker doses to account for missed dose.

Table 1. Missed external doses based on K-25 TBD.[2]

Period	Penetrating LOD (rem)	Non-penetrating LOD (rem)[a]	Exchange frequency	Maximum annual missed dose (rem)	
				Penetrating	Non-penetrating
1945-1974	0.03	0.03	Weekly	1.560	1.560
1975-1987	0.03	0.03	Quarterly	0.120	0.120
1988 – present	0.005	0.005	Monthly[b]	0.060	0.060

a. K-25 does not distinguish between open-window and shielded dosimeter measurements when reporting minimum detectable levels (MDLs). It is implied that the MDLs should be considered the same.

b. The TBD indicates monthly exchanges for 1988 but does not indicate the exchange frequency for subsequent years. A review of claimant data for those years indicates that workers were on either a quarterly or monthly cycle. Therefore, a monthly cycle has been assumed, which is claimant favorable.

Special Considerations

Certain aspects of the external dosimetry practices at the K-25 site documented in the TBD[2] were considered in the analysis of the site data. These include:

- In some cases, values less than the dosimeter LOD were reported by the site. For example, values as low as 10 or 20 mR were reported even though the LOD was considered to be 30 mrem (or 30 mR) prior to 1988.

- Prior to 1975, even though dosimeters were issued to essentially all workers, only a fraction of the dosimeters were actually processed. Thus, the possibility exists that the annual doses reported do not represent the actual annual doses received by some employees.

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 K-25 site based on the considerations described above.

7.0 K-25 COWORKER ANNUAL DOSE SUMMARIES

Based on the information and approaches described above, K-25 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 monitoring data provided by DOE. These summaries were developed using the following steps:

1. As described in Section 6.0 above, the penetrating and "skin" doses available from CEDR were converted to annual data by summing the reported quarterly data (1976 and later). Consistent with the guidelines in ORAUT-OTIB-0020,[1] doses for individuals with less than four quarters of data for a particular year were converted to annual doses by extrapolating (i.e., one quarterly result was multiplied by 4; two quarterly results were multiplied by 2; and three quarterly results were multiplied by 1.333). In 1977, the result "104" appeared for numerous employees for one particular quarter; it appears that these values were nominal and were entered due to damaged film that could not be processed. Thus, all such values were eliminated from the analysis. Prior to 1976, reported doses were not extrapolated since the reported values apparently represented doses received during the entire year.

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

3. The 50th and 95th percentile annual penetrating and shallow doses were derived from the doses calculated in Step 2 by ranking the data into cumulative probability curves and extracting the 50th and 95th percentile doses for each year.

4. Because the reported "skin" doses include both penetrating and non-penetrating radiation, the percentile doses pertaining to penetrating radiation identified in Step 3 were subtracted from the percentile doses pertaining to the reported "skin" 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 K-25 workers with no or limited monitoring data using the methodologies outlined in Section 7.0 of ORAUT-OTIB-0020.[1] In general, the 50th percentile dose may be used as a best estimate of a worker's dose when professional judgment indicates the worker was likely exposed to intermittent low levels of external radiation. The 50th percentile dose should not be used for workers who were routinely exposed. For routinely exposed workers (i.e., workers who were expected to have been monitored), the 95th percentile dose should be applied. For workers who are unlikely to have been exposed, external on-site ambient dose should be used rather than co-worker doses.

Table 2. Annual K-25 external coworker doses modified to account for missed dose (rem).

Year	Gamma 95th%	Gamma 50th%	Non-pen 95th%	Non-pen 50th%
1945	1.290	1.240	0.802	0.773
1946	1.455	0.805	0.884	0.065
1947	1.015	0.780	1.745	0.030
1948	1.264	0.780	0.838	0.000
1949	1.035	0.780	0.470	0.040
1950	0.841	0.780	0.115	0.000
1951	1.052	0.780	0.582	0.015
1952	0.951	0.780	1.549	0.035
1953	1.096	0.780	2.053	0.095
1954	0.913	0.780	1.088	0.000
1955	0.835	0.780	0.237	0.000
1956	0.855	0.780	0.566	0.000
1957	1.088	0.780	0.896	0.000
1958	1.049	0.780	1.325	0.000
1959	1.245	0.810	1.775	0.030
1960	1.154	0.791	1.078	0.024
1961	0.942	0.778	0.741	0.010
1962	0.824	0.780	0.663	0.022
1963	0.840	0.780	0.619	0.033
1964	0.841	0.780	0.363	0.034
1965	0.936	0.780	0.490	0.066
1966	0.952	0.780	1.188	0.040
1967	0.928	0.780	1.122	0.056
1968	0.906	0.780	0.506	0.000
1969	0.946	0.780	1.106	0.000
1970	1.041	0.780	1.436	0.038
1971	1.092	0.780	0.635	0.010
1972	1.034	0.779	0.381	0.088
1973	0.871	0.780	0.515	0.000
1974	1.065	0.835	0.339	0.008
1975	0.111	0.062	0.119	0.043
1976	0.149	0.060	0.069	0.000
1977	0.089	0.060	0.058	0.000
1978	0.136	0.052	0.043	0.013
1979	0.088	0.060	0.063	0.000
1980	0.145	0.060	0.160	0.000
1981	0.085	0.060	0.120	0.000
1982	0.060	0.060	0.425	0.000
1983	0.060	0.060	0.245	0.000
1984	0.060	0.060	0.125	0.000
1985	0.060	0.060	0.105	0.000

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 of 30-250 keV consistent with information in the external dosimetry TBD for the K-25 site,[2] and

non-penetrating doses are assigned as electrons >15 keV with corrections applied to account for clothing attenuation or other applicable considerations.

With the methodology described above, null values for non-penetrating dose can occur because of the subtraction of the reported penetrating doses from the reported shallow doses and the claimant-favorable method described above to establish coworker doses based on the addition of potential missed doses. However, a "zero" value in Table 2 for non-penetrating dose will not result in a dose of zero being assigned to an organ such as the skin. For example, the 50th percentile dose to the skin in 1948 would be assigned entirely as 0.780 rem of photons. This approach does not result in an underestimation of probability of causation (which is determined by the Department of Labor) because assigning beta dose as gamma dose in IREP has no negative effect, since the radiation effectiveness factors are the same for >15 keV electrons and >250 keV photons, and are higher for 30–250 keV photons.

The values in Table 2 do not show an increase in dose when the site began monitoring essentially all workers and reporting all results beginning in the mid 1970s. The values actually show a marked decrease compared to the values associated with the period during which a weekly badge exchange occurred. This is an indication that the methodology described in this TIB to adjust the reported annual doses based on potential missed dose more than compensates for any underreporting of annual doses by the site due to incomplete monitoring.

8.0 K-25 COWORKER ANNUAL DOSE DISTRIBUTIONS

Reserved