



ORAU TEAM Dose Reconstruction Project for NIOSH

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Document Title: Use of Coworker Dosimetry Data for External Dose Assignment	Document Number: ORAUT-OTIB-0020 Revision: 02 Effective Date: 12/04/2008 Type of Document: OTIB Supersedes: Revision 01
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New
 Total Rewrite
 Revision
 Page Change

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PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
12/29/2004	00	New technical information bulletin to provide general information to allow ORAU Team dose reconstructors to assign doses to workers at DOE sites who have no or limited monitoring data, based on site coworker external dosimetry data. First approved issue. Initiated by Steven E. Merwin.
10/07/2005	01	Provides clarifications and updates to reflect recent OCAS guidance. Approved issue of Revision 01. Training required: As determined by the Task Manager. Initiated by Steven E. Merwin.
12/04/2008	02	Approved revision that cancels changes from draft revisions 01 PC-1-A and 01 PC-1-B. Section 3.0 was revised to include language developed during the review of this TIB by the Advisory Board Working Group on Procedures. Section 7.0, Attributions and Annotations was added. Editorial changes include an update of Section 1.0, Purpose, and movement of Section 6.0, References, to the end of the document with consequent renumbering of following sections. References updated as necessary. Incorporates formal internal and NIOSH review comments. Training required: As determined by the Task Manager. Initiated by Matthew H. Smith.

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1.0 PURPOSE

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 [42 U.S.C. § 7384l(5) and (12)].

The purpose of this TIB is to provide general information to allow Oak Ridge Associated Universities (ORAU) Team dose reconstructors to assign doses to workers at DOE sites who have little or no individual monitoring data, based on site coworker external dosimetry data. This TIB is to be used in conjunction with separate TIBs or other approved documents that provide site-specific coworker data.

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. For the purpose of this document, coworkers are considered to be workers at a site (potentially grouped by work location, job description, or other appropriate category) whose measured doses are considered representative of those that were received by one or more claimants with no individual monitoring data.

Cases without individual external monitoring data can 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 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 for the worker might be available, but it is insufficient to facilitate a dose reconstruction.

Some cases with little or no individual monitoring data can be processed in the absence of completed coworker studies, most notably those falling under the first category listed above. For example, nonradiological workers with no potential for workplace radiation exposures may be assigned onsite ambient doses. Even some cases falling under the second and third categories above do not require coworker studies (e.g., radiological workers who may in some cases be assigned reasonable upper limits provided that the total probability of causation is less than 45%). In relation to the last category above, if sufficient information is available, a prorated dose can be assigned in certain circumstances.

3.0 GENERAL APPROACH

The general approach to applying coworker data for cases with little or no individual 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 be assigned had the employee been monitored. As described in Section 5.0, the percentile doses include consideration of missed dose. This is necessary because the coworker data are intended to represent the results for unmonitored workers had they been monitored, and missed doses are assigned for each dosimeter result reported as zero or less-than one-half of the limit of detection (LOD) as equal to the LOD divided by 2 using OCAS-IG-001 (NIOSH 2007) guidance for monitored workers.

Site-specific coworker datasets that contain 50th- and 95th-percentile penetrating and nonpenetrating doses are provided in separate, site-specific TIBs. 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. Also note that certain construction trades (e.g., pipefitters) might have received higher exposures than construction trade workers in general; therefore, they might fall into the category of workers who were expected to have been monitored. For workers who are unlikely to have been exposed, external onsite ambient dose should be used rather than coworker doses. The site-specific TIBs also provide information on the sources of the site data, validation of the data, and conversion of the data to annual doses to be applied in dose reconstructions.

The coworker doses in the site-specific TIBs should be treated as constant values. However, they do not include all factors that must be applied by the dose reconstructor to assign doses. Specifically, site-specific adjustments based on technical considerations (e.g., dosimeter bias) must be incorporated by the dose reconstructor based on the site technical basis documents. In addition, organ dose conversion factors based on OCAS-IG-001 (NIOSH 2007) must be applied; for likely compensable or likely noncompensable cases, they should be applied in the same manner in which they are applied for monitored employees. Otherwise, the organ dose conversion factors should be applied as a triangular distribution.

4.0 APPLICATIONS AND LIMITATIONS

In parallel with the development of site-specific TIBs that document the external coworker datasets to be used in dose reconstructions, cases not yet completed are screened to identify those cases that require external coworker data to facilitate case processing. As previously described, some cases with little or no individual monitoring data have been processed using methods that are not dependent on coworker data. Cases that are identified as requiring coworker data should be processed as described in Section 6.0.

Some workers are concerned that their dose records are not accurate because they were encouraged or instructed by a supervisor not to wear their badges (dosimeters), or they were not given badges while doing jobs that could have resulted in exposures sufficient to exceed an administrative or regulatory dose limit. If this concern is expressed by a claimant verbally in an interview or in written correspondence, the dose reconstructor should try to determine if this could have happened by examining the dose records and considering the workplace conditions, potential source terms, and incident reports. In cases in which the dose reconstructor believes this could have happened, it might be necessary to modify the dose reconstruction and/or perform additional research.

5.0 DEVELOPMENT OF SITE COWORKER DATASETS AND DISTRIBUTIONS

External dosimetry data for DOE sites are potentially available from several sources. These include the Center for Epidemiologic Research databases maintained by ORAU, the Comprehensive Epidemiologic Data Resource databases maintained by DOE, other datasets maintained by DOE, and data maintained by the sites themselves. In addition, claimant data that has been submitted by DOE

sites to NIOSH in response to requests for the purposes of this dose reconstruction project provide a useful subset of sitewide data.

Development of site-specific data summaries and distributions involves a careful examination of the various data sources with the objective of identifying the most complete and accurate dataset available. Before the analysis of the selected data and the development of summary statistics and dose distributions, a sampling of the data are compared to claim-specific data that have been submitted to NIOSH by the DOE sites. This comparison helps to verify the accuracy and completeness of the site data that was selected for use in coworker studies because the data that have been submitted to NIOSH are often more detailed than the sitewide datasets (e.g., individual badge data are typically provided to NIOSH, while the sitewide data often represent annual summarized data). The comparison also provides information that is needed to adjust the sitewide datasets to account for missed dose, partial year data, etc. If significant issues arise during the course of this comparison that shed doubt on the accuracy or completeness of the site data that was selected for analysis, additional evaluations should take place to ensure that a valid dataset has been selected.

The specific datasets that were selected for a particular site and the rationale for their selection are documented in site-specific coworker data TIBs titled *External Coworker Dosimetry Data for the [DOE Site]*. Before publication of these site-specific TIBs, the data are subjected to an independent and separately documented validation process.

Once coworker data have been selected to represent a particular site, the data are analyzed for the purpose of developing annual 50th- and 95th-percentile doses. Before calculating the percentile doses, however, the doses are adjusted to account for missed dose based on the badge exchange frequency and the dosimeter limit of detection (LOD). For example, the median annual reported dose might be zero at a particular site and in a particular year, but it would be inappropriate to assign a dose of zero as a median value because of the potential for missed dose, which must be included in the dose estimates for claimants (NIOSH 2007). Specifically, one-half of the maximum annual missed doses are added to the reported annual doses, except for reported positive doses in which case the maximum missed dose is reduced by the dose that corresponds to one badge exchange (because it is not possible that all individual badge results were zero if a positive annual dose was reported). The 50th- and 95th-percentile annual penetrating and shallow doses are then derived by ranking the data into cumulative probability curves and extracting the 50th- and 95th-percentile doses for each year. Additional details on the incorporation of missed dose in the site coworker data are provided in the site-specific TIBs.

The site-specific external coworker dosimetry data TIBs provide information on adjustments to the data that were necessary to develop annual doses and distributions for use in dose reconstructions. For example, partial year dosimetry data in the site data are extrapolated to provide annual values that represent the doses that would have been received for a full year of employment for all monitored employees. The objective is to provide data on the annual doses that were received by employees had they been monitored for a full year; dose reconstructors may then prorate the data for individual cases, as appropriate, to account for partial years of employment.

6.0 APPLICATION OF SITE COWORKER PERCENTILE DOSES AND A COMPARISON TO MAXIMUM LIKELIHOOD DOSES

Data are presented in a table in each site-specific external coworker TIB as 50th- and 95th-percentile annual penetrating and nonpenetrating doses for monitored workers. These doses, together with the application of dosimeter bias factors and organ dose conversion factors as described in Section 3.0, are intended to represent reasonable estimates of doses for workers who were not monitored. Also as described in Section 3.0, the 50th-percentile doses should be applied if the worker was likely

exposed intermittently, and the 95th-percentile doses should be applied if the worker was likely exposed routinely. External onsite ambient doses should be used instead of external coworker doses if the worker was unlikely to have been exposed. Doses should be prorated, as appropriate, to account for partial years of exposure.

The approach this document describes is highly likely to result in a significant overestimate of external dose for unmonitored workers. This overestimate is attributable largely to the manner in which missed doses are applied to the coworker datasets [e.g., the use of nLOD/2 as prescribed in OCAS-IG-001 (NIOSH 2007) and described in Section 5.0 above]. This overestimate is intentional, because the nLOD/2 approach is known to overestimate a monitored individual's actual dose when the majority of monitoring results are low in comparison with the LOD (NIOSH 2007), and it would be inappropriate to treat unmonitored individuals who perhaps should have been monitored differently than individuals who happen to have been monitored.

The extent to which the coworker data that are assigned in accordance with the principles that are established in this document represent overestimates can be demonstrated by comparing site-specific percentile doses that have been calculated in accordance with these principles to doses that have been calculated using the maximum likelihood approach. For example, Table 7-1 compares the percentile doses for K-25 from ORAUT-OTIB-0026 (ORAUT 2006; the site-specific coworker TIB) to doses that were calculated from the same dataset but using the maximum likelihood approach [in the same manner as was performed for Y-12 film badge data in ORAUT-RPRT-0032 (ORAUT 2005)]. When comparing the values in Table 7-1, note that the LOD assumed for the maximum likelihood analysis was the same as given in ORAUT-OTIB-0026. Also, the calculated maximum likelihood doses for 1954-1958 were replaced with the value from 1959 because of an overwhelming number of individuals who had zero or low-dose results [i.e., the geometric mean (GM) values for this period were very low and the geometric standard deviation (GSD) values were very high], and the year 1945 has not been included in the table because the data were insufficient to facilitate a maximum likelihood analysis. Finally, the 95th-percentile doses provided in the table for the maximum likelihood approach are calculated from the relevant GMs and GSDs.

Table 7-1. Comparison of K-25 external coworker penetrating doses (rem) modified to account for missed dose from ORAUT-OTIB-0026^a to doses calculated using maximum likelihood approach.

Year	ORAUT-OTIB-0026 50th percentile	ORAUT-OTIB-0026 95th percentile	Maximum likelihood GM	Maximum likelihood GSD	Maximum likelihood 95th percentile
1946	0.805	1.455	0.046	6.383	0.970
1947	0.780	1.015	0.031	4.110	0.317
1948	0.780	1.264	0.013	7.321	0.344
1949	0.780	1.035	0.021	5.168	0.313
1950	0.780	0.841	0.006	5.518	0.100
1951	0.780	1.052	0.014	5.324	0.219
1952	0.780	0.951	0.017	4.150	0.177
1953	0.780	1.096	0.029	4.316	0.321
1954	0.780	0.913	0.037	4.783	0.486
1955	0.780	0.835	0.037	4.783	0.486
1956	0.780	0.855	0.037	4.783	0.486
1957	0.780	1.088	0.037	4.783	0.486
1958	0.780	1.049	0.037	4.783	0.486
1959	0.810	1.245	0.037	4.783	0.486
1960	0.791	1.154	0.032	4.497	0.379
1961	0.778	0.942	0.023	3.112	0.149
1962	0.780	0.824	0.015	2.423	0.064
1963	0.780	0.840	0.019	2.261	0.073
1964	0.780	0.841	0.016	2.208	0.059
1965	0.780	0.936	0.026	3.172	0.174
1966	0.780	0.952	0.022	3.744	0.193
1967	0.780	0.928	0.026	3.691	0.223
1968	0.780	0.906	0.006	7.157	0.153
1969	0.780	0.946	0.012	4.911	0.164
1970	0.780	1.041	0.012	6.720	0.275
1971	0.780	1.092	0.019	4.007	0.186
1972	0.779	1.034	0.026	2.822	0.143
1973	0.780	0.871	0.012	3.521	0.095
1974	0.835	1.065	0.079	2.416	0.337
1975	0.062	0.111	0.016	2.564	0.075
1976	0.060	0.149	0.045	1.643	0.102
1977	0.060	0.089	0.023	1.896	0.066
1978	0.052	0.136	0.040	1.746	0.100
1979	0.060	0.088	0.029	1.619	0.064
1980	0.060	0.145	0.064	2.051	0.209
1981	0.060	0.085	0.046	1.546	0.094
1982	0.060	0.060	0.046	1.478	0.087
1983	0.060	0.060	0.037	1.723	0.091
1984	0.060	0.060	0.032	1.787	0.083
1985	0.060	0.060	0.033	1.601	0.072

a. ORAUT (2006).

7.0 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. 03, Office of Compensation Analysis and Support, Cincinnati, Ohio, November 21.

ORAUT (Oak Ridge Associated Universities Team), 2005, *Historical Evaluation of the Film Badge Dosimetry Program at the Y-12 Facility in Oak Ridge, Tennessee: Part 1 – Gamma Radiation*, ORAUT-RPRT-0032, Rev. 00, Oak Ridge, Tennessee, April 13.

ORAUT (Oak Ridge Associated Universities Team), 2006, *External Coworker Dosimetry Data for the K-25 Site*, ORAUT-OTIB-0026, Rev. 00 PC-2, Oak Ridge, Tennessee, November 15.