Document Title: **External Coworker Dosimetry Data for the Portsmouth Gaseous Diffusion Plant**	Document Number: ORAUT-OTIB-0040 Revision: 00 PC-1 Effective Date: 11/07/2006 Type of Document: OTIB Supersedes: None

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☐ New ☐ Total Rewrite ☐ Revision ☒ Page Change

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PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
05/02/2005	00-A	New technical information bulletin to provide information to allow ORAU Team dose reconstructors to assign doses at the Portsmouth Gaseous Diffusion Plant to certain workers who have no or limited monitoring data, based on site coworker data. Initiated by Steven E. Merwin.
05/11/2005	00-B	Incorporates internal reviewer comments. Initiated by Steven E. Merwin.
06/30/2005	00-C	Incorporates OCAS review comments. Also incorporates recent direction from OCAS regarding the calculation and use of coworker doses. Initiated by Steven E. Merwin.
07/29/2005	00	First approved issue. Training required: As determined by the Task Manager. Initiated by Steven E. Merwin.
11/07/2006	00 PC-1	Approved page change revision due to release of ORAUT-OTIB-0052 Rev 00. Updates required language on page 4 in Section 1.0. References ORAUT-OTIB-0052 Rev 00 on page 6 in Section 5.0. Completes Section 8.0 on page 9. No changes occurred as a result of formal internal review. This revision results in an increase in assigned dose and a PER is required. Training required: As determined by the Task Manager. Initiated by Matthew H. Smith. Approval: Signature on File 10/18/2006 John M. Byrne, Document Owner Signature on File 10/17/2006 Edward F. Maher, Task 5 Manager Signature on File 10/23/2006 Kate Kimpan, Projector Director Brant A. Ulsh Signature on File for 11/07/2006 James W. Neton, Associate Director for Science

TABLE OF CONTENTS

LIST OF TABLES

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. 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 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 Portsmouth Gaseous Diffusion Plant (PGDP) 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 PGDP External Dosimetry TBD,[2] operations at the site began in 1954. Initially, personnel received dosimetry based on job assignments. In 1960, dosimeters were issued to all employees, contractors, and visitors as part of their personnel badge; however, not all visitor or contractor badges were analyzed. There does not appear to be any significant administrative practice that would jeopardize the integrity of the recorded dose of record; however, the corrections recommended by the TBD (e.g., 1.125 for the reported deep photon dose between 1981 and 1986) are appropriate for the coworker doses established in this TIB, since the doses are based on the PGDP 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. Some PGDP workers may have worked at more than one major site 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.

2. Summary statistics based on PGDP dosimetry data presented in this TIB do not extend beyond 1992 because at the time this TIB was drafted, later data were not available. However, the absence of these data (and the subsequent development of dose distributions) should not interfere with the processing of most PGDP cases having a lack of external dosimetry data since well before 1992 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 1992 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 potential for neutron exposures at the PGDP is limited to certain site areas and facilities, and the associated doses were low.[2] Therefore, the PGDP 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 coworker doses assigned in accordance with this TIB, because any such doses would have already been included in the dosimetry results reported by the site which were used as the basis for the coworker dose distributions presented below.[2,4]

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-0015-6, Technical Basis Document for the Portsmouth Gaseous Diffusion Plant – Occupational External Dose, Rev 00, January 18, 2005.

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-PROC-0060, External On-Site Ambient Dose Reconstruction for DOE Sites, Rev 00, March 7, 2005.

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

6. ORAU Team, ORAUT-OTIB-0052, Parameters to Consider When Processing Claims for Construction Trade Workers, Rev. 00, August 31, 2006.

6.0 PGDP COWORKER DATA DEVELOPMENT

Dosimetry data for monitored PGDP workers were obtained from the site in a database named "HR_prior_1993.mdb." Historical external data through 1992 were contained in a table within the database titled "Doseext_dat." In all cases, the reported data corresponded to individual badge readings of deep dose (i.e., penetrating gamma radiation) and shallow dose (i.e., penetrating plus non-penetrating radiation).

The annual data calculated based on the summation of individual badge results were prorated to account for partial years of employment based on an analysis of the length of employment associated with each year (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 claimant dosimetry data submitted by the site as part of the EEOICPA Subtitle B program and comparing it to the data selected as described above. A review of annual data for ten claimants covering more than 130 worker-years of monitored employment at PGDP indicated excellent agreement between the two data sets. Specifically, a perfect match was found for more than 99% of the reported values. It is concluded that the data cited above are acceptable for the development of coworker doses for the PGDP.

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 PGDP claimants in the 1950s when badge exchanges were frequent. Table 6-1 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.[5]

Table 6-1. Missed external doses based on PGDP Occupational External Dosimetry TBD and ORAUT-OTIB-0017.

Period	Penetrating LOD (rem)	Non-penetrating LOD (rem)[a]	Exchange frequency	Maximum annual missed dose (rem)	
				Penetrating	Non-penetrating
1954–1956	0.03	0.03	Weekly	1.560	1.560
1957	0.03	0.03	Varied[b]	1.230	1.230
1958	0.03	0.03	Varied[c]	0.990	0.990
1959	0.03	0.03	Varied[d]	0.690	0.690
1960	0.03	0.03	Varied[e]	0.390	0.390
1961–1963	0.03	0.03	Monthly	0.360	0.360
1964	0.03	0.03	Varied[f]	0.240	0.240
1965–1980	0.03	0.03	Quarterly[g]	0.120	0.120
1981–1982	0.015	Not applicable[h]	Monthly	0.180	Not applicable[h]
1983–1998	0.01	0.04	Quarterly	0.040	0.160
1999–Present	0.01	0.03	Quarterly	0.040	0.120

a. ORAUT-OTIB-0017 (Attachment C) provides an explanation for the non-penetrating LODs for the PGDP.
b. The exchange frequency was weekly, then biweekly during this year.
c. The exchange frequency was biweekly, then weekly (maximizing assumption) during this year.
d. The exchange frequency was weekly (maximizing assumption), then every four weeks during this year.
e. The exchange frequency was every four weeks, then monthly (maximizing assumption) during this year.
f. The exchange frequency was monthly (maximizing assumption), then quarterly during this year.
g. From 1975 through 1980 selected female employees were monitored monthly. However, this frequency was not used in this table since all such employees would have been monitored and coworker data would not be applied in the reconstruction of their dose.
h. See ORAUT-OTIB-0017 (Attachment C) for an explanation.

Special Considerations

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

- In some cases, values less than the dosimeter LODs (listed in Table 6-1 above) were reported by the site. For example, in the 1990s single-digit doses in millirem were reported occasionally, even though the LOD was considered to be 10 mrem. This does not appear to be an issue prior to 1981, however, since a review of case submittals covering employment during that era did not reveal examples of positive badge readings reported less than the stated LOD for that period (30 mrem).

- As discussed previously, the data available to analyze coworker doses represent dose summaries for individual workers from individual badge data with unknown specific monitoring dates other than the relevant calendar years. Because these data may 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 favorable to claimant approach was adopted in the development of coworker dose summaries, and this approach is intended to account for any underestimate of doses to radiological workers at the PGDP based on the considerations described above.

7.0 PGDP COWORKER ANNUAL DOSE SUMMARIES

Based on the information and approaches described above, PGDP 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 annual deep and shallow doses obtained from summing the individual badge data were modified to account for partial years of employment. This adjustment was made by analyzing the NOCTS employment data for PGDP 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 PGDP 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. One-half of the maximum annual missed doses listed in Table 6-1 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 shallow 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 shallow doses to derive percentile doses pertaining to non-penetrating radiation.

5. The results are presented in Table 8-2 below. These percentile doses should be used for selected PGDP 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.

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 8-2 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 PGDP,[2] and non-penetrating doses are assigned as electrons >15 keV with corrections applied to account for clothing attenuation or other applicable considerations.[5]

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 favorable to claimant method described above to establish coworker doses based on the addition of potential missed doses. However, a "zero" value in Table 8-2 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 1960 would be assigned entirely as 0.195 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.

8.0 PENETRATING DOSE VALUES BASED ON ORAUT-OTIB-0052 GUIDANCE FOR SELECTED CONSTRUCTION TRADE WORKERS

Table 8-3 contains penetrating dose values that have been adjusted using the guidance given in Section 8.0 of ORAUT-OTIB-0052, "Parameters to Consider When Processing Claims for Construction Trade Workers."[6] This guidance is applicable for construction trade workers who meet the criteria given in Section 3.0 of ORAUT-OTIB-0052.[6]

Table 8-2. Annual PGDP external coworker doses modified to account for missed dose(rem).

Year	Gamma 95th%	Gamma 50th%	Non-pen 95th%	Non-pen 50th%
1954	1.736	0.780	0.055	0.000
1955	1.104	0.874	0.048	0.000
1956	0.945	0.799	0.016	0.000
1957	0.714	0.615	0.335	0.000
1958	0.857	0.574	0.434	0.031
1959	1.164	0.591	0.579	0.040
1960	0.283	0.195	0.123	0.000
1961	0.240	0.180	0.086	0.000
1962	0.332	0.180	0.094	0.000
1963	0.360	0.180	0.051	0.000
1964	0.262	0.120	0.021	0.000
1965	0.140	0.060	0.050	0.000
1966	0.136	0.060	0.010	0.000
1967	0.122	0.060	0.005	0.000
1968	0.338	0.060	0.007	0.000
1969	0.281	0.085	0.011	0.000
1970	0.459	0.158	0.047	0.005
1971	0.281	0.060	0.065	0.000
1972	0.367	0.078	0.173	0.000
1973	0.407	0.077	0.087	0.000
1974	0.337	0.060	0.033	0.000
1975	0.474	0.078	0.114	0.000
1976	0.415	0.060	0.050	0.000
1977	0.365	0.078	0.050	0.000
1978	0.414	0.077	0.223	0.016
1979	0.181	0.060	0.174	0.000
1980	0.307	0.060	0.001	0.000
1981	0.120	0.090	N/A[1]	N/A[1]
1982	0.112	0.090	N/A[1]	N/A[1]
1983	0.053	0.020	0.112	0.060
1984	0.053	0.020	0.080	0.060
1985	0.045	0.020	0.083	0.060
1986	0.058	0.020	0.082	0.053
1987	0.063	0.020	0.083	0.046
1988	0.057	0.020	0.087	0.060
1989	0.063	0.020	0.091	0.047
1990	0.075	0.022	0.098	0.055
1991	0.057	0.020	0.101	0.050
1992	0.054	0.020	0.109	0.060

[1] See ORAUT-OTIB-0017 for a discussion of the assignment of non-penetrating doses for the years 1981 and 1982.[5]

Table 8-3. Annual PGDP external penetrating coworker doses modified in accordance with OTIB-0052 (rem).

Year	Gamma 95th%	Gamma 50th%
1954	2.124	0.780
1955	1.240	0.918
1956	1.017	0.812
1957	0.759	0.615
1958	1.007	0.612
1959	1.498	0.696
1960	0.324	0.195
1961	0.270	0.180
1962	0.398	0.180
1963	0.439	0.180
1964	0.325	0.120
1965	0.178	0.060
1966	0.173	0.060
1967	0.152	0.060
1968	0.455	0.060
1969	0.375	0.101
1970	0.624	0.203
1971	0.375	0.060
1972	0.495	0.091
1973	0.552	0.090
1974	0.454	0.060
1975	0.645	0.091
1976	0.563	0.060
1977	0.493	0.091
1978	0.561	0.090
1979	0.235	0.060
1980	0.411	0.060
1981	0.135	0.090
1982	0.124	0.090
1983	0.068	0.020
1984	0.068	0.020
1985	0.056	0.020
1986	0.075	0.020
1987	0.083	0.020
1988	0.073	0.020
1989	0.083	0.020
1990	0.099	0.024
1991	0.074	0.020
1992	0.070	0.020