2.0 Practice of the Hanford Internal Dosimetry Project

It is IDP policy to comply with 10 CFR 835 and the Hanford Radiological Health and Safety Document (DOE 2001). Similarly, it is IDP practice to follow, to the extent practical, the guidance and good practice recommendations issued through the DOE Internal Dosimetry Program Guide (1999a), the International commission on Radiological Protection (ICRP), National Council on Radiation Protection and Measurements (NCRP), U.S. Environmental Protection Agency (EPA), DOE, Health Physics Society (HPS), and American National Standards Institute (ANSI).

This chapter describes the conduct of the IDP and provides for interpretation of applicable regulations and guidance for use at Hanford. The Hanford Personnel Dosimetry Advisory Committee (HPDAC) has reviewed and concurred with these practices described here. Modifications to these practices require endorsement by the HPDAC.

2.1 Assessment and Documentation of Internal Dose

This section presents criteria used to assess, document, and revise internal doses at Hanford.

2.1.1 Criteria for Assessing Internal Dose

Assessment of potential internal exposure is conducted for

- any potential occupational intake reported to PNNL Internal Dosimetry staff by site radiation protection organizations with a request for dose assessment.
- any bioassay measurement that indicates a potential occupational intake that has not been evaluated previously, resulting in a committed effective dose equivalent greater than 10 mrem. This screening level is suitable for occupational workers, as well as minors and members of the public.
- single or cumulative exposures to airborne radioactivity that result in greater than 10 DAC-hours exposure in a calendar year, after correction for respiratory protection.
- any “baseline” bioassay measurement indicating a detectable intake that has not been evaluated previously and that is not readily associated with a non-occupational source.
- any employee, hired by RL, ORP or a DOE contractor, who has incurred an occupational intake or internal dose considered significant by the former employer relative to regulatory guidance in place at the time of intake.

The initial assessment generally should include bioassay measurements to confirm the intake. To the extent practicable, measurements should consist of at least:

- one bioassay measurement following a workplace indication of an intake, or

- two bioassay measurements following a bioassay indication of an intake.

Assessments performed as a result of occupational intakes or assigned doses previous to Hanford employment may not necessarily warrant Hanford measurements.

A potential intake is considered to be confirmed if:

- a bioassay result exceeding the decision level (and the environmental screening level, if applicable) is associated with a known incident, or

- a bioassay result not associated with a known incident, exceeding the decision level and the screening level, is followed by two consecutive bioassay measurements, one of which exceeds the decision level or screening level.

- An occupational internal dose is assigned.

If follow-up measurements are not obtained following a bioassay result that exceeds the decision and screening levels, an intake will be assumed to have occurred unless there is overriding evidence that one did not. In this circumstance the assumption of an intake is taken as "confirmation" and any appropriate internal doses will be calculated, recorded, and reported. The overriding evidence must be discussed in the evaluation.

Hanford visitors whose baseline bioassay measurements detected radioactivity and whose end-of-assignment measurements are consistent with their baseline measurements will not have their prior occupational dose assessed by Internal Dosimetry unless the site contractor requesting the measurements specifically requests Internal Dosimetry to do so. Instead, the requesting site contractor and the Hanford Radiological Records Project (HRRP) staff will be notified by letter of the activity detected.

2.1.2 Dose Assessment Practices

The estimation of internal dose shall be based on bioassay data rather than air concentration values unless bioassay data are unavailable, inadequate, or estimates based on representative air concentration values are demonstrated to be as, or more, accurate. The determination that bioassay data are inadequate, or air concentration values are more accurate will be made on a case-by-case basis by the internal dosimetrist, in consultation with the facility's radiological control organization, and at least one other internal dosimetrist. Generally, air sample data would be used for radionuclides with physical or effective half-lives that are too short to accomplish bioassay measurements, e.g., radon/thoron progeny or when likely low-level intakes are below the bioassay detection capabilities. Prior-to-Hanford exposure expressed in working level months, MPC-hours, or DAC-hours will be converted to internal dose according to methods established in program documentation without consulting Field Dosimetry.

CEDEs Less Than 500 mrem

If the available evidence suggests that the committed effective dose equivalent (CEDE) from an intake does not exceed 500 mrem and specific information is not readily available, generalized (default) models and assumptions may be used to assess the dose. These general assumptions are as follows:

- The intake occurred by inhalation.
- The intake is acute.
- If the actual intake date is unknown, the intake occurs at the midpoint to the potential exposure period for acute intakes or through the potential exposure period for chronic intakes.
- For monitored workers, the potential exposure period extends back one monitoring period unless known to be otherwise.
- The radionuclides observed in bioassay measurements, or otherwise known to be present, are included in the assessment. All radionuclides potentially involved in the exposure are considered, including those not specifically identified in the initial bioassay measurements but expected to be present.
- The physiological characteristics of the workers are the same as those of the Reference Man or Woman in ICRP 23 (1974).
- The biokinetic models and parameters described in *Methods and Models for Hanford Internal Dosimetry*, PNNL-MA-860 are to be used for radionuclides included in that document; otherwise, models and parameters endorsed or prescribed by the NCRP or ICRP are to be used.
- The dose to the embryo/fetus is calculated separately from the dose to the mother.

CEDEs Above 500 mrem

At projected CEDEs above 500 mrem, actions are taken as follows:

- Bioassay and exposure characterization data are obtained to enable adjustments to be made to the default assumptions and models, as appropriate.
- Consideration may be given to individual-specific physiological characteristics.

Recording Doses

Dose equivalents are recorded as calculated for each assessment, with the following special provisions:

- Quantified doses of less than 10 mrem are rounded to the nearest whole number, and doses of 10 mrem or greater may be rounded to two significant figures.
- Organ dose equivalents are recorded for any organ contributing more than 10% to a CEDE exceeding 100 mrem. This criterion applies to each intake separately, even if a worker has more than one intake a year. (For

radionuclides such as tritium and radio-cesium, which provide dose homogeneously to all organs, the dose may be recorded as effective dose; however, it is understood that the same dose applies to all organs.)

- Committed organ and effective dose equivalents will be assigned to the year of intake.

2.1.3 Documentation of Dose Assessments

Assessments of occupational internal doses are documented. The documentation includes or references the methods, assumptions, and data used to make the assessment and lists the assessed dose equivalents. A copy of the documented assessment is provided to HRRP for placement in the worker's radiation exposure file. For each assessment, a letter is sent either to the worker directly or to the worker's radiation dosimetry organization. The letter summarizes the conclusion of the assessment and updates the worker's current internal dose status.

Intake assessments are issued within 3 months of obtaining all the necessary data (including bioassay and source-term characterization). Alternative completion times are negotiable with customers considering the priority of specific evaluations and the total evaluation workload. Customers will be notified if lower-priority evaluations are rescheduled beyond the 3-month target because of other expedited evaluations.

Chronic intakes are assessed on a calendar-year basis for continuing exposures.

2.1.4 Dose Assessment Revisions and Updates

The dose assessment for an active worker with a prior intake will be reviewed and updated at the request of the contractor dosimetry organization. In addition, workers maintained on bioassay for radionuclides previously evaluated are reviewed in light of the previous evaluation each time that new measurements are obtained, and a determination is made as to the consistency of the current results with the anticipated results. If results are not consistent, then the reason for the discrepancy is investigated.

Assessments for active workers are revised when information demonstrates a change in the currently assessed committed effective dose equivalent of 0.5 rem or a factor of 1.5 of the previously assigned dose for that intake, whichever is higher.

When the revision involves a specific worker's intake, the contractor dosimetry representative is notified, in advance, of the need to issue a revised assessment.

When the revision results from general changes in dosimetry techniques, assumptions, or regulations, and multiple workers are affected, then Internal Dosimetry presents a discussion of the impacts of the change to the Hanford Personnel Dosimetry Advisory Committee.

2.2 Internal Dose Reports

Internal Dosimetry provides reports of internal dose to contractor dosimetry organizations and to HRRP as described in the following subsections.

2.2.1 Reports Provided to Contractor Dosimetry Organizations

A final assessment summary letter is provided to the worker and/or contractor dosimetry organization upon completion of the intake evaluation report. Preliminary assessments (verbal or written) are provided upon request. The summary letter contains the following information:

- the identity and magnitude of any confirmed occupational intake
- committed effective dose equivalent for a confirmed occupational intake
- committed organ dose equivalents to significant organs when the CEDE exceeds 100 mrem
- date of intake
- facility at which intake occurred
- any long-term follow-up bioassay recommendations.

It is the contractor's responsibility to report the worker's annual TEDE and dose status relative to any control levels.

2.2.2 Reports Provided to the Hanford Radiological Records Project

The IDP provides internal dose information to the Hanford Radiological Records Project for inclusion in the Radiation Exposure (REX) System.

2.3 Bioassay Monitoring Program

The HIDP maintains accreditation for indirect radiobioassay under the Department of Energy Laboratory Accreditation Program (DOELAP), as required by 10 CFR 835.402(d)(1). Accreditation is maintained for DOELAP-proffered radionuclides or categories of radionuclides which are of concern at Hanford. Criteria for accreditation are described in DOE-STD-1112-98 (DOE 1998). The letter and certificate granting accreditation are maintained in the program Records Inventory and Disposition (RIDS) Schedule, with copies provided to the Historical Files and the HPDAC. The DOELAP accreditation for direct radiobioassay measurements at Hanford is maintained by the In Vivo Monitoring Program.

Internal Dosimetry provides, to the extent that Hanford Site contractors and RL/ORP will support and that technical capabilities will allow, a bioassay monitoring program capable of detecting an intake potentially resulting in a CEDE of 100 mrem.

Facility-specific radionuclide mixtures and characteristics are considered in the development of the bioassay-monitoring program. Bioassay capabilities are optimized, considering sensitivity requirements and costs.

2.3.1 Objectives for Periodic Bioassay Monitoring

The following objectives are established as guidance for cost-effective bioassay monitoring programs which comply with 10 CFR 835.

- The 100-mrem sensitivity does not have to be achieved for all radionuclides measured if workers are not potentially exposed to those radionuclides.

- The 100-mrem sensitivity does not have to be achieved for confirmatory monitoring (i.e., limited surveillance to verify periodic monitoring is not required). Minimum detectable dose (MDD) calculations are not appropriate for confirmatory monitoring.

- For radionuclides or mixtures of radionuclides for which existing bioassay methods and frequencies achieve the 100-mrem sensitivity recommendation, changes should not be allowed that degrade the sensitivity to where the MDD exceeds nominally 100-mrem. This does not preclude the switching of one bioassay method for another to best accomplish Site needs so long as the resulting MDD stays less than 100 mrem.

- For radionuclides or mixtures of radionuclides for which existing bioassay methods and frequencies do not achieve the 100-mrem sensitivity recommendations, changes should be discouraged that significantly degrade the sensitivity.

- For radionuclides or mixtures of radionuclides for which existing bioassay methods and frequencies do not achieve the 100-mrem sensitivity recommendation, the weighting given for cost and inconvenience of the bioassay method decreases as the MDD increases. However, it is recognized that for mixtures composed principally of actinides, the best intake-monitoring program is provided by aggressive workplace monitoring and prompt initiation of special bioassay.

A grace period for all bioassay samples, during which no work restriction is imposed, consists of the calendar month in which the sample is scheduled (the due period) and the immediately following calendar month (the probation period) An excreta sample or in vivo measurement not obtained during the due period is considered late on the first day of the probation period, and delinquent following the end of the grace period. Late bioassays warrant attention to make sure they are obtained during the probation period. Failure to comply with a bioassay request by the end of the grace period should result in a work restriction for the worker until the in vivo measurement is obtained or the excreta sample is provided to the laboratory. The work restriction may be lifted following a receipt of a valid sample. No work restriction should be imposed for a failed analysis, however the grace period will immediately resume with the reporting of the failed analysis.

2.4 Program Documentation

The practices and general recommendations of the IDP are documented in this controlled distribution manual. Copies of the manual and updates to the manual are maintained in the Hanford Radiation Protection Historical Files.

Suggestions and recommendations for specific work situations, radiation work permits, or facilities may alternatively be documented in letters, memorandum, or special reports. Such guidance supersedes that contained in this manual. A copy of such guidance will be included in the Historical Files.

Changes in general practices and recommendations presented in this manual are made by Interim Change Notices or manual revisions. Changes are distributed to the controlled distribution for the appropriate document. A copy of the change is maintained in the Historical Files.

The following items are also documented or referenced in the Historical Files and program RIDS (discussed in Section 9):

- operating procedures
- technical bases
- biokinetic models
- computer codes
- Excreta Laboratory Statement of Work
- QA Plan.
- DOELAP Accreditations

2.5 References

10 CFR 835. 1999. Department of Energy, *Occupational Radiation Protection*. U.S. Code of Federal Regulations.

International Commission on Radiological Protection (ICRP). 1974. *Report of Task Group on Reference Man*. ICRP Publication 23, Pergamon Press, New York, New York.

Pacific Northwest National Laboratory (PNNL). *Methods and Models of the Hanford Internal Dosimetry Program*, PNNL-MA-860. Richland, Washington. (Internal manual.) Available at URL http://www.pnl.gov/eshs/pub/pnnl860.html.

U.S. Department of Energy (DOE). 1998. *DOE Standard The Department of Energy Laboratory Accreditation Program for Radiobioassay*. DOE-STD-1112-98, Washington, D.C.

U.S. Department of Energy (DOE). 1999. *Implementation Guide for Internal Dosimetry Program Guide*. DOE G441.1-3, Washington, D.C.

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