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Radiation and Health Technology

IN VIVO MONITORING PROJECT MANUAL

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Responsible Staff Member:

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Timothy P. Lynch
In Vivo Monitoring Project Manager

Approved for Use
and Application by:

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M. E. Hevland, Manager
Radiation and Health Technology
Environmental Technology Division

Pacific Northwest National Laboratory
Richland, Washington 99352

Introduction

The In Vivo Monitoring Project for Hanford (IVMPH), previously known as the Hanford Whole Body Counting Project, has been an integral part of the personnel dosimetry program at Hanford since 1959. The project is a necessary portion of the worker monitoring program that Hanford has developed for radiation protection of the workforce. The project has evolved over the years to accommodate the increased needs for worker protection. This manual provides an overview of the project and explains how the project is organized and how it is operated.

The IVMPH is a Hanford-sitewide project operated by the Pacific Northwest National Laboratory (PNNL) for all U.S. Department of Energy (DOE) and DOE-contractor personnel. It provides the in vivo bioassay services required by the Hanford Internal Dosimetry Project (IDP), as specified by Title 10, Code of Federal Regulations, Part 835, "Occupational Radiation Protection" (10 CFR 835), and related implementation guidance. Staff from Radiation and Health Technology of PNNL's Environmental Technology Division are responsible for administering the project. IVMPH is part of overall internal dosimetry activities that include:

- assessing and documenting occupational doses from intakes of radionuclides
- determining compliance with applicable internal dose standards
- administering the routine bioassay monitoring program required by site contractors including in vivo bioassay
- providing technical guidance to contractors on internal dosimetry matters
- establishing models for evaluating internal radionuclide deposition
- performing or initiating actions for prompt evaluation of the internal exposure of personnel involved in accidents and emergencies.

Scope of Services

The IVMPH provides the following services for the benefit of all site employees:

- administering the routine in vivo bioassay monitoring program for internally deposited radionuclides
- providing emergency in vivo counting services
- utilizing the best available facilities and equipment, procedures, and practices to estimate the amounts of internally deposited radioactive material

- providing the in vivo measurement records and supporting data to the Hanford Radiological Records Project (HRRP) for final disposition.

The IVMPH is committed to providing a quality service that meets or exceeds all DOE regulations and requirements and incorporates pertinent information from guidance documents. Project staff employ methods and practices accepted by the DOE in vivo measurement community. Improvements in technology and maintaining state-of-the-art practices are advanced to the extent possible based on cost effectiveness, technical improvements, and continuity of operations.

Limitations of Service

The capabilities for in vivo counting are directly related to the degree to which the contractors use the service. It is assumed that the contractors in consultation with the Hanford IDP will determine the appropriate in vivo bioassay monitoring for the workers. The IVMPH staff, work closely with the contractors to ensure that workers receive the required measurements.

It is expected that each contractor will communicate the basis for in vivo bioassay measurements with the workers and the need to address questions regarding measurements. Questions about the in vivo measurement results are referred to the contractor field dosimetry representative. However, IVMPH exempt staff will discuss in vivo measurement results with workers if there is an immediate concern or question following the measurement. An internal dosimetrist can also be contacted for worker consultation, if needed.

Project Authorization

The need for IVMPH is based on the requirements continued in 10 CFR 835 and the *Hanford Site Radiological Control Manual* (DOE-RL 1992). Additional guidance is contained in the DOE Implementation Guide G-10CFR835/C1, Rev. 1, *Internal Dosimetry Program* (DOE 1994).

Additional technical guidance is found primarily in the reports by the National Council on Radiation Protection and Measurements (NCRP), the International Council on Radiation Protection (ICRP), the Institute of Electrical and Electronic Engineers (IEEE), DOE Technical Standards, and the American National Standards Institute (ANSI)/Health Physics Society (HPS).

Project Relationships

The IVMPH staff work closely with Hanford contractor dosimetry organizations to provide the necessary in vivo counting services. However, the Project is not directly responsible for worker protection, for monitoring or conducting surveillance of work environments, or for ensuring worker cooperation with in vivo bioassay measurement requests.

The IVMPH supplies in vivo measurement results to the IDP for dose assessment. The in vivo counting records are transferred to the HRRP for final disposition.

Manual Contents

This manual, in addition to the latest versions of the *Whole Body Counting Project Procedures Manual* and the *Quality Assurance Plan for the Operation of the Hanford Whole Body Counting Project*, LSC-021, constitute the IVMPH documentation.

The contents of this manual include:

- Project Administration
- Facilities and Equipment
- In Vivo Measurement Systems
- In Vivo Measurement Performance
- Quality Assurance
- In Vivo Measurement Data Processing
- Calculation of In Vivo Measurement Results
- In Vivo Measurement Records
- Appendices.

The tables, figures, and appendices included in the manual reflect the most current information at the time of the revision of this manual; information may be changed without the change being reflected in this manual prior to the next scheduled revision.

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1.0 Project Administration

The following sections cover seven areas of the In Vivo Monitoring Project for Hanford (IVMPH) administration: organizational structure and responsibilities for planning and reporting; handling of cleanup requests; coordination of in vivo examination; schedule of examinations; administration of examinations; reporting of results; and quality assurance.

1.1 Organizational Structure, Planning, and Reporting

Overall responsibility for the management of the IVMPH rests with the IVMPH Project Manager (PM). The PM is generally responsible for providing the required in vivo counting services for Hanford Site contractor employees. To help in meeting this responsibility, the PM oversees the following administrative tasks:

- Budgeting and planning are continuously performed to ensure that an adequate level of technical resources including staff, equipment, and facilities are available to support the project.

- Costs are periodically reviewed and compared against progress to identify variances from anticipated spending rates.

- Steps are taken to minimize the variance from the projected spending rate.

- Reports are prepared periodically (e.g., quarterly) to inform Pacific Northwest National Laboratory (PNNL) management, other contractors, and the Department of Energy (DOE), Richland Operations Office (RL) about the status of the project, including problems and highlights.

- An annual report is prepared to summarize the project activities as an historical record.

- Information on the number and types of counts performed is routinely submitted for proper costing of the services.

- Technical direction is provided for the project.

The responsibility for the daily operations of the IVMPH is delegated to the Operations Supervisor (OS). The OS oversees the work of the technicians and support personnel to ensure that work is performed in accordance with the clients' requirements and the appropriate policies and procedures. The OS reports directly to the IVMPH PM.

Figure 1.1, illustrates the IVMPH organizational structure. Note that the IVMPH PM does not have line-management responsibility for the project

scientist, who reports to the IVMPH PM for the project responsibilities. The project support staff (e.g., Craft Services and Radiation Protection Technicians) are from different organizations and interface with the OS.

Changes are made to programmatic documents, measurement records, and software when new methods are developed and implemented, when new requirements are established, or when errors or deficiencies in practices or measurement results are identified. Changes to the information contained in this manual are made by Interim Change Notices and revisions to the manual.

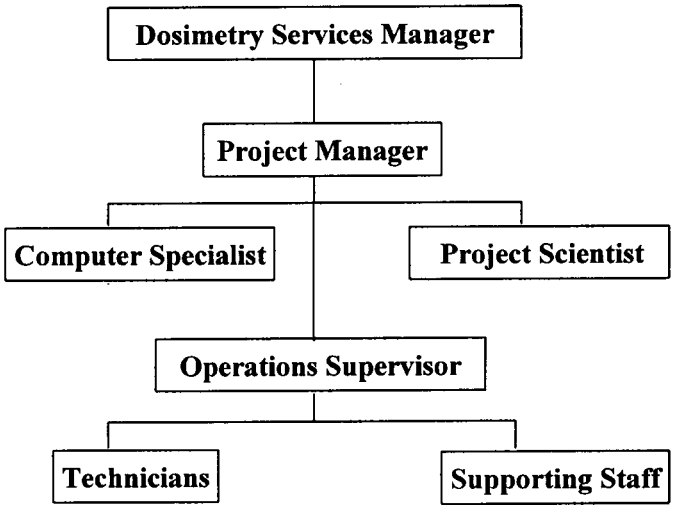

Figure 1.1. IVMPH Organizational Structure

1.2 Coordinating In Vivo Examinations

Coordination of in vivo measurements involves receiving authorizations for routine measurements and requests for nonroutine measurements.

1.2.1 Authorizations for In Vivo Measurements

Each contractor is responsible for determining the specific radionuclides an employee may be exposed to during work assignments. The contractor and the Internal Dosimetry Group (IDG) then determine the type of in vivo measurement(s) required. These measurements are typically scheduled when an employee is newly hired, terminated, begins or ends a special project involving radioactivity, or upon a request for a periodic routine measurement.

In vivo measurements are performed whenever a count authorization has been received. There are three types of recognized and accepted authorizations: computerized, written, and special.

1.2.1.1 *Computerized Authorization*

The Hanford Radiological Exposure System (REX) is used to schedule in vivo examinations. Each contractor receives a weekly allotment of appointment times to schedule the different types of counts. Unused allotments are made available to all contractors 48 hours before the scheduled time and/or date. Daily schedules are downloaded to an IVMPH computer over the network. The information contains personal identifiers and information on the type of count to be received. The IVMPH staff can also schedule personnel through REX as a service to the contractors and for nonroutine counts (e.g., for visitors).

The IVMPH staff generate a daily file for return to REX. The file includes a list of the persons counted on a specific day. The file is available to the contractors through REX and is used as input to the Access Control System.

1.2.1.2 *Written Authorizations*

Written authorizations can be received from the employee upon arrival at the In Vivo Radioassay and Research Facility (IVRRF). The authorization specifies the employee's name, payroll number, Social Security number, the reason for the count, and the type of measurement required. These written requests are handled as if the person were scheduled through REX. However, the automated scheduling through REX allows the IVMPH staff to coordinate daily operations more efficiently.

1.2.1.3 *Special Authorizations*

This type of authorization is usually received verbally from the IDG but occasionally may also come from the contractors or RL. Specially authorized measurements may be performed on individuals for any of the following reasons:

- unusual exposures
- field requests
- exposure evaluator requests
- follow-up measurements.

1.2.2 Requests for In Vivo Measurements

A worker who may have incurred an intake of radioactive material in the workplace is given the highest priority for receiving a measurement. Requests for incident-related in vivo measurements are usually received from the IDG. The IVMPH staff immediately notify the IDG of any requests for incident-related in vivo counts received directly.

In some cases of internal contamination, the IDG needs more information to complete dosimetry calculations. This group will then request additional in vivo measurements. These specialized measurements will be scheduled in advance to allow enough time to prepare for the requested measurements.

When these requests conflict with the routine schedule, the routine measurements may be delayed or rescheduled.

A DOE contractor may request nonroutine measurements for such reasons as skin contamination, elevated air samples, or concern of the worker. All contractor requests are channeled through the IDG. The IDG determines which measurements should be performed and coordinates appointments with the IVMPH staff and the contractor.

1.3 Scheduling Specific Exams

In addition to routine authorizations, in vivo measurements are requested for incident-related intakes, more complete dosimetric calculations, or other factors that raise concerns for contractors or workers. Routine whole body counts are scheduled for a particular day but not for a specific time during the day. However, an appointment date and time is required for a routine lung count, chest wall thickness measurement, and other organ-specific counts.

Routine in vivo counting hours are currently from 8:00 a.m. to 3:00 p.m.,Monday through Friday. The majority of the routine counting is performed at the main facility (747A Building). Special arrangements can be made for measurements at other times by calling (509) 376-6102. The IVRRF personnel are available on-call to respond to an incident involving the potential for an internal deposition of radioactive material. During off-hours, IVRRF staff can be reached by contacting the on-call PNNL Exposure Evaluator (376-2222, pager 85-618), the PNNL emergency contact (375-2400), or the Patrol Operations Center (373-3800).

For DOE contractors, routine whole body counts are scheduled for a specific day. However, no specific time is assigned for the routine whole body count. Measurements can be performed on a walk-in basis. If an individual arrives and is not listed on the daily schedule, the respective scheduling organization is contacted to make sure that person requires a count. If a count is needed, the individual is given the option to wait until they can be counted or to

reschedule the count for another day. Most of the unscheduled individuals who require only whole body counts are done the same day.

Contractors schedule lung counts and other organ counts for specific times during the day using REX. Generally, the routine lung counts are scheduled to 80-90% of capacity to accommodate unplanned measurements. However, scheduling to capacity or extending operating hours are periodically done to handle peak demand. A reasonable attempt is also made to accommodate unscheduled lung and other counts. However, because of the time required to perform the lung and other counts, it is likely that a person will need to be rescheduled for another day and time.

The in vivo measurements for the non-DOE clients are scheduled to avoid conflict with the DOE measurements. When a conflict arises, the DOE measurement usually receives priority and the non-DOE measurement is rescheduled.

The IVMPH staff work closely with the contractor scheduling organizations to make sure that the required in vivo counting services are provided in a timely manner. To assist the IVMPH staff in accommodating the contractors' needs, the counts are prioritized, based on the reason for the count. The counts are listed below in order of decreasing priority:

1. Incident counts within the first two days after the incident
2. Recount of an unexpected positive result
3. Work termination counts
4. Anyone previously canceled
5. Scheduled DOE contractor counts
6. Anyone later than 30 minutes for a scheduled appointment.

1.4 Administering In Vivo Exams

The administration of in vivo exams includes: greeting the workers, having the workers complete the In Vivo Count Record form, taking precautions to minimize interference from external contamination, conducting a count, and providing information about the count results to the person counted.

1.4.1 In Vivo Count Record Form

When the routinely scheduled subjects arrive, they will be listed on the daily schedule. The individual is then requested to fill out the applicable sections of the In Vivo Count Record form (Figure 1.2).

IN VIVO COUNT RECORD

PLEASE FILL IN THE INFORMATION BELOW

Last Name, First Full Name, MI	Social Security No.

Payroll No.	Employer

Birth Date (MM/DD/YY)	Height (in)	Weight (lbs)	Gender	Today's Date

PLEASE READ AND ANSWER BEFORE RETURNING FORM

- Are you claustrophobic? _____
- Have you had a nuclear medicine study or radiopharmaceutical injection within the past two months? (This does not include counts at this facility.) _____
- The technician has audio and visual communication with you while you are being counted. The technician will assist you in exiting the cell if necessary.
- For chest counts there is a signal button within reach to alert the technician. You may exit the cell if necessary. The technician will describe the self exit procedure to you before your count is started.
- I have read and understand the above statements.

_____

(Signature)

FOR IVRRF STAFF USE ONLY

REASON CODE	REX	BODY CODE	REX	DET CODE	SERIAL NO.	COMMENTS
Periodic	PR	WBC (WB)	WBD	1		
Baseline	BL	HEAD (HD)	SK1			
Termination	TM	CHEST (C1)	CH1	2		
Special	SP	CHEST (C2)	CH1	3		
Contractor Requ	CR	THROAT (TH)	THY			
Recount	RA	HAND (WN)	WND	4		
End Assignment	EA	SPECIAL (LV)	LIV	5		
Contract Work	12	SPECIAL (LY)	LYM			
Research (Person)	TS			6		
IVRRF Research	13					

Measured Height (in.) _____ Measured Weight (lbs.) _____ CWT _____

Figure 1.2. In Vivo Count Record

1.4.2 Ensuring Measurement of Internally Deposited Radioactive Material

To ensure that only internally deposited radioactive material is measured and to limit the amount of naturally occurring radioactivity being transferred into the shielded enclosures, two precautions are taken:

- For a routine whole body count, the subject removes his/her coat, hat, and other outer apparel.

- If the measurement shows a detectable amount of radioactive material present, the subject showers, including washing hair, and changes into a pair of coveralls. This is done to remove radioactive material that may be present on the skin, hair, or clothing. The subject is then recounted.

When the subject has potential internal contamination from an incident that occurred within the past 24 hours, a survey is conducted for external contamination. After the monitoring, the subject showers, including washing hair, and puts on a pair of coveralls and disposable slippers before being counted.

1.4.3 Lung Count

For a routine lung count, the subject puts on a pair of cotton coveralls and foam slippers. If the lung measurement shows a detectable amount of radioactive material, the subject showers, including washing hair, and is recounted for a longer period of time to lower the detection level for the measurement.

When a change of clothing is necessary, the subject is given a locker in the change room and a lock to store clothing and valuables. Valuable personal items may also be checked with the technician at the front desk.

1.4.4 Information and Safety Instructions for the Subject

The IVMPH staff attempt to make those who arrive for counts feel as comfortable as possible during the measurement procedure. A pamphlet entitled, "The Hanford In Vivo Radioassay and Research Facility," describing the different types of measurements that are performed, is available in the lobby. (A copy of the pamphlet is included as Appendix C.)

For the routine standup whole body count: The subject is instructed to step into the counter for the measurement. He or she is typically told the length of the count and is told to step out of the counter when the count is complete.

For lung counts, other organ counts, and coaxial HPGe counts: When the subject is in an enclosed counting room for a measurement, the technician will provide the following information before starting the count:

- the length of the count
- the use of the intercom and emergency button
- the use of the video camera for surveillance
- the self-exit procedure
- the need to remain still during the count.

The technician will also answer any additional questions a subject may have about the procedure.

A very small percentage of workers who receive counts in the shielded rooms are claustrophobic. These persons can be counted with the door open. This elevates the detection level slightly for the measurement. A note is placed in the record if the door was open during the measurement.

1.5 Reporting of Results

The electronic records of the in vivo measurement results are routinely transmitted to REX. This is typically accomplished within 10 working days after a count is completed. Each contractor may then access the in vivo measurement results for their employees through REX. Electronic records of the in vivo measurement results combined with the spectral data used to calculate the results are transferred to the Hanford Radiological Records Program (HRRP) periodically. The routine quality control data, calibration data, and supporting spectral data are also routinely transferred to the HRRP.

At the completion of each routine in vivo measurement exam, the subject is given a letter that summarizes the measurement results and provides the name of the contractor's radiation protection representative. An example of a typical letter is shown in Figure 1.3. If requested, the IVMPH will provide the preliminary results to the subject. Detailed questions are typically referred to the contractor radiation protection representative listed on the letter given to the subject. When a subject needs to speak with someone immediately about their results, the OS, the PM, or their designee is available to discuss the results.

Reports of no-activity counts; requested, incident-related, or positive counts; and non-DOE-contractor counts are discussed below.

1.5.1 Routine Counts that Show No Radioactivity: DOE Contractors

Routine measurement results are transferred to the HRRP on a weekly basis.

1.5.2 Contractor Requests, Incidents, or Positive Counts

Results of the examinations for incident-related counts and positive counts are immediately conveyed to the IDG. If necessary, additional follow-up measurements as well as excreta sampling may be requested to obtain sufficient data to perform a dose evaluation.

Subjects who have detectable activity are typically given the initial results and told that the final results will be available through their particular radiation protection organization. If the subject requests more detailed or immediate information, seems worried, or requests technical information, the IVMPH OS, PM, or on-call Exposure Evaluator can talk to the subject in person or by telephone. The subject is also instructed to contact their company internal dosimetry representative if they have additional questions or concerns.

1.5.3 Reporting Non-DOE-Contractor Results

Results are typically mailed to the company representative for radiation protection within two weeks after the measurement. Results are telephoned to the representative immediately when any subject is measured at specified contractual values. Any questions regarding results are referred to the IVMPHPM.

1.6 Project Quality Assurance

The IVMPH Quality Assurance Plan is contained in the current version of LSC-02 1, "The Operation of the In Vivo Monitoring Project for Hanford." The plan specifies the quality assurance program requirements for the IVMPH. Other aspects of the overall project QA are discussed in greater detail in Section 5.0.

PRELIMINARY ANALYSIS OF IN VIVO EXAMINATION

NAME:
PAYROLL:
REASON CODE:
EXAM DATE:

Preliminary analysis of your in vivo examination(s) indicates:

__(1) Your in vivo measurements are completed, and the results do not exceed the criteria for follow-up.

__(2) Your first in vivo measurement indicated the possible presence of internal radioactivity; however, your second count, which was longer and more sensitive, did not detect radioactivity. Your first count is considered a false positive reading; due to the nature of radioactivity counting, false positive readings are expected to occur about 5% of the time.

__(3) Final analysis of the examination data is not immediately available. This may be due to a temporary suspension of the analysis portion of the computer software or a need to review the quality of the detection system performance. The results of this examination will be provided to your company's radiation protection organization when available.

__(4) Your measurement exceed a screening level. This can result from a random, statistical fluctuation in the background measured by the detector, very low-level skin contamination, an intake of naturally occurring or medical-related radioactive material not related to your work, or an occupational intake. A further review of the examination will be performed and your radiation protection organization will be notified of the results. Followup measurements may be required.

If you have any questions, please contact your radiation protection representative listed below.

Contractor Name:
Contact Name:
Contact Phone:

Please note: This report is based on a preliminary evaluation of your measurement by computer and is subject to change based upon additional review. If there is a change from the above reported results, Personnel Dosimetry will notify your company's radiation protection organization.

Figure 1.3. Example of Results Letter