

Appendix F

PERSONNEL MONITORING

I. PERSONNEL MONITORING

Personnel monitoring devices, more commonly referred to as personnel monitoring badges, shall be provided to measure the radiation dose for all individuals who are likely to receive more than 10% of the annual dose limit permitted by the Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-1200, "Occupational Dose Limits for Adults." The whole body radiation dose limit which requires personnel monitoring is 500 millirem per year or greater.

However, an Applicant may provide calculations which demonstrate that an individual is not likely to exceed the dose limit and is not required to be provided personnel monitoring. Instructions for estimating an individual's annual radiation dose is provided in Attachment 1 of this Appendix.

Complete Form F, Personnel Monitoring Program, describing the proposed radiation dose monitoring program and submit the completed form with the application.

II. DESCRIPTION OF PERSONNEL MONITORING DEVICES

A. General

Personnel monitoring badges must detect beta, gamma and neutron radiation, so verify the capabilities of available badges before making a selection. Dosimetry processors must hold accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology. A list of NVLAP accredited dosimetry vendors is available on the Internet at www.nist.gov.

Each order of badges includes a control badge for measuring the amount of background radiation the badges receive each monitoring period. This enables the background to be subtracted from the total reading to provide an accurate record of each worker's occupational radiation dose. When not in use the badges should be stored with the control badge to ensure accurate dosimetry records. The control badge must be stored in a low background radiation location and must be returned with the other badges each monitoring period.

B. Film Badges

Film badges are small pieces of x-ray film contained in a plastic holder. The film darkens in proportion to the amount of radiation it has been exposed to, so measurements of the film density provides a measurement of the wearer's radiation exposure. Film badges should be protected from extreme environmental conditions which may affect their ability to accurately record radiation. Film badges must be exchanged on a MONTHLY basis.

C. Thermoluminescent Dosimeters (TLD)

TLDs are personnel monitoring badges that contain small crystals capable of storing some of the energy from radiation. If the crystals are then heated to a specific temperature, they release the stored energy as light. The amount of light released is proportional to the amount of radiation the TLD badge received, which can be measured to determine the badge wearer's dose. TLDs should be protected from extreme environmental conditions which may affect their ability to accurately record radiation. They must be exchanged at least every THREE months.

D. Optically Stimulated Luminescent Dosimeters (OSLDs)

OSLDs measure radiation through a thin layer of aluminum oxide. A laser light stimulates the aluminum oxide after use, causing it to become luminescent in proportion to the amount of radiation exposure. OSLDs must be exchanged at least every THREE months.

III. INSTRUCTIONS FOR USING PERSONNEL MONITORING DEVICES

A. General Instructions

A whole body personnel monitoring badge (film, TLD or OSLD) will be worn at all times when handling, using, or transporting a portable nuclear gauge. Each Authorized User will be assigned a badge, which can only be worn by the individual to whom it has been assigned. Badges are to be worn on the front of the torso, at or above the waist and below the shoulder. Badges must be promptly returned to the Radiation Safety Officer (RSO) at the end of each monitoring period to ensure rapid processing.

Recommended Work Practices for Personnel Monitoring

- ◆ Never leave badges in close proximity to a gauge or other radiation source
- ◆ Protect badges from moisture, intense heat or light and chemicals
- ◆ When not in use, store badges with their control badge in a low background radiation area

B. Special Instructions for New Hires and Lost/Damaged Badges

To ensure accurate monitoring of occupational dose, an assigned badge will be ordered immediately for new gauge operators. A spare/visitor badge may be provided to new workers until the assigned badge arrives. Spare badges may also be used to replace a badge that has been lost or damaged before the end of the monitoring period. To ensure their use by only one individual, spare badges will be imprinted with the

worker's name or another form of identification. Workers assigned spare badges will have the dose recorded by the badge added to their occupational dose record. In the event of a lost/damaged badge, the RSO will estimate the worker's dose for the period the badge was worn, and must request approval from the Department to revise the individual's dosimetry record.

IV. PERSONNEL MONITORING RECORDS REQUIREMENTS

A. Records of Prior Occupational Dose

Prior to assigning a badge to a worker the worker's occupational radiation dose received during the current year will be determined. In addition, every reasonable effort must be made to obtain the individual's records indicating the individual's cumulative occupational radiation dose. If a worker is unable to provide the information, records from their previous employer will be obtained. Prior occupational dose records shall include all of the information required by the Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-2826, "Cumulative Occupational Exposure History", Department Form Z, or an equivalent form.

B. Records of Individual Monitoring Results

Records of doses received by each monitored worker will be maintained as long as the company's license remains in effect. Dosimetry records will be kept in accordance with the Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-2804, "Notifications and Reports to Individuals" on Department Form Y, Paragraph RH-2825, or an equivalent form, and will contain all of the information required by Paragraph RH-2804. These records will be updated annually.

C. Annual Reports to Monitored Individuals

Each worker assigned a personnel monitoring badge will receive a written annual dose report describing the past year's monitoring results, as required by the Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-2804, "Notifications and Reports to Individuals". Records documenting that the reports have been furnished to monitored workers will be maintained for at least 3 years.

D. Termination Reports to Monitored Individuals

Within 30 days of termination of employment, or within 30 days after the individual's exposure has been determined, whichever is later, each monitored worker will receive a written report summarizing the individual's occupational radiation dose, as required by Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-2804, "Notifications and Reports to Individuals". Records documenting that the reports have been furnished to monitored workers will be maintained for at least 3 years.

E. Records for Declared Pregnancies

The fetal dose will be closely monitored so as not to exceed 500 millirem. Female gauge operators that have declared themselves pregnant will be instructed to always wear their assigned badge at waist level to estimate the embryo/fetus dose.

Recordkeeping requirements specified in the Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-1207, “Dose to an Embryo/Fetus” and RH-1500.f.5., “Records of Individual Monitoring Results”, will be met.

F. Occupational Dose Limits for Minors

Minors will not exceed an annual occupational dose of 500 millirem. Recordkeeping requirements specified in Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-1206, “Occupational Dose Limits for Minors” and Paragraph RH-2804, “Notifications and Reports to Individuals”, will be met.

G. Worker Overexposure Reports

When a report of an individual’s exposure is sent to the Arkansas Department of Health as required by Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-1505, “Notifications and Reports to Individuals”, the exposed individual will also be notified no later than when the report is sent out.

Appendix F

Form F

PERSONNEL MONITORING PROGRAM

Describe the proposed personnel radiation dose monitoring program by marking the appropriate boxes. Submit the completed Form with the Application

1. Personnel Monitoring Device to be Used:

- Film OSLD TLD

2. Radiation Detected:

- Beta Gamma Neutron

3. Type Monitoring:

- Whole body Extremity

4. Frequency of exchange:

- Monthly Quarterly

5. Supplier of Personnel Monitoring Service: _____

Vendor Registration Number: _____

- PERSONNEL MONITORING IS NOT REQUIRED BECAUSE THE PROJECTED PERSONNEL RADIATION DOSE IS CALCULATED TO BE LESS THAN 500 MILLIREM PER YEAR FOR EACH INDIVIDUAL.

Justification for this decision is provided in the completed Form F, Table 1.

Appendix F

Attachment 1

Guidance for Demonstrating That Unmonitored Individuals Are Not Likely to Exceed 10 Percent of the Allowable Limits

Personnel monitoring is required for individuals who are likely to receive a radiation dose of more than 10% of the annual dose limit permitted by the Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-1200, "Occupational Dose Limits for Adults." The whole body radiation dose limit which requires personnel monitoring is 500 millirem per year or greater. However, if individuals are not expected to receive this dose, personnel monitoring may not be required.

To demonstrate that personnel monitoring devices are not required, the applicant must perform an evaluation to estimate the annual radiation dose to workers and must submit the evaluation with the Application. The applicant/licensee must also retain a copy of the evaluation for inspection purposes.

Common ways that individuals may exceed 10% of the applicable limits are by frequently using the gauge and by performing routine cleaning and lubrication of gauges. Thus, a licensee would must evaluate the radiation doses workers might receive in performing these tasks to determine if personnel monitoring is required.

Applicants who wish to demonstrate that they are not required to provide personnel monitoring must prepare a written evaluation that includes all potential pathways of radiation exposure (transport, field use, maintenance) similar to that shown in the following example. **The expected dose rates, times, and distances used in the example may not be appropriate to your situation.** In the evaluation, you must use information appropriate to your types of gauges that will be possessed and used. This type of information is generally available from the gauge manufacturers or the Sealed Source and Device Catalogue Registration Sheet maintained by the U.S. Nuclear Regulatory Commission and the Agreement States.

Example

One gauge manufacturer has estimated the doses to the whole body and the extremities of an individual performing routine cleaning and lubrication of one of its gauges. The gauge is authorized to contain up to 9 millicuries of Cesium-137 and 44 millicuries of Americium-241. The manufacturer based its estimate on observations of individuals performing the recommended procedure according to good radiation safety practices. The manufacturer determined the following types of information:

- Time needed to perform the entire procedure (e.g., 10 min)
- Expected dose rate received by the whole body of the individual, associated with the shielded source and determined using measured or manufacturer-determined data (e.g., 20 millirem per hour at contact with the shield)

- Time the hands were exposed to the unshielded source (e.g., 3 min)
- Expected dose rate received by the extremities of the individual associated with the unshielded source and determined using measured or manufacturer-determined data for the typical distance that the hands would be from the sealed source (e.g., 900 millirem per hour or 15 millirem per minute)

From this information, the manufacturer estimated that the individual performing each routine cleaning and lubrication could receive the following:

- Less than 4 millirem, dose to the whole body

Calculation: 10 min X 20 millirem/hour X 1 hour/60 minutes = 3.3 millirem
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- 45 millirem, dose to the hands

Calculation: 3 minutes X 900 millirem/hour X 1 hour/60 minutes = 45 millirem

The applicable limit (whole body) is 5000 millirem per year and 10% of that value is 500 millirem per year. If one cleaning/lubrication results in 4 millirem, then an individual could perform 125 of these operations each year and remain within 10% of the applicable limit.

The applicable limit for the extremities is 50,000 millirem per year and 10% of that value is 5,000 millirem per year. If one cleaning/lubrication results in 45 millirem, then an individual could perform 111 of these operations each year and remain within 10% of the applicable limit. Based only on this specific situation, personnel monitoring may not be required.

However, using the same type of analysis, the applicant must also determine the radiation dose that the workers receive from the routine daily use of the gauge. Specifically, the evaluation must include the following:

- Removal of gauge from permanent storage and securing the gauge in the transport vehicle
- At the job-site, removal of the gauge from the vehicle and transporting the gauge to the work area
- Set up and use of the gauge at the work area (exposing the radiation source, taking measurements, etc.)
- Return the gauge to the vehicle and secure the gauge in the vehicle
- Return the gauge to the permanent storage at the end of the work day

Radiation survey data provided (by the Sealed Source and Device Catalogue Registration Sheet maintained by the U.S. Nuclear Regulatory Commission and the Agreement States) for a typical gauge includes the following:

1. Surface of the gauge in the closed or shielded position:

Bottom: 12 millirem per hour Side: 14 millirem per hour Top: 6 millirem per hour

Front: 21 millirem per hour Back: 5 millirem per hour

2. Highest radiation level at 24" from a gauge in the closed or shielded position:
0.3 millirem per hour
3. Highest radiation level at the surface of the shipping case with gauge for shipment:
Top: 4 millirem per hour Side: 3.5 millirem per hour
4. Radiation level to Operator with probe 8" in soil:
Operator in stooped position at about 18" in back of gauge: About 1 millirem(0.65 millirem)
Personnel in a position at about 36" front of gauge: About 1 millirem (1.25 millirem)

Guidance to Licensees

Table 1, Personnel Dose Evaluation, may be helpful in preparing and documenting an Applicant's evaluation of the personnel monitoring program.

Licensees should review the evaluation periodically and revise it as needed. Licensees must check assumptions used in their evaluations to ensure that they continue to be up-to-date and accurate. For example, if workers become lax in following good radiation safety practices, in the example used above, the extremities could be closer to the unshielded source, and they would receive more than 15 mrem per minute. Alternatively, workers could perform the task more slowly than the estimated 10 minutes total and 3 minutes with the hands near the unshielded source. Also, the purchase of new gauges containing sources of different activities, different radionuclides, or different cleaning/lubrication procedures would require a new evaluation.

Table 1
Personnel Dose Evaluation

Dosimetry Evaluation for _____ Portable Gauge, Model _____

1. USING THE GAUGE

NOTE: This estimate is for the Annual Whole Body dose and does not include the extremities (hands)

- Remove gauge from storage: Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem
 - Securing gauge in vehicle: Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem
 - Remove gauge from vehicle
and transport to job-site Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem
 - Set up and use gauge Time _____ hr X Dose Rate _____ millirem/hr X
Number of times gauge is used during work day _____ = Dose _____ millirem
 - Transport and secure gauge
in vehicle Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem
 - Return gauge to storage Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem
- Add the Dose Column** **Daily Dose** _____ **millirem**

Number of days gauge used in a year by same individual _____ days /yr X Daily dose _____ millirem/day =

Annual Dose _____ **millirem**

2. MAINTAINING THE GAUGE

NOTE: This estimate is for the Annual Whole Body dose and the Extremities (hands) dose

- Remove gauge from storage

Whole Body Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem

- Perform the cleaning and lubrication procedure

Whole Body Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem

Extremity Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem

- Return gauge to storage

- Whole Body Time _____ hr X Dose Rate _____ millirem/hr = Dose _____ millirem

Add the Dose Column **Whole Body Dose** _____ millirem

Extremity Dose _____ millirem

Number of times the gauge is maintained by same individual _____ times/yr X Whole Body Dose _____ millirem =

Annual Whole Body Dose _____ millirem

Number of times the gauge is maintained by same individual _____ times/yr X Extremity Dose _____ millirem =

Annual Extremity Dose _____ millirem

3. TOTAL ANNUAL ESTIMATED DOSE

Whole Body Dose

Whole Body Dose due to Using the gauge _____ millirem
Whole Body Dose due to Maintaining the gauge _____ millirem
Add the Whole Body Dose
Total Annual Estimated Whole Body Dose _____ millirem

Extremity Dose

Extremity Dose due to Maintaining the gauge _____ millirem

Total Annual Estimated Extremity Dose _____ millirem

4. REQUIREMENTS FOR PERSONNEL MONITORING

Annual Whole Body Dose equal to or greater than 500 millirem requires personnel monitoring

Annual Extremity Dose equal to or greater than 5000 millirem requires personnel monitoring