

<b>ISSUING EXTREMITY, NEUTRON AND MULTIBADGE DOSIMETERS</b>	Identifier: MCP-189 Revision*: 13 Page: 1 of 18
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Companywide	Management Control Procedure	For Additional Info: <a href="http://EDMS">http://EDMS</a>	Effective Date: 01/07/14
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Manual: 15C – Radiological Control Procedures

**USE TYPE 3**

Change Number: 340033-1, 340919

\*The current revision can be verified on EDMS.

## 1. INTRODUCTION

### 1.1 Purpose

The purpose of this procedure is to provide guidance and direction for issuing extremity and neutron dosimeters and monitoring radiation exposure to personnel in non-uniform radiation fields through use of multibadging.

### 1.2 Scope and Applicability

This procedure begins when planning indicates any of the following:

- A. Extremity dosimeters are to be issued to an individual
- B. A temporary neutron dosimeter is to be issued to an individual
- C. It will be necessary for an individual to enter an area where non-uniform radiation fields are expected.

The criteria for neutron, extremity, and multibadging dosimeters and their placement are presented. Issuing, use, and processing of the dosimeters are covered. The procedure ends with documenting an individual's exposure.

## 2. RESPONSIBILITIES

Performer	Responsibilities
Radiation Dosimetry and Records	Provide dosimeters to Radiological Control (RadCon) and process after use.
RadCon Personnel	Evaluate need for routine extremity and neutron and multibadge dosimeters and specify their use, if appropriate.

## 3. PREREQUISITES

None.

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**4. INSTRUCTIONS****4.1 Provide Dosimeters**

4.1.1 Radiation Dosimetry and Records (RDR): Provide TLD dosimetry for extremity, and neutron dosimetry and multibadging dosimeter sets as requested by RadCon personnel.

**4.2 Issuing Routine Extremity Dosimeters (not required for multibadging)**

4.2.1 RadCon Personnel: Evaluate work to be performed and determine if extremity dosimeters are needed. Use Form 441.12, "Request for Special Dosimetry Processing." This form allows multiple individuals on one form.

**NOTE:** *Personnel extremity dosimetry is required when radiological workers who, under typical conditions, are likely to receive: "an equivalent dose to the skin or any extremity (see defs.) (external shallow dose) of 5 rem or more in a year" (10 CFR 835).*

4.2.1.1 When an individual has been monitored for extremity exposure at some time during the calendar year, but is not monitored for the entire year, use the equivalent dose to the skin from the whole body dosimeter as the extremity dose of record (external shallow dose) for periods when extremity dosimeters are not worn.

**NOTE:** *The accounting of extremity dose in the SENTINEL Radiation Protection Management is inclusive of both the measured equivalent dose to the skin of the whole body as well as equivalent dose to the extremity when it has been monitored.*

4.2.1.2 During an as low as reasonably achievable review, evaluate the need for extremity dosimetry, being aware that ratios less than 5 to 1 of equivalent dose to the extremity to that of the *equivalent dose to the whole body* (see def.) would not result in an individual exceeding 80% of the annual extremity monitoring requirement of 5,000 mrem (see TBL-385, "Technical Basis for the ICP Extremity Dosimeter").

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- 4.2.1.3 Once extremity dosimetry is determined to be needed, assess the composition of the radionuclide source term, photon, and/or beta energies. If possible, equate the exposure photon and/or beta energy to an Extremity Source Calibration Factor (ESCF) in Table 1, or at least determine which radionuclide has the predominant high energy photons ( $^{137}\text{Cs}$ ,  $^{60}\text{Co}$ , etc.), betas (i.e., uranium,  $^{90}\text{Sr}/^{90}\text{Y}$ ,  $^{85}\text{Kr}$ ), and low energy photons or X-rays (i.e.  $^{238}\text{Pu}$ ,  $^{239}\text{Pu}$ ,  $^{241}\text{Am}$ ).

Table 1. Extremity Source Calibration Factors developed for ANSI/HPS N 13.32-2008 extremity beam codes.

ANSI/HPS N 13.32-2008	Average Energy	Extremity Source Calibration Factor
M30	20 keV	E1 * 0.98
M60	35 keV	E1 * 0.70
H50	39 keV	E2 * 1.98
M100	53 keV	E2 * 1.40
Am-241	59 keV	E2 * 1.04
NS80	65 keV	E2 * 1.0
M150	73 keV	E2 * 1.08
H150	118 keV	E2 * 0.92
Cs-137	662 keV	E2 * 1.20
Co-60	1250 keV	E2 * 1.20
Uranium	620 keV	E1 * 1.27
Sr/Y-90	840 keV	E1 * 0.95
Kr-85	260 keV	E1 * 2.5

- 4.2.1.4 Contact RDR Technical Staff if assistance is needed in determining and assigning an ESCF.

**NOTE:** *RDR technical assistance is available to perform an extremity dual chipstrate TLD ratio characterization study to help establish a new ESCF that is different from the project/job specific pre-assigned ESCF shown in Table 2.*

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Table 2. Project-assigned default extremity source calibration factors.

Facility/Job Specific Description	Assigned Storage Location	Predominate Extremity Exposure Radionuclide and/or Energies	Pre-assigned ESCF
INTEC	053	High energy photon, Cs-137, 662 keV	E2 * 1.2
RWMC	814	Low energy photon, Am-241, 59 keV	E2 * 1.2 <sup>a</sup>
TRA-ICP	043	High energy photon, Co-60 1250 keV	E2 * 1.2
MFC D&D	268 267	Sr/Y-90 High energy photon, Cs-137, 662 keV	E1 * 0.95 E2 * 1.2
AMWTP	853	Low energy photon, Am-241, 59 keV	E2 * 1.2
INTEC D&D	054	High energy photon, Cs-137, 662 keV	E2 * 1.2

a. The source term at RWMC is seen as a high energy photon exposure as a result of personal protective equipment being worn and use of a glove box. See TBL-385 for further explanation.

**NOTE:** *When assigning extremity dosimetry, an ESCF that corresponds with the predominant radionuclide and/or predominant source term energy needs to be identified and assigned in order to correctly assess extremity dose received.*

4.2.1.5 Notify RDR Technical staff or Manager when an extremity source of exposure is expected to be different from that which was pre-assigned and shown in Table 2.

**NOTE:** *Wearing of personal protective equipment (PPE) on extremities can also change the extremity exposure energy spectrum and may need factored in when establishing an accurate extremity source calibration factors.*

4.2.1.6 If an individual is entering an area where the expected shallow dose to an extremity is greater by a factor of 5 or more than the expected deep dose to the whole body and the expected exposure rate to the extremity will be greater than 250 mrem/hr (shallow dose) and greater than 400 mrem/job (shallow dose), specify extremity dosimetry to be worn. Any deviation can be documented in a Technical Basis or ALARA review. (see TBL-385, “Technical Basis for the ICP Extremity Dosimeter”).

4.2.1.7 Monitor all extremity exposure to individuals, who have accumulated an extremity dose (equivalent dose to the

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skin plus supplemental monitored equivalent dose to the extremity) of 5 rem or greater, for the remainder of the year.

**NOTE:** *For facilities where extremity dosimetry are routinely issued and where an ESCF has been determined as being representative and consistent for a facility's particular radionuclide source term, an ESCF that corresponds to a particular facility code will be assigned by RDR in DOC's software and used in extremity dose processing. It may be necessary to assign more than one extremity source calibration factor if for example, at one location the extremity exposure is to uranium where another area extremity exposure is to high energy photons, i.e., Cs-137. A uranium exposure would be under-estimated by a factor of 5 if an ESCF for Cs-137 was used to estimate dose received.*

- 4.2.1.8 At projects where more than one ESCF is needed, ensure extremity TLDs issued by that facility are identified with colored dots to assist RadCon, workers, and RDR in distinguishing work locations having different ESCFs. Ensure the colored dots are placed carefully. Ensure dots are not placed on or near the chipstrate where it can interfere with the phosphor element response.
- 4.2.1.9 RadCon and Employee Wearing Extremity Dosimetry: Ensure that the correct set of extremity dosimetry is worn as issued for a work task or job with an appropriately assigned ESCF for that work.
- 4.2.1.10 RadCon Personnel: Issue a multipack set of extremity dosimeters through Sentinel Rad Worker Management following Appendix A user guide.
- 4.2.1.11 When the extremity dosimeter set cannot be assembled and issued in Sentinel, then manually document the assignment of the ESCF on Form 441.12.
- 4.2.1.12 Return extremity TLDs together with the completed Form 441.12 to RDR for processing.
- 4.2.2 If necessary, use any of the following options available to minimize discomfort with wearing of extremity dosimeters, and note cautions about making adjustments with the extremity holder and orientation to be worn.

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**NOTE:** *The extremity holder was developed as a “soft” or pliable holder capable of being molded around a variety of finger sizes. As such, it suffers from extreme pressure or rough treatment. Unless the source is gripped in the palm of the hand, the best orientation is with the phosphor pouch facing up on top of the finger.*

- A. Extremity dosimeters worn on the fingers may be worn either on thumb or pinky (small finger) if comfort is an issue.
- B. Extremity dosimeters needs to be worn with barcode/phosphor/plastic pouch orientated toward where the extremity exposure is most apt to be received.
- C. A soft sided tape, e.g., duct tape, can be applied on the back and sides of the Velcro strap, up to where the extremity hanger hinges, helping to protect the wearer from being scraped from abrasive plastic sides of the extremity holder.
- D. Extremity holder may be taped together as a finger ring when the devise is expected to be worn several times during a wear period.
- E. A small piece of soft-sided tape can be placed down each side of the center section of the extremity dosimeter to protect the wearer from being irritated from the plastic sides of the extremity holder.
- F. The abrasive sides **only** of the Velcro strap may be trimmed with scissors to improve comfort.

**CAUTION**

**Placing tape over or behind the barcode/phosphors/plastic pouch could compromise the calibrated response of the extremity dosimeter.**

- G. Tape must not be placed over the barcode/phosphors/plastic pouch.
- H. Extremity dosimetry is to be worn on the fingers or if necessary on the toes to measure extremity occupational dose-of-record. Source-specific calibration factors having been developed for use in this configuration.

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**CAUTION**

**Moving extremity dosimetry from the fingers or toes to a different extremity location may require developing a more appropriate calibration factor.**

- 4.2.3 If extremity dosimetry must be moved from the fingers or toes to a different extremity location, then contact RDR Technical Support for assistance and to develop a more appropriate calibration factor.

**4.3 Issue Routine Neutron Dosimeters**

- 4.3.1 RadCon Personnel: Evaluate work to be performed and determine if neutron dosimetry is needed.

**NOTE:** *Neutron sources are energy dependant and must have an appropriate Facility Neutron Calibration Factor (FNCF) assigned.*

- 4.3.1.1 Either know what FNCF is to be assigned or have an FNCF determined before issuing temporary neutron dosimetry in Sentinel to a radiation worker.

- 4.3.1.2 If an individual is entering a radiation area where one of the primary sources of exposure will be from neutrons and the radiation worker is expected to receive an annual deep dose greater than 100 mrem, then issue a beta-gamma-neutron dosimeter in Sentinel.

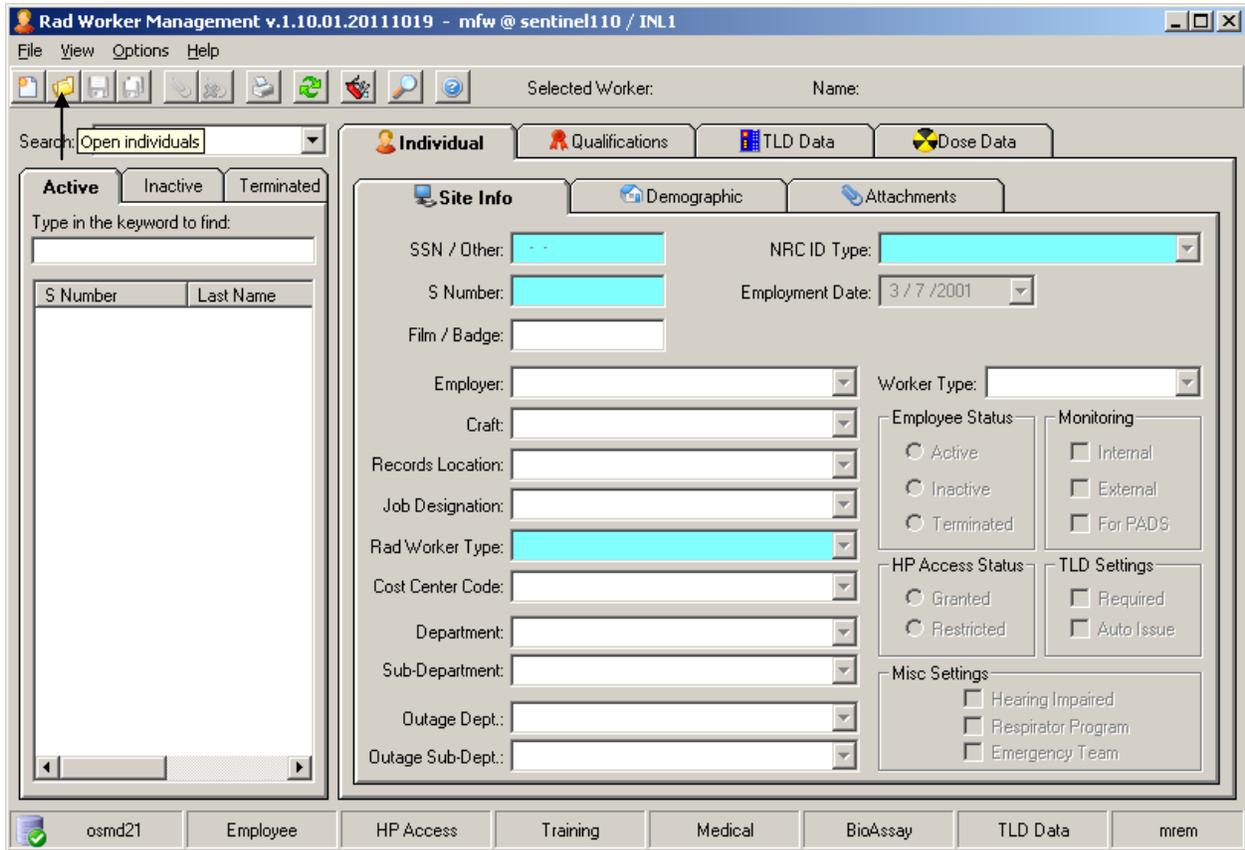
- 4.4 FDC: Issue a temporary beta-gamma-neutron dosimeter by using the following steps.

- 4.4.1 In Sentinel, select the Rad Worker Management tab.

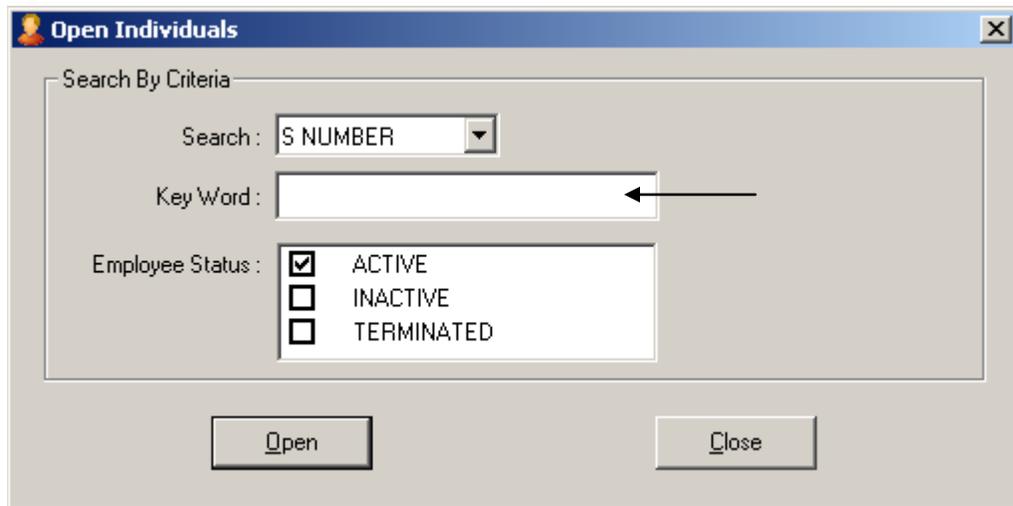


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4.4.2 Select “the “Open Individuals” tab.



4.4.3 Enter individuals S# or SSN.



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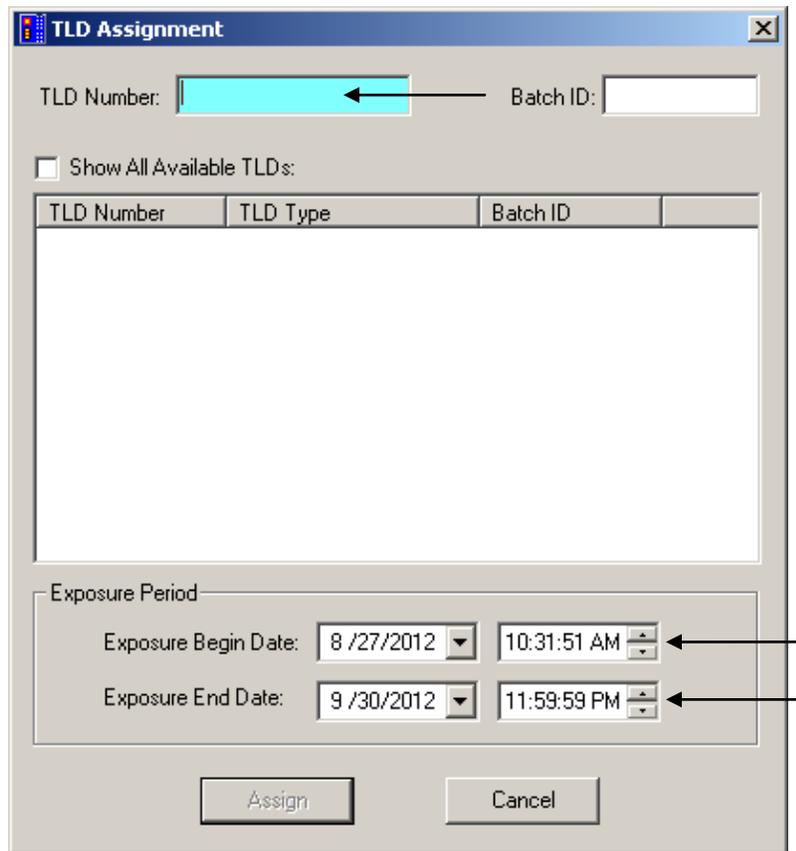
**NOTE:** *RDR has pre-assigned the neutron dosimeter together with the beta-gamma dosimeter for issue by the FDC as a temporary BGN dosimeter. The Panasonic UD-808 beta-gamma TLD number must be used to issue the attached neutron albedo dosimeter.*

4.4.4 Double click individual to populate the Site Info panel and then select the “TLD ASN” tab.



4.4.5 This will open up the TLD Assignment panel where you enter the beta-gamma TLD number that you are issuing. Enter the “Exposure Begin Date and time” and the “Exposure End Date and time.” Then select “Assign”.

**NOTE:** *For temporary TLD’s the End Date will be the end of the month.*



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- 4.4.5.1 Insure that the *TLD Type* shown BGN as the dosimeter type assigned to the employee.
- 4.4.5.2 Manually document the assignment of the assigned FNCF on Form 441.12, “Request For Special Dosimetry Processing,” for each individual.

#### 4.5 Issue Multibadge Dosimeters

- 4.5.1 RadCon Personnel: Evaluate work to be performed and determine if multiple dosimeters are needed.

- 4.5.1.1 If an individual is entering a non-uniform radiation field and is expected to receive more than 100 mrem, and the radiation fields vary by more than 50% over the area of the whole body, ensure that the technical work document specifies the use of multiple dosimeters.
- 4.5.1.2 Determine how many and where the multiple dosimeters are to be worn.

**NOTE:** *When a multibadging set of whole-body dosimeters are needed that differ from a CWI predefined multipack set of 7 dosimeters/body locations, consisting of the Head, Chest, Waist, Left Upper Arm, Right Upper Arm, Left Upper Leg and Right Upper Leg, dosimetry technical support will be ask by Radcon organization for assistance with assigning in the SENTINEL database a job specific oriented set of multiple whole-body dosimeters.*

- 4.5.2 Issue multibadge set of dosimeters in SENTINEL database to employee
  - 4.5.2.1 Record that a “multibadge set” is to be worn on the Radiological Work Permit (RWP).

**NOTE:** *Extremity dosimetry is a separate dosimeter assignment type and must not be included when assigning multiple dosimetry to whole body locations; i.e., head, chest, waist, left upper arm, right upper arm, left upper leg, right upper leg.*

- 4.5.2.2 Determine if the permanent dosimeter needs read to determine the accumulated total exposure for the individual prior to issuing the **multiple badge** set.

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- 4.5.2.3 Assign a multiple badge set of wholebody dosimeters in Dosimetry Record Database through SENTINEL Multipack



management .

- 4.5.2.4 Search by “S NUMBER” with Key Word enter S number of employee and open to initiate assigning a multiple badge set of dosimeters.

- 4.5.2.5 Double click to select employee shown in the right hand panel and then from the header line click ASN multipack TLD assignment.

- 4.5.2.6 A menu box will appear, from the Select Multipack set the arrow provides a dropdown list, select “Predefined Multipack” where both BEA and CWI default multipack sets appear. Select the CWI multiple pack set of 7 wholebody dosimeters.

- 4.5.2.7 In the TLD placements window record the TLD ID numbers that are to be assigned and worn at the default wholebody locations that appear in the placement window.

- 4.5.2.8 To the extent practical, make sure the dosimeters are positioned so that they are most likely facing the source of exposure during the most significant exposure portion of the working period.

**NOTE:** *The individual’s permanent dosimeter, which is normally worn on the chest, is not worn at the same time as a multiple wholebody dosimetry set.*

- 4.5.2.9 Remove individual’s permanent dosimeter and exchange with the “chest” dosimeter assigned in the multibadge set. Place the remaining dosimeters at their pre-assigned wholebody locations.

**NOTE:** *All whole-body dosimeters in the multibadge set will be documented on Form 441.55 only.*

- 4.5.2.10 For each individual using a multibadge set, initiate Form 441.55, “Whole-Body/Extremity Multibadging Processing Request,” to document the location where badges in the set were worn. Record each dosimeter badge’s number on the line corresponding to the whole body

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location where the badge was located. Record the RWP number and multi-pack number on the form.

**NOTE 1:** *Lens of eye dose from an issued multipack dosimeter set is determined from the chest badge dosimeter location. If a different location, i.e. head, is deemed more appropriate for an assigned lens of eye dose, note the change on Form 441.55 and notify dosimetry technical support of requesting change.*

**NOTE 2:** *Extremities are monitored separately from the wholebody and should not be included in an assigned multibadge dosimeter set, but assigned as an extremity dosimetry set separately. Extremity means hands and arms below the elbow or feet and legs below the knee.*

#### 4.6 Document Dosimeter Use and Process Dosimeters

4.6.1 RCT or RadCon Foreman: For routine extremity and neutron dosimetry during conditions when they cannot be issued directly via Sentinel, document on Form 441.12, "Request for Special Dosimetry Processing," for all individuals the timeframe in which the multipack sets of dosimetry were worn, the multi-pack number, body location(s) with assigned TLD(s), and applicable RWP or work procedure number. When monitoring has been completed, return dosimeters and Form 441.12 to RDR.

4.6.2 RCT or RadCon Foreman: For multibadging dosimetry during conditions when the dosimeters cannot be issued directly via Sentinel, document on Form 441.55, "Whole-Body/Extremity Multibadging Processing Request," the timeframe in which the multi-pack sets of dosimetry were worn, the multi-pack number, body location(s) with assigned TLD(s), and applicable RWP or work procedure number. When monitoring has been completed, return dosimeters and Form 441.55 to RDR.

4.6.3 RDR: Process the dosimeters and determine the effective dose.

**NOTE 1:** *Equivalent dose for wholebody multiple dosimetry is determined from weighted compartment factors recommended by the Health Physics Society Standards N13.41-1977, "Criteria for Performing Multiple Dosimetry."*

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**NOTE 2:** *Equivalent dose for extremity dosimetry is determined with an extremity source calibration factor (ESCF), that is appropriate for a given source term and any appreciable attenuation caused by PPE (lead-lined gloves, glove boxes, lead blankets, etc.). An appropriately assigned ESCF needs to be considered by the RadCon staff whenever an extremity dosimeter is issued.*

**NOTE 3:** *Equivalent dose for neutron dosimetry is determined with FNCFs, that are unique for a given neutron spectra, scatter geometry, and working distance. Appropriateness of the assigned FNCF needs to be considered by the RadCon staff, whenever, a neutron dosimeter is issued.*

4.6.4 RDR: Report the results to the facility RadCon group.

4.6.5 Radiological Engineer: Evaluate the data reported by RDR.

4.6.6 Radiological Engineer: If any changes are needed to the dose assessment, report them to RDR on Form 441.04, "Personnel Exposure Questionnaire."

4.6.7 RDR: Verify and enter the assigned dose in the INL Radiation Dosimetry System records.

## 5. RECORDS

Form 441.04, "Personnel Exposure Questionnaire"

Form 441.12, "Request for Special Dosimetry Processing"

Form 441.55, "Multibadging Processing Request"

**NOTE:** [MCP-557, "Records Management,"](#) the [INL Records Schedule Matrix](#), and associated [record types list\(s\)](#) provide current information on the storage, turnover, and retention requirements for these records.

## 6. DEFINITIONS

*Equivalent dose to any extremity.* Shallow dose equivalent to any extremity, commonly referred to as extremity dose

*Equivalent dose to the skin.* Shallow dose equivalent to the skin, commonly referred to as shallow dose

*Equivalent dose to the whole body.* Deep dose equivalent, commonly referred to as deep dose

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*FDC.* Facility Dosimetry Coordinator

*Sentinel Radiation Protection Management.* Radcon program management and dosimetry records database

**7. REFERENCES**

10 CFR 835, “Occupational Radiation Protection”

MCP-188, “TLD Usage and Obtaining Personnel Dose History”

PRD-183, “ICP Radiological Control Manual”

TBL-385, “Technical Basis for the ICP Extremity Dosimeter”

**8. APPENDIX**

Appendix A, Issuing Extremity Dosimeter in Sentinel

Appendix B, Procedure Basis

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## Appendix A

### Issuing Extremity Dosimetry in Sentinel

From the *Sentinel Launch* window click on the *Rad Worker Management* icon



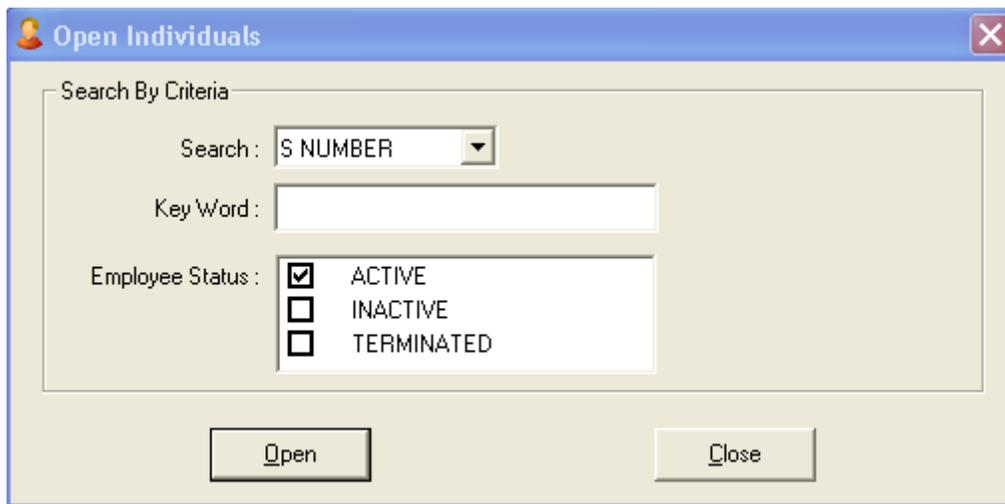
From the tool bar click on the file icon “*Open Individuals*”



Using Form 441.12, “Request for Special Dosimetry Processing,” record employee information, extremity body location (right and left fingers or right and left toes), and extremity TLD ID#s for whom extremity dosimeters are being issued.

Select pairs of extremity dosimeters from the available dosimeters for the given assignment wear period. Record the extremity TLD ID numbers and assigned extremity body location on Form 441.12 for each individual being issued extremity dosimetry.

Enter the person’s S# in the Key Word search field. Click open.

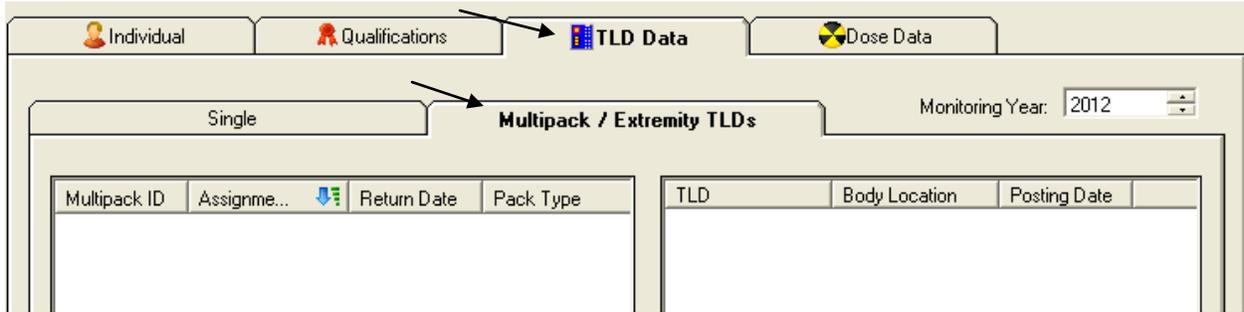


Double click on the individual’s name to open their record.

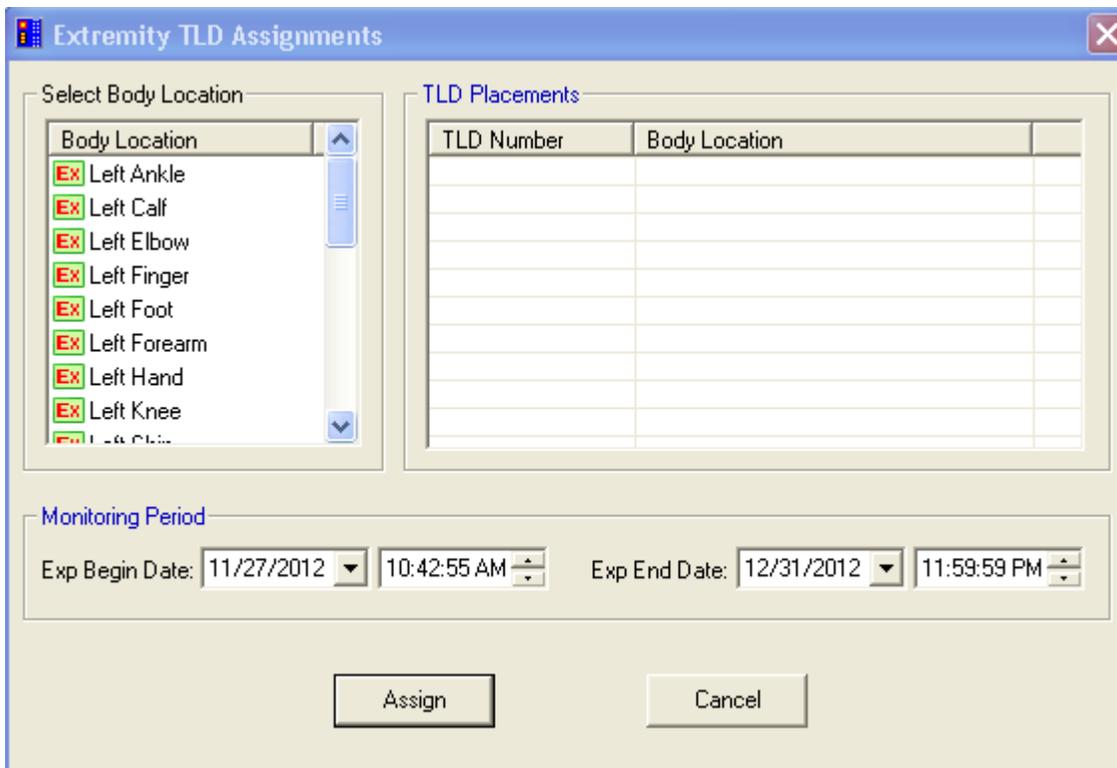
S Number	Last Name	First Name	M
035136	ANDERSEN	BRIAN	L

Click on the *TLD Data* tab, then *Multipack/Extremity TLDs* tab.

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From the tool bar click on the icon  to make extremity TLD assignments.

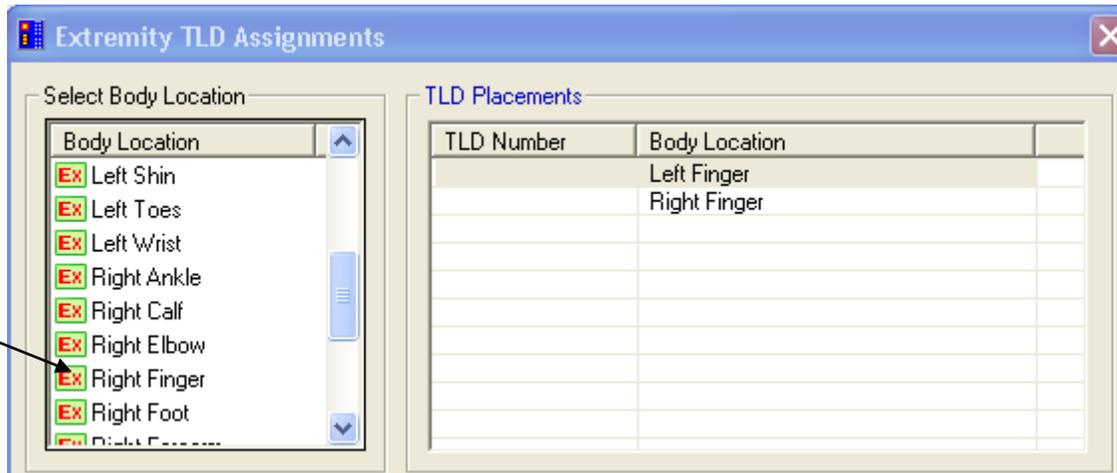


To assign upper extremity (fingers) scroll *Body Location* field and double click on right finger and left finger.

To assign lower extremity (toes) scroll *Body Location* field and double click on left toes and right toes.

**CAUTION:** Needing to assign extremity body location other than fingers and toes are to be discussed with radiological engineering and dosimetry technical support before making assignment to the Sentinel Database.

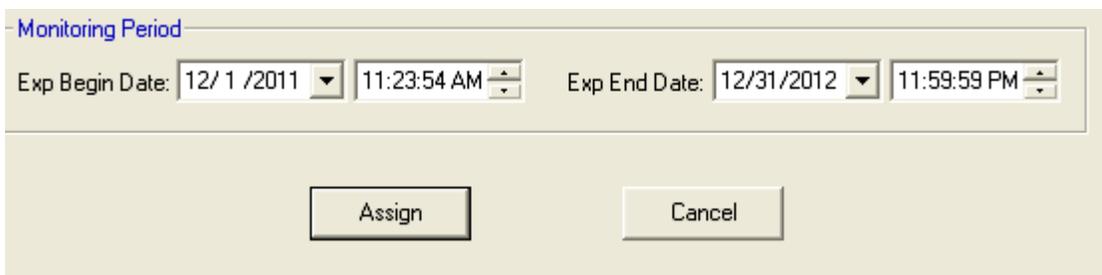
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Put the cursor in the *TLD Number* column and click. Referring to the recorded extremity TLDs shown on Form 441.12, assign the appropriate extremity ID numbers in Sentinel to the individual's left and right extremity body location.



Adjust the *Exposure Begin Date* to the correct assignment date and approximate time. Ensure the *Exposure End Date* and time is set for the end of the wear period. Then click assign.



Contact Radiation Dosimetry and Record if an invalid TLD number is received when making an extremity TLD assignment.



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## Appendix B

### Procedure Basis

Step	Basis	Source	Citation
4.1	Radiation Dosimetry and Records is responsible to provide extremity, neutron and multibadge dosimeters	PRD-183, ICP Radiological Control Manual (RCM) 10 CFR 835 Implementation Guide	Chapter 4 Part 1, Article 512.a, and paragraph 1. DOE G 441.1-1C, Section 6.4.1.4, 05/19/2008
4.2	Evaluate conditions and issue extremity dosimeters	ICP RCM 10 CFR 835 Implementation Guide	Chapter 4 Part 1, Article 512, and paragraph 5. DOE G 441.1-1C, Section 6.4.1.4, 05/18/2008
4.3	Evaluate conditions and issue neutron dosimeters	ICP RCM 10 CFR 835 Implementation Guide	Chapter 4 Part 1, Article 512, and paragraph 5. DOE G 441.1-1C, Section 6.4.1.4, 05/18/2008
4.4	Evaluate conditions and issue multiple dosimeters	ICP RCM 10 CFR 835 Implementation Guide	Chapter 4 Part 1, Article 512, and paragraph 5. DOE G 441.1-1C, Section 6.4.1.4, 05/18/2008
4.5	Document dosimeter use and process dosimeter for dose history.	ICP RCM 10 CFR 835 Implementation Guide	Chapter 3 Part 4 Article 343. DOE G 441.1-1C, Section 6.4.1.4, 05/19/2008