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External Dosimetry

Procedures Manual

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Purpose

This External Dosimetry Procedures Manual (EDPM), in conjunction with the Quality Program Manual (QPM) [1] and the Technical Basis Manual (TBM) [2], form the foundation of the Fermilab External Dosimetry Program (EDP). The primary purpose of this document is to collect the various EDP operational procedures, as well as to serve as a reference and as training materials for the Dosimetry Program Manager (DPM), Backup Dosimetry Program Manager, and the EDP Administrative Support Assistant.

The procedures contained in this manual have been established in accordance with the guidelines set forth by 10 CFR 835 [3], DOE-STD-1095-2018 [4], and the Fermilab Radiological Control Manual (FRCM) [5] and serve to ensure that the EDP operates in a safe, methodical, accurate, and efficient manner.

Scope

Fermilab is currently accredited by the Department of Energy Laboratory Accreditation Program (DOELAP) for the following dosimeters and fields:

Whole Body Dosimeter: Landauer InLight Model 2T
Testing Categories:

IA	Accident, photons: General
IIA	Photons/photon mixtures: General
IIIA	Betas: General
IIID	Betas: Uranium slab
IVA-1	Photon/beta mixtures: IIA + IIIA
IVD-1	Photon/beta mixtures: IIA + IIID
VB-1	Neutron/photon mixtures: IIA + Bare Neutrons

Extremity Dosimeter: Landauer Saturn Ring
Testing Categories:

IA	High-Dose, photons: General
IIA	Photons: General
IIIA	Betas: General
IIID	Betas: Uranium slab

This External Dosimetry Procedures Manual describes each of the External Dosimetry Program's operational procedures, providing sufficient details and step-by-step instructions to ensure that external dosimetry results are accurate, repeatable, verifiable, and properly

recorded. More detailed information about the technical aspects of the EDP can be found in Fermilab RP Note 124, Technical Basis for External Dosimetry at Fermilab [2], also known as the Technical Basis Manual.

Environmental dosimetry is not addressed in this document, as devices used for environmental dosimetry are not required to be accredited by DOELAP. In addition, any devices used for dosimetry of individuals who are not required to be monitored under 10 CFR 835.402 are not subject to DOELAP accreditation and thus are not addressed in this manual.

It should be noted that while almost all Radiological Workers are assigned dosimetry, only certain individuals are provided dosimetry pursuant to 10 CFR 835.402. These individuals are identified through ongoing dose tracking as well as identification of radiological work that has the potential to result in doses approaching the threshold for required monitoring under 10 CFR 835.402. These same individuals form the population who would be considered eligible for participation in a Planned Special Exposure pursuant to 10 CFR 835.204.

Fermilab's Dosimeter of Record

Currently, the Fermilab dosimeter of record is Landauer's InLight LDR Model 2T, referred to at Fermilab as the "dosimetry badge." Note that despite routine training, obsolete names such as "TLD" and "film badge" continue to be used by Fermilab personnel.

Technical Description

This dosimeter utilizes Optically Stimulated Luminescence (OSL) technology and onsite studies have shown that this dosimeter is well suited for use at Fermilab. Results of studies comparing the InLight LDR Model 2T to other dosimeters can be found in the Dosimetry Program Office.

The InLight LDR Model 2T dosimeter is designed for personnel monitoring of the whole body. It measures exposure to beta/gamma radiation. The placement of CR-39 within the holder, with boron-loaded Teflon over one half, allows for the additional measurement of thermal, intermediate, and fast neutron exposure. The InLight LDR Model 2T has detection capabilities of 5 mrem to 1000 rem for photons (x-ray and gamma) with energies between 5 keV and 20 MeV, and 5 mrem to 1000 rem for beta particles. The CR-39 element can measure neutrons with energies of 0.25 eV to 40 MeV, with a dose range of 10 mrem to 25 rem.

The InLight LDR Model 2T consists of a plastic holder (cover and subcarrier), which snaps shut and contains the dosimeter (case and slide); see Figure 1. The dosimeter consists of a case that contains metal and plastic filters and a plastic slide holding the detector elements; see Figure 2. The detector element is a layer of Al_2O_3 sandwiched between two layers of polyester for a total

thickness of 0.3 mm. Optically Stimulated Luminescence (OSL) is the method used to obtain data from the detector.

Technical specifications for the InLight LDR Model 2T detector elements are shown in Table 1.

Figure 1: Components of the Landauer InLight LDR Model 2T Dosimeter

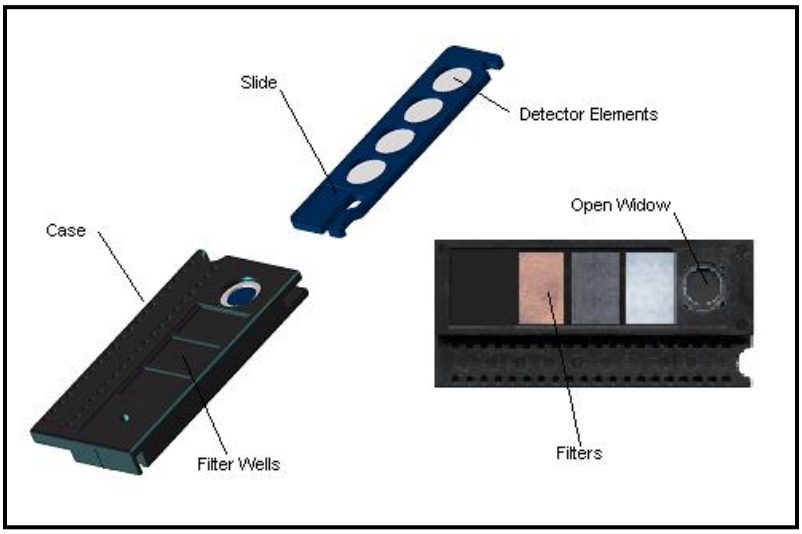

Figure 2: Detector elements of the Landauer InLight LDR Model 2T Dosimeter

Table 1: Technical Specifications for the Detector Elements of the Landauer InLight LDR Model 2T Dosimeter

FRONT							
				Thickness (mg/cm^2)			
Dosimeter Element	**Density (g/cm^3)**	**Thickness (mm)**	**Thickness (10^{-3} in)**	**OW**	**PL**	**Al**	**Cu**
Polycarbonate Cover	1.21	0.76	30.00		92	92	92
Label							
Polyester Film*	1.33	0.05	1.97	7	7	7	7
Acrylic Adhesive*	1.20	0.02	0.79	2	2	2	2
Laminate for Label							
Polyester Base*	1.26	0.03	1.00	3	3	3	3
Acrylic Adhesive*	1.20	0.02	0.79	2	2	2	2
Case Serial Number Label	1.20	0.02	0.79		2	2	2
Case Window	2.70	0.01	0.44	3			
Plastic Filter ABS	1.26	0.70	27.56		88		
Cu	8.96	0.40	15.75				358
Al	2.69	0.70	27.56			188	
Case Plastic ABS	1.26	0.70	27.56		88	88	88
Polyester Substrate	1.26	0.10	3.94	13	13	13	13
			Total	**30**	**298**	**398**	**568**
BACK							
				Thickness (mg/cm^2)			
Dosimeter Element	**Density (g/cm^3)**	**Thickness (mm)**	**Thickness (10^{-3} in)**	**OW**	**Plastic**	**Cu**	**Al**
Polycarbonate Cover	1.21	0.76	30.00		92	92	92
Case Serial Number Label	1.20	0.02	0.79		2	2	2
Case Window	2.70	0.01	0.44	3			
Plastic Filter ABS	1.260	0.70	28		88.20		
Cu	8.960	0.40	16			358.40	
Al	2.690	0.70	28				188.30
Case Plastic ABS	1.260	0.70	28		88.20	88.20	88.20
Polyester Substrate	1.260	0.10	4	12.60	12.60	12.60	12.60
			Total	**15.60**	**283.60**	**553.80**	**383.70**

Fermilab's Extremity Dosimeter

Currently, Fermilab uses Landauer's Saturn Ring TLD as its extremity dosimeter; see Figure 3. This dosimeter consists of one Li-7, TLD-100 chip, which is processed using Landauer's laser-heated TLD reader. All Saturn Ring badge documentation can be found in the Landauer documentation binder in the Dosimetry Program Office.

Technical Description

The Saturn Ring dosimeter consists of an LiF chip (TLD 100 or MTS-N), a ring label cap, and a ring base. The LiF chip (TLD 100) is encapsulated in a laser-etched identification ring label cap, which is ultrasonically welded over it. The TLD 100/MTS-N detector is composed of Li:Mg, Ti (TLD Poland Model Number MTS-N or TLD-100), and it is nearly tissue-equivalent, having an atomic number of 8.2 (the atomic number for tissue is 7.42).

This dosimeter configuration allows for detection of beta and photon radiation. The skin dose, Hp(0.07), range is 10 mrem to greater than 1000 rem for photons, and 10 mrem to 1000 rem for energetic beta particles.

The Saturn Ring dosimeter can be analyzed on Landauer-designed laser-heated TLD readers. These readers use a CO_2 laser to heat the TLD chip, and a photon counting system to measure the resultant luminescence from the TLD chip.

Technical specifications for the Saturn Ring TLD dosimeter detector elements are shown in Table 2.

Figure 3: Landauer Saturn Ring TLD Dosimeter

Table 2: Landauer Saturn Ring TLD Specifications

Material	**Dimensions (LxW) (mm)**	**Weight (g)**
LiF chip (TLD 100) + ring cap + ring base	22 X 19	1.07

Material	**Density (g/cm³)**	**Thickness (mm)**	**Density Thickness (mg/cm²) (E1)**
Polyethylene	0.93	0.345	27.9
		Total	27.9

Fermilab's Dosimetry Badge Database and Applications

The laboratory's Core Computing Division has developed an in-house database for tracking the assignment of dosimetry badges, as well as a number of software applications for various aspects of the External Dosimetry Program. All of these applications have been collected onto a single webpage, which can be accessed at this URL: https://www-esh.fnal.gov/pls/apex/f?p=118.

The following are currently available for use on the dosimetry applications webpage:

- Search
- Check-In
- Load Quarterly Packing List Data
- Vendor Dump
- Switch to Next Quarter
- Issue Temporary Badge
- Annual Dose Reports
- End-of-Quarter Email
- Missing Badge Email
- Missing Badge Report

Additionally, the dosimetry application webpage contains links to several useful websites, including the vendor's online database and the application privileges page.

The usages of many of these applications are described in further detail in the relevant sections of this document.

The Dosimetry Program Manager should suggest ideas for improvements to the dosimetry database and applications to the Core Computing Division Business Applications Department via the Service Desk ticket system, and participate in the testing of all upgraded applications prior to their publication.

Inventory System

For both the InLight LDR Model 2T and the Saturn Ring, the vendor assigns each dosimeter a unique eight-digit number and associated QR code specifically for use with Fermilab's in-house inventory system. This number, referred to as the "Chipset ID" in the dosimetry database system, and its QR code are printed on the badge label. The loading of this data is addressed in FNAL-DP-07.

The Chipset ID can be used to search for a particular badge in the dosimetry database, or it can be entered into the Dosimetry Badge Database Check-In page to mark a badge as having been returned to the Dosimetry Program Office. To expedite the check-in of large numbers of badges, the QR code can be scanned, which will automatically enter the Chipset ID number in the Check-In page. However, before scanning a subsequent badge, care must be taken to ensure the correct (upper) QR code was read by the scanner, and that the Check-In page did not report an error.

After the end of the quarter, the Dosimetry Program Manager or EDP Administrative Support Assistant will scan the badges' QR codes after collection to create an absent badge listing. Refer to Dosimetry Program Procedure FNAL-DP-08. Exposure investigations shall be completed for those badges that are declared lost; see FNAL-DP-09.

Vendor Contract [FNAL-DP-04]

The contract with Fermilab's dosimetry vendor is written for one base year with four additional one-year options. Note that a prerequisite for the contract is that the vendor must be DOELAP qualified and be able to provide a dosimeters that can pass all of the irradiation categories in which Fermilab has requested testing. The vendor must also assist Fermilab in maintaining DOELAP accreditation.

Responsibilities

The dosimetry contract is prepared by the Procurement Department within the Finance Section. However, the Dosimetry Program Manager is responsible for maintaining Exhibit B of the contract, which outlines the technical requirements of the dosimetry program and the services that the vendor has agreed to provide. An electronic copy of this document is attached (see

Attachment A). If any changes are made to this document, a copy must be forwarded to the Procurement Department.

Contract Procedures

1. To Exercise an Option

    a. Prepare a memo indicating this intent and send it to the Procurement Department. Under the current contract, the vendor must be notified sixty days prior to the expiration of the contract or option. Currently the contract is renewed in June. This will also provide adequate time to prepare the associated paperwork and funds added to the contract.

    b. Review Exhibit B for modifications.

    c. Prepare a purchase requisition to add funds to the existing contract (the quoted charges for the next year of dosimetry services) to be charged to the dosimetry project task code. The memo, Exhibit B, and the purchase requisition should then be forwarded to the Procurement Department.

    d. If the amount is to be determined at a later date because the vendor has specified a potential price change in the original contract, wait until the Procurement Department sends notification of the total. The purchase requisition will need to be approved by the Senior Radiation Safety Officer and/or the Chief Safety Officer before being sent to the Procurement Department.

2. To Renegotiate a Contract with the Same Vendor (Sole Source)

    a. Review Exhibit B and make any required modifications.

    b. Prepare a memo indicating the intent to renegotiate the contract and send it to the Procurement Department. In this memo, state the reasons why these services need to be sole-sourced. Again, this should be done with enough lead time to allow for the associated paperwork to be completed.

    c. Use the information in the memo to prepare the required Sole Source Justification Form. Complete this form and have it approved by the Senior

Radiation Safety Officer.

d. Send Exhibit B and the completed Sole Source Justification Form to the ES&H Section budget contact person, who will then forward this package to the Procurement Department.

e. The Procurement Department will prepare the bid package that is sent to the selected vendor. Any objections from the vendor regarding the requirements included in Exhibit B need to be resolved.

f. After an annual cost has been determined, prepare a purchase requisition for an amount equal to one year of dosimetry services to be charged to the dosimetry program task code. This purchase requisition will need to be approved by the Senior Radiation Safety Officer and/or the Chief Safety Officer before being sent to the Procurement Department.

3. To Open the Contract for Competitive Bidding

a. Review Exhibit B and make any required modifications.

b. Prepare a memo indicating the intent to open the contract for competitive bidding and send it to the Procurement Department. This should be done with significant lead time to allow for the associated paperwork to be completed, and for the vendors to submit their bids.

c. The Procurement Department will prepare a bid package that is sent to the vendors. Any objections from vendors regarding the requirements included in Exhibit B need to be resolved.

d. After a vendor is selected and an annual cost has been determined, prepare a purchase requisition for an amount equal to one year of dosimetry services to be charged to the dosimetry program task code. This purchase requisition will need to be approved by the Senior Radiation Safety Officer and/or the Chief Safety Officer before being sent to the Procurement Department.

Documentation

Attachment A is a copy of the current version of Exhibit B. The Procurement Department is responsible for maintaining the official file copy of the entire contract. Reference copies of

memos submitted to the Procurement Department and subsequent purchase requisitions should be maintained as long as they are valid.

Permanent-Service Dosimetry Badges [FNAL-DP-05]

10 CFR 835 requires personnel dosimetry for the following:

- Radiological workers who, under typical conditions, are likely to receive a total effective dose to the whole body of 0.1 rem (0.001 Sv) or more in a year, an equivalent dose to the skin or to any extremity of 5 rem (0.05 Sv) or more in a year, or an equivalent dose to the lens of the eye of 1.5 rem (0.015 Sv) or more in a year.

- Declared pregnant workers who are likely to receive from external sources a dose to the embryo/fetus in excess of 10% of the applicable limit of 0.5 rem (0.005 Sv).

- Occupationally exposed minors likely to receive a dose in excess of 50% of the applicable limit of 0.1 rem (0.001 Sv) in a year from external sources.

- Members of the public and minors entering a controlled area likely to receive a dose in excess of 50% of the appropriate limit of 100 mrem in a year from external sources.

- Individuals entering a Radiation Area, High Radiation Area, or Very High Radiation Area.

- Extremity monitoring as determined by the assigned RSO.

For individuals who will be onsite for a substantial period of time, it is recommended that they be assigned a permanent-service dosimetry badge. Permanent-service dosimetry badges are obtained from the vendor on a quarterly basis and are color-coded by quarter. Permanent badges are assigned into three separate accounts: 75901 (for employees), 151629 (for visitors), and 151630 (for subcontractors).

At least three control dosimeters for each account and badge type are included with every shipment from the vendor. These control dosimeters are used for background subtraction and accompany the field dosimeters in transit to and from the vendor. During the quarter the control dosimeters are stored on the 7th floor of Wilson Hall, a low-background-radiation area. The low background in this area is verified quarterly using designated area monitors from the 75902 account.

The scope of this procedure covers the issue, distribution, and collection of permanent badges, tracking of missing badges, and minimizing the number of badges turned in late. Temporary badging is covered in Dosimetry Program Procedure FNAL-DP-06.

Responsibilities

The Dosimetry Program Manager is ultimately responsible for processing all requests for permanent badge service, notifying individuals of their dosimetry badge status, maintaining the dosimetry badge inventory, returning the dosimetry badges to the vendor for processing and keeping appropriate auditable records of dosimetry service. The DPM may be assisted in these tasks by the EDP Administrative Support Assistant.

Certain dosimetry program contacts (e.g., Radiological Control Technicians) or the RSOs may review requests for permanent dosimetry badge service and verify that training requirements have been satisfied. They may also provide input to the Dosimetry Program Office as to the dosimetry needs of personnel working in their assigned Division, Section, or Center, and assist in the assignment of the permanent-service badges to specific badge racks. As a further check, the Dosimetry Program Manager shall review these permanent badge service requests for completeness and accuracy.

Each badge wearer is responsible for the dosimeter itself. If a badge is damaged, lost, or in some other way compromised, the badge wearer must immediately notify either the Dosimetry Program Office or their assigned RSO. Additionally, the badge wearer is responsible for informing the Dosimetry Program Office of any changes in status that affect the badge assignment, and for providing accurate contact information so that radiation exposure reports can be forwarded appropriately.

Issuing Permanent-Service Dosimetry Badges

1. Receiving and Reviewing RP Form 001

   Requests for permanent-service dosimetry badges are considered similar to any other change request and are subject to the same deadlines. These deadlines are set by the DPM and announced to the RSOs and other dosimetry contacts on a quarterly basis. Requests received after the change request deadline will be made the following quarter.

   In general, permanent-service badges are only assigned when the individual requesting the badge will be at Fermilab for more than six consecutive months. The process is initiated when an individual completes a copy of RP Form 001, the Permanent Service Request Form [6] (see Attachment B). The RSO or contact should concur that a permanent dosimetry badge is required before the completed form is sent to the

Dosimetry Program Office.

The form is then reviewed by the DPM for accuracy, legibility, and completeness.

2. If the Request is Denied
   If any information on the form is illegible, incomplete, or if it was submitted on an obsolete version of RP Form 001, it must be returned to the requester with an explanatory note. A blank copy of the current form should be included if needed.

   Note that a permanent mailing address must be provided; Fermilab Village housing addresses are not acceptable.

   Keep the rejected RP Form 001 on file for one additional quarter, especially if the denial is due to incomplete training. The training status can then be checked during the next quarter and the badge assigned if training is successfully completed. Another option is to assign the badge and assure that the training is checked before badge distribution for the following quarter. Retain the requester's dosimetry badge if training still has not been completed.

3. If the Request is Approved
   First, the DPM or EDP Administrative Support Assistant should complete the "Dosimetry Program Office Use" section on the back of RP Form 001. The Radiological Control Technicians (RCTs) may offer advice on the proper series code/subaccount for a particular individual.

   Note that Social Security Numbers are no longer used for identification purposes in the EDP. Fermilab assigns two identification numbers to all individuals with laboratory ID badges, a five-digit-plus-one-letter ID number that appears on the ID badge, and a six-digit "CNAS" number (called the "Unique ID Number" on RP Form 001), which can be found online in the laboratory's Workday system. Both of these numbers will be used in the process of assigning a permanent-service dosimetry badge.

   Next, search the dosimetry program database to see if the person was ever previously on permanent badge service. If so, verify the participant number (called "Control #" in the dosimetry database system). In some cases, a participant number may need to be reassigned. A person should be assigned their Fermilab ID as their participant number in the appropriate account.

Using the vendor's online database, assign a badge to this person in the appropriate account. Currently, this online database is MyLDR from Landauer, which the DPM can access. Detailed instructions for adding new permanent badge holders to MyLDR can be found in a How-To guide [7] stored in the ES&H Section Document Database (DocDB).

The Backup DPM and the EDP Administrative Support Assistant should also have MyLDR accounts. New accounts can be obtained by contacting Fermilab's Landauer representative at midwest@landauer.com. Complete reference material and instructions for using MyLDR is available by clicking on the "Training/Help" link once the user has logged in to MyLDR.

The setup checklist on the back of RP Form 001 should be followed to complete the addition of the new badge requester. These steps include adding them to the dosimetry program's FileMaker Pro database (see Dosimetry Program Procedure FNAL-DP-07), creating name tags for the appropriate rack, sending them a copy of RP Form 006 [8] (see Attachment C), making a new exposure history file folder for them (with the original copy of RP Form 001 in it), and entering the user in the dosimetry_users Listserv database. If the requester is female, a copy is also sent of RP Form 013 [9] (see Attachment D), which contains information on prenatal exposures. (Note that it is the responsibility of the assigned RSO to evaluate the radiological conditions of the work areas of declared pregnant workers.)

Most of these tasks are usually handled by the EDP Administrative Support Assistant; however, the DPM will send an Occupational Exposure History form (RP Form 002) [10] should one be required. See Dosimetry Program Procedure FNAL-DP-10 for additional information. A copy of RP Form 002 is available as Attachment E.

The final step before sending the trunks to the vendor for badge loading is the rack check. As new permanent-service badge holders are added and others are removed, the racks must be adjusted to match the dosimetry database. This final rack check ensures that the badge racks match what is in the database, ensuring that the vendor will not have any problems loading the badges on the racks.

Distributing Permanent-Service Dosimetry Badges

The vendor loads the badges in the appropriate location on the badge racks and returns the trunks to Fermilab by an agreed-upon date. At this point, the DPM and/or the EDP

Administrative Support Assistant conduct a physical inspection (aka "rack check") to ensure all of the badges are present and in their proper places on the racks. Prior to the beginning wear date of the next quarter, ES&H Section personnel distribute the badge racks to designated locations around the laboratory; see Dosimetry Program Procedure FNAL-DP-07 for more details.

Some permanently assigned dosimeters are mailed to specific locations, for example the badges assigned to personnel at the Radiation Physics Calibration Facility. These badges are mailed through the laboratory mail system around the same time that the racks are being distributed, ensuring their delivery prior to the start of the next quarter. The Dosimetry Program FileMaker Pro database indicates which badges these are.

Collecting Permanent-Service Dosimetry Badges

Near the end of each quarter, the DPM uses the dosimetry database system to send an email message reminding everyone on permanent service that the end of quarter is approaching. The badge wearers are expected to place their previous quarter dosimetry badge on the appropriate badge rack, and then retrieve their next quarter's badge from its rack. One to two weeks into the new quarter, the previous quarter's racks are collected by ES&H personnel and returned to the Dosimetry Program Office. For badges that were mailed to a specific location, the contact person at that location is responsible for collecting all the previous quarter's badges and mailing them back to the Dosimetry Program Office in a timely manner.

The badges are scanned in as soon as possible, after which an absent badge list can be generated by the dosimetry database system. Email messages are sent to each person on this list (and their supervisor, if desired) reminding them again to turn in their badge. The RSOs and RCTs can also assist with absent badge retrieval. After approximately another week, the badges are removed from the racks and sent back to the vendor for processing. See Dosimetry Program Procedure FNAL-DP-08 for more information.

Dosimetry badges may also be mailed directly to the Dosimetry Program Office at MS 119 when a quarter is over or the badge is no longer needed. Alternatively, badges may be placed in the dosimetry badge drop box located on the ground floor of Wilson Hall. This box is checked regularly for badges throughout the quarter by ES&H Section personnel.

Also, should the need arise for immediate processing at any time during a quarter, badges may be brought directly to the ES&H Section on the 7th floor of Wilson Hall.

Permanent-Service Extremity Dosimeters

There are a number of individuals that are also assigned a permanent-service extremity dosimeter. These individuals routinely handle sealed radioactive sources or other radioactive

materials, and thus it is expected that they will receive a measurable radiation dose to the hand. Saturn Ring badges are assigned using the vendor's database system, just like the whole body dosimeters.

Each quarter, the DPM and the EDP Administrative Support Assistant are responsible for ensuring that each badge holder's Saturn Ring dosimeter is placed on the proper badge rack or mailed to the correct location.

Note that the ring badges in the BCS subaccount of the 151630 account are part of the blind audit program.

Returning Permanent-Service Dosimetry Badges to the Vendor for Processing

Approximately three weeks after the end of the quarter, when the majority of the badges have been collected, the badges need to be returned to the vendor for processing. The badges are returned to the vendor in bulk (not on the racks) and are transported to the vendor by the Fermilab Shipping and Receiving Department on an "exclusive trip" with no stops along the way. A Material Move Request (MMR) form is needed to ship the boxes of dosimeters.

At least one control dosimeter from each account must be included in each package of dosimeters being returned to the vendor. These control dosimeters will be used for background subtraction.

As absent badges are recovered, they are periodically sent to the vendor via FedEx, along with the appropriate control dosimeters. All packages must be clearly marked "Do Not X-Ray."

Due to the short distance and shipment duration, no significant transit dose is expected.

Fetal Monitoring Dosimeters

When a female worker declares her pregnancy in writing by signing RP Form 086 (Radiation Exposure Evaluation for Declared Pregnant Workers) [11] or by some other method, she is classified as a declared pregnant worker, and the dose limit of 500 mrem to the fetus for the entire gestation period applies. See Attachment F for copy of this form.

Fermilab has established a policy and appropriate procedures to allow a female radiological worker to make a knowledgeable decision regarding the risk to her unborn child. Members of the Radiological Control Organization and the Medical Department will make themselves available to answer questions and address concerns regarding prenatal radiation exposure raised by any radiological worker.

RP Form 086 outlines the options that are available for a declared pregnant worker. If she chooses to continue working the same job assignment, it is the responsibility of the assigned

RSO to evaluate the radiological conditions, estimate the radiation exposure to the fetus for the duration of the pregnancy, and impose any required restrictions.

The worker may opt to wear a fetal dosimeter, which will be exchanged on a monthly basis. The RSO will indicate this on RP Form 086.

When the evaluation is complete, the RSO will send the form to the Dosimetry Program Office for DPM concurrence with the evaluation and estimated dose. If the DPM has questions or concerns, the RSO will be contacted immediately. If the DPM agrees with the evaluation, the DPM signs the form and sends a copy to the Medical Office. Copies of all documentation will be filed in the worker's dosimetry file.

Temporary Dosimetry Badges [FNAL-DP-06]

Most radiological workers at Fermilab are on permanent dosimetry service, which means that they automatically receive a new dosimeter at the beginning of each quarter; however, there are circumstances where someone who is not a part of this program requires a dosimeter. This includes visiting scientists, subcontractors, or an employee that only occasionally needs a dosimeter. These people will be issued a temporary, or spare, dosimeter to use for all or part of the current quarter. For the convenience of the badge requester, several employees in various Divisions/Sections have been given training that enables them to issue temporary badges; these employees are referred to as Temporary Dosimetry Badge Issuers.

Temporary dosimetry badges are received from the vendor in account 75903; the participant numbers on these badges are sequential and are not reused.

At least three control dosimeters for each badge type in the 75903 account are included with every shipment from the vendor. These control dosimeters are used for background subtraction and accompany the field dosimeters in transit to and from the vendor. During the quarter the control dosimeters are stored on the 7th floor of Wilson Hall, a low-background-radiation area. The low background in this area is verified quarterly using designated area monitors from the 75902 account.

Distributing Temporary Badges

Temporary badges are primarily distributed to individuals from the Security Operations Center (SOC), formerly known as the Communications Center, while others are available from designated dosimetry contacts at select locations. The RSOs also have a number of temporary badges available to issue to members of tour groups that will be escorted into Radiation Areas. All of these temporary badges are exchanged quarterly.

Each quarter, the EDP Administrative Support Assistant keeps track of which temporary badges have been sent to each Temporary Dosimetry Badge Issuer and makes this information available to the DPM.

On occasion, a Temporary Dosimetry Badge Issuer may issue all of the badges that were sent to them. Upon being notified that more badges are needed, the EDP Administrative Support Assistant will arrange for another set of badges to be delivered and will update the list of badges sent accordingly.

The remaining dosimeters are stored in the Dosimetry Program Office on the 7th floor of Wilson Hall. The low background radiation in this area is verified quarterly using designated area monitors from the 75902 account.

Training for Temporary Dosimetry Badge Issuers

Temporary Dosimetry Badge Issuers are trained to primarily use the Temporary Dosimetry Badge Request Form webpage to issue badges, and to use the printed information cards as a backup should there be a problem with the webpage.

Temporary Dosimetry Badge Issuers are required to maintain current training in FN000428/CR, Issuing Temporary Dosimetry Badges. Should this training expire, formerly trained individuals will automatically lose access to the Temporary Dosimetry Badge Request Form webpage. Training records for those who are currently trained to issue temporary dosimeters can be found in the External Dosimetry Technical Basis Manual.

The DPM and Backup DPM are Authorized Instructors for the Issuing Temporary Dosimetry Badges training, as are the Deputy Security Chief and the Security Operations Center Group Leader, who are included as they are responsible for the training of SOC personnel.

Training materials for FN000428/CR are developed and maintained by the DPM and are located in the ES&H Section DocDB [12].

Issuing Temporary Dosimetry Badges

When someone requests a temporary dosimeter for the first time, they will need to have already input certain information into Fermilab's computer system, including their permanent address. If they have not yet done this, they can do so from their computer or from one of the computers in the email center on the ground floor of Wilson Hall, where instructions are located next to each terminal.

Temporary badges are intended for use by those individuals not currently on permanent badge service. The use of temporary badges by individuals on permanent badge service is strongly

discouraged. Individuals requiring dosimetry service for more than six consecutive months are encouraged to apply for permanent badge service.

A dosimetry badge cannot be issued unless all of the required information is obtained, and the required training is current. Anyone requesting a temporary dosimetry badge whose Fermilab ID badge is expired will be automatically rejected by the Temporary Dosimetry Badge Request Form webpage and instructed to get their ID badge renewed. Anyone requesting a badge who is under the age of 18 will be similarly rejected and will be instructed to contact an RSO. The DPM has the ability to override these rejections but may only do so in accordance with FRCM guidelines (e.g., Senior Radiation Safety Officer (SRSO) approval is required for minors to receive dosimetry badges).

At times, it may be necessary for someone to request a temporary badge shortly after completing the required training courses. If this is the case, the Radiological Worker Practical Factors instructor or an RSO may give the badge requester a signed orange approval card (see Figure 4), which can be presented to the Temporary Dosimetry Badge Issuers when requesting the dosimetry badge.

Individuals who need a temporary dosimeter but who will be continuously escorted in radiological areas (and who thus would require a waiver for the training) should contact an RSO. This same orange approval card can be signed by the RSO and be used to indicate that the training has been waived.

FERMILAB DOSIMETRY BADGE APPROVAL CARD

The Radiological Worker Training Requirement for:

Individual's Name: _____ **Fermilab ID:** _____
(Print Name)

☐ **HAS BEEN MET** [Rad Worker Classroom: _____ Practical Factors: _____]
(Training Date) (Training Date)

☐ **IS WAIVED BY THE ASSIGNED RSO/CLASS INSTRUCTOR**

RSO/Class Instructor Printed Name: _____

RSO/Class Instructor Signature: _____ **Date:** _____

Figure 4: Temporary Dosimetry Badge Approval Card

Collecting Temporary Dosimetry Badges
Temporary dosimetry badges are issued for an entire quarter. It is the badge holder's responsibility to ensure that their badge is returned before they permanently leave the site or at the end of the quarter, whichever comes first. To assist in the prompt return of these badges, near the end of each quarter, the DPM uses the dosimetry database system to send an email message reminding everyone who received a temporary badge that quarter that the end of quarter is approaching.

Badges can be mailed to the Dosimetry Program Office at MS 119, placed in the drop box on the ground floor of Wilson Hall, or attached to a badge rack at their work location. Should the need arise for immediate processing at any time during a quarter, badges may be brought directly to the ES&H Section on the 7th floor of Wilson Hall.

Temporary Extremity Dosimeters
The Dosimetry Program Office maintains an inventory of extremity (ring) dosimeters to be issued to personnel in the event that they are assigned jobs during the quarter where it is expected that they will receive a measurable radiation dose to the hand, such as when handling radioactive materials for extended periods of time.

Like the temporary whole body dosimetry badges, temporary extremity badges can be assigned using the Temporary Dosimetry Badge Request Form webpage; however, the DPM should be directly involved in the issuing of any temporary extremity dosimeters.

Updating the Vendor Database
When the Temporary Dosimetry Badge Request Form webpage is used to issue a badge, the Fermilab dosimetry database system is automatically updated with the relevant data. In circumstances where the information card was used instead, the DPM or an RSO will have to manually enter the data from the card into the system. Care must be taken to match the badge holder to a previous entry in the database should one exist; this is particularly true for so-called "true visitors," who lack Fermilab-assigned ID and CNAS numbers and must be matched by other information such as address and birth date.

At the end of the quarter, this temporary badge data (including for any temporary extremity dosimeters that were issued) must be entered into the vendor's database prior to the sending the badges back to the vendor for processing.

Returning Temporary Dosimetry Badges to the Vendor for Processing
Approximately three weeks after the end of the quarter, when the majority of the badges have been collected, the badges need to be returned to the vendor for processing. The badges are returned to the vendor in bulk (not on the racks) and are transported to the vendor by the

Fermilab Shipping and Receiving Department on an "exclusive trip" with no stops along the way. A Material Move Request (MMR) form is needed to ship the boxes of dosimeters.

At least one control dosimeter from account 75903 must be included in each package of temporary dosimeters being returned to the vendor. These control dosimeters will be used for background subtraction.

As absent badges are recovered, they are periodically sent to the vendor via FedEx, along with the appropriate control dosimeters. All packages must be clearly marked "Do Not X-Ray."

Due to the short distance and shipment duration, no significant transit dose is expected.

Badge Rack Shipping, Receiving, Distribution, and Packing List Data [FNAL-DP-07]

The setup and maintenance of the dosimetry badge racks is a key aspect of the EDP's quality assurance processes, as it serves to ensure that all permanent-service dosimeters are accounted for. This procedure covers how the dosimeters are distributed to the badge wearers. All activities involving dosimeter handling, in addition to dosimeter storage, take place in the Dosimetry Program Office on the 7th floor of Wilson Hall.

Responsibilities

The Dosimetry Program Manager is responsible for the physical maintenance of the badge racks and their shipping trunks, the implementation of all change requests for permanent badge service, the arrangement for shipment of trunks to the vendor, and the site-wide distribution of the badges. The EDP Administrative Support Assistant assists with many of these items.

Once the badge racks have been distributed throughout the laboratory (see FNAL-DP-05), the assigned RSO is responsible for maintaining the integrity of the racks and the area around them. The dosimetry program contacts and assigned RSOs are also responsible for informing the Dosimetry Program Office of any needed changes (rack relocations, name changes, employment status changes, deactivations, additions, etc.) to the badge racks. This notification can be verbal, but written records of requests are preferred.

The Dosimetry Program Manager establishes a deadline every quarter after which no change requests will be processed until the following quarter.

Physical Maintenance

The dosimeter racks and trunks are subject to wear and tear. Spare racks and trunks are available in the Dosimetry Program Office if needed. Copies of the design drawings for the trunks and racks are maintained for reference.

When working with a trunk, assess the overall trunk integrity and note any problems with the hinges, handles, or casters. A few tools and supplies for minor repairs are available in the Dosimetry Program Office. Arrange for any needed major repairs with the onsite Carpenter Shop. Repairs should be scheduled for the period of time during the quarter when the trunks would normally be stored unused in the Dosimetry Program Office.

When working with a rack, make sure the handle and all mounting strips are secure. If tightening the screws does not work to secure a loose attachment, replace the rack with a spare.

Adding or Removing a Rack from Service

Before setting up a new rack location, work with the assigned RSO to verify that the rack would be located in an accessible area with low background radiation.

To place a rack into service:

1. Assign the rack to a particular trunk.

2. Verify that the name and identification code on the rack matches what appears on the site distribution list and in the FileMaker Pro database.

3. Create a new rack monitor for the rack in the vendor database. Add this to the FileMaker Pro database.

4. Arrange the rack's nametags first by account number and then alphabetically.

5. Add the new rack location to the site distribution list.

When completely removing a rack from service, remove all the nametags and other identifying markers, including the rack name and identification code. This will make it easier should the rack later be placed back into service. Deactivate the Rack Monitor badge in the vendor database and delete the rack's entry from the site distribution list.

Making the Quarterly Dosimetry Changes

The Dosimetry Program Office relies on FileMaker Pro for maintaining the dosimetry database. The FileMaker Pro database file is located on the ES&H server. All processed change requests are also recorded on the hard copy alphabetical listing of the FileMaker Pro database.

1. Quarterly changes should be done far enough in advance to allow the vendor time to generate the badges and place them on the rack. Making these changes no less than five

weeks before the beginning of the next quarter is recommended. The vendor's manufacture date for each quarter can be found in their online database system.

2. Create new nametags to reflect the changes being made. A duplicate set needs to be made and retained for use with the set of racks that is currently in the field.

3. Print out a copy of the badge racks listing from FileMaker Pro for use in setting up the racks. The listing should be sorted first by account number and then alphabetically.

4. Using these rack listings, update the badge racks to reflect all changes, additions, and removals that have been requested. This is referred to as the "rack check."

5. Update the dosimetry_users Listserv database, adding and removing users as needed.

6. A printed copy of the badge rack listing from FileMaker Pro should be put into the dosimetry supporting documentation binder. Copies of the previous versions should be retained for at least two quarters for reference.

Transportation of Badge Racks to and from the Vendor

1. The anticipated dates for badge rack arrival at the vendor and their subsequent return to Fermilab should be decided at the beginning of each year by the Dosimetry Program Manager in conjunction with the vendor.

2. Once all quarterly changes have been made to the racks, print out an alphabetical and a box/rack listing from the FileMaker Pro database for reference. These will list all individuals on permanent badge service for the quarter.

3. Export a copy of the FileMaker Pro database data and send it to the vendor. Inform them that all changes have been made for the upcoming quarter, and that the badges can be released.

4. Attach the lids to the trunks. Note any problems for future maintenance.

5. Complete a Material Move Request (MMR) form for the transportation of the trunks to the vendor.

6. It is recommended to allow the vendor approximately one month for badge preparation and rack loading. Also, allow the Dosimetry Program Office a week for inspection of the loaded racks upon their return before they can be distributed (see below).

7. The vendor uses a courier to ship the trunks to Fermilab each quarter. No other stops are made en route, and the delivery vehicle carries no other items besides the dosimeter trunks and boxes. Due to the short distance and shipment duration, no significant transit dose is expected. At least one member of the dosimetry program staff is required to meet the courier, sign for the delivery, and transport the dosimeters to the Dosimetry Program Office.

Distribution of Dosimetry Badges

Once the badges have arrived from the vendor, the racks must be inspected. Make sure all badges are present and properly secured on each rack. Note any change requests that were not properly implemented by the vendor and correct them immediately if possible. Otherwise, retain a record of the error so that it can be corrected next quarter.

After this physical inspection of the racks, the ES&H Section personnel assigned to distribute them can place them in their field locations. Generally, the rack delivery is scheduled to be a few days prior to the beginning of the next quarterly wear period. These wear periods begin on January 1st, April 1st, July 1st, and October 1st.

Some dosimeters are not included in the rack distribution process and are instead mailed to specific locations. These badges are mailed through the laboratory mail system around the same time that the racks are being distributed, ensuring their delivery prior to the start of the next quarter. The FileMaker Pro database indicates which badges these are. The recipients of these badges are responsible for ensuring that all of the previous quarter's badges are returned in a timely fashion.

An RCT is assigned by the Radiation Physics Operations (RPO) Department Head to be responsible for all quarterly area monitoring badges. The appropriate area monitoring badges from accounts 75902 and 180899 are mailed to this RCT, who will place them in selected locations throughout the Accelerator Division and Particle Physics Division areas. At times, there may be special requests for monthly area monitors. Extra area monitoring badges from the 75902 account are kept in the Dosimetry Program Office on the 7th floor of Wilson Hall, a known low-background-radiation area. The low background in this area is verified quarterly using designated area monitors from the 75902 account.

Distribution of temporary dosimetry badges in the 75903 account is addressed in FNAL-DP-06.

Loading Dosimetry Badge Data

Once the new badges for the upcoming quarter have been received from the vendor, the hard copy alphabetical packing list on file is exchanged with the new packing list. This paper copy is retained for reference.

Electronic versions of the packing lists are available on the vendor's online database. This data must be loaded into Fermilab's dosimetry database system for its various features to function.

To load the packing list data:

1. Export the packing list text files for the 75901, 75903, 151629, and 151630 accounts from the vendor's online database.

2. Open each file, delete the lines containing data about the control dosimeters, and resave them with the following filenames:
   - 75901RSL.PKL
   - 75903RSL.PKL
   - 151629RSL.PKL
   - 151630RSL.PKL

3. Open the shared folder \\eshserver1\eshdrop\prd\tld\.

4. Create a new subfolder and name it for the upcoming year and quarter, e.g. "2018Q3."

5. Move the four files from Step 2 into this new folder.

6. Use the Load Quarterly Dosimetry Badge Packing List Data webpage to load the data.

7. An automatic email notification will be sent to confirm that the packing list has been loaded.

Absent/Lost Dosimetry Badges [FNAL-DP-08]

Fermilab's goal is to maintain accurate, complete records of occupational radiation exposures for each person monitored. In an effort to recover absent badges, and thus eliminate gaps that could occur in the records due to lost badges, this procedure will outline the steps involved in determining which badges are missing.

Dosimetry badges are considered to be lost if they are not received by the Dosimetry Program Office within 45 days after the end of a quarter. If a badge has been declared lost, an exposure investigation must be performed; see Dosimetry Program procedure FNAL-DP-09.

Responsibilities
It is the responsibility of the Dosimetry Program Manager to generate an initial absent badge list using the dosimetry program database application. This should be done as soon as possible after the racks have been collected, as the goal will be to maximize the number of badges returned for processing in the first shipment to the vendor. The EDP Administrative Support Assistant may assist with this process.

Generating Fermilab's Absent Badge List
First, use the Dosimetry Badge Database Check-In page to scan the QR code or manually enter the bar code number of each returned badge (see the Inventory System section of this manual). The dosimetry program database application system can then be used to generate an email message to each person on the absent badge list reminding them to return their dosimeter for processing. The same application can be used to generate a spreadsheet with the absent badge data. This spreadsheet can be shared with various personnel who can be of assistance in retrieving absent badges, such as the EDP Administrative Support Assistant, the RSOs, the RCTs, and any relevant dosimetry contacts.

As absent badges are recovered, they should be checked in, and the absent badge list updated. Further reminder emails may be sent, including to the supervisors of the absent badge holders.

In instances where a badge cannot be located, an Exposure Investigation Report is required, as outlined in the FRCM. Refer to Dosimetry Program procedure FNAL-DP-09 for additional information.

The Vendor's Unreturned Dosimeter List
A list of unreturned dosimeters in each account is available from the vendor's online database approximately five days after the arrival of the badges at the vendor. This list should be verified against the Fermilab absent badge list to check for any discrepancies, such as a badge that might have been missed during the scanning process at Fermilab, but which arrived at the vendor. Any discrepancies between these two lists must be understood.

The vendor's online system does allow for badges to be marked as checked in, but this feature should not be used. Instead, comparing the two independent absent badge lists provides a useful quality assurance check.

Exposure Investigations [FNAL-DP-09]

This procedure outlines the responsibilities of the Dosimetry Program Office with regard to exposure investigations. All exposure investigations should be documented on the Exposure Investigation Report form (RP Form 003) [13]. A copy of this form and its accompanying instructions can be found in Attachment G.

Initiating an Exposure Investigation

Fermilab is required to monitor the occupational radiation exposures of personnel and to maintain accurate, complete records of occupational radiation exposures for each individual monitored. Generally, this is accomplished through regular reporting from the dosimetry vendor. However, in certain situations, the vendor's dosimetry reports may be inadequate or incomplete, and an exposure investigation (EI) may be required.

The FRCM outlines the circumstances under which an exposure investigation should be initiated. To summarize here, an exposure investigation should be performed whenever there is a gap in the monitoring data available due to loss or damage of a dosimeter, or there is uncertainty about the reported dose received by the individual.

Quarterly EI Meetings

In some instances, an EI may be automatically triggered due to a lost badge, a neutron exposure, etc. In other cases, the Dosimetry Program Manager may request an exposure investigation. However, it is always the responsibility of the assigned RSO or RCT to complete an EI report. The Dosimetry Program Manager should hold a quarterly meeting with the RSOs and RCTs during which the list of new and outstanding EIs is reviewed, and the appropriate RSO or RCT is assigned to each EI.

Neutron Exposures

Due to various administrative and engineering controls, neutron exposures at Fermilab are extremely rare. However, in the event of a confirmed neutron exposure, an exposure investigation will automatically be initiated. This EI will take into account the characteristic neutron fields around the accelerator complex, as it is possible that personnel can be exposed to neutron fields of a wide range of energies. (Note that Landauer's InLight Model 2T dosimeter contains a CR-39 element with an energy response range of approximately 0.25 eV to 40 MeV and a dose range of 10 mrem to 25 rem.) Machine logs and instrumentation data can provide a beam profile for a given point and time, as well as a record of any beam losses.

Since neutron exposures are extremely unlikely, Fermilab has chosen not to routinely use neutron field correction factors. However, in the event of a measured neutron dose, and taking

into account the actual observed neutron fields, Fermilab does reserve the right to make any additional adjustments that are appropriate to the exposed individual's dose record.

EI Tracking
A FileMaker Pro database called "EI_Tracking" has been established on the ES&H server to track the assignment and completion of exposure investigations. Once it has been determined that an EI should be performed, it must be tracked to completion. However, in cases where the necessary information cannot be obtained (e.g., when the badge wearer is unable to be contacted), the Dosimetry Program Manager has the authority to terminate an exposure investigation. This termination should be documented on the EI form and included in the individual's file.

Technical Review
Upon receiving a completed EI report (RP Form 003), the Dosimetry Program Manager is responsible for reviewing the document for technical accuracy and completeness. An exposure investigation is considered complete when all signatures have been obtained. Note that subtractions to an individual's dose record require the signature of the SRSO.

If the report appears to be missing any information, is illegible, or does not sufficiently document and justify the dose assessment, the Dosimetry Program Manager will return the EI to the investigator and include the reasons as to why it was not approved in writing. These deficiencies must be corrected and the EI resubmitted while adhering to the established deadlines.

Dose Adjustments
After the technical review has been completed and the Dosimetry Program Manager has approved the EI, any dose adjustments must be made in the vendor's database and also recorded in a way that they can be accounted for in the calculation of the laboratory's collective Total Effective Dose (TED). As a DOE prime contractor, Fermilab has the authority to make these dose adjustments; notification to the State of Illinois is not required.

Even if no adjustment is necessary, the EI form and supporting documentation must still be sent to the Dosimetry Office and filed with the individual's exposure history.

For both additions (including the assignment of "SL," a value below the selected reporting limit of 10 mrem) and subtractions:

1. Send a memo to the vendor documenting the basis for the addition/subtraction including name, account number, and wear period information so that the change can accurately be made. These memos are kept on file in the Dosimetry Program Office.

2. Upon receipt of this memo, the vendor will make the appropriate adjustments to the individual's exposure history. The vendor will then send an updated dose report indicating this change.

3. The DPM should officially review the dose report to confirm that the change was made accurately. File the approved report with the other reports from that quarter. Also, indicate that the change was made on the dose adjustment memo.

4. Update the quarterly TED data to reflect any additions or subtractions.

Record Keeping
The completed Exposure Investigation form is filed in the individual's dosimetry records folder. If the badge wearer was not on permanent service (and thus lacks a records folder), the completed Exposure Investigation is to be filed alphabetically in the Dosimetry Program Office with the other EIs completed for temporary badges.

Exposure Histories [FNAL-DP-10]

Fermilab is required to maintain occupational exposure histories for all individuals monitored for radiation exposure in accordance with 10 CFR 835. This includes exposures that were received at other facilities.

At times, this information may not be readily available. In these instances, the Dosimetry Program Manager documents that the effort has been made to obtain this information. In addition, the DPM provides exposure information for individuals monitored at Fermilab to other facilities. The DPM will also, upon written request, provide this information to the monitored individual.

Some scientific institutions will annually request exposure information for all of their personnel for the previous calendar year.

Incoming Requests

1. It is a goal of the Dosimetry Program Office to respond to all incoming requests within 60 days of receipt.

2. Upon receiving a request for an occupational exposure history from another facility, verify that the employee has granted authorization for the release of their occupational radiation exposure information to the requesting facility. If additional information is

needed, such as employment dates, it may be necessary to contact the requesting facility.

3. Next, determine whether the requested data is for a person who is or was on permanent dosimetry service, was never on permanent service but was issued one or more temporary dosimetry badges, or was never monitored for radiation exposure at Fermilab. See FNAL-DP-16, which describes the records search process.

    a. If the requested data is for a person who was on permanent dosimetry service, obtain that individual's dosimetry file folder, which contains all of their radiation exposure information including copies of annual reports. Prior to 01 July 2010, NRC Form 5 was used for annual reports. Since that date, RP Form 021 has been in use; however, it is still common to hear the annual report be referred to as "Form 5" around the laboratory. A sample copy of RP Form 021 is included as Attachment H.

    b. If the requested data is for a person who was not on permanent dosimetry service, their radiation exposure information may be obtained from the Annual Dose Report application in Fermilab's dosimetry database system or from the dosimetry vendor.

4. Send a memo to the requesting facility that contains a summary of the individual's radiation exposure while working at Fermilab. When relevant, attach a copy of the most recent annual report on file. If the requested data was for a person who was never monitored for radiation exposure at Fermilab, include a statement to that effect in the memo.

5. File the request and a copy of the response in the individual's dosimetry file. If the person was only issued temporary dosimetry badges, the request and response should be filed in the "Miscellaneous Exposure History" file.

Outgoing Requests

The procedure below is to be followed if the Dosimetry Program Office is made aware of the fact that a person has been monitored for radiation exposure while working at another facility. Most often, this information comes from the Permanent Service Request Form (RP Form 001), which asks the requester to indicate whether or not they were ever monitored for occupational radiation exposure at another facility and if so, the facility information and the employment/ monitoring dates.

1. An Occupational Exposure History form (RP Form 002) is sent to the individual by the Dosimetry Program Manager. This form requires the badge wearer's signature to acknowledge that permission has been given for Fermilab to request the radiation exposure information.

2. Once the form has been completed and the badge requester has signed it, the form should be signed by the Dosimetry Program Manager.

3. Make a copy of the form.

4. The original form is mailed to the previous monitoring institution. Note the date that the original was sent on the copy and file the copy in the individual's exposure history folder.

5. If after an appropriate period of time, the Dosimetry Program Office has not received a response, a duplicate request may be sent, with another copy again being placed in the individual's dosimetry file. This process may be repeated again at the discretion of the DPM.

6. If a response is received, the DPM should review the information provided.

    a. If no exposure was received at that facility, file the response in the individual's dosimetry file.

    b. If an exposure was received at that facility, enter this information into the vendor's database, or send a memo to the vendor requesting the additional dose be added to the individual's lifetime dose records. File a copy of this letter along with the response from the facility in the individual's dosimetry file.

       Should a previous internal exposure be noted in the response from the facility, refer to the vendor's reference materials, or contact the vendor, for specific details on how to include this information.

Blind Audit Program [FNAL-DP-11]

The blind audit program, also referred to as "badge spiking," provides a method for in-house evaluation of personnel dosimetry results submitted by the vendor. The program is intended to supplement DOELAP accreditation performance testing.

Dosimetry badges in the BCS subaccount in account 151630 have been designated for use with the blind audit program. All of these dosimeters are identical to the field dosimeters and are assigned data similar to that provided for actual employees so that the vendor is unaware of which badges are part of the blind audit program and the doses delivered to these dosimeters.

The procedure involves irradiating whole body dosimeters on a quarterly basis to known doses of beta, gamma, neutron, and occasionally x radiation. Extremity dosimeters are also exposed to known doses of beta and gamma radiation. These doses are based on the typical dose distributions received by Fermilab personnel in recent quarters.

The blind audit dosimeters are submitted along with the personnel dosimeters for processing on a quarterly basis. The reported results obtained from the vendor are then compared to the delivered doses and are evaluated using the previous DOELAP criteria. Signed copies of the completed blind audit analysis spreadsheets can be found in the External Dosimetry Technical Basis Manual.

Procedure for Performing Blind Audit Irradiations

1. Obtain the badges in the BCS subaccount, which have been reserved for the blind audit program and their associated rack monitor.

2. Contact Radiation Physics Calibration Facility (RPCF) personnel to schedule a date to perform the blind audit irradiations.

3. Design the quarterly test, including calculations of expected dose. A number of sources are available at RPCF, including Cs-137, Cf-252, AmBe, Sr-90, and Am-241. Specific operating procedures for the High Level Calibration Facility (HLCF) and Low Level Calibration Facility (LLCF) can be found at RPCF.

   RPCF personnel provide a spreadsheet for use in calculating desired doses and irradiation times. All sources at RPCF are calibrated on a regular basis, and the spreadsheet is periodically updated with this calibration data to ensure accurate calculation of exposure and irradiation times, taking air kerma at a given distance into account.

4. Record the badge numbers that will receive each of the delivered doses in the blind audit logbook. Include printouts of the relevant RPCF spreadsheet calculations.

5. On the scheduled date, take the badges to the Radiation Physics Calibration Facility and perform the irradiations.

   A 30 cm x 30 cm Poly(methyl methacrylate) (PMMA) phantom is available for use. Align the laser with the center mark on the phantom. For beta and gamma doses, the badges should be positioned on the face of the phantom, so that the face of the dosimeter is at the zero-position mark on the table. The zero-position mark corresponds to the distance to the source in free air.

   When using the phantom, it will be necessary to remove the clip on the back of the dosimeter, so that the dosimeters sit flush with the phantom. Dosimeter positions for a maximum of 12 dosimeters are indicated on the phantom. Since CR-39 is not an albedo dosimeter, the phantom is not necessary for use during neutron irradiations; the "free air" badge holder should be used instead.

   Additionally, a PMMA rod is available for use with the extremity dosimeters. Place the rod in the ring stand, then place each ring badge onto the rod, ensuring that the face of the ring is facing the radioactive source, and that it is at the zero-position mark on the table. The laser should be used to center the rings on the PMMA rod.

6. When finished, collect all the badges used in the blind audit program, including the rack monitor, and return them to the vendor with the field dosimeters.

7. Compare the delivered doses to the reported doses and record all results in the blind audit analysis spreadsheet. Include a copy of the report from the vendor in the logbook so that the reported doses can be verified.

8. After a thorough review of the reported results, sign and date the spreadsheet and file it in the External Dosimetry Technical Basis Manual. The previous DOELAP criteria are used to determine if the results are considered acceptable (see the Performance Criteria and Evaluation section below).

Blind Audit Documentation

All data and calculations will be recorded in the designated logbooks and analysis spreadsheets and must include the following:

- Date(s) of irradiation.
- Dosimeter wear period.

- Source ID numbers.
- Test description and any additional information used in calculating the delivered dose.
- Portable integrating dosimeter instrument model, number, and measurements (when used).
- Delivered dose and reported results for each badge, and the associated statistical analysis.
- Any actions taken to resolve discrepancies between the expected and observed results.

Performance Criteria and Evaluation
In order to have a criterion against which to measure the vendor's performance in the blind audit tests, Fermilab has continued to use the criterion previously specified by DOELAP. This is undertaken with the understanding of both Fermilab and the vendor that such blind tests do not constitute a valid DOELAP performance test. The DOELAP test criterion used is:

$$\mathbf{B + S \leq L}$$

where *B* is the bias, *S* is the standard deviation of the performance quotients, and *L* is 0.30 for beta/gamma/neutron radiation, and 0.124 for extremity doses. A spreadsheet has been developed to easily calculate this criterion.

Significant deviations from the performance criterion should be followed up on, and if necessary, brought to the vendor's attention. Notable trends in the performance of the vendor are raised during the periodic meetings/discussions/assessments with the vendor and, if necessary, appropriate corrective actions are taken and documented.

It should be noted that the current criterion that is used for DOELAP performance testing is:

$$\mathbf{B^2 + S^2 \leq L^2}$$

Radiation Dose Reporting and Report Distribution [FNAL-DP-12]

Another key aspect of the EDP at Fermilab involves dose reporting and record keeping. The FRCM outlines the specific documentation requirements for the dosimetry program; the following instructions provide guidance to ensure proper implementation of those requirements.

Responsibilities
It is the responsibility of the DPM to ensure that dosimetry data is made available to the RSOs in a timely manner and also to satisfy the annual reporting requirements of 10 CFR 835.

Once the report data has been provided to the RSOs, they are responsible for reviewing the data to ensure that the reported results are reasonable and that unnecessary or unexpectedly high doses are not being received. They are also responsible for making this information available to individuals in their assigned areas, should someone inquire about their dose. This information is also available through the Dosimetry Program Office, although a written request will be necessary.

Quarterly Dosimetry Badge Results

Within 30 days of receipt of dosimeters, the vendor is required to provide copies of the dose results. One version, the Dosimetry Program Office file copy, can be identified by the presence of the individuals assigned unique ID number and birth date. A second version is sent that omits this information in case a copy of a report is requested by an RSO or RCT.

The reports are also required to be in the appropriate format and contain the required information in accordance with 10 CFR 835 and DOELAP. Dose data may also be obtained in an electronic format from the vendor's online database.

1. The Dosimetry Program Manager is responsible for reviewing the exposure reports and will confirm that they have reviewed the information. This is done by initials and date or another suitable method.

2. Upon receipt of the exposure reports, the Dosimetry Program Manager reviews the data to ensure technical accuracy. Unusual exposures, missing data, abnormally large exposures, etc. are noted.

3. Individuals identified as having unusual or unexpected exposures should be placed on the exposure investigation tracking list and the assigned RSO notified. These exposures are examined on a case-by-case basis with knowledge of the radiological conditions under which the individual was working and the type of work that was performed. See FNAL-DP-09 for more information on EIs.

4. For instances in which a dosimeter could not be processed, an exposure investigation must be completed.

5. If there are significant problems with the reported results, the vendor should be contacted immediately.

6. If the reports are considered to be accurate, the DPM will make the data available to the RSOs for review of results for individuals in their assigned areas.

7. Because of the importance of getting this information to the RSOs, it is imperative that the review process be done in a timely manner. A goal should be to have the RSOs receive the dose reports within a week of receipt from the vendor, barring any significant problems with the reported results.

8. The Dosimetry Program Office copies are filed in binders provided by the vendor with the corresponding account and wear period recorded on the spine and front cover.

Collective Total Effective Dose (TED)

The combined total of all laboratory personnel's radiation doses is one way that management assesses laboratory performance and the effectiveness of the As Low As Reasonably Achievable (ALARA) program. This collective Total Effective Dose (TED) is the sum total of the effective dose results for all individuals monitored for radiation exposures and is reported in units of person-rem. This data is tracked by calendar and fiscal year and is updated periodically by the DPM as additional dose information becomes available. This information is provided to interested parties via the ES&H Section DocDB [14][15] and the FermiDash webpage.

Another use for the collective TED received by all personnel at Fermilab is to normalize it to the number of 8 GeV protons delivered by the Booster. This parameter remains a reasonable one to track because the denominator includes all protons used in the Fermilab high energy physics research program--in effect, the "product" of the Laboratory's accelerator operations, while the numerator represents the "cost" of this "product" in terms of radiation dose. This calculation is performed annually by the DPM and is available on the ES&H Section DocDB [16].

Annual Reports

10 CFR 835 requires that the Dosimetry Program Office provide an annual report to each individual monitored for radiation exposure. Once the annual data is provided by the vendor, most of these reports are sent electronically via the Annual Dose Report application, and a hard copy is maintained in each individual's dosimetry file.

A notification is sent to the DPM for any annual report that is unable to be delivered electronically. For these individuals, home mailing address labels are generated, and a printed copy of the annual report is sent by mail. Mailings that are unable to be delivered are returned and kept on file in the Dosimetry Program Office to document the attempt.

The DPM is also responsible for ensuring that the annual dose data is properly formatted and submitted to the DOE prior to the deadline (usually March 31st of each year).

ALERT List [FNAL-DP-13]

The administrative goals for dose limits at Fermilab are described in detail in the FRCM. The Laboratory Director has established an administrative goal of 1500 mrem effective dose in a calendar year for occupational radiation exposures. The Fermilab "ALERT List" system has been established to ensure this administrative goal is not inadvertently exceeded. The following procedure supplements the FRCM and provides specific guidance for the Dosimetry Program Office.

Responsibilities

The Dosimetry Program Manager is responsible for informing the assigned RSO when a reported dose result is considered inaccurate or uncharacteristic of the working environment. If the reported dose exceeds the thresholds provided in the FRCM, the assigned RSO is required to thoroughly investigate the dose and document the results on the Exposure Investigation Report (RP Form 003), in compliance with the requirements of the FRCM.

Investigation of Large Doses

1. The dosimetry vendor will notify the Dosimetry Program Office when a dosimeter reading has exceeded 300 mrem.

2. The Dosimetry Program Office will then review these names and/or badge numbers.

    a. If the dosimeters in question are in the BCS subaccount, no further action is necessary. These badges are part of the EDP dosimetry blind audit program (badge spiking) and do not reflect exposures to personnel.

    b. If the dosimeters have been used as area monitors or test badges, no further action is required.

    c. If the dosimeters in question are assigned to personnel and have exceeded 350 mrem, immediately notify the assigned RSO, initiate an exposure investigation, and place the individual on the ALERT List.

i. If the RSO requests a re-read of a dosimeter, the Dosimetry Program Manager will notify the vendor and obtain a second reading of that dosimeter.

ii. If the reported dose result is between 1000 mrem and 1500 mrem, the assigned RSO shall provide the Dosimetry Program Manager with a preliminary EI report within 5 working days.

iii. If the investigation is for a reported whole-body exposure in excess of 1500 mrem, a preliminary written report from the Dosimetry Program Manager, with input from the assigned RSO, shall be given to the Senior Radiation Safety Officer within 24 hours of the initial notification from the vendor. If there is any indication that the exposure may be valid based on this preliminary written report, the DOE Fermi Site Office will be also be notified.

iv. Final reports are to be completed within 30 days of the initial notification.

A. If the conclusions of the exposure investigation indicate that the badge wearer did not receive the entirety of the reported exposure, that part of the equivalent dose may be subtracted from the individual's exposure history.

B. If the exposure investigation confirms the reported dose, the badge wearer will remain on the ALERT List and is subject to the work restrictions described in the FRCM. These restrictions serve to limit further dose to this individual for the remainder of the calendar year.

Documentation

The ALERT List shall be provided to the RSOs on a quarterly basis unless there is no one on the list.

The exposure investigation shall be documented on an Exposure Investigation Report form (RP Form 003) and is subject to the requirements for exposure investigations specified in the FRCM. See FNAL-DP-09 for more details about exposure investigations.

Medical Exposures [FNAL-DP-14]

On occasion, a radiological worker may undergo a medical procedure involving the administration of radioactive materials. Although radiological workers are not required to inform the Medical Department or the Radiological Control Organization, they are highly encouraged to do so.

Consistent with the FRCM, doses from such procedures are not to be included in an individual's occupational radiation exposure history record. In addition, the radioactivity within the body may interfere with radiation surveys of equipment and personnel frisking. For these reasons, reporting such a procedure is encouraged. RP Forms 088 [17] and 091 [18] should be used to document such exposures; see Attachments I and J.

1. A radiological worker who has received a nuclear medicine procedure should inform the Medical Department, the assigned Radiation Safety Officer, and/or the Dosimetry Program Manager. The individual should then be instructed to complete RP Form 088, Medical Procedures Involving Radioactive Material, with guidance from the assigned RSO.

2. After reviewing RP Form 088, the assigned RSO should complete RP Form 091, Area RSO Checklist for Radiological Workers Who Have Had a Nuclear Medicine Procedure.

3. Upon receipt of RP Form 088, the Dosimetry Program Manager should take appropriate steps to ensure that if the individual was issued a dosimeter, then that dosimeter was not worn during or immediately after the procedure. If the dosimeter was worn, it should immediately be sent to the vendor for processing, and an exposure investigation should be initiated.

4. The assigned RSO will have estimated when the affected individual can return to performing radiological work and will monitor the individual accordingly. Depending on the isotope and the activity administered, this could be from two or three days to four or more weeks. The individual's immediate supervisor should be notified of the work restrictions in order to allow a temporary work assignment to be made if necessary.

5. After the predetermined amount of time has elapsed for the necessary radioactive decay to occur, the assigned RSO is expected to verify that the radiation detected is at background levels and to document this on RP Form 091. At this time, the RSO, with input from the employee's supervisor, can allow the employee to resume performance of

radiological work.

6. The completed RP Forms 088 and 091 should be retained in the individual's exposure history file along with any other relevant documentation.

Employee Terminations [FNAL-DP-15]

Fermilab is responsible for ensuring that all laboratory property is returned prior to an employee's departure from the laboratory, and dosimetry badges are considered to be laboratory property. Additionally, the Dosimetry Program Office strives to ensure that all dosimetry badges are returned for processing each quarter. As such, the Dosimetry Program Office must be involved in each individual's termination process. This process is handled through the use of the laboratory's Workday system, which is managed by the Workforce Development and Resources Section (WDRS).

Scheduled Terminations

The Dosimetry Program Manager and the EDP Administrative Support Assistant must be automatically alerted by the laboratory's Workday system whenever an employee termination takes place; this alert is usually delivered by email. (To request these alerts for a new DPM or Administrative Support Assistant, contact the Compensation & HCM Department in WDRS.)

Either the DPM or the EDP Administrative Support Assistant must acknowledge this alert in Workday before the employee's termination can proceed. The information contained these notifications is considered sensitive information and is handled accordingly. The various steps of the following procedure may be completed by either the DPM or the EDP Administrative Support Assistant.

1. After receiving a termination notice from Workday, check the dosimetry database to see if the person is on permanent service or has been issued a temporary badge for the current quarter. Also, check to see if there is a pending or incomplete exposure investigation for the person.

2. If the terminated person did not have a dosimetry badge, simply acknowledge the Workday alert.

3. If the terminated person has a temporary badge, send an email to the assigned RSO asking them to obtain the badge and return it to the Dosimetry Program Office. The Workday alert can be acknowledged.

4. If the terminated person has a permanent badge, print a copy of the termination notice and file it with the other changes for the upcoming quarter. Also, send an email to the assigned RSO asking them to obtain the badge and return it to the Dosimetry Program Office. The Workday alert can be acknowledged.

5. If an exposure investigation is pending or incomplete for the terminated individual, inform them that they are to contact their assigned RSO to complete the exposure investigation before getting clearance to leave the laboratory. Do not acknowledge the Workday alert until the assigned RSO has the information needed to complete the EI, or until the DPM terminated the EI.

Annual Rack Audit

As an additional quality assurance check on the Workday termination notices, the DPM conducts an annual audit of the permanent service badge rack listing. The purpose of this is to discover and remove from permanent service any overlooked badge holders who are no longer at the laboratory.

1. Export or print a copy of the latest badge rack listing from the FileMaker Pro database, sorted alphabetically by last name.

2. Open the dosimetry database Search page. Click on the Name List drop-down box.

3. Starting at the top of the badge rack list, begin typing the last name of each badge holder. The drop-down list will jump to the name being typed. Verify that the badge holder does not have "Terminated" after their name in the Name List box. If they do, make a note of it on the badge rack list. Repeat this for all the names on the badge rack list.

4. Next, compile a list of anyone who was found to have "Terminated" after their name. Review this list and decide which ones should be removed from service. Note that in some cases, visiting scientists and subcontractors may temporarily fall into the "Terminated" category but will be reinstated a short time later. It may be necessary to contact some of the individuals on the list to verify their status.

5. File the list of badge holders that should be removed from permanent service with the other changes for the upcoming quarter (see FNAL-DP-05).

Dosimetry Records Searches [FNAL-DP-16]

This procedure describes the method used to identify current or former dosimetry badge holders and efficiently locate their associated occupational exposure records. The dosimetry vendor is the official repository of Fermilab's dosimetry records; however, copies of nearly all records are retained by the Dosimetry Program Office for convenience. Should any occupational exposure records be unable to be located with this procedure, they may be requested from the vendor.

1. First, conduct a search of Fermilab's dosimetry database system by utilizing its Search application. The dosimetry database contains records dating back to the third quarter of 2002.

   Click on the Name List drop-down box and begin typing the last name of the badge holder. If the name being typed appears in the drop-down list, the list will jump to that name. Click on the Search button.

   a. In the search results, individuals on permanent service will be shown as having been issued dosimetry badges in the 75901, 151629, or 151630 accounts. If this is the case, there will be an occupational exposure history file for this person in the Dosimetry Program Office. The Annual Dose Report application can be used to generate copies of the individual's annual dose records, and the quarterly dosimetry report records for these accounts are available in the Dosimetry Program Office files (see FNAL-DP-12). Additionally, dose records from the previous 2 years can be retrieved from the vendor's online database.

   b. If the results show only dosimeters from the 75903 account, the individual only ever received temporary badges. The Annual Dose Report application can be used to generate copies of the individual's annual dose records, and the quarterly dosimetry report records for this account are available in the Dosimetry Program Office files (see FNAL-DP-12). Additionally, dose records from previous years can be retrieved from the vendor's online database.

   c. If the individual's name does not appear in the list, proceed to Step 2.

2. For individuals who may have been issued a badge prior to 2002 (i.e., anyone born before about 1986), and who thus would not show up in the laboratory's dosimetry database system, a search for that person should be conducted in the dosimetry vendor's

online database.

Currently, that vendor database is Landauer's MyLDR system, which holds the name and other identifying data for every person ever monitored for occupational radiation exposure at Fermilab. Conduct a search for the individual in the 75901, 75903, 151629, and 151630 accounts on MyLDR.

a. In the search results, individuals on permanent service will be found in the 75901, 151629, or 151630 accounts (some individuals may appear in more than one account). If this is the case, there will be an occupational exposure history file for this person in the Dosimetry Program Office. Also, the quarterly dosimetry report records for these accounts are available in the Dosimetry Program Office files (see FNAL-DP-12).

b. If the individual only appears in the 75903 account, they only ever received temporary badges. The quarterly dosimetry report records for this account are available in the Dosimetry Program Office files (see FNAL-DP-12).

c. If the individual's name does not appear in a search of the vendor's database, proceed to Step 3.

3. As a final check, search for an occupational exposure history folder for this individual in the Dosimetry Program Office files. If a folder is found that does not contain the specific dose data requested, conduct a search of the quarterly dosimetry report records.

4. If records for the individual do not appear in the laboratory's dosimetry database, in the vendor's online database, or in the Dosimetry Program Office occupational exposure history files, it is reasonable to presume that this individual was never monitored for radiation exposure at Fermilab.

Non-Destructive Testing [FNAL-DP-17]

This procedure is also known as "component verification." Its purpose is to test whether the dosimeters in each quarterly shipment have been constructed properly.

Each quarter, five randomly chosen dosimeters not assigned to personnel are to be inspected and disassembled by the Dosimetry Program Manager to verify the presence of the OSL

material and the CR-39 element, and that all filters are present and in the correct position. An ongoing listing of each quarter's results is recorded in the ES&H Section DocDB [19].

Should any dosimeters fail this testing, both the vendor and Fermilab's Senior Radiation Safety Officer are to be informed of the deficiency in writing. Copies of all correspondence on the subject shall be kept in the ES&H Section DocDB referenced above.

Although this is a non-destructive test, these dosimeters shall be separated from the rest of the inventory and sent back to the vendor as unused.

Control of Document

The most current version of this manual shall be stored in the ES&H Section DocDB as ESH-doc-6167.

References

1. External Dosimetry Quality Program Manual, M. Vincent, ESH-doc-6164, 17 February 2021

2. Technical Basis for External Dosimetry at Fermilab, S. McGimpsey, Fermilab RP Note 124, July 2018

3. 10 C.F.R. § 835

4. Department of Energy Laboratory Accreditation Program for Personnel Dosimetry DOE-STD-1095-2018, U.S. Department of Energy, October 2018

5. Fermilab Radiological Control Manual, https://eshq.fnal.gov/manuals/frcm/

6. FRCM: RP Form #001 - Permanent Badge Service Request, ESH-doc-1282, November 2020

7. Dosimetry Program How-To: The Dosimetry Program Manager's Guide to Adding New Users to Permanent Service, M. Vincent, ESH-doc-5638, 28 April 2020

8. FRCM: RP Form #006 - Dosimetry Badge Information, ESH-doc-1292, May 2014

9. FRCM: Radiation Exposure to Unborn Children, M. Vincent, ESH-doc-1291, 16 February 2021

10. FRCM: RP Form #002 - Occupational Exposure History, M. Vincent, ESH-doc-1284, August 2019

11. FRCM: RP Form #086 - Radiation Exposure Evaluation for Declared Pregnant Workers, ESH-doc-1321, February 2017

12. Issuing Temporary Dosimetry Badges [FN000428/CR/01], M. Vincent, ESH-doc-3206, May 2020

13. FRCM: RP Form #003 - Exposure Investigation Report, ESH-doc-1260, February 2021

14. Collective Dose Quarter-by-Quarter Spreadsheet, S. McGimpsey and M. Vincent, ESH-doc-1640

15. Collective Dose Graph, S. McGimpsey and M. Vincent, ESH-doc-1641

16. Collective Doses and Normalization to Booster Protons, D. Cossairt and M. Quinn, ESH-doc-3056

17. FRCM: RP Form #088 - Medical Procedures Involving Radioactive Material, ESH-doc-1323, July 2015

18. FRCM: RP Form #091 - Area RSO Checklist for Radiation Workers Who Have Undergone a Nuclear Medicine Procedure, ESH-doc-1325, May 2015

19. External Dosimetry Non-Destructive Testing Records, M. Vincent, ESH-doc-6171

Attachments

A. Exhibit B (July 2018)

EXHIBIT B

RADIATION DOSIMETRY SERVICE AND REPORTING REQUIREMENTS

1.0 GENERAL

1.1 The subcontractor shall supply dosimeters, computer software, reports, and any necessary equipment to support Fermilab's Radiation Dosimetry Program.

1.2 The Fermilab Dosimetry Program Office shall have the ability to make changes (i.e. additions, deactivations) to the list of individuals being supplied with dosimeters. These types of changes will not be sent through the Fermilab Procurement Department.

1.3 An "on-line" system must exist to allow Fermilab to make personnel additions, deactivations, and transfers directly to the subcontractor database. This system shall have the ability to generate a written confirmation of such changes.

1.4 Information concerning individuals monitored for radiation exposure by Fermilab, especially their Social Security numbers and dates of birth, is considered sensitive confidential information by Fermilab and the Department of Energy and governed by the Privacy Act of 1974. None of this information, including dosimetry information, shall be disclosed either officially or unofficially by subcontractor's employees to anyone other than members of the Fermilab Dosimetry Program Office. The subcontractor shall specifically inform its employees of this restriction.

1.5 Meetings shall be held between the subcontractor and Fermilab at a frequency that is mutually convenient to discuss issues related to services being provided by the subcontractor.

1.6 This is an indefinite quantity type subcontract and is effective for the period stated. The quantities of services specified are estimates only and are not necessarily purchased by the subcontract. Fermilab will order at least $5,000.00 (total cumulative) in services for the base year of the subcontract. Accordingly, this does not ensure that a certain number of badges and/or associated items will be ordered, but merely a minimum of $5,000.00 will be ordered during the base year.

2.0 DOSIMETER TYPES AND SERVICES REQUIRED

2.1 General Description

X-ray, Beta, and Gamma detection capabilities (whole body)
Track-etch neutron dosimeter (whole body)
TLD ring badges (extremity monitoring)

On-line database and associated support

Alphabetical packing list for accounts 75901, 151629 and 151630, this includes one hard copy and one electronic copy on a 3.5" diskette or other suitable media

Packing list for account 75903, this includes one hard copy and one electronic copy on a CD or other suitable media

Missing dosimeter summary for permanent and temporary (spare) dosimeters

Emergency processing - three (3) working day turnaround

Load badge racks

Dose reports (as specified below)

2.1.1 Four copies of quarterly dose reports for accounts 75901, 75903, 151629 and 151630. Sorted by account number, then series code, then last name.

2.1.2 Annual electronic summary of equivalent doses and total effective dose for all individuals issued a dosimeter during the previous year. This can be accomplished through a secured server or Website managed by the subcontractor. This data shall be sent via suitable electronic media to be used for the annual report submitted to the DOE. See requirement 6.2.5.

The subcontractor shall maintain permanent exposure histories for all participants in account 75901, 75903, 151629 and 151630.

3.0 CHANGES IN SERVICE

3.1 Fermilab will make all dosimeter changes directly on the subcontractor database using an Internet connection. All necessary software shall be

supplied by the subcontractor and licensed to allow a Fermilab PC or equivalent to perform these functions.

3.2 Previous exposure histories for participants added during the course of this subcontract shall be completed by Fermilab using the subcontractor's database or by written request to the subcontractor.

4.0 SPECIFIC SERVICE REQUIREMENTS

4.1 All dosimeters are to be organized into six master accounts with multiple series codes. Series codes are distinguished by up to three letters and are determined by Fermilab's Dosimetry Program Manger.

4.1.1 Permanent account 75901 will be reserved for Fermilab employees.

4.1.2 Dosimeters in accounts 75902 and 180899 will not be worn by personnel. These dosimeters will be used for test dosimeters, quality assurance or area monitoring.

4.1.3 Account 75903 will be reserved for temporary (spare) dosimetry badges.

4.1.4 Permanent account 151629 will be reserved for non-Fermilab employees such as guest scientists.

4.1.5 Permanent account 151630 will be reserved for subcontract personnel.

4.2 Numbering Scheme

4.2.1 Individuals in Account 75901 shall be permanently numbered according to their Fermilab I.D. number (up to 5 digits).

4.2.2 Dosimeters in Account 75902 and 180899 shall be numbered as determined by Fermilab's Dosimetry Program Manager.

4.2.3 Dosimeters assigned to Account 75903 shall be numbered consecutively with no numbers being reused. The sequence shall be determined from input from Fermilab's Dosimetry Program Manager.

4.2.4 Individuals in Account 151629 will be permanently numbered according to their Fermilab visitor's I.D. number (up to 5 digits).

4.2.5 Individuals assigned to Account 151630 will be permanently numbered according to their Fermilab contractor I.D. number (up

to 5 digits).

4.3 Supply of Badges

4.3.1 A hard copy of the packing list, sorted alphabetically shall be provided with each shipment. An electronic list, on a 3.5" diskette or other suitable media, shall also be provided. The list shall include all participants in Accounts 75901, 151629 and 151630 and shall include each individual's name, badge number, account and series code. If a Social Security number (or other I.D. number), gender, and date of birth have been made available to the subcontractor, that information shall also be included on the master packing list.

4.3.2 All dosimeters in Accounts 75901, 151629 and 151630 shall be loaded by the subcontractor. The OSL beta/gamma detector (with filters) and track etch neutron dosimeter shall fit in a single holder. The dosimeters shall be placed directly onto the labeled badge rack for shipment back to Fermilab. Fermilab shall supply the dosimeter racks and a dosimeter listing for all participants assigned a dosimeter. If the dosimeter has no position on a rack, it shall be shipped in bulk.

4.3.3 Dosimeters for Accounts 75903 (whole body and extremity dosimeters) shall be shipped in bulk, supplied on request and loaded by the subcontractor. The OSL beta/gamma detector (with filters) and track etch neutron dosimeter shall fit in a single holder, which shall alternate colors to differentiate quarters. They shall be numerically sorted and attached to a suitable carrier to prevent random mix. A packing list, hard copy and electronic copy, that contains the dosimeter information for this account, shall be provided. See requirement 4.3.1.

4.3.4 Dosimeters in account 180899 shall be shipped in bulk and on request. The detector elements shall be loaded by the subcontractor, as specified by Fermilab.

4.3.5 The dosimeter label, which shall alternate colors to differentiate quarters, shall clearly indicate the wearer's name (Accounts 75901, 151629 and 151630 only), participant number, series code, and wear period.

4.3.6 All dosimeters in accounts 75901, 75902, 75903, 151629 and 151630 shall clearly display the serial number and corresponding 2-D bar code.

4.3.7 Dosimeters shall be shipped to arrive back at Fermilab at least five (5) working days before the next quarter. Fermilab's Dosimetry Program Manager will contact a Landauer Representative, at the beginning of each year, to specify anticipated dates for dosimeter rack arrival at Landauer and return to Fermilab.

4.3.8 A rack monitor shall be included by the subcontractor for each dosimeter rack. Control dosimeters shall be supplied with each shipment. The following table contains the number of controls that shall be shipped with the primary quarterly shipment. The subcontractor's standard procedures for assigning control dosimeters is appropriate for subsequent shipments during a given quarter.

Account	Total Number of Controls
75901	15
75902	5
75903	20
151629	10
151630	5
180899	5

5.0 PROCESSING REQUIREMENTS

5.1 All dosimeters shall be readout for fast neutrons. If any should not be, a list shall be provided by Fermilab of all series codes of individual dosimeters not to be readout for fast neutrons.

5.2 All dosimeters which have an exposure of greater than 1 rem or a neutron exposure with no accompanying gamma exposure shall be re-read, and examined by a health physicist to have the initial reading verified.

5.3 All participant dose equivalent results shall be calculated using an algorithm designed for compliance with the DOELAP and consistent with the algorithm used during DOELAP performance testing.

5.4 Any changes in the established algorithm used to calculate equivalent doses shall be communicated to Fermilab in writing.

5.5 Fermilab shall have the option of specifying calibration sources. The beta sources that are currently available are (SR/YR, Thallium, Kr-85, and Depleted Uranium slab), and the neutron sources are (Moderated or Unmoderated Californium). These selections can be made at the location

level or specifically for any individual.

5.6 If other calibration sources should be used in the future, these changes will be communicated to the subcontractor by Fermilab in writing.

5.7 All dosimeters shall be processed in accordance with the subcontractors established quality assurance procedures. Any deviations from these procedures that potentially affect Fermilab's dose results shall be communicated in writing, along with the corrective actions that were taken.

6.0 REPORTING REQUIREMENTS

6.1 General

6.1.1 A telephone notification shall be made by the subcontractor to Fermilab's Dosimetry Program Manager immediately upon discovering an indication of a whole body equivalent dose of 300 mrem or greater.

6.1.2 The subcontractor shall contact Fermilab's Dosimetry Program Office regarding all dosimetry matters.

6.1.3 The subcontractor shall maintain permanent exposure histories for all participants in accounts 75901, 75903, 151629 and 151630.

6.2 Accounts 75901, 151629 and 151630:

6.2.1 Quarterly reports (four copies of printout) shall be provided to Fermilab, sorted first by wear period and then sorted by series code. Each wear period should start a new page, as should each series code. Within series codes, individuals shall be sorted alphabetically. Individual birth dates, sex and Social Security numbers shall not appear on two of the hardcopy printouts.

6.2.2 These dose reports, listing skin, lens of the eye, whole body (gamma, neutron and total) equivalent doses, shall be supplied such that they arrive at Fermilab no later than thirty (30) working days after the shipment of used dosimeters is received by the subcontractor.

6.2.3 The symbol (SL) shall be used to designate a dose equivalent below the selected reporting limit of 10 mrem. The symbol (M) shall be used to designate an exposure below the reportable limit for TLD extremity dosimeters (ring badges).

6.2.4 Fermilab shall have access to electronic copies of all reports. This can be accomplished through a secured server or Website,

managed by the subcontractor, or suitable electronic media.

6.2.5 On an annual basis, the subcontractor shall provide Fermilab with a summary of equivalent dose results, for all individuals issued a dosimeter during the previous year. This can be sent on 3.5" diskettes, or other suitable media. This summary shall contain all of the data required for submitting the annual report to the DOE.

6.2.6 Fermilab shall have access to an electronic copy of the annual summary. This can be accomplished through a secured server or Website, managed by the subcontractor, or suitable electronic media.

6.2.7 A single consolidated list of all dosimeters not returned for a given wear period shall be made available by the subcontractor. This list shall contain the participant number, and first/last name.

6.2.8 Late dosimeters shall have their reported doses credited to the proper wear period and participant upon processing.

6.3 Account 75903 Only (spare dosimeters)

6.3.1 Each dosimeter in account 75903 that is returned to the subcontractor will have been issued to a participant or returned as 'Unused'. If the dosimeter was issued, the participant information will be sent to the subcontractor's on-line database. Using this information, the subcontractor shall perform one of the following:

(a) If Fermilab determines that the dosimeter was worn by a participant currently or previously in account 75901, 151629 or 151630, the dose equivalent from the spare dosimeter shall be added to his/her permanent record and reported as outlined in 6.2.2 and 6.2.3.

(b) If Fermilab determines that the dosimeter was not worn by a participant currently or previously in account 75901, 151629 or 151630, then he/she is to be considered a participant in account 75903 and assigned a participant number in that account. If the individual has already been assigned a participant number in the 75903 account and is issued a subsequent dosimeter, the exposure records shall be combined. The subcontractor shall keep a record for each participant in account 75903 of his/her total exposure for the current calendar year. Matching between different dosimeters worn by the same individual shall be by Social Security number or other unique I.D. number as made

available by Fermilab.

6.3.2 Quarterly reports (four copies of printout) shall be provided to Fermilab, sorted first by wear period and then sorted by series code. Each wear period should start a new page as should each series code. Within series codes, individuals shall be sorted alphabetically. Individual birth dates, sex and Social Security numbers shall not appear on two of the hardcopy printouts.

6.3.3 These dose reports, listing skin, lens of the eye, whole body (gamma, neutron and total) equivalent doses, shall be supplied such that they arrive at Fermilab no later than thirty (30) working days after the shipment of used dosimeters is received by the subcontractor.

6.3.4 The symbol (SL) shall be used to designate an exposure below the selected reporting limit of 10 mrem. The symbol (M) shall be used to designate an exposure below the reportable limit for TLD extremity dosimeters (ring badges).

6.3.5 On an annual basis, the subcontractor shall provide Fermilab with a summary of equivalent dose results, for all individuals issued a dosimeter during the previous year. This can be sent on 3.5" diskettes, or other suitable media. This summary shall contain all of the data required for submitting the annual report to the DOE.

6.3.6 If a dosimeter is sent back to the subcontractor labeled "Unused", the dose result shall not appear on the report. The data field which normally contains the participants name will indicate the that the dosimeter was 'UNUSED'. If Fermilab later determines that the dosimeter was issued and worn, Fermilab shall supply the subcontractor with the participant information. The subcontractor shall then adjust the individuals dose records accordingly and issue a corrected dose report.

6.3.7 Late dosimeters shall have their reported equivalent doses credited to the proper wear period and participant upon processing.

6.3.8 A single consolidated list of all dosimeters not returned for a given wear period shall be made available by the subcontractor. This list shall contain the participant number, and first/last name if the dosimeter was issued.

6.4 <u>Accounts 75902 and 180899 only (Area Monitoring Dosimeters)</u>

6.4.1 Quarterly reports (four copies of printout) shall be provided to

Fermilab, sorted first by wear period. The quarterly result for each dosimeter shall be reported by dosimeter number. Each wear period should start a new page.

6.4.2 No accumulated totals are required. Reports for dosimeters sent in mid-wear period do not need to be held until the end of the wear period.

7.0 PERFORMANCE STANDARDS

7.1 The subcontractor shall maintain accreditation by the National Bureau of Standards through participation in the National Voluntary Laboratory Accreditation Program (NVLAP).

7.2 The subcontractor shall assist Fermilab with maintaining accreditation under the Department of Energy Laboratory Accreditation Program (DOELAP)[1, 2].

7.3 The subcontractor shall provide Fermilab with their monthly QC data for all relevant processing systems.

7.4 The subcontractor shall provide Fermilab with their monthly blind audit data.

7.5 The subcontractor shall provide Fermilab with the following current documentation regarding the DOELAP accredited dosimeter. If these documents are revised, this shall be communicated to Fermilab in writing.

7.5.1 Results of angular dependence and lower limit of detectability studies as outlined in the DOELAP standard.[1]

7.5.2 Uncertainty analysis

7.5.3 Fade Studies

7.5.4 Energy Response Studies

7.5.5 Current algorithm implemented to determine equivalent dose

7.5.6 Dosimeter design such that all elements of the dosimeter are contained in a single holder.

7.6 The subcontractor shall also perform the following with respect to the DOELAP accredited dosimeter.

7.6.1 Use dosimeter materials with low fade or compensation such that

they may be used for wear period of three (3) months and be processed up to one year later.

7.6.2 Compensate for any non-linear effects such as supra-linearity, fading, loss of sensitivity, etc.

7.7 The subcontractor shall process blind audit dosimeters, irradiated to known doses by Fermilab. Fermilab will make these blind audit results available to the subcontractor. Performance issues related to the results of the blind audit tests will be discussed during regularly scheduled meetings between the subcontractor and Fermilab.

8.0 EMERGENCY PROCESSING

8.1 The subcontractor shall maintain back up facilities and equipment. The subcontractor shall also have a detailed procedure to be followed in case of a serious incident during the subcontractor's off-shift hours (including weekends and holidays) or in case dosimeters must be processed on a priority basis for other reasons. This procedure should indicate subcontractor's definition of "off-shift" hours.

9.0 MISCELLANEOUS

9.1 Unreturned dosimeter fees will be refunded to Fermilab once the dosimeter has been received by the subcontractor.

9.2 Fermilab retains the unilateral right to request that the subcontractor supply an electronic and printout listing containing the cumulative exposure totals and other personal information for all participants in all accounts except 75902.

10.0 REFERENCES

1. ANSI/HPS N13.11-2009, *American National Standard for Dosimetry – Personnel Dosimetry Performance – Criteria for Testing.*

2. ANSI/HPS N13.32-2008, *American National Standard, Personnel Testing of Extremity Dosimeters.*

B. RP Form 001 Permanent Dosimetry Badge Service Request

Fermilab

Permanent Dosimetry Badge Service Request

Legal Name _____ Date _____
Last First MI MM/DD/YYYY

Fermilab ID _____ Employee ____ Visitor ____ Contractor ____ Gender M ____ F ____

E-mail _____ Birthdate _____
MM / DD / YYYY

Mail Station _____ Extension _____

Permanent Mailing Address _____
Number Street

_____

_____
City State

_____
Country Zip Code

Division / Section / Center or Experiment # _____ Department: _____

Supervisor/Lab Contact _____

Have you ever used a dosimeter at Fermilab? YES ____ NO ____

If yes, approximate dates? _____

Estimate of occupational radiation dose for current calendar year: _____ mrem

Have you ever been monitored for radiation exposure at another facility? YES ____ NO ____

If yes, please complete table below.

PREVIOUS EMPLOYER	EMPLOYER'S ADDRESS	DATES OF EMPLOYMENT

_____ _____
Requester's Signature Date

Send completed form to Division / Section / Center RSO

RP Form 001

DocDB #1282
Revised 11/2020

Radiation Safety Officer:

Is it necessary that this individual be on permanent badge service? Yes ____ No ____

Has this individual received appropriate radiological training? Yes ____ No ____

Radiological Worker - Classroom (Virtual) (FN000470 / CR) Date _____

Radiological Worker - Practical Factors (FN000471 / OJ) Date _____

Dosimetry Badge Location _____

RSO Signature _____

Dosimetry Program Office Use

Badge Number _____ Account Number _____ Series Code _____

Unique ID Number _____ Initiation of Permanent Service _____

Rack _____ Termination of Permanent Service _____

CHECKLIST FOR SETUP

____ Notification Sent to Badge Wearer

____ Information to Permanent Badge Holders Sent (R.P. Form #6)

____ Information on Prenatal Exposure Sent (R.P. Form 13)

____ Occupational Exposure History Requests (R.P. Form #2) forwarded

____ Entered into Vendors Database

____ Entered into Dosimetry Program Office Database

____ Rack Tags Prepared

____ Individual Exposure History File Prepared

____ Entered in ListServ Database

____ mrem Cumulative Exposure Upon Termination

C. RP Form 006 Dosimetry Badge Information

Fermilab

DOSIMETRY BADGE INFORMATION

1. You have been issued a Dosimetry Badge. You must wear your dosimetry badge in all areas marked "Caution Radiation Area or Caution High Radiation Area" or as directed by your area Radiation Safety Officer.

2. Your dosimetry badge should remain at the Laboratory at all times. You may use the badge rack if one is provided in your work area to store your badge when you are not using it. **Be sure your dosimetry badge is available for collection on the first working day of each quarter.**

3. The observance of the following guidelines will make your exposure record more accurate.

   a. **Always** wear your badge on the front of your body between your neck and waist.

   b. **Never** leave your badge behind in a radiological area.

   c. **Do not** wear your badge when receiving dental or medical X-rays or radioisotope treatments.

   d. **Do not** launder it.

   e. Take care not to damage the kapton window. If the window is punctured, the dosimetry badge should be replaced.

   f. **Do not** tamper with the dosimetry badge. If the pin holding the clip in place comes out, this will need to be fixed. The Dosimetry Program Office has replacement pins. Or the dosimetry badge should be replaced.

4. If you have reason(s) to believe that your dosimetry badge has been damaged or if you lose it, contact your area Radiation Safety Officer immediately.

5. If you find a badge that appears to have been lost, it is important that it be returned to the Dosimetry Program Office. **Do not** return it to the owner or to the badge rack. Take or send the badge to the Dosimetry Program Office, WH7E, MS 119, with a note clipped to it providing this information.

   - Name(s) of finder(s).
   - Date and time found.
   - Location where found.

6. You have the right to inquire about your radiation exposure at any time. On an annual basis, you will receive a summary of the radiation exposure that you may have received during the previous year. You may also request a summary upon termination. This request must be in writing.

7. The Fermilab Director has established a maximum Administrative Control Level (ACL) of 1500 mrem for occupational radiation exposures. Any individual who receives a reported dose of over 350 mrem from the dosimetry badge or pocket dosimeter in any one quarter will be assigned to the ALERT list.

8. Additional information on Fermilab radiological policies can be found in the Fermilab Radiological Control Manual. If your job assignment changes, or if for any reason you feel that you no longer need a permanent dosimetry badge, please discuss the matter with your division/section Radiation Safety Officer or call the Dosimetry Program Office, x8386.

R.P. Form #6
Revised May, 2014

Fermilab

RULES FOR WORKING IN RADIATION AREAS

It is Fermilab policy that no person shall be exposed to radiation and/or radioactive materials unnecessarily. Therefore, observe the following rules in order to minimize your exposure.

1. Do not go into radiological areas unless your job requires it.
2. Carefully plan your work before entering a radiological area.
3. Stay in a radiological area only as long as necessary to complete the job.
4. When in doubt about radiation safety procedures, consult the Radiation Safety Officer responsible for your area of work.

R.P. Form #6
Revised May, 2014

D. RP Form 013 Radiation Exposure to Unborn Children

Fermi National Accelerator Laboratory

Fermilab

Memorandum

Michael C. Vincent
Radiation Physicist
Dosimetry Program Manager

ESH / Radiation Physics Science
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Kirk Road and Pine Street
Batavia, Illinois 60510-5011 USA
Office: 630.840.3692
Mobile: 630.338.9531
vincent@fnal.gov

Date: February 16, 2021
To: Female Radiation Workers at Fermilab
From: Michael Vincent Digitally signed by Michael Vincent, UID:vincent Date: 2021.02.16 15:55:47 -06'00'
Re: Radiation Exposure to Unborn Children (RP Form 013)

As discussed in Fermilab's Radiological Worker training, the embryo and fetus are more sensitive to radiation than are adults. It is Fermilab's intent to ensure that no pregnant woman be exposed to radiation doses large enough to result in a significant risk to the embryo or fetus. To accomplish this, all female personnel who work in radiological areas must be informed of the increased sensitivity of the fetus to radiation and of the proper steps required to keep radiation exposures to a minimum.

For reference, below are Fermilab's policies on radiation exposure to unborn children and common questions and answers related to prenatal exposure. This information is provided so that women who become pregnant can make an informed decision on whether or not to formally declare their pregnancy.

Please be aware that these policies are binding for Fermilab employees but may only be used as guidance for visitors and subcontractors. Visitors and subcontractors are highly encouraged to contact their employers to learn of their prenatal policies. Members of the Radiological Control Organization are available to address concerns regarding prenatal radiation exposure. In addition, they will aid in the implementation of prudent measures to minimize radiation exposure to the unborn child.

If you have further questions or would like additional information, please contact your Radiation Safety Officer, the Dosimetry Program Office (x3692; dosimetry@fnal.gov), or the Occupational Medicine Office (x3232).

This memo serves as RP Form 013.

FERMILAB RADIOLOGICAL CONTROL MANUAL
CHAPTER 9
PART 5 PRENATAL POLICY/PROCEDURES

951 Prenatal Policy and Procedures

Members of the Radiological Control Organization, typically division/section RSOs, are available to answer questions and concerns regarding prenatal radiation exposure raised by any radiological worker. In addition, they will provide assistance in implementing prudent measures to minimize exposure of the unborn child. The requirements of this Article pertain only to Fermilab employees. To learn of options available to them, female employees of subcontractors or other institutions should contact their own employer. As appropriate, the following may be used as guidelines in outlining a course of action for employees of subcontractors or other institutions.

Fermilab has established a policy and appropriate procedures to allow a radiological worker to make a knowledgeable decision regarding the risk to her unborn child. Once a woman declares her pregnancy in writing, the dose limit of 500 mrem to the embryo/fetus for the gestation period established in Article 213 applies.

If a woman knows or suspects that she is pregnant, she must choose one of the following options:

1. Choose not to notify the Occupational Medicine Office in writing of her pregnancy. In this case, the usual occupational exposure limits will continue to apply. Women who choose this option should only do so with full awareness that the fetus is more sensitive to radiation than are adults.

2. Voluntarily notify the Occupational Medicine Office, the assigned RSO, or the Dosimetry Program Manager in writing as soon as possible. The declared pregnant radiological worker may request that her pregnancy be kept private to the extent possible during her first trimester. The documentation of declarations of pregnancy should be made on the Declared Pregnant Worker Evaluation Form (R.P. Form No. 86) and distributed as stated on the form.

    a. After a radiological worker voluntarily notifies Fermilab in writing that she is pregnant, she is considered a declared pregnant worker for the purpose of fetal/embryo dose protection. At this time, a radiation safety staff member will measure radiation levels in her work area(s) and estimate the exposure to the unborn child for the term.

    b. After this evaluation is conducted, the declared pregnant worker who is a Fermilab employee has the following options:

        1) Request a temporary reassignment to work in areas involving a lower potential for radiation exposure. If a transfer is recommended by the Occupational

Medicine Office and radiation safety, Fermilab shall make a reasonable attempt to find an assignment of equal pay and status for the employee.

2) Ask for a leave of absence. Leaves of absence under such circumstances are subject to the requirements of the Personnel Policy Guide.

3) Continue working at the same job assignment and reducing her dose to less than 500 mrem throughout the duration of the pregnancy, where practical, by using shielding, increasing distances from radiation sources and decreasing the amount of time spent in radiation areas. Fermilab radiation safety personnel shall make recommendations to the woman's supervisor such that reasonable steps can be taken to minimize her radiation exposure.

4) Terminate employment at the Laboratory.

The option selected shall be documented and dated in writing and retained by the Dosimetry Program Manager.

c. To learn options available to them, female users should contact the administrator of their sponsoring institution and female subcontractor employees should contact their own employer.

3. If the dose to the embryo/fetus is determined to have already exceeded 500 mrem when a worker notifies her employer of her pregnancy, the worker shall not be assigned to tasks where additional occupational exposure is likely for the duration of her pregnancy.

4. Efforts shall be made to avoid exceeding 50 mrem per month to the declared pregnant worker. The worker shall be assigned a pocket dosimeter and wear it while working in controlled areas in order to monitor her dose on a monthly basis.

5. The Fermilab dosimetry vendor offers the option of an additional badge for fetal monitoring. Declared pregnant workers who frequently work in non-uniform fields or in close proximity to radioactive materials such that the fetal dose might differ significantly from the pregnant worker's whole-body dose are encouraged to use this option.

6. In the event that a declared pregnant radiological worker needs to revoke this declaration, she should contact the Dosimetry Program Manager or her assigned RSO. It is recommended that the declared worker sign the Declared Pregnant Worker Evaluation Form (R.P. Form No. 86) to document the revocation.

Frequently Asked Questions

1. **What is a Declared Pregnant Worker?**

   Section 835.2 of Title 10, Part 835, of the Code of Federal Regulations (10 CFR 835) defines a declared pregnant worker as "a woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational exposure limits to the embryo/fetus." This declaration may be revoked, in writing, at any time by the declared pregnant worker.

2. **What is the exposure limit for an embryo/fetus?**

   10 CFR 835.206 mandates that "the equivalent dose limit for the embryo/fetus from the period of conception to birth, as a result of occupational exposure of a declared pregnant worker, is 0.5 rem (0.005 Sv)," or 500 mrem. This regulation also requires Fermilab to ensure the declared pregnant worker avoids being exposed to "substantial variation above a uniform exposure rate."

3. **How does Fermilab monitor the external exposure to the embryo/fetus?**

   10 CFR 835.402 specifies the requirements for monitoring external and internal occupational dose to a declared pregnant worker. Fermilab must monitor the external occupational dose to a declared pregnant worker who is likely to receive an equivalent dose to the embryo/fetus in excess of 10 percent of the applicable limit, or 50 mrem.

   Such monitoring is accomplished with the dosimetry badges assigned to the pregnant worker, which are exchanged and read on a quarterly basis. In this case, Fermilab assumes that the dose to the embryo/fetus is equivalent to the dose to the mother (in actuality the embryo/fetus usually receives only a fraction of the dose that the mother receives).

   For more precise monitoring, the Dosimetry Program Office can issue fetal monitoring dosimetry badges if that is the desire of the declared pregnant worker; these badges are exchanged and read on a monthly basis.

   In addition, for an instantaneous assessment, pocket dosimeters are often assigned to declared pregnant workers to ensure that the exposures are minimized.

4. **If I become pregnant, am I required to inform my employer of my pregnancy?**

   No. It is your choice whether or not to declare your pregnancy. If you choose to declare your pregnancy, a lower radiation dose limit will apply to you. If you choose not to declare your pregnancy, you will continue to be subject to the same radiation dose limits that apply to all radiological workers.

5. **What happens if I declare my pregnancy to my employer in writing?**

   The amount of radiation that you will be allowed to receive will decrease because both the Nuclear Regulatory Agency and the Department of Energy have a lower dose limit for the embryo/fetus of female workers who have formally declared their pregnancy in writing.

   Ordinarily, the radiation dose limit for a radiological worker at Fermilab is 1500 mrem in a year. The dose limit to the embryo/fetus is 500 mrem over the course of the 9-month pregnancy. In addition, Fermilab must make efforts to ensure that a substantial variation above a uniform monthly dose rate does not occur. This may mean that if you declare your pregnancy, you may not be permitted to perform some of your normal job functions, and you may not be able to participate in emergency response situations. If you are a visitor or subcontractor, you may wish to inquire specifically about what would happen in such an instance.

6. **Why do the regulations have a lower dose limit for a woman who has declared her pregnancy than for a normal worker?**

   The purpose of this lower limit is to protect the unborn child. Scientific advisory groups recommend that the dose before birth be limited to 0.5 rem (as opposed to the usual 5 rem occupational annual dose limit) because of the sensitivity of the embryo/fetus to radiation. [1,2]

7. **What effects can radiation exposure have on my child's development?**

   Possible effects include deficiencies in the child's development, especially the child's neurological development, and an increase in the likelihood of cancer. The effects of large doses of radiation on human development are quite evident and easily measurable, whereas at low doses the effects can only be inferred.

   For example, studies of the effects of radiation on animals and humans demonstrate clearly and conclusively that large doses of radiation—such as 100 rem—cause series developmental defects in many of the body's organs when the radiation is delivered during the period of rapid organ development. [2,3,4,5]

The developing human brain has been shown to be especially sensitive to radiation. Intellectual disabilities have been observed in the children who were exposed *in utero* to the atomic bombings in Japan. Additionally, some other groups exposed to radiation *in utero* have shown lower than average intelligence scores and poor performance in school. [4]

The sensitivity of the brain undoubtedly reflects its structural complexity and its long developmental period. The most sensitive period is roughly during the 8th to 15th weeks of gestation, followed by a substantially less-sensitive period for the two months after the 15th week. There is no known effect on the child's developing brain during the first two months or the last three months of pregnancy. [4]

No developmental effects caused by radiation have been observed in human groups at doses at or below the 5 rem occupational dose limit; however, scientists are still uncertain whether there are developmental effects at doses below 5 rem. It may be that the effects are present but are too small to measure because of the normal variability from one person to the next, and because the tools to measure the effects are not sensitive enough. Or it may be that there is some threshold dose below which there are no developmental effects whatsoever. Recent studies suggest that there is a teratogenetic threshold of 30 to 61 rem for intellectual disability, and one of 150 rad for microcephaly. [4]

8. **How much will the likelihood of cancer be increased?**

Radiation exposure has been found to increase the likelihood of cancer in many studies of adult human and animal groups. At doses below the occupational dose limit, an increase in cancer incidence has not been proven, but is presumed to exist even if it is too small to be measured.

While the evidence for increased sensitivity of the embryo/fetus to cancer induction from radiation exposure is inconclusive, it is prudent to assume that there is some increased sensitivity. Scientific advisory groups assume that radiation exposure before birth may be 2 or 3 times more likely to cause cancer over a person's lifetime than the same amount of radiation received as an adult. [1] If this is true, there would be one radiation-induced cancer death in 2000 people exposed *in utero* at the embryo/fetus limit of 0.5 rem in addition to the 400 cancer deaths from all causes that one would normally expect in the same group.

9. **How does the risk to the embryo/fetus from occupational radiation exposure compare to other risks?**

There are many risks associated with pregnancy. Some of these are avoidable; others are not. [6] The risk to the embryo/fetus from 0.5 rem or even 5 rem of radiation exposure is relatively small

compared to some other risks of pregnancy.

Of particular concern is excessive consumption of alcohol during pregnancy. The US Public Health Service has concluded that heavy alcohol consumption during pregnancy (three drinks or more per day) is the leading known cause of intellectual disability. [7] Children whose mothers drank heavily during pregnancy may exhibit developmental problems such as hyperactivity, distractibility, short attention spans, language difficulties, and delayed maturation, even when their intelligence is normal.

In studies tracking the development of children born to light or moderate drinkers, researchers have also correlated their mothers' drinking patterns during pregnancy with low birth weight, decreased attention spans, delayed reaction times, and lower IQ scores at 4 years of age.

10. **What if I decide that I do not want any radiation exposure at all during my pregnancy?**

    You may ask your employer for a job that does not involve any exposure to occupational radiation at all, but your employer may not have such a position, or may not be willing to provide you with a job involving zero radiation exposure. Even if you receive no occupational exposure at all, note that you will typically receive a dose of about 0.3 rem from unavoidable background radiation. [8]

11. **What effect will formally declaring my pregnancy have on my job status?**

    Only your employer can tell you what effect a declaration of pregnancy will have on your job status. As part of this packet, you received a copy of Fermilab's policies with respect to the job status of its declared pregnant employees. Visitors and subcontractors are strongly encouraged to speak with their supervisor to learn of the policies that may affect them.

12. **What information must I provide to my employer in my declaration of pregnancy?**

    A sample declaration letter is attached to this memo. RP Form 086, available from your Radiation Safety Officer, the Dosimetry Program Office, or the Occupational Medical Office, may also be used as your declaration of pregnancy.

    In general, you must provide your name, a declaration that you are pregnant, the estimated month and year of conception, and the date that you gave your letter to your employer. Fermilab employees should direct their letter to the Occupational Medical Office. Visitors and subcontractors should direct their letters to their employer. It is requested that the Dosimetry Program Office (MS 119) be copied on such correspondence so that we can most effectively help

you to minimize the radiation exposure of your unborn child.

13. **To declare my pregnancy, do I need to have documented medical proof that I am pregnant?**

    For Fermilab employees, the pregnancy does not need to be confirmed by Fermilab's Occupational Medicine Office. Visitors and subcontractors should ask their employer.

14. **Can I tell my employer orally rather than in writing that I am pregnant?**

    No. For your protection, the declaration must be in writing. As far as the regulations are concerned, an oral declaration or statement is equivalent to not telling your employer you are pregnant.

15. **If I have not declared my pregnancy in writing, but my employer notices that I am pregnant, do the lower dose limits apply?**

    No. The lower dose limits for pregnant women apply only if you have declared your pregnancy in writing. The choice of whether to declare your pregnancy is yours, not your employer's. Your employer may not remove you from a specific job because of the possibility of occupational radiation exposure if you appear pregnant.

16. **If I am planning to become pregnant, but am not yet pregnant, and I inform my employer of that in writing, do the lower dose limits apply?**

    No. The lower dose limits apply only if you declare that you are already pregnant. However, because many women often do not realize they are pregnant for the first several weeks, it would be prudent to discuss any concerns that you have with a Radiation Safety Officer, the Occupational Medicine Office, or the Dosimetry Program Office. It is always good practice to take steps to minimize your exposure whenever you can.

17. **What if I have a miscarriage or find out that I am not pregnant?**

    If you have declared your pregnancy in writing, you should promptly inform your employer that you are no longer pregnant. The regulations do not require that the revocation of a declaration be in writing, be we recommend that you revoke the declaration in writing to avoid confusion.

    If you have a miscarriage and become pregnant again before you have revoked your original declaration, you should submit a new declaration because the date of conception has changed.

18. **How long is the lower dose limit in effect?**

    The dose to the embryo/fetus must be limited until either your employer knows you have given birth, you inform your employer that you are no longer pregnant, or you inform your employer that you no longer wish to be classified as a declared pregnant worker.

19. **If I have declared my pregnancy in writing, can I revoke it even if I am still pregnant?**

    Yes, you may. If you revoke your declaration of pregnancy, the lower dose limits no longer apply. Again, this revocation must be made in writing.

20. **What other steps can I take to lower my radiation dose?**

    In the same ways that were discussed in the Radiological Worker training that you received. If you become pregnant, it is a good time to review the training materials on the methods and procedures that you were provided in this training. However, you should ask your supervisor or Radiation Safety Officer whether any additional steps can be taken.

References

1. National Council on Radiation Protection and Measurements, *Limitation of Exposure to Ionizing Radiation*, Report No. 1116. Bethesda, MD: 1993.

2. *ICRP Publication 60 -- 1990 Recommendations of the International Commission on Radiological Protection, Ann. ICRP 21:* No. 1-3. Pergamon Press, 1991.

3. *Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V),* Committee on the Biological Effects of Ionizing Radiations, National Research Council, National Academy Press, Washington, DC, 1990.

4. United Nations Scientific Committee on the Effects of Atomic Radiation, *Sources and Effects of Ionizing Radiation*, United Nations, New York, 1993.

5. National Council on Radiation Protection and Measurements, *Considerations Regarding the Unintended Radiation Exposure of the Embryo, Fetus or Nursing Child,* NCRP Commentary No. 9, National Council on Radiation Protection and Measurements, Bethesda, MD 1994.

6. Kane, D. F., E. Sims, L. Stecker, F. Bloe, P. Early and K. O'Brien. *The Declared Pregnant Worker in Nuclear Medicine. Journal of Nuclear Medical Technology*. Volume 24, Number 2, pp. 83 - 91. June 1996.

7. *Alcohol, Tobacco and Other Drugs May Harm the Unborn*, U.S. Department of Health and Human Services, Public Health Service, Alcohol, Drug Abuse, and Mental Health Administration, DHHS Publication No. (ADM)92-1711, Rockville, Maryland, 1990.

8. National Council on Radiological Protection and Measurements, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, Report No. 94, Bethesda, MD, 1987.

Fermi National Accelerator Laboratory

Fermilab

To: _____

I do hereby voluntarily declare that I am pregnant. My estimated date of conception was _____ (MM/YYYY).

I understand that this means that my occupational radiation dose during my entire pregnancy will not be allowed to exceed 500 mrem (5 mSv), unless my occupational radiation exposure has already exceeded this limit upon submittal of this letter.

I also understand that meeting this lower dose limit may require additional restrictions on my work or even a change in job responsibilities for the duration of my pregnancy.

I am aware that I may revoke this declaration at any time, and that this revocation must be made in writing.

_____

(Signature)

_____

(Printed name)

_____

(Date)

E. RP Form 002 Occupational Exposure History

Fermi National Accelerator Laboratory

Fermilab

Date

Michael C. Vincent
Radiation Physicist
Dosimetry Program Manager

ESH / Radiation Physics Science
P.O. Box 500, MS 119
Kirk Road and Pine Street
Batavia, Illinois 60510-5011
USA
Office: 630.840.3692
Mobile: 630.338.9531
vincent@fnal.gov

Attn: Name O. Recipient
Organization
Address
City, State 12345- Country

Dear Name O. Recipient,

Under the provisions of the U.S. Department of Energy regulations entitled *Occupational Radiation Protection*, 10CFR835, I request the external and internal occupational exposure data for the individual named below for the time they were associated with your facility. A form is provided on the subsequent page for your convenience. If you have any questions or require additional information, please contact me at the above address.

Sincerely,

Michael Vincent
Dosimetry Program Manager
Fermi National Accelerator Laboratory

cc: Individual exposure history file, ESH Section Office, WH7E

Release of Information

Authorization is hereby given to release my previous occupational radiation exposure records to the Fermi National Accelerator Laboratory Dosimetry Program Office.

Name (please print): _____

Signature: _____

Date of birth: _____

Period at your facility: _____ to _____

RP Form #2
Revised August 2019

Fermi National Accelerator Laboratory

Fermilab

Occupational Exposure History

Name: _____

Facility: _____

Period of Exposure: _____ to _____

External Exposure	Current CY		Previous	
Equivalent Dose to the Whole Body:	_____	mrem	_____	mrem
Equivalent Dose to the Lens of the Eye:	_____	mrem	_____	mrem
Equivalent Dose to the Skin:	_____	mrem	_____	mrem
Skin Equivalent Dose to the Extremities:	_____	mrem	_____	mrem
Internal Exposure				
Committed Effective Dose (CED):	_____	mrem	_____	mrem
Please include radionuclides and date of intake in the comments section.				
Total Effective Dose (TED):	_____	mrem	_____	mrem

Comments: _____

_____

_____

_____

_____

_____

_____

_____ _____

Signature of Facility Representative Date

_____

Print Name

_____

Title

RP Form #2
Revised August 2019

F. RP Form 086 Radiation Exposure Evaluation for Declared Pregnant Workers

Fermilab

Radiation Exposure Evaluation for Declared Pregnant Workers

Instructions and information for the declared pregnant radiological worker:

By signing this form, you are declaring your pregnancy. As a declared pregnant worker at Fermilab, you have several options. These options are detailed in Article 951 of the Fermilab Radiological Control Manual. If you are a visitor or subcontractor, you should also inform your home institution or employer. You are strongly encouraged to adhere to the same restrictions and recommendations as Fermilab employees, should you choose to continue working at Fermilab. **You may revoke your declaration of pregnancy, in writing, at any time.**

1. Please select one of the options below that you would like to follow during your pregnancy. For visitors and subcontractors, this option should also be communicated to your home institution or employer.

   ❑ **Option 1** You may request a temporary reassignment to work in areas involving a lower potential for radiation exposure. If a transfer is recommended by the Medical Department and radiation safety personnel, Fermilab shall make a reasonable attempt to find an assignment of equal pay and status.

   ❑ **Option 2** You may ask for a leave of absence. A leave of absence under such circumstances is subject to the requirements of the Personnel Policy Guide, as administered and interpreted by the Workforce Development and Resources Section.

   ❑ **Option 3** You may continue working at the same job assignment and reducing your dose to less than 500 mrem for the duration of your pregnancy, where practical, by using shielding, increasing distances from radiation sources and decreasing the amount of time spent in radiologically controlled areas.

   ❑ **Option 4** You may terminate employment at the Laboratory if you are a Fermilab employee.

2. If you choose to continue performing radiological work, or working with radioactive sources, the following applies: The dose limit for the embryo/fetus from conception to birth is 500 mrem. Efforts will be made to avoid exceeding 50 mrem/month. **You must wear both a dosimetry badge and a pocket dosimeter while working in areas controlled for radiological purposes. Weekly pocket dosimeter readings must be recorded in GetDose for dose tracking by radiation safety personnel.**

3. You have the option of an additional dosimetry badge for fetal monitoring if your working conditions are such that the fetal dose might differ from your whole body dose.

4. An evaluation of your work area to assess the potential radiation dose to your unborn child during your pregnancy will be conducted. This evaluation will be documented on the back of this form. Authorized radiation safety personnel will make recommendations to you and your supervisor so that reasonable steps can be taken to minimize radiation dose to you and your unborn child.

   If the total estimated dose is determined to **exceed 500 mrem**, you shall not be assigned to tasks where additional occupational radiation dose is likely for the remainder of your pregnancy. If total estimated dose is determined to **approach 500 mrem**, it is recommended that you seek task reassignment for the remainder of your pregnancy.

My signature also confirms my option choice as indicated above and provides consent to obtain the information required to perform the radiation exposure evaluation.

Declared Pregnant Worker _____ Date _____

I am revoking my declaration of pregnancy _____ Date _____

R.P. Form #86
Revised 2/17

TO BE COMPLETED BY DIVISION/SECTION/CENTER RADIATION SAFETY OFFICER OR DOSIMETRY PROGRAM CONTACT

Declared Pregnant Worker Name: _____ Fermilab ID: _____

Division/Section: _____ Phone Ext: _____ Mail Station: _____

Email Address: _____

Estimated Due Date: _____

Total weeks remaining in pregnancy (# of weeks between declaration date and due date): _____

Total estimated (or actual if known) occupational radiation dose prior to declaration: _____

Radiation Exposure Evaluation:

Work Area(s)	Area Posting	Occupancy Time (hrs/wk)	Average Area Dose Rate (mrem/hr)	Estimated Weekly Dose (mrem)

Total estimated occupational radiation dose during pregnancy: _____

Fetal monitor requested? Yes ☐ No ☐

RSO Comments: (Attach additional sheets if necessary)

Forward the original completed evaluation form, and other supporting documentation to the ES&H Section Dosimetry Program Manager (MS 119). Send copies of the form to the Declared Pregnant Worker, and the Fermilab Medical Department (MS 204). For visitors and subcontractors, a copy should also be sent to the home institution or employer/

RSO Signature: _____ ID # _____ Date: _____

Reviewed by Declared Pregnant Worker: _____ Date: _____

Concurrence of Dosimetry Program Manager: _____ Date: _____

R.P. Form #86
Revised 2/17

Radiation Safety Officers and/or Division/Section/Center Contacts

Accelerator Division
Maddie Wolter X4807
Wayne Schmitt X4407

Environment, Safety, Health and Quality Section
Sue McGimpsey X8386

Facilities Engineering Services Section
Sue McGimpsey X8386

Particle Physics/Neutrino Division
Maddie Wolter X4807

Technical Division
Kathy Graden X4939

Computing Division
Kathy Graden X4939

Work Force Development and Resources Section
Sue McGimpsey X8386

Directorate
Sue McGimpsey X8386

Senior Radiation Safety Officer
Don Cossairt X3465

R.P. Form #86
Revised 2/17

G. RP Form 003 Exposure Investigation Report

Fermi National Accelerator Laboratory

Fermilab

Exposure Investigation Report

Date: _____ Wear Period: _____

Section A: Personal Information

Name: _____ Fermilab ID: _____ N ☐ V ☐ C ☐

Mail Stop: _____ Ext.: _____ Email: _____

Div. / Sec. / Exp.: _____ Supervisor / Lab Contact: _____

Is individual on permanent badge service? Yes ☐ No ☐

Section B: Circumstances Requiring Investigation

☐ 1 Badge reported lost
☐ 2 Badge could not be processed
☐ 3 Unexpected neutron exposure reported
☐ 4 Excessive skin dose reported
☐ 5 Suspected inaccuracy in the exposure record
☐ 6 More than 50 mrem between dosimetry badge and other dosimetry
☐ 7 Individual placed on ALERT list
☐ 8 Other (explain):

Section C: Dosimetry Data

Affected Badge # _____ Permanent ☐ Temporary ☐ Ring ☐

Complete for the same wear period: (Indicate if data are not available.)

Whole Body	Neutron	Lens of Eye	Skin Dose	Extremity Dose

Pocket Dosimeter Reading: _____ mrem Other Dosimetry: _____ mrem

R. P. Form #003
Doc DB #1260

Revised 2/2021

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Fermi National Accelerator Laboratory

Section D: Analysis and Dose Assessment

Interview with badge wearer: (Include areas entered, dates of entry, lengths of time in areas, type of work being performed, etc. Indicate if Badge Wearer Unavailable. Attach additional sheets as necessary.)

Individuals with whom the badge holder worked:

Name	Badge #	WB	Lens	Skin

If EI is performed for Reason 1 or 2 (Section B), complete for wear periods in which similar work was done:

Wear Period	WB	Lens	Skin

Survey performed of reference areas? Yes ☐ No ☐ If yes, attach survey map

Was work performed under an RWP? Yes ☐ No ☐ If yes, attach a copy

If applicable attached access records to support dose assignment.

Include other documentation to support dose assignment (i.e. dosimeter card, job review, etc.).

Follow-up actions and other comments: (Attach additional sheets if necessary)

Section E: Exposure Adjustment:

☐ No Adjustment Necessary ☐ Addition ☐ Subtraction

☐ Neutron exposure adjustment by Dosimetry Program Manager based on evaluation of neutron energy dependence.

Badge Wearer: _____ RSO / Investigator: _____

Dosimetry Program Manager: _____

Assoc. Head for Radiation Protection (Subtractions Only): _____

ALARA Coordinator (For Alert List EI's Only): _____

Fermilab
ES&H Section

INSTRUCTIONS FOR COMPLETING AN EXPOSURE INVESTIGATION (RP Form #3)

In the absence of a quarterly reported radiation dose, this document will become the legal record of the person's radiation exposure. Before forwarding the Exposure Investigation Report to the Dosimetry Program Office, please review the information provided and verify that it is complete and the dose assignment is substantiated.

It is recommended that RP Form #3 is completed electronically. If it is not, errors should be denoted by a single line through them. Any changes that are made must be initialed and dated. No Whiteout or similar compound should be used on these forms and they must be completed in ink. If you have questions regarding this form or the Exposure Investigation process, contact the Dosimetry Program Manager at X8386.

1. The DATE referenced should be the initiation date of the exposure investigation.

2. The WEAR PERIOD refers to the wear period of the affected badge. If the EI is only addressing a portion of the wear period, these dates should be put here.

3. Print the name of the badge wearer on the appropriate line. This should be the individual's legal name, not a nickname.

4. Section A: Personnel Information

   a. The letters N, V, and C after Fermilab ID refer to the employment status of the individual. N is for employees; V is for visitors and C is for contractors. If the information is not available, indicate this on the form. This section may be used to help clarify details included in the report.

   b. Answer the question "Is the person on permanent badge service?" by circling either YES or NO.

5. Section B: Circumstances Requiring Investigation

   In this section, mark the box indicating the reason why the exposure investigation is being performed. It is the responsibility of the division/section/center to review the dosimetry reports for exposures that might require investigation. (See Part 7 of Chapter 5 of the FRCM). The Dosimetry Program Office is available as a resource. You will be notified by the Dosimetry Program Office if the badge could not be processed or if the individual has been placed on the ALERT list. Often, the Dosimetry Program Office may also identify those persons with unexpected neutron exposure, shallow doses or suspected inaccuracies. If the badge has been lost, the date the loss was discovered should be documented. High exposures to others in the work group should be categorized by OTHER.

6. Section C: Dosimetry Data

   a. Record the badge number of the affected badge. The badge number is the five digit number in the lower right corner of the badge or the number reported as the participant number on the dosimetry reports. If you do not know what the badge number is, contact the Dosimetry Program Office.

   b. If the person was issued another dosimetry badge during the quarter, to replace a lost dosimetry badge, that information would be included in this section. If the badge wearer did not wear a pocket dosimeter or other supplemental dosimetry, note this in the blanks with NA, not worn, etc.

7. Section D: Analysis and Dose Assessment

   a. Under the Interview with Badge Wearer portion, record highlights of any communication between you and the affected badge wearer. If this communication involved e:mail messages, attach a copy of the message.

Reference any radiological areas entered, dates of entry, lengths of time in the area, work being performed and any other pertinent information. Define all terms and acronyms where applicable. If all efforts to contact the badge wearer have been unsuccessful, note this here and document what efforts you made. If the badge wearer is unavailable, but it is possible to interview his/her colleagues or supervisor, do so. Document who was being interviewed and the relationship to the badge wearer. Somewhere in this section, the equivalent dose being assigned, including an assignment of "Minimal", needs to calculated and the basis for that assignment. Note that assignments based solely on pocket dosimeter readings will NOT be accepted. If additional space is needed to appropriately document the dose assessment, you can attach extra sheets.

b. Where appropriate, provide the dosimetry data for at least two co-workers of the badge wearer. This may mean that the EI cannot be completed until this information is available. Again, Pocket Dosimeter readings may be included, but will not be accepted by themselves.

c. If the badge has been lost or damaged, the next table must be completed. For many badge wearers, this is essentially the dose that they received during the three most recent quarters. However, some people have assignments that are cyclical in nature. For example, a person may be involved in a Li lens change out during the first quarter of a year. If he/she then does this again during the second quarter of the following year, it may make more sense to consider the exposure received during the previous Li lens work and not the most recent quarters. If the work is unique, one-time-only, then document this fact.

d. For supporting documentation, include as an attachment, **ALL** documents that you referred in completing the exposure investigation. You are not limited to the documents listed on the form. This is to ensure that the referenced document is retained for the same period and is immediately available for review. If you are unable to attach a document, a reference to this document may be provided with the approval of the Dosimetry Program Manager. The pocket dosimeter total for the quarter may be recorded without copies of all pocket dosimeter cards.

e. In this area, record any actions that you have taken as a result of this investigation. This may include recommendations for a procedural change, reassessment of the individual's dosimetry needs, instructions or training provided to the person in how to wear and care for his/her dosimetry, notification of the person's supervisor/contact, and anything else that you feel is relevant. This section must be completed if the Exposure Investigation is being conducted because the person has been placed on the ALERT List.

8. Section E: Exposure Adjustment

Check the applicable box and complete the table for all additions or subtractions. Please include the sign of the number being added or subtracted. If the exposure investigation is being done for a missing badge, an addition of Minimal should be noted if that is the conclusion. There is no threshold on dose adjustments.

If the investigation is being performed for a suspected inaccuracy (questioned by the Dosimetry Program Manager, RSO or badge wearer) and the dose is found to be valid, the 'no adjustment necessary' box must be checked, supporting documentation attached, and the form still sent to the Dosimetry Office.

9. Section F: Approvals

You as the investigator must sign and date the original form, in addition to the badge wearer. If the badge wearer is unavailable and you have documented this in Section D, the badge wearer's supervisor or lab contact can sign for him/her. The form then needs to be forwarded to the Dosimetry Program Office, MS 119. The Dosimetry Program Manager will review the completed report. If there are no problems or concerns, he/she will approve the completed EI. If the Dosimetry Program Manager has questions, the form
will be returned to you with R.P. Form #3b and the concerns noted.

If a subtraction is recommended, this must be approved by the Dosimetry Program Manager and the Associate Head for Radiation Protection. If the EI is performed due to the person being placed on the Alert List, the ALARA coordinator must also sign the form.

H. RP Form 021 Occupational Radiation Exposure Record

OCCUPATIONAL RADIATION EXPOSURE RECORD

This report is furnished to you under the reporting requirements of the U.S. Department of Energy. If you have any questions regarding this report, please contact the Dosimetry Program Office @ 630-840-8386 or dosimetry@fnal.gov.

Any dose reported as ND indicates that the dose was below the selected limit of 10 mrem for the whole body, lens of the eye and skin, or that the dose was below the minimum reportable quantity of 10 mrem for extremity dosimeters.

Prepared with data supplied by

LANDAUER ®

Landauer, Inc. - 2 Science Road - Glenwood, Illinois 60425-1586
Telephone (708) 755-7000 - Facsimile: (708) 755-7016

ACCOUNT NUMBER	SERIES CODE	PARTICIPANT NUMBER

1. NAME (LAST, FIRST, MIDDLE)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX	5. DATE OF BIRTH
	ON FILE AT FERMILAB			*ON FILE AT FERMILAB*

6. MONITORING PERIOD	7. LICENSEE NAME	8. LICENSE NUMBER(S)	9a.	9b.
	FERMI NAT'L ACCEL. LAB.		RECORD	ROUTINE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN uCi

DOSES (in rem)

EQUIVALENT DOSE - WHOLE BODY	11
EQUIVALENT DOSE TO THE LENS OF THE EYE	12
EQUIVALENT DOSE TO THE SKIN	13
EQUIVALENT DOSE TO MAX EXTREMITY	14
COMMITTED EFFECTIVE DOSE	15
COMMITTED EQUIVALENT DOSE, MAXIMALLY EXPOSED ORGAN	16
TOTAL EFFECTIVE DOSE (BLOCKS 11 + 15) (TED)	17
TOTAL ORGAN EQUIVALENT DOSE MAX ORGAN (BLOCKS 11 + 16)	18

19. COMMENTS

CUMULATIVE TOTAL EFFECTIVE DOSE (IN REM)
WHOLE BODY
LENS OF THE EYE
SKIN
EXTREMITY
TED

R.P. Form #21 Rev. #00

I. RP Form 088 Medical Procedures Involving Radioactive Material

Fermilab

MEDICAL PROCEDURES INVOLVING RADIOACTIVE MATERIAL

Medical and background exposures are not to be included with personnel occupational radiation exposure histories. For this reason, Fermilab asks that the Dosimetry Program Office be notified of any diagnostic or therapeutic medical procedures involving radioactive material that you may undergo. This information will help to determine when you may resume radiological work. This information will also be necessary in the event that an exposure investigation needs to be completed.

Questions regarding the actual dose that you may receive from this procedure should be directed to your physician.

Personal Information: Date: _____

Name: _____ ID #: _____

Div/Section: _____ Lab Extension: _____

Work Location(s): _____

Medical Procedure Information:

Type of Procedure: _____

Have you already undergone treatment? Yes ☐ No ☐

If not, what is your scheduled date for treatment? _____

Have you been issued a dosimetry badge for the current quarter? Yes ☐ No ☐

Have you worn your dosimetry badge since your treatment?* Yes ☐ No ☐

Radioisotope used for Procedure: _____ Activity Administered _____

Radioisotope used for Procedure: _____ Activity Administered _____

Date of treatment: _____ Time of treatment: _____

Comments:

Radiation Safety Officer:

* If yes, R.P. Form #3, *Exposure Investigation*, must be completed.

After reviewing this form, please complete R.P. Form #91, *Area RSO Checklist for Radiation Workers Who Have Undergone a Nuclear Medicine Procedure.*

R. P. Form #88
Revised July, 2015

J. RP Form 091 Area RSO Checklist for Radiological Workers Who Have Had a Nuclear Medicine Procedure

Fermilab

Area RSO Checklist for Radiological Workers Who have had a Nuclear Medicine Procedure

This form should be used in conjunction with RP Form #88, "Medical Procedures involving Radioactive Material". Follow the guidelines in FRCM Article 962. Additional information is contained on the back of this form. If you have any questions, contact the ESH&Q Section Dosimetry Program Manager.

☐ Inform individual's supervisor that the person is restricted from performing work radiological

☐ Confiscate the individual's dosimetry badge until the individual is released for radiological work. Inform the Dosimetry Program Manager.

☐ Instruct individual to take their used napkins, tissues, and discarded gum with them for home disposal.

☐ Instruct individual that there are no restrictions on lavatory use. However, care should be taken for items thrown into the regular trash receptacle. Disposal of napkins into the lavatory trash receptacle from drying hands after washing is acceptable.

☐ Confirm dose rates to co-workers near individual's workbench/desk are less than 0.05 mrem/hr the majority of the time.

☐ Using the information obtained on RP Form #88, estimate the date when the individual will be able to frisk/resume radiological work: _____

☐ Individual's dose (count) rate at 1meter
(1st reading): Date:
Instrument # _____ Cal. Date _____ _____ _____

☐ Individual's dose (count) rate at 1 meter
(2nd reading): Date:
Instrument # _____ Cal. Date _____ _____ _____

☐ Individual's dose (count) rate at 1 meter
(3rd reading): Date:
Instrument # _____ Cal. Date _____ _____ _____

☐ Verify individual will be able to frisk for contamination.

☐ Return dosimetry badge to the individual (if necessary), and inform the supervisor that he/she can return to his/her duties as a radiological worker.

R.P Form # 91
Revised May, 2015

Page 1 of 2

Procedure for Radiation Safety Personnel

1. Ensure confidentiality of the individual is maintained. Do not disclose private medical information to other workers. Questions regarding dose received by the individual from the nuclear medicine procedure should be directed to his/her physician.

2. Inform the person's supervisor that the person is restricted from performing work in Radiation Areas (because they cannot wear their dosimetry badge or frisk).

3. Ensure that an individual's dosimetry badge does not record medical exposure as an occupational exposure. **Confiscate the individual's dosimetry badge until the individual is released for radiological work**. Have the individual complete Radiation Physics Form # 88. After reviewing the information, forward this form to the Dosimetry Program Manager. If the dosimetry badge was inadvertently worn, collect the individual's dosimetry badge and return it to the Dosimetry Program Manager. The badge will be sent in for immediate processing. An exposure investigation may be necessary to subtract out the dose accumulated as a result of the nuclear medicine procedure.

4. Confirm dose rates to co-workers near individual's workbench/desk are less than 0.05 mrem/hr the majority of the time. In consultation with the person's supervisor, it may be advantageous to recommend that the person remain on sick leave in the hours following their nuclear medicine procedure if their dose rates are causing co-workers to receive greater than 0.05 mrem/hr and they cannot temporarily be assigned to a different work location.

5. Ensure that the individual's bodily fluids do not end up in the regular trash bins at Fermilab. Fermilab personnel who have had a nuclear medicine procedure should take all of their trash that may have bodily fluids, e.g., tissue and napkins, with them each day and dispose of it at home for as long as necessary.

6. Do not permit an individual to enter any enclosure or other area that requires a personnel frisk until their residual rates have decreased to the point where they can effectively perform a contamination frisk of themselves. Residual rates may persist for several days or weeks such that these persons will not be able to check themselves for contamination when they exit the accelerator enclosures. A rule of thumb is that it takes 7 effective half-lives for these radionuclides to decay so that the dose rates return to background levels.

7. Recommended dose rate survey schedule of personnel who have undergone a nuclear medicine procedure to evaluate the residual dose rates and confirm that they will be able to perform a contamination frisk before allowing them to enter an enclosure.

   ^{99m}Tc: Check dose rate **at 1 meter** once daily for 3 days, then as needed with an Analyst (or Frisker).

   ^{201}Tl: Check initial dose rate at **1 meter**, then once a week for three weeks until their dose rates have returned to background levels. The 4th week, verify that they will be able to frisk.

   ^{131}I: Check initial dose rate at **1 meter**, then once a week until their external dose rate has retuned to background levels.