	ES&H Section Procedures	
Procedure Number/Name ESH-RPO-SOURCE-01 Fermilab Sealed Radioactive Source Control and Accountability Program		Effective Date: 4/12/2022
Written by: Kathy Graden	Reviewed and Updated By: Kathy Graden	Revision: 15

Fermilab Sealed Radioactive Source Control and Accountability Program

Approvals

Written By:

Kathy Graden, Source Physicist

Reviewed By:

Ben Russell, Radiation Safety Officer

Approved By:

Maddie Schoell, RPO Department Head

Revision History

Author	Description of Change	Revision Number	Revision Date
K. Graden	Not known	0	December, 1988
K. Graden	Reflects changes to DOE N 5400.9	1	April, 1993
K. Graden	Incorporates changes to Fermilab sealed radioactive source program	2	February, 1994
K. Graden	Incorporates self-assessment suggestions	3	4/1/1996
K. Graden	Reflects changes to 10 CFR Part 835	4	4/17/2000
K. Graden	Adheres to revision schedule	5	1/31/2005
K. Graden	Incorporates changes to the Fermilab Sealed Radioactive Source Program	6	April, 2006
K. Graden	Editorial changes to document	7	2/22/2007
K. Graden	Reflects DOE N 234.1, Reporting of Radioactive Sealed Sources	8	6/2/2009
K. Graden	Adheres to revision schedule, creates a new document format, inclusion of DOE O 462.1, leak testing procedural change, sealed source procurement revision, source degradation and useful life addition, internal review of source use and storage addition	9	2/26/2013
K. Graden	Editorial changes	10	2/24/2016
K. Graden	Changes include incorporation of ES&H Section procedure template, new numbering system, and editorial changes	11	1/3/2017
K. Graden	Change ES&H Section Radiation Physics Engineering Team to ES&H Section Radiation Physics Engineering Department	12	1/17/2019
K. Graden	Editorial changes to include prioritization of use of government-owned vehicles vs. personal vehicles to transport radioactive sources installed on radiation survey instruments.	13	9/14/2020
K. Graden	Incorporation of procedure into ESH RPO template. Inclusion of electronic purchase requisition approval system. Editorial changes	14	2/24/2021
K. Graden	Incorporation of FRCM update to reflect no eating/drinking when sources are in use	15	4/12/2022

Table of Contents

Fermilab Sealed Radioactive Source Control and Accountability Program	1
Approvals	1
Revision History.....	2
Table of Contents	3
List of Acronyms	5
Procedure	6
1.0 Purpose.....	6
2.0 Scope	6
2.1 Review, Revision, and Change Control.....	6
2.2 Applicable DOE Regulations	6
3.0 Summary.....	6
4.0 Definitions	6
5.0 Responsibilities	7
5.1 Source Physicist/Backup.....	7
5.2 Source Technician/Backup	8
5.3 Radiation Physics Engineering Instrumentation Team.....	8
5.4 RPO Department and Hazard Control Technology Team (HCTT).....	9
5.5 Source Projector Facility Operators	9
5.6 Source Monitors.....	9
5.7 Source Users	10
6.0 Health and Safety Warnings	10
7.0 Material & Equipment Required.....	10
8.0 Procedural Steps	10
8.1 Source Physicist/Backup Training and Qualification.....	10
8.2 Radioactive Source User Policies	11
8.3 Sealed Radioactive Source Procurement.....	11
8.4 Sealed Radioactive Source Loans and Written Work Authorization	15
8.5 Sealed Radioactive Source Returns, Transfers, and Sources To Be Disposed	15
8.6 Sealed Radioactive Source Inventory Number System	16
8.7 Sealed Radioactive Source Labeling.....	17
8.8 Sealed Radioactive Source Inventory Database and Inventory Lists.....	17
8.9 The DOE Radiological Source Registry and Tracking (RSRT) System	18

8.10	Summation of Accountable Radioactive Source & Nuclear Material Activity Totals Spreadsheet	18
8.11	Sealed Radioactive Source Access Controls.....	19
8.12	Industrial Radiography Source Controls	19
8.13	Sealed Radioactive Source Reports and Records.....	20
8.14	Sealed Radioactive Source Leak Testing and Physical Inventory	20
8.15	Internal Review of Sealed Radioactive Source Use and Storage	21
8.16	Other Accountable Nuclear Materials (OANM) - Sealed Neutron Sources	22
8.17	Sealed Radioactive Source Program Violations	22
9.0	Data and Records Management	22
10.0	Quality Assurance/Quality Control	23
11.0	References	23
12.0	SOP Signature Sheet.....	24
13.0	Procedure Specific Training Checklist	24
14.0	Attachments	24

List of Acronyms

AM-241	Americium-241
ANSI	American National Standards Institute
CF-252	Californium-252
CFR	Code of Federal Regulations
DOE	Department of Energy
DOE FSO	Department of Energy Fermi Site Office
D/S	Division/Section
ES&H	Environment, Safety, Health
FERMILAB, FNAL	Fermi National Accelerator Laboratory
FESHM	Fermilab Environment, Safety and Health Manual
FRCM	Fermilab Radiological Control Manual
HCTT	Hazard Control Technology Team
IAEA	International Atomic Energy Agency
LLW	Low Level Waste
MC&A	Materials Control and Accountability
mR/hr	milliRoentgen per hour
ND	Neutrino Division
NM	Nuclear Materials
NMR	Nuclear Materials Representative
OANM	Other Accountable Nuclear Materials
RPCF	Radiation Physics Calibration Facility
R.P. FORM	Radiation Physics Form
RPP	Radiation Protection Program
RSO	Radiation Safety Officer
RSRT	Radiological Source Registry and Tracking
Source ID	Source Identification or Inventory Number
USNRC	United States Nuclear Regulatory Commission

Procedure

1.0 Purpose

The purpose of the Fermilab Sealed Radioactive Source Control and Accountability Program is to describe how the requirements set forth in applicable DOE regulations are implemented at Fermilab.

2.0 Scope

Title 10 Code of Federal Regulations Part 835, Subpart M prescribes radioactive sealed source control requirements. Appendix E of this regulation sets threshold values for accountable radioactive sources based on radioisotope and activity. Only small portions of the Fermilab inventory of sealed radioactive sources are accountable per 10 CFR Part 835, Appendix E values. The Fermilab source program scope is not limited only to Appendix E accountable sources but includes all sealed radioactive sources in the Fermilab inventory, regardless of activity.

The Fermilab Radiological Control Manual (FRCM) describes general radioactive sealed source program policies and procedures which are intended to fulfill the requirements set forth in the Fermilab Radiation Protection Program (RPP).

2.1 Review, Revision, and Change Control

The Fermilab Sealed Radioactive Source Control and Accountability Program and other procedures referenced in this document are reviewed and revised as necessary to reflect changes in the Fermilab sealed radioactive source program, Laboratory mission, applicable DOE Directives, or every five years. The Fermilab sealed radioactive source program documents are subject to change control. Change control is identified in the document Revision History section.

2.2 Applicable DOE Regulations

The following DOE orders and guidance documents are applicable to the Fermilab sealed source program:

- Title 10 Code of Federal Regulations Part 835, Occupational Radiation Protection, current revision
- DOE Order 231.1 B, Environment, Safety, and Health Reporting, current revision
- DOE Order 462.1, Import and Export of Category 1 and 2 Radioactive Sources and Aggregated Quantities, current revision

3.0 Summary

Sealed radioactive source program management, policies, and procedures are established to control and account for sealed radioactive sources at Fermilab. This program document describes radioactive source program responsibilities, training requirements, radioactive source procurement, source accountability and control procedures, written authorization, inventory database description, leak testing program, sealed source records, internal reviews of source use and storage, and reports. Note in this document and throughout other program documents, the terms “sealed radioactive source,” “sealed source,” “radioactive source,” and “source” have the same meaning and are used interchangeably.

4.0 Definitions

N/A. See list of acronyms.

5.0 Responsibilities

The Fermilab sealed radioactive source control and accountability program is administered by the Fermilab ES&H Section. The ES&H Section Chief Safety Officer or designee appoints the Source Physicist. The Source Physicist is a member of the Radiation Physics Operations (RPO) Department and reports to the RPO Department Head. Note that in all instances where “Source Physicist” and “Source Technician” are stated, it is intended that these responsibilities and duties also apply to the backup for each position.

5.1 Source Physicist/Backup

- 5.1.1 Issues sealed radioactive sources, coordinates source transfers, returns, and shipment of sources to and from Fermilab.
- 5.1.2 Coordinates purchase of new sealed radioactive sources, reviews and approves purchase requisitions for radioactive sources, and serves as a vendor resource to source users.
- 5.1.3 Approves receipt of radioactive sources and requests approval to ship radioactive sources.
- 5.1.4 Maintains radioactive source database inventory and provides updated inventory listings to Source Technician/Backup.
- 5.1.5 Completes monthly sealed radioactive source accountability report.
- 5.1.6 Completes DOE required reports.
- 5.1.7 Enters data and changes to the DOE Radiological Source Registry and Tracking System database.
- 5.1.8 Completes the Fermilab Activity Summation of Radioactive Source and Nuclear Materials Inventory List in accordance with DOE STD 1027-92.
- 5.1.9 Maintains list of Previously Used Radioactive Source ID Numbers and provides updated list to Source Technician/Backup.
- 5.1.10 Maintains inventory list of accountable radioactive sources in the Fermilab inventory.
- 5.1.11 Maintains inventory list of on-site radioactive sources to be disposed that are no longer in the Fermilab active inventory of sealed sources.
- 5.1.12 Maintains a source monitor list and key log.
- 5.1.13 Coordinates the issue, duplication, and return of source lock keys and maintains source monitor tags for source boxes.
- 5.1.14 When possible, assists with semi-annual sealed radioactive source inventory and leak testing.
- 5.1.15 Maintains a list of large safe box numbers and source ID numbers listed by isotope.
- 5.1.16 Maintains the online Radioactive Source training course.
- 5.1.17 Maintains sealed source program Radiation Physics (R.P.) forms.
- 5.1.18 When possible, periodically verifies radioactive source labeling and area postings.
- 5.1.19 Coordinates the approval and use of radioactive sources that constitute Radiation Areas and generates Radiological Work Permits (RWPs) or other written authorizations.
- 5.1.20 Coordinates the use of sealed neutron sources and generates RWPs for this work.
- 5.1.21 Conducts periodic internal reviews of sealed source use and storage and implements corrective actions based on these internal reviews.

- 5.1.22 Informs the Source Technician of routine source activities and any problems that may arise.
- 5.1.23 Responds to source incidents, investigates loss of sources, potential source problems, and source policy violations.

5.2 Source Technician/Backup

- 5.2.1 Maintains radioactive sealed radioactive source records and paperwork (including shipping papers).
- 5.2.2 Receives radioactive sources from Fermilab Shipping/Receiving Department, completes proper shipping/receipt paperwork, and packages sources for shipment off-site. Provides copies of paperwork on shipments and receipts of sealed radioactive sources to the Source Physicist.
- 5.2.3 Conducts exposure rate surveys on radioactive sources and maintains survey records.
- 5.2.4 Assigns inventory numbers and labels new radioactive sources.
- 5.2.5 Installs radioactive sources in source holders, modifies existing source configurations, and supervises installation of sources in experimental apparatus.
- 5.2.6 Provides radiological postings and source ID labels for sources installed in experimental apparatus.
- 5.2.7 Conducts wipe surveys and inventory verification of sources on loan and in storage.
- 5.2.8 Completes Source Inventory Log (R.P. Form # 67) in accordance with ESH-RPO-SOURCE-05, Sealed Source Leak Testing and Inventory Verification procedure. This procedure is located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=155>
- 5.2.9 Decontaminates sources.
- 5.2.10 Conducts radioactive source deliveries, transfers, and returns.
- 5.2.11 Notifies the Source Physicist of all transfers of sources within ES&H Section areas.
- 5.2.12 Responds to radioactive source incidents.
- 5.2.13 Supervises the use of high activity radioactive sources on a case-by-case basis.
- 5.2.14 Provides radiological posting for source storage and use when necessary.
- 5.2.15 In consultation with the Source Physicist, disposes of sources that are degraded, leaking, or decayed to the point that they are no longer useful.
- 5.2.16 Informs the Source Physicist of routine sealed radioactive source activities, source policy violations, and potential problems that may be observed.

5.3 Radiation Physics Engineering Instrumentation Team

- 5.3.1 Installs and removes radioactive sources on radiation survey instruments and notifies Source Physicist of these changes via email.
- 5.3.2 With Source Physicist approval, orders and purchases radioactive sources for radiation detection instruments and instrument calibration.
- 5.3.3 Maintains High and Low Level Calibration Facility Procedures and radioactive source decay sheet.

- 5.3.4 Assists radioactive source users in special measurements and serves as an instrumentation resource to both source users and the Fermilab Radiological Control Organization.
- 5.3.5 Maintains a list of instruments due for calibration.
- 5.3.6 Notifies Source Physicist of instruments containing radioactive sources that are overdue for calibration and have not been returned to the Radiation Protection Instrumentation Team.

5.4 RPO Department and Hazard Control Technology Team (HCTT)

- 5.4.1 RPO Department and HCTT personnel assist the Source Physicist and Source Technician as the need arises and notify them of any sealed radioactive source program issues.

5.5 Source Projector Facility Operators

- 5.5.1 Only properly trained ES&H Section personnel may operate the High Level Calibration Facility and the Low Level Calibration Facility located at the Radiation Physics Calibration Facility (RPCF). The physical description of the facility, including the safety features, personnel authorization requirements, and facility operating procedures are contained in the Fermilab ES&H Section High Level Calibration Facility Operating Procedures and the ES&H Section Low Level Calibration Facility Operating Procedures. Low Level Calibration Facility procedures are located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1645>
High Level Calibration Facility procedures are located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1644>

5.6 Source Monitors

- 5.6.1 Source monitors are lab employees or experimenters who are designated by the Source Physicist. Source monitors are assigned source box keys to designated source storage boxes.
- 5.6.2 Source monitors are required to have current Radiological Worker training (FN000470 and FN000471) and Radioactive Source training (FN000048).
- 5.6.3 When the source box key is issued, the Source Physicist/Backup reviews Source Monitor Responsibilities and policies with the source monitor as described in Radioactive Source Training (FN000048) and Source Monitor Responsibilities (R.P. Form #101). As verification of this additional instruction, source monitors complete Source Monitor Information Sheet (R.P. Form #101).
- 5.6.4 Source monitors are responsible for the control of the source box key issued to them by the ES&H Section. In consultation with the Source Physicist, source monitors may share a source box key with other source monitors.
- 5.6.5 Source monitors are responsible to unlock and lock source boxes and log sources in and out on the Radioactive Source Access Log (R.P. Form #37).
- 5.6.6 When a source access log sheet is full, source monitors are instructed to send the completed log to the ES&H Section Source Physicist.

- 5.6.7 Source monitor names and contact information should be posted near or on each source box.
- 5.6.8 When a person is no longer designated a source monitor, he/she is instructed to return the key to the ES&H Section Source Physicist.

5.7 Source Users

- 5.7.1 Source users must have current Radiological Worker training (FN000470 and FN000471) and Radioactive Source training (FN000048). Users must comply with Fermilab sealed radioactive source program policies.

6.0 Health and Safety Warnings

Though highly unlikely, ES&H personnel involved in the radioactive source program may come into contact with contaminated and/or potentially contaminated radioactive sources. As such, proper precautions should be taken to reduce the spread of radioactive contamination and prevent personnel contamination during installation or removal of radioactive sources from holders, or upon receipt of new radioactive sources. A Radiological Work Permit is in place to cover work with radioactive sources at Site 40.

7.0 Material & Equipment Required

7.1 Material & Equipment Required

- Computer
- Writing utensils
- Contamination wipes and envelopes
- Dosimetry badges
- Various Radiation Physics Forms

7.2 Training Required

- Radiological Worker Training (FN000470 and FN000471) or DOE Core Academics for RCTs (FN000277) and RCT Continuing Training and Requalification (FN000300)
- Radioactive Source Training (FN000048)

8.0 Procedural Steps

8.1 Source Physicist/Backup Training and Qualification

- 8.1.1 The Source Physicist and Source Physicist Backup are members of the ES&H Section RPO Department. The requirements for RPO Department members include a minimum of three to five years of radiation protection experience and a bachelor's degree in Health Physics or related field. An advanced degree may be substituted for a portion of the required experience.
- 8.1.2 RPO Department members are required to complete a series of Fermilab-specific radiation protection training courses.
- 8.1.3 The Source Physicist and Source Physicist Backup must remain current in Radiological Worker training (FN000470 and FN000471) and Radioactive Source training (FN000048).

8.2 Radioactive Source User Policies

- 8.2.1 The user shall not tamper with, disassemble, or modify a source or its holder in any way, nor remove any source from its holder or housing. Requests for source installation or modification must be discussed with ES&H Section personnel.
- 8.2.2 Eating and drinking are prohibited in areas where radioactive sources or radioactive materials are being used. Please keep food and drinks out the area while using radioactive sources or working with radioactive materials. This policy does not apply to radioactive sources mounted on radiation survey instruments.
- 8.2.3 If a user purchases a radioactive source, purchase requisitions must be routed through the ES&H Section Source Physicist (or designee) for proper approval and signatures.
- 8.2.4 Radioactive sources shall not be brought to or taken from Fermilab unless approved in advance by the Fermilab Senior Radiation Safety Officer (SRSO) or designee.
- 8.2.5 Radioactive sources shall be kept in a locked box/cabinet when not in use. The storage box/cabinet shall bear sign(s) "*Caution Radioactive Material*."
- 8.2.6 Sources shall be accessible to ES&H Section personnel for monthly inventory and leak testing.
- 8.2.7 Dosimetry badges shall be worn, and a "*Caution Radiation Area*" sign shall be displayed when the exposure rate is ≥ 5 mR/hr at 30 cm (1 foot) from source. A Radiological Work Permit will be required.
- 8.2.8 A "*Caution Radioactive Material*" sign shall be displayed near the source during use. If a source is contained within detection equipment, a "*Caution Radioactive Material*" label with the source ID clearly stated must be attached to the outside of the equipment.
- 8.2.9 The user shall not leave sources unattended. Sources should be under constant surveillance, or they should be secured. The Source Physicist (or designee) shall be notified if a source is to be used for an extended period of time (days or weeks) without returning it to its designated storage location. Special arrangements shall be made to ensure adequate source control.
- 8.2.10 The user shall not detach the "*Caution Radioactive Material*" or source ID tag/label from the source.
- 8.2.11 ES&H Section Source Physicist shall be contacted to arrange for on-site source transfers. Sources may only be transferred by ES&H Section personnel in government vehicles.
- 8.2.12 The user shall notify the ES&H Section Source Physicist (or designee) when the source is no longer needed. ES&H Section personnel will pick up the source and return it to ES&H Section storage.
- 8.2.13 The user shall promptly notify the ES&H Section Source Physicist (or designee) if a source is discovered missing, lost, or found.
- 8.2.14 If a user suspects that a source is broken or causing contamination, the user shall call or have someone call x3131 immediately. The source should not be removed from its current use/storage location. Others should be kept away from the source.
- 8.2.15 Exceptions to any of the above rules shall be approved in advance in writing by the SRSO. Departures from these rules may result in confiscation of the source(s) or other disciplinary actions.

8.3 Sealed Radioactive Source Procurement

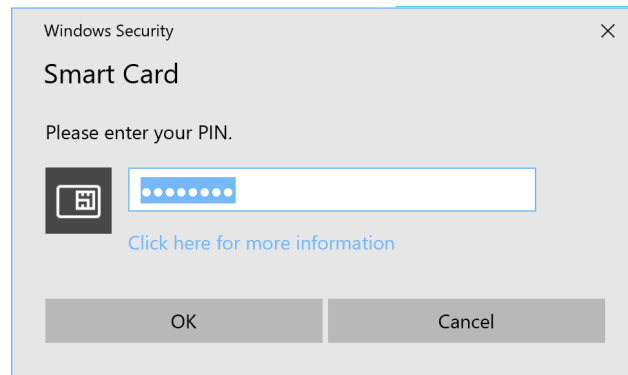
8.3.1 Approving Radioactive Source Purchase Requisitions

- Radioactive source procurement policies are described in FRCM Chapter 4

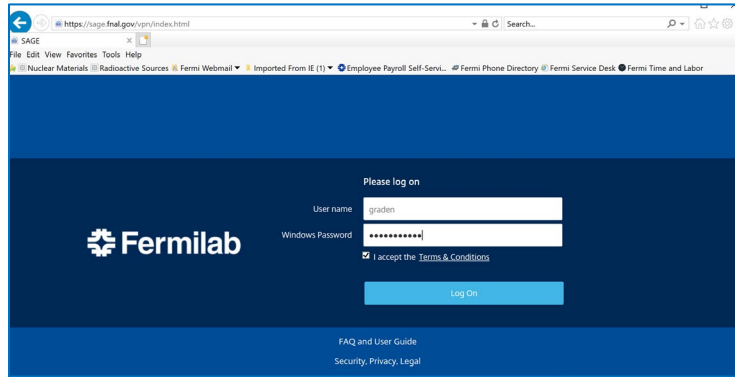
- Source Physicist and Senior Radiation Safety Officer (SRSO) approvals are required
- Radioactive source purchase requisitions must be approved by the Safety Officer that represents the Division/Section where the sealed radioactive source will be used
- The Source Physicist and SRSO receive email notifications when purchase requisitions are pending and need approval
- Purchase requisitions are approved electronically via the following website: sage@fnal.gov
- To access this website, you must have a Yubikey or RSA token
- Go to sage@fnal.gov. Click OK to confirm certificate as shown below:



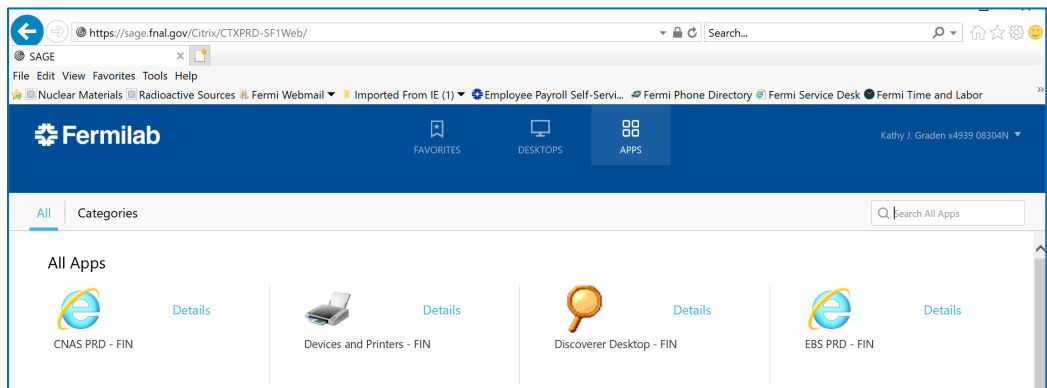
- Enter your Yubikey/RSA token credentials as shown below:



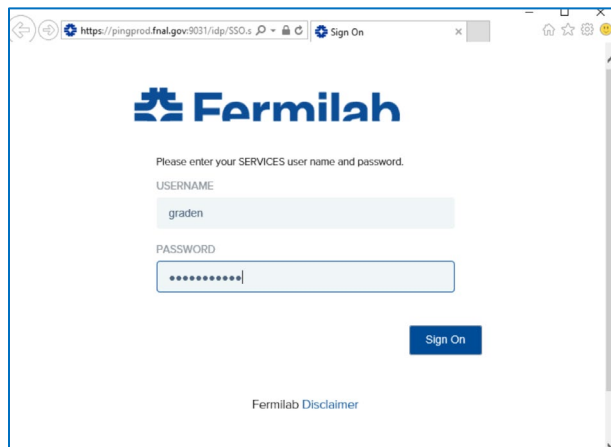
- Enter Username and Windows Password as shown below:



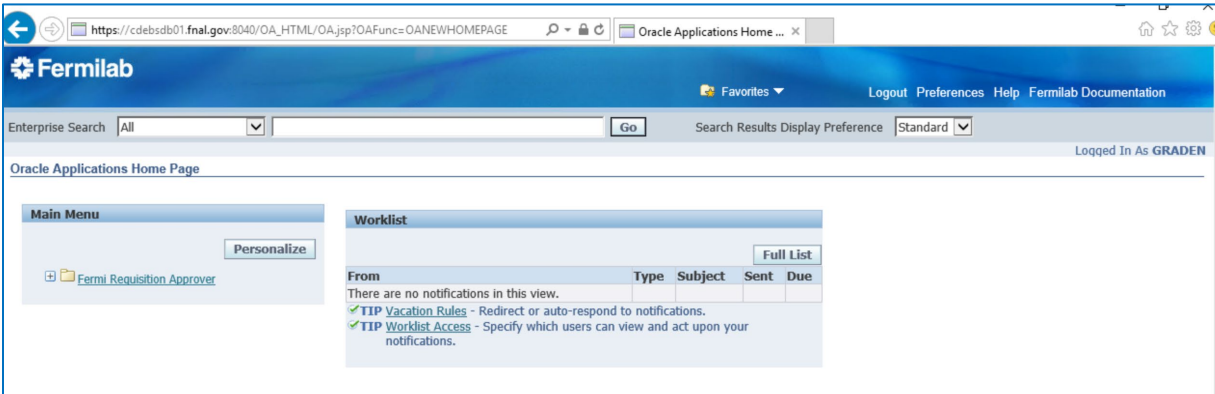
- Click Apps and then click EBS-PRD-FIN as shown below:



- Enter Username and Windows Password and click Sign On as shown below:



- The purchase requisition notification will appear in the worklist window. The example below doesn't have any notifications to view



- Click on Notification in Worklist
- Read over Notes in upper right hand corner of webpage
- Approve and forward to the SRSO
- Logout of the EBS-PRD-FIN system
- If the electronic purchase requisition EBS-PRD-FIN application is not working or not accessible, the Source Physicist completes and signs ES&H Section Radioactive Source Purchase Requisition and Approvals form (R.P. Form #107). This form provides notes to the buyer, receiver, and the vendor as follows:
 - *Note to Buyer: Mark P. O. "Contains radioactive material. Prime DOE Contractor. No license required."*
 - *Note to Receiver: Hold at Receiving. Contact ES&H Section HCTT on arrival.*
 - *Note to Vendor: Removable activity must be less than 5 nanoCuries.*
- The Source Physicist attaches the signed ES&H Section Radioactive Source Purchase Requisition and Approvals form to the purchase requisition and returns the requisition to ES&H Section Admin Team.
- In the case of import or export of International Atomic Energy Agency (IAEA) Category 1 and 2 sealed sources, DOE Order 462.1, *Import and Export of Category 1 and 2 Radioactive Sources and Aggregate Quantities*, will be followed.

8.3.2 Shipping and Receiving Radioactive Sources

- Sealed radioactive sources purchased from outside vendors or shipped to Fermilab from other institutions are shipped to the ES&H Section through Fermilab Receiving Department.
- The Source Physicist communicates with potential shippers to provide them with Fermilab shipping requirements and policies.
- The Source Physicist/Backup approves receipt of radioactive sources and requests approval to ship radioactive sources. Refer to Checklist for Approval of Receipt and Shipment of Rad Materials and Sources (R.P. Form #115) for the checklist items to complete for shipping and receiving radioactive sources. This blank form is located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=4199>

8.4 Sealed Radioactive Source Loans and Written Work Authorization

8.4.1 Sealed Radioactive Source Loans

- When a sealed radioactive source is issued, the Source Physicist completes the ES&H Section Radioactive Source Loan Form (R.P. Form #12). The Source Physicist verifies that the source user has current Radiological Worker (FN000470 and FN000471) and Radioactive Source training (FN000048)
- The source user reads, signs, dates, and returns this form to the Source Physicist/Backup
- The Source Technician maintains a file of this form
- The Source Physicist retains a copy until the source inventory database has been updated to reflect the change
- When a source is issued, ES&H Section personnel deliver the sealed source to the designated source box indicated on the source loan form

8.4.2 Written Work Authorization

- Written work authorization is required for use of sealed radioactive sources with exposure rates high enough to constitute Radiation Areas.
- The Source Physicist maintains a list of sealed radioactive sources and their associated exposure rates that are equal to or greater than 5 mR/hr at one foot (30 cm). This list is maintained on Loaned Sources that Require a Radiological Work Permit (R.P. Form #26).
- To document written authorization, the Source Physicist/Backup generates a Job-Specific Radiological Work Permit to cover the work.

8.5 Sealed Radioactive Source Returns, Transfers, and Sources To Be Disposed

8.5.1 Radioactive Source Returns

- When a sealed source is returned to ES&H Section storage, the Source Physicist or Source Technician completes a Source Return Form (R.P. Form #44)
- The Source Technician maintains a file of this form. The Source Physicist retains a copy until the source inventory database is updated
- Periodically, a lab-wide source collection may be conducted. Any sources which are no longer needed or that have not been used for extended periods of time (more than 6 months) are returned to ES&H Section storage at Site 40.
- If returned sealed radioactive sources need to be used on a subsequent experiment, they may be reissued at that time following the procedures described above

8.5.2 Radioactive Source Transfers

- When an authorized user needs to use a source in any location other than the one listed on the source loan form, the user must notify ES&H Section personnel to make arrangements for a source transfer
- ES&H Section personnel transport the source to the new location in a government vehicle
- The Source Physicist completes a Source Transfer Form (R.P. Form #45)

- The Source Technician maintains a file of this form and the Source Physicist retains a copy until the source inventory database is updated
- When sources are transferred from one location to another within the ES&H Section, the Source Technician notifies the Source Physicist of these transfers
- Use of government-owned laboratory vehicles by radiological control personnel takes priority over use of personal vehicles for transport of radioactive sources and for sources installed on radiation survey instruments

8.5.3 Radioactive Sources To Be Disposed

- Periodically, the Source Technician reviews sources in storage and identifies sources that have degraded or decayed to the point that they are no longer useful
- The Source Technician consults the Source Physicist to determine which sources should be disposed
- The Source Technician documents pertinent information on the Source Disposal Form (R.P. Form #4). Itemized lists of the sources awaiting disposal are maintained by the Source Technician
- The Source Physicist/Backup maintains an inventory list of on-site sources to be disposed
- When alpha-emitting sources are deemed to have compromised integrity based on age or other conditions resulting in the potential for leakage, such sources are removed from service. Determination of useful life for alpha-emitting sources is based on manufacturer's data, as available. Current manufacturer information provides data for alpha-emitting sources up to twenty years. Therefore, alpha-emitting sources that are twenty years or older may need to be removed from service.

8.6 Sealed Radioactive Source Inventory Number System

8.6.1 Radioactive Source Inventory Number System

Fermilab has a unique system of source identification. Each sealed source is assigned an individual inventory number commonly known as the source ID. Inventory numbers previously assigned to any sources, including those on the disposed list are not reused.

8.6.2 For alpha, beta, and gamma sources, the first of the three-part inventory number represents the atomic mass of the isotope.

8.6.3 The second of the three-part number represents the initial activity in microCuries (rounded to one significant figure).

8.6.4 The third number of the three-part inventory number is the next sequential number denoting the number of sources of that atomic mass and activity that have been assigned source inventory numbers in the past. Examples are as follows:

- a. For the 54th 1,000 microCurie Strontium-90 source in the inventory:

$$90-3.1-54 \leftarrow 54^{\text{th}} \text{ source in inventory}$$

↑ ↑

Atomic mass 1×10^3 microCuries (rounded)

- b. For the 400th 0.5 microCurie Cesium-137 source in the inventory:

$$137(-1.5)400 \leftarrow 400^{\text{th}} \text{ source in inventory}$$

↑ ↑

Atomic mass $5 \times 10^{-1} = 0.5$ microCuries

- 8.6.5 For sealed neutron sources, the scheme is as follows:

- a. An Americium-241 Beryllium neutron source producing 4×10^5 neutrons per second is identified as 241Be-5.4-1.
- b. A Californium-252 neutron source producing 2×10^7 neutrons per second is identified as 252-7.2-1.

- 8.6.6 For mixed gamma sources, a different scheme is followed. The source inventory number for these sources is "QCD.1-next sequential number in the inventory." The next sequential number is determined by referring to the list of previously used source ID numbers. For example, the 80th mixed gamma source in the Fermilab inventory would be identified as QCD.1-80.

8.7 Sealed Radioactive Source Labeling

- 8.7.1 A sealed radioactive source label bears the standard propeller symbol for ionizing radiation and states the unique Fermilab inventory number and the receipt date of the source.
- 8.7.2 Whenever possible, metal source tags are used to label sources. These tags are securely attached to the source. In cases where metal tags cannot be used, tape labels are attached to the source.
- 8.7.3 Radioactive sources mounted on experimental apparatus that are hidden from direct view have readily visible labels affixed to the external surface of the apparatus with a "Caution, Radioactive Materials" label and source ID.

8.8 Sealed Radioactive Source Inventory Database and Inventory Lists

- 8.8.1 ESH-RPO-SOURCE-02, Fermilab Radioactive Sources Database Data Entry Procedure, Source Inventory Lists, and Accountability Report, provides step-by-step procedures for entering data into the radioactive sources database. This procedure is located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2139>

- 8.8.2 The Source Physicist is responsible for maintaining and updating the radioactive sources database. Access to this Oracle APEX database is restricted to the Source Physicist, Backup, and RPO Department Head.
- 8.8.3 On a monthly basis, the Source Physicist enters data for new sources into the radioactive sources database, deletes sources to be disposed, updates sources that have been issued, returned, transferred, and removed/installed on radiation detection instruments. Radioactive sources that are permanently shipped off-site to other institutions are removed from the active inventory. If a source is returned to Fermilab, it is returned to the active inventory at that time.
- 8.8.4 Radioactive sources that are shipped off-site to other institutions for a period of time and then returned to Fermilab are listed as “off-site other institutions” while they are at other institutions.
- 8.8.5 On a monthly basis, the Source Physicist provides inventory lists to the Source Technician after the database has been updated. Three source inventory lists are provided. The first is sorted by radioisotope, the second is sorted by location, and the third inventory list is a field copy. The Source Physicist/Backup emails these lists to the Source Technician and Source Technician Backup.
- 8.8.6 An inventory list of pre-existing source ID numbers is also provided to the Source Technician periodically.

8.9 The DOE Radiological Source Registry and Tracking (RSRT) System

- 8.9.1 DOE Order O 231.1B, *Environment, Safety and Health Reporting* identifies requirements for centralized inventory and transaction reporting for sealed radioactive sources. Each DOE site/facility operator/contractor that owns, possesses, uses or stores accountable sealed radioactive sources identified in Appendix E of 10 CFR Part 835 and the International Atomic Energy Agency (IAEA) Categories 1 and 2 sealed radioactive sources identified in Appendix A of DOE Order 321.1B, must submit sealed source inventory data to the DOE RSRT system.
- 8.9.2 On an annual basis, the Source Physicist/Backup completes the Annual Verification of International Atomic Energy Agency (IAEA) Category 1 and 2 Sealed Radioactive Sources.
- 8.9.3 ESH-RPO-SOURCE-03, Fermilab Data Entry Procedure for DOE Radiological Source Registry Tracking (RSRT) and Annual Verification Report provides detailed instructions for submitting data to the RSRT database. This procedure is located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=930>
- 8.9.4 The RSRT User Manual can be found in Attachment 1 of ESH-RPO-SOURCE-03.

8.10 Summation of Accountable Radioactive Source & Nuclear Material Activity Totals Spreadsheet

- 8.10.1 DOE Standard 1027-92, *Hazard Categories of DOE Nuclear Facilities* provides requirements and guidance for determining if a DOE nuclear facility is a Hazard Category (HC) 1, 2, 3, or below HC-3 nuclear facility, as required by Title 10 of the Code of Federal Regulations (CFR) Part 830, *Nuclear Safety Management*. In establishing the safety basis for a hazard category 1, 2, or 3 DOE nuclear facility,

Fermilab is responsible to categorize accountable radioactive sources and nuclear materials consistent with this DOE Standard.

- 8.10.2 The Fermilab Activity Summation of Radioactive Source and Nuclear Materials Inventory List spreadsheet is maintained in accordance with DOE STD 1027-92 to ensure minimum category threshold values are not exceeded.
- 8.10.3 ESH-RPO-SOURCE-04, DOE STD 1027-92 Summation of Accountable Radioactive Source & Nuclear Material Activity Totals procedure provides instructions for completing this spreadsheet. This spreadsheet is located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=151>

8.11 Sealed Radioactive Source Access Controls

- 8.11.1 Sealed radioactive sources on loan are stored in locked source boxes. Keys to source box locks are issued to source monitors. Source boxes are equipped with two source boxes. The upper box is used to store sources and is kept locked. In the event that a source monitor is not available to return the source to the upper box, a lower source box is available which allows a source user to secure the source. In this case, a source user places the source into the lower box, closes the lid to lock the box, and contacts a source monitor as soon as possible. The source monitor is responsible to open the lower box, retrieve the source, return it to the main source box, and complete the source access log.
- 8.11.2 During use, sealed radioactive sources must be under continuous supervision by qualified source users or the radioactive source must be secured.
- 8.11.3 Sources placed in experimental apparatus on a temporary basis must be secured in such a way that individuals do not have ready access to the radioactive source. Usually, rooms are locked, or areas are cordoned off to limit access to sources placed in experimental equipment on a temporary basis. Source users are instructed to post a sign that reads "Testing in progress. Do not disturb."
- 8.11.4 Sealed radioactive sources stored under ES&H Section control are secured in a large safe with a combination located in the locked source room at Site 40.
- 8.11.5 Padlocks and combination locks for radioactive source cabinets, neutron storage cave, source projector facility source containers, and source safes are changed in when deemed necessary by the Source Physicist/Backup.
- 8.11.6 The Radiation Physics Engineering Instrumentation Team Leader or designee maintains combination codes. Random changing of combinations is prohibited.

8.12 Industrial Radiography Source Controls

- 8.12.1 Specific procedures for use of radiography sources are described in FRCM Article 362. To minimize the hazard associated with the use of radiography sources at Fermilab, stringent controls are in place. Industrial radiography sources present a serious radiological hazard to personnel unless handled with extreme care.
- 8.12.2 The Source Physicist/Backup is responsible to ensure the contractor has a valid U. S. Nuclear Regulatory Commission (NRC) or Agreement State license, emergency procedures, and radiographer training certifications.
- 8.12.3 The Source Physicist/Backup completes RSO and RCT Radiography Checklist (R.P. Form #112) and provides this checklist to the lead RCT for the radiography job.

- 8.12.4 The Source Physicist/Backup sends an email approval request to the SRSO describing the controls in place for the radiography work.
- 8.12.5 After the SRSO approves the radiography, the Source Physicist/Backup sends a memo to Security Department management, Fire Department management, RPO Department management, Division/Section DSO, Division/Section Admin managers, and other personnel involved with the radiography work. Radiography notification memos should be posted on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=3359>

8.13 Sealed Radioactive Source Reports and Records

- 8.13.1 In addition to other reports previously described above, the Source Physicist/Backup completes the Radioactive Source Accountability Report (R.P. Form #38) on a monthly basis. Instructions for completing this report are described in ESH-RPO-SOURCE-02, Fermilab Radioactive Sources Database Entry Procedure, Inventory Lists, and Accountability Report. The Radioactive Source Accountability Report documents source loans, returns, transfers, additions, and deletions. This report identifies the number of ES&H Section sources, sources on loan, sources mounted on instruments, sources mounted in detectors, and the number of sources at various locations. The total number of sources in the inventory is reconciled each time the report is generated. If a discrepancy is found, the Source Physicist identifies the discrepancy and corrects it. The Source Physicist maintains the accountability report and files a copy in the ES&H Section files. This report is posted on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=153>
- 8.13.2 On a monthly basis, the Source Technician generates the Source Activity Report (R.P. Form #62). This report documents sources loaned to users, new sources received, sources returned, source transfers, and sources to be disposed. This report is generated independent of the accountability report described above. This report provides another check and balance to the source inventory system.
- 8.13.3 On a monthly basis, the Source Technician completes a Sealed Neutron Source Physical Inventory Log (R.P. Form #47) to document the physical inventory of sealed neutron sources.

8.14 Sealed Radioactive Source Leak Testing and Physical Inventory

- 8.14.1 The procedure for leaking testing sealed radioactive sources is described in ESH-RPO-SOURCE-05, Sealed Radioactive Source Leak Testing Procedure. This procedure is location on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=155>
- 8.14.2 Sealed radioactive source leak testing is divided into Loaned, Neutron, and Radiation Physics Sources.
- 8.14.3 In general, loaned and neutron sources are wiped monthly except for sources located in areas that are unsafe for human entry or otherwise inaccessible (e.g. sealed sources installed in detectors). Sources installed in experimental apparatus are inventoried and this action is documented on the Source Inventory Log (R.P. Form #67). During shutdown or if staff is reduced for other reasons,

these sources may be inventoried and leak tested less frequently than every month, but no less frequently than every six months.

- 8.14.4 Sealed radioactive sources in ES&H Section storage are leak tested every six months, unless they have been removed from service.
- 8.14.5 The Radiation Physics Engineering Instrumentation Team conducts leak tests on sealed radioactive sources mounted on instruments when instruments are returned for calibration, repair, or source replacement.
- 8.14.6 Sealed radioactive sources removed from service or placed in storage, including sources mounted on stored instruments, are not subject to periodic leak testing. Such sources shall be wiped prior to being returned to service.
- 8.14.7 Sealed radioactive sources are leak tested whenever damage is suspected. Sources found to be leaking shall be controlled in a manner that minimizes the spread of contamination and shall be removed from service.
- 8.14.8 Depleted uranium in ES&H Section storage is physically inventoried every two years as part of the Fermilab Materials Control and Accountability (MC&A) Plan.
- 8.14.9 All sealed radioactive source wipes are counted on the Radionuclide Analysis Facility (RAF) sample changer. If wipe results indicate that contamination levels exist above threshold set points, the source will be removed from service immediately. The source is decontaminated and held in storage for a number of days. The source is then leak tested a second time. If contamination reappears on the source after it has been decontaminated and stored for a period of time (a few weeks up to 30 days), the source is either designated as “to be disposed” or sent back to the manufacturer for replacement or repair. If the source shows no further contamination, it is returned to service and is available for use.
- 8.14.10 An ES&H Section Radiological Work Permit is in place to address sealed radioactive source work at Site 40.

8.15 Internal Review of Sealed Radioactive Source Use and Storage

- 8.15.1 Periodically, the Source Physicist/designee conducts field checks of the use and storage of sealed sources. This internal review serves to identify and correct sealed radioactive source use and storage discrepancies. The Review Checklist for Sealed Source Use and Storage (Radiation Physics Form #106) is used to document these reviews.
- 8.15.2 A separate checklist form is completed for each location where sealed sources are used and stored. This form identifies items to review such as comparison of sources in source boxes with the inventory list, physical condition of sealed sources, verification that sealed source labels and tags are intact, review of sealed source access logs, source monitor training status, radiological postings, observation of individuals using sources, and source user training status.
- 8.15.3 If possible, all identified discrepancies are corrected on the spot. In all cases, the Source Physicist is notified of any discrepancies and corrective actions. The Source Physicist conducts follow-up discussions and implements corrective actions as necessary.

8.16 Other Accountable Nuclear Materials (OANM) - Sealed Neutron Sources

- 8.16.1 Sealed neutron sources are tracked in the radioactive sources database and also in the nuclear materials database because they are defined as OANM. Nuclear materials control and accountability procedures are documented in the Fermilab Nuclear Materials Control and Accountability Plan. The Fermilab Nuclear Materials Representative maintains these documents.
- 8.16.2 Sealed neutron sources are stored in the neutron source storage cave located in Cave One at the RPCF. Locked doors, a surveillance system, and combination locks are used to restrict access to neutron sources.
- 8.16.3 A list of authorized users is posted in the RPCF Cave 1 that lists personnel who have authorized access to sealed neutron sources.
- 8.16.4 The procedure for use of a neutron source in experimental areas is described in ESH-RPO-SOURCE-06, Procedure for Neutron Source Use in Experimental Areas. This procedure is located on DocDB here: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=186>

8.17 Sealed Radioactive Source Program Violations

- 8.17.1 ES&H Section personnel may confiscate sources if policies stated in FRCM Chapter 4 are violated or in any other case deemed necessary to maintain proper sealed radioactive source controls. In such a case, the Source Technician or the Source Physicist notes that a particular source has been confiscated on the Source Access Log (R.P. Form #37).
- 8.17.2 The Source Physicist notifies the appropriate source user of the source policy violation and determines follow-up actions, as appropriate.
- 8.17.3 Only designated ES&H Section personnel can reissue confiscated sources.

9.0 Data and Records Management

DOE-STD-1027-2018, Hazard Categorization of DOE Nuclear Facilities,

<https://www.standards.doe.gov/standards-documents/1000/1027-astd-2018>

ESH-RPO-01, Fermilab Sealed Radioactive Source Control and Accountability Program,

<https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=156>

ESH-RPO-SOURCE-02, Fermilab Radioactive Sources Database Entry Procedure, Inventory Lists, and Accountability Report, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2139>

ESH-RPO-SOURCE-03, Fermilab Data Entry Procedure for DOE Radiological Source Registry Tracking (RSRT) and Annual Verification Report, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=930>

ESH-RPO-SOURCE-04, DOE STD 1027-92 Summation of Accountable Radioactive Source & Nuclear Material Activity Totals Spreadsheet, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=151>

ESH-RPO-SOURCE-05, Sealed Source Leak Testing and Inventory Verification procedure, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=155>

ESH-RPO-SOURCE-06, Procedure for Neutron Source Use in Experimental Areas, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=186>

High Level Calibration Facility Procedures, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1644>

Low Level Calibration Facility Procedures, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1645>

Radiography Notification Memos, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=3359>

10.0 Quality Assurance/Quality Control

This procedure is subject to a review/update frequency requirement of five years and is due 2/2026.

11.0 References

Radiation Physics Form #4, Source Disposal Form, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2381>

Radiation Physics Form #8, ES&H Section Radioactive Source Use Log, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2385>

Radiation Physics Form #12, ES&H Section Radioactive Source Issue Form, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1290>

Radiation Physics Form #26, Loaned Sources that Require a Radiological Work Permit, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1297>

Radiation Physics Form #37, Radioactive Source Access Log, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1302>

Radiation Physics Form #38, Fermilab Radioactive Source Accountability Report, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2770>

Radiation Physics Form #44, Source Return Form, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1306>

Radiation Physics Form #45, Source Transfer Form, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1307>

Radiation Physics Form #47, Sealed Neutron Source Physical Inventory Log, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=6422>

Radiation Physics Form #48, New Sources Received, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=6425>

Radiation Physics Form #61, Sources Issued, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=6428>

Radiation Physics Form #62, Source Activity Report, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2382>

Radiation Physics Form #67, Source Inventory Log, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1313>

Radiation Physics Form #83, Sources Returned/Transferred, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=6431>

Radiation Physics Form #101, Fermilab Source Monitor Responsibilities, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=1334>

Radiation Physics Form #106, Review Checklist for Sealed Source Use and Storage, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2383>

Radiation Physics Form #107, ES&H Section Radioactive Source Purchase Requisition Notes and Approvals Form, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=2384>

Radiation Physics Form #112, RSO and RCT Radiography Checklist, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=3960>

Radiation Physics Form #115, Checklist for Approval of Receipt and Shipment of Rad Materials and Sources, <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=4199>

12.0 SOP Signature Sheet

N/A. Training described in section 7.2 is tracked in TRAIN.

13.0 Procedure Specific Training Checklist

N/A. Training described in section 7.2 is tracked in TRAIN.

14.0 Attachments

N/A