ENVIRONMENT, SAFETY & HEALTH

RADIATION SAFETY POLICY

Document-116276
Version 2
June 2016

Table of Contents

Version Control

Responsible Person	Document Control Number	Document Version	Publication Date	Description of Change
Charles P. Lichtenwalner	Document-116276	1	10/07/2014	Initial release.
Charles P. Lichtenwalner / Noel Schroeder	Document-116276	2	06/07/2016	Added Ionizing Radiation-Producing Machines to Policy, including references to ANSI/HPS N43.1. Changes to reflect current practices and based on comments from CASPAR readiness review committee and collaboration.

1.0 PURPOSE

It is the policy of SDSTA to protect employees, users, visitors, and the general public from excessive radiation created by any activity at SDSTA. This policy shall be implemented by the establishment of procedures and processes designed to limit exposure to all personnel to levels as low as reasonably achievable (ALARA). The overarching procedures described below establishes the roles and responsibilities of SDSTA personnel, identifies necessary detailed procedures and sets reference standards for measuring the achievement of this policy.

2.0 SCOPE

This policy and procedures covers work with radiation-producing materials licensed by the state regulator for radioactive materials. South Dakota is a "non-agreement state", which means that the Nuclear Regulatory Commission (NRC) is the state regulator for radioactive materials. Ionizing radiation-producing machines policy and procedures will be covered by the ANSI/HPS standard N43.1 "Radiation Safety for the Design and Operation of Particle Accelerators" and will be licensed by the SDDENR.

3.0 RESPONSIBILITIES

Laboratory Director

- Ensure that Sanford Lab management NRC license responsibilities are fulfilled per NUREG-1556 Volume 7 Section 3.

ESH Director

- Appoints Sanford Lab Radiation Safety Officer.

Science Director

- Appoints Radiation Contamination Subcommittee members to evaluate the introduction of radioactive materials into shared laboratory spaces and the effects of accelerators on experimental operations.

Radiation Safety Officer (RSO)

- Ensure radiological safety and compliance with NRC and DOT regulations per NUREG-1556 Vol 7 Appendix I.
- Ensure radiological safety and compliance with recommendations of ANSI/HPS N43.1.
- Register ionizing radiation-producing machines as required by the SDDENR.
- Conduct physical inventories as required by the NRC license.
- Ensure tests for leakage and/or contamination are conducted for sealed sources as required by the NRC license.
- Develop and submit reports as required by the NRC license.
- Authorize Radiation Users at Sanford Lab.
- Apply for license amendments and renewals to maintain compliance.
- Ensure appropriate radiation monitoring equipment is available, maintained and calibrated.
- Review designs of accelerator radiation safety interlock systems.

- Assure proper maintenance of radiological protection records.
- Supervise shipments of radioactive materials entering or leaving the Sanford Lab site.

Authorized User (AU)

- Ensure that radioactive materials and machines used in his or her particular laboratory or area are used safely and according to regulatory and Sanford Lab requirements.
- Ensure that engineering and administrative controls are used to keep occupational doses and doses to members of the public below NRC limits and that no individual be exposed to radiation unnecessarily. (ALARA)

Radiation User

- Follow radiation safety procedures.
- Report unsafe conditions to supervisor and RSO.
- Report any irregularities or abnormal events, as specified in the Incident and Near Miss Reporting and Response Investigation.

Warehouse Shipping/Receiving Personnel:

- Identify a package containing radioactive material according to labeling, shipping papers, and associated prior notification.
- Segregate the package from other incoming items in a secured area until released by the RSO.
- Notify the RSO when radioactive materials are received.
- RSO is responsible for the preparation and shipping of radioactive materials from SDSTA.

4.0 DEFINITIONS

ALARA: As low as reasonably achievable.

Authorized Management Representative: Specified during the NRC application process. The Sanford Lab Laboratory Director is the Authorized Management Representative.

Radiation Safety Officer (RSO): The person responsible for implementing and managing the radiation safety program.

Radiation User: An individual authorized by the RSO to handle radioactive materials under the direction of an Authorized User. Evidence of training is required to be designated as a Radiation User.

Authorized User: An individual whose training and experience have been reviewed and approved by NRC, who is named on the license, and who uses or directly supervises the use of licensed material.

Facility: The term "Facility" in this document refers to the Sanford Underground Research Facility.

NRC: Nuclear Regulatory Commission.

SDDENR: South Dakota Department of Environment and Natural Resources.

Public: The term "Public" in this document refers to all individuals who do not have radiation safety training.

Surface Wipe (Swipe) Test: A test for radioactive contamination on a surface.

5.0 PROCEDURES

5.1. Recordkeeping

All radiation safety records, including those listed below, shall be stored on DocuShare:

- Procedures related to handling radioactive materials and calibrating detectors are reviewed and approved by Sanford Lab and are available in the respective experiment areas on DocuShare
- Inventory of radioactive materials
- List of authorized Radiation Users
- Radioactive material receipts
- Leak and contamination swipe test results
- Procedures associated with accelerator operations (in respective science collaboration areas).

A Wiki has been developed to facilitate locating the documents.

5.2. Transportation, Material Receipt & Accountability

All packages containing radioactive materials shall be delivered to the Ross Warehouse. Warehouse shipping/receiving personnel shall identify and segregate the package(s) and notify the RSO. It is important to coordinate shipments of radioactive materials to and from Sanford Lab property with the RSO.

Approved procedures for testing packages for leaks are available, as are the receipt records for these materials.

5.3. Dose Considerations

A prospective evaluation has determined that, based on current radioactive materials and activities at Sanford Lab, unmonitored individuals are not likely to receive, in one year, a radiation dose in excess of 10% of the allowable limits in 10 CFR Part 20 (typically an annual effective dose equivalent to 50 mSv (5000 mrem)), which corresponds to 5 mSv/yr (500 mrem/yr).

Dose-rate surveys by or under the direction of the RSO will be performed in locations where Radiation Users are exposed to radiation levels that might result in radiation doses in excess of 10% of the occupational dose limit (as described above) or where an individual is working in a dose rate of 0.0025 mSv/hr (0.25 mrem/hr) or more, derived from the annual dose limit above.

5.3.1 Occupational Dose

The following practices will be used to control the radiation dose to all individuals to below 10% of the NRC allowable limits:

- Due to the sensitivity of experiments at SDSTA, most radioactive sources are expected to be below (or near) exempt quantities.
- NRC does not define exempt quantity limits for alpha-emitters. The maximum activities for alpha-emitting calibration sources should be kept as low as possible.
- When feasible, all radioactive sources are placed in lockable lead (Pb) - lined storage safes when not in use for calibrating detectors. Exceptions shall be approved by the RSO.
- Radioactive sources should be used in collimators with beams directed at detectors (away from laboratory occupants). Exceptions shall be approved by the RSO.

5.3.2 Public Dose

Radiation dose to the public will be controlled below 10% of the NRC allowable radiation limits using the procedures noted above. In addition, with the exception of sanctioned, organized tours, the public is not allowed in the science collaboration laboratories. The laboratories are inaccessible except via 4850 feet deep shafts.

5.4. Work Practices & Emergency Procedures

Work Practices: Written procedures for handling radioactive materials and machines are reviewed and approved by Sanford Lab personnel (including the RSO) and include emergency considerations. Procedures for handling radioactive materials and accelerator operations are filed in the respective science collaboration areas on DocuShare.

Emergency Procedures: Details of how emergencies are handled at Sanford Lab can be found in the Emergency Response Plan.

5.5. Surveys

Surveys for radioactive contamination will be conducted at least quarterly in all areas where sources are used or immediately if there is a suspicion of a leak. The procedure for conducting contamination and leak testing can be found as a sheet in the workbook Sanford Lab Leak & Contamination (Swipe) Tests.

5.6. Authorization

Authorization for Radiation Users will be issued by the RSO upon receiving evidence of training and acknowledgement of specific Sanford Lab expectations.

5.7. Radiation Producing Machines

5.7.1. Radiation Safety Program

A documentation system shall be established such that the safety programs are defendable and auditable. To ensure continuing compliance, a periodic (at least once every three years) self-assessment shall be conducted.

A safety assessment document (Experimental Planning Statement) shall be written which sufficiently covers safe operation. At a minimum, it shall include

- Description of the facility
- Beam parameters for all operational modes
- Radiation hazard analysis – hazards and risks to the workers, public and the environment
- Engineered and administrative safety systems adequate to prevent unacceptable risk to individuals and the environment.

A quality control and configuration control system shall be implemented to assure safety systems are in place (for passive systems) and operated (for active systems) as designed.

5.7.2. Radiation Control System (RCS)

The radiation control system shall be a complete shielding system so that negligible radiation is detectable outside radiation controlled areas. It shall be designed or reviewed by a radiation safety professional. It may include beam or radiation interlocks.

The shield system shall be designed conservatively to limit the maximum annual dose to no more than:

- Radiation Users: < 5 mSv/year (500 mrem/year)
- Public: < 1 mSv/year (100 mrem/year)
- Off-site dose to maximally exposed individual: < 0.1 mSv/year (10 mrem/year)

Any changes to the radiation control system shall be approved by the RSO.

5.7.3. Access Control System

An access control system is not required for areas with dose rates < 0.05 mSv/hour (5 mrem/hour). Machines capable of generating dose rates greater than this will require startup warnings, enclosures, personnel entryway doors/gates, interlocks, and exclusion areas as specified in the current version of ANSI/HPS N43.1 Table 5.1 (see Appendix for 2011 version).

If required, the access control system shall be

- Reliable, fail-safe, tamper-resistant
- Subject to configuration control during operation and maintenance
- Function and integrity checks conducted periodically
- Certified annually

5.7.4. Machine Operations

A readiness review shall be conducted prior to machine commissioning and formal authorization from Sanford Lab is required prior to any production of beam. Machine commissioning shall be conducted prior to routine operation. Commissioning shall include:

- Verification that machine operation and hazards are controlled
- Shielding verification survey

Machine operations shall be conducted only by qualified and authorized operators using written procedures reviewed and approved by Sanford Lab personnel, including the RSO. Routine maintenance and safety system repairs shall be part of operational plan and schedule.

The machine control panel shall be staffed during operation (when the beam is on or potential hazards exist).

- When the operator is not present, the machine should be off or the control panel access secured.
- Under special operating conditions a machine may be operated unattended, providing:
    - Potential emergencies are addressed beforehand
    - Operating parameters and resulting hazards are controlled by engineering means
    - Long term unattended operation requires regular status monitoring
    - If operational parameters exceed preset ranges, the operation shall be terminated automatically. Startup may only resume after RSO permission.

No unapproved interlock bypass nor deviation from safety procedures shall occur. All interlock bypasses or deviations from safety procedures shall be approved by the RSO. All interlock bypasses and removals shall be documented. Normal interlock operation shall be resumed as soon as the bypass has served its purpose.

5.7.5. Operational Radiation Safety (ORS) and Personnel Training

An operational radiation safety program shall be written. For each specific experiment, the ORS program shall be incorporated into routine practices and shall be clearly assigned to individuals who are trained and authorized to perform these tasks. The **operational radiation safety program** (ORS) shall specify the activities, process measurements and evaluations necessary to maintain safe operations. At a minimum it shall include the following elements appropriate to the hazard

- Facility area access control
- Personal and area dose rate monitors
    - Personal dosimetry required when expected annual dose > 5 mSv (500 mrem), consistent with Section 5.3
    - Personal dosimetry recommended when expected annual dose > 1 mSv (100 mrem)
- Measurement and control of radiation levels in the workplace and facility boundary
- Radiation instrument use and calibration

- Control of radioactive sources and waste
- Contamination monitoring and control
- Radiological environmental protection
- Facility cleanup and decommissioning

Areas of the facility with potential radiation hazards shall be classified and posted based on shielding design and area monitoring results.
An area monitoring program shall be established to assure the dose rates and integrated doses within and external to the facility are within acceptable levels. At a minimum, the radiation levels around the machine shall be monitored.
The facility shall evaluate (via measurements or calculations) the potential for activation or contamination of the accelerator or beam line components as well as the surrounding media.
The identification, characterization, processing, storage, transport, use or disposal of potentially radioactive sources or waste shall be addressed.

Training
Science collaborations shall be responsible for implementation of safety training and periodic retraining programs subject to Sanford Laboratory review and approval.
Individuals who operate or work in the vicinity of machines shall receive basic radiation safety training that familiarizes them with radiation sources, risks in perspective to potential doses, methods to minimize dose, machine hazards and controls.

6.0 REFERENCE AND RELATED DOCUMENTS

6.1. References

- NRC Regulations Title 10, Code of Federal Regulations
- ANSI/HPS N43.1 “Safe Operating Practice for Users of Non-Medical X-Ray Radiographic and Radioscopic Equipment”

6.2. Related Documents

- NRC Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope NUREG-1556 Vol. 7
- EHS Training Policy
- Sanford Lab Radiation Safety Manual (Wiki)
- Sanford Lab Leak & Contamination (Swipe) Tests
- Emergency Response Plan
- First Report and Incident Investigation Form
- Incident & Near Miss Reporting, Response and Investigation Policy
- DOE O 420.2 “Safety of Accelerator Facilities”
- DOE G 420.2-1A, Accelerator Facility Safety Implementation Guide for DOE O 420.2C, Safety of Accelerator Facilities
- Code of Federal Regulations 10 CFR 835 Department of Energy “Occupational Radiation Protection”

Appendix

Access Control System Requirements from ANSI/HPS N43.1-2011

Table 5.1. Graded access control system (ACS) features for prompt radiation hazards.

Dose rate (mSv h^{-1}) [a]	Dose category	Start-up warning	Enclosure	Personnel entryway door/gate	Interlock redundancy	Area secure system
0.05–1	Minimum	None	Rope	No restriction	None	Not required
1–10	Low	Visible & audible	Barrier	Locked or interlocked	Recommended	
10–100	Moderate	Visible & audible; emergency-off recommended	Barrier	Locked; interlock recommended	Recommended	Required (exclusion area)
> 100	High	Visible & audible; emergency-off	Barrier	Locked and interlocked	Required	

[a] 1 mSv h^{-1} = 0.1 rem h^{-1}.

The dose rate values refer to the maximum effective dose expected during any 1 h due to prompt radiation inside an accelerator or beamline housing area (operated within the operation envelope).

An ACS is required for an area with dose rates > 0.05 mSv h^{-1} (5 mrem h^{-1}). Areas with dose rate levels ≤ 0.05 mSv h^{-1} (5 mrem h^{-1}) are not subject to the ACS requirements in this section. Administrative access control requirements and recommendations to areas with dose rate ≤ 0.05 mSv h^{-1} (5 mrem h^{-1}) are described in Section 8.0.