Chapter 9: Radiological Safety

Facility Design and Operation Requirements

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1 Purpose

The purpose of these requirements is to ensure that facilities are designed and operated to protect workers from the prompt radiation produced. They cover the design, configuration management, and operational approval of *radiation safety systems (RSS)*. They apply to workers, supervisors, project managers, and Radiation Protection and any other group involved in these activities.

2 Requirements

2.1 Engineering Controls (Design)

Engineering controls are physical means designed to reduce, eliminate, or control hazards; they include passive controls (shielding and fences) and active controls (for example the *personnel protection system [PPS]* and *beam containment system [BCS]*).

2.1.1 Radiation Shielding

Radiation shielding and other physical barriers like fences are engineered safeguards designed to attenuate radiation or otherwise reduce the prompt dose rate to acceptable levels. Such passive engineering controls are preferred over active engineering controls, such as BCS, and administrative controls, such as ropes and signs. Administrative controls may be used to supplement the engineering controls and should be used only if adding shielding or other barriers is not practicable. All primary beams (original accelerator beams) and synchrotron radiation beams must be fully enclosed by shielding and barriers that cannot be circumvented in an unauthorized manner.

2.1.1.1 Shielding Design Criteria

During normal operations, all beam lines and experimental facilities must be shielded to control individual doses from external radiation to less than 1,000 mrem total effective dose (TED) per year and be kept as low as reasonably achievable (ALARA).

Shielding must also be designed to protect individuals under abnormal operating conditions (mis-steering and system-failure cases). See Radiation Safety Systems Technical Basis Document for details.

2.1.1.2 Shielding Design Protocol

The radiation safety officer (RSO) must approve shielding design specifications. The Radiation Physics Group (RPG) within RPD is responsible for determining the shielding required for a facility and must be consulted before the construction of a new facility or the modification of an existing facility. To obtain approval of a shielding design from the RSO, it is the responsibility of the line manager (or designee) to provide information in writing and work with a radiation physicist within the RPG who is tasked with oversight of facility construction or modification where shielding is required. The radiation physicist will then propose a shielding design and seek concurrence from the RSO on the design. The line manager (or designee) must keep the records on the design of new or modified shielding as well as on the verification of the material composition and make these records available to RPG for review.

2.1.2 Personnel Protection Systems

At SLAC, the interlocked access control system is called the *personnel protection system (PPS)*, which protects personnel from exposure to prompt ionizing radiation from beams and interlocked electrical hazards in the accelerator housing. A PPS consists of access interlock logics, display of access states, key controls, and other controls. The interlocked access control system that protects personnel from exposure to prompt ionizing radiation in synchrotron radiation beam line hutches is called the *hutch protection system (HPS)*. The general design requirements, review, and approval of the HPS are similar to those described for the PPS.

New and modified PPSs, as well as PPS bypasses, must be approved by the RSO before implementation.

Accessible beam lines must have a PPS to protect personnel from prompt radiation. The PPS prevents exposure through the use of beam stoppers (or beam inhibiting devices). The PPS also prevents entry to beam enclosures when beams are operating and turns off beams when a security violation is detected.

The PPS must be established and maintained to be fail-safe. To meet this goal, the PPS is scrutinized continuously via configuration control, periodic certification, and testing of its physical and electrical components.

Before a new PPS is used for routine operation, it must be reviewed and documented by drawings and a written function description. PPS modification must also be documented, reviewed, and approved.

In the case of an access violation, the PPS will automatically terminate the radiation hazard by removing or redirecting beam and/or inserting metal plugs into the beam line path.

Key controls at access doors are used to account for personnel in accelerator and beam line housings when access states are in the controlled access configuration (each person has a key). Qualified operators enforce these key controls as personnel enter and exit accelerator housings. When keys are removed, the system provides a safety interlock to ensure a beam cannot be directed into areas occupied by personnel.

Large, illuminated signs are generally located adjacent to each major beam line housing entrance. The signs display access-state information (such as NO ACCESS, RESTRICTED ACCESS, or CONTROLLED ACCESS) that alerts personnel to possible hazardous conditions in the beam line housing.

2.1.3 Beam Containment Systems

Radiation safety policy at SLAC requires that beams be transported within their designated channels to the designed termination point, such as a detector, beam dump, or injection into a storage ring.

If beams diverge from their proper channels, high radiation levels can occur in unprotected areas.

The *beam containment system (BCS)* prevents beams from diverging from the designated channel, and detects excessive beam power or beam losses that could cause radiation levels exceeding established radiation limits.

Containment of beams is usually accomplished by a combination of passive devices, such as collimators, that are designed to absorb errant beams, and active devices, such as electronic monitors, that shut off beams when out-of-tolerance conditions are detected.

Beam parameters such as energy and current, and/or beam losses in an area, may need to be monitored and limited by BCS devices to prevent excessive radiation levels outside the shielding enclosure. BCS devices are also used to turn off the beam if the beam power striking a device designated to contain it exceeds the power safety limit of that device.

The details of BCS design are described in Radiation Safety Systems Technical Basis Document.

2.2 Administrative Controls and Personal Protective Equipment (Operation)

Administrative controls are safety policies, rules, supervision, posting, and work procedures designed to reduce duration, frequency, and severity of exposure to hazards.

2.2.1 Authorization

2.2.1.1 Beam Authorization Sheet and Beam Line Authorization

A beam authorization sheet (BAS) is used to authorize the safety operations of accelerators.
A beam line authorization (BLA) is use to authorize the safety operation of photon beam lines. The BAS and BLA are jointly prepared, issued, and approved by the Radiation Protection Department, the facility safety officer, and operations manager representing the line organization. See the Conduct of Accelerator Facility Operations for details.

2.2.2 Configuration Control

Any facility that requires radiation shielding will have an appropriate configuration control program to ensure the shielding is properly in place before and during accelerator operation (see Conduct of Accelerator Facility Operations for details). Such processes will be described in written procedures. The configuration control program also applies to all radiation safety-significant systems such as the PPS and BCS.

2.2.2.1 Radiation Safety Work Control Form

A radiation safety work control form (RSWCF) is part of the configuration control program, which is used to control work performed on, or that may affect, all radiation safety systems such as PPSs, BCSs, BSOICs, and shielding. The facility safety officer issues the RSWCF with approval from the radiation physicist.

3 Forms

The following forms and systems are required by these requirements:

- See the Conduct of Accelerator Facility Operations

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- See the Conduct of Accelerator Facility Operations

5 References

SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)

- Chapter 9, "Radiological Safety"
  - Radiological Control Manual (SLAC-I-720-0A05Z-001)
  - Radiation Safety Systems Technical Basis Document (SLAC-I-720-0A05Z-002)
  - Radiation Protection Program Site (SharePoint)

Other SLAC Documents

- Conduct of Accelerator Facility Operations (CACM-2019-059)
- Radiation Protection Department