

SNS 109090000-SR0001-R00

Spallation Neutron Source

Systems Requirements Document for Personnel Protection System

March 2000



A U . S . D e p a r t m e n t o f E n e r g y M u l t i L a b o r a t o r y P r o j e c t

SPALLATION NEUTRON SOURCE

Argonne National Laboratory • Brookhaven National Laboratory • Lawrence Berkeley National Laboratory • Los Alamos National Laboratory • Oak Ridge National Laboratory

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FOR PERSONNEL EQUIPMENT PROTECTION**

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1. PROJECT MISSION

Global Controls shall provide an accelerator personnel protection system (APPS) to protect workers from hazards associated with accelerator operations. The APPS shall be fully integrated with the operation of the accelerator. The APPS will provide the following basic protective functions:

- Restrict access to beam-line tunnels when the accelerator is capable of operation.
- Automatically place the accelerator in a safe state if there is a tunnel access violation during operation.
- Restrict accelerator beam operation to unoccupied beam lines when downstream beam-line tunnels are occupied.
- Support administrative functions related to searching beam lines before operation.
- Provide audible and visual warnings and indications for various operating modes both inside and outside the beam-line tunnels.
- Shut down accelerator operations if unacceptable radiation levels are detected inside occupied tunnels or outside of tunnel shielding.

2. INTRODUCTION

Accelerator operations can produce hazardous-to-lethal levels of radiation inside the beam-line tunnels. Hazards are also present inside the tunnels because of radio frequency (RF) klystron operation and exposed energized electrical conductors. In the event of equipment malfunction or improperly configured shielding, hazardous levels of radiation could be present outside the beam-line tunnel shielding. The APPS is provided to protect workers from these hazards.

The majority of the APPS equipment is “safety significant,” which means that it protects workers from facility hazards. The APPS will be designed, procured, installed, and tested according to rigorous standards and procedures to provide a high level of system performance.

The APPS will be installed in stages as the accelerator equipment is commissioned. Oversight will be provided by the Radiation Safety Committee to ensure that sufficient APPS equipment is present to provide protection against potential hazards from the installed equipment before operation.

3. SYSTEM REQUIREMENTS

1. The primary function of the APPS is to protect workers from prompt radiation from accelerator operations. The APPS will also protect workers from hazards associated with energize equipment while working inside the beam line tunnels.
2. The APPS will be developed in accordance with Instrument Society of America (ISA) Standard S84.01-1996, *Application of Safety Instrumented Systems for the Process Industries*. Detailed requirements for the safety-related portion of the APPS will be documented in the “Safety Requirement Specification,” as required by ISA S84.01.
3. The APPS shall perform safety functions as required by *Selection of Safety Integrity Levels for Application of ISA-S84.01 to the SNS Accelerator Personnel Protection System* (SNS-102030103ES0001R00).

4. The APPS shall be designed to meet the probability of failure on demand (PFD), as required by *Selection of Safety Integrity Levels for Application of ISA-S84.01 to the SNS Accelerator Personnel Protection System* (SNS-102030103ES0001R00).
5. The accelerator tunnels shall be divided into segments. The APPS shall be designed to allow operations to continue in one segment while APPS testing or repair is conducted in another segment.
6. Critical devices (such as beam stops, high-voltage and RF power supplies, and turning magnets) are used to stop beam production or prevent beam transport into occupied areas. The status of each critical device shall be monitored by the APPS. If the APPS determines that a critical device is not in the safe position when commanded, the beam shall be cut off and beam operation prevented until reset by the operator.
7. The APPS shall provide the following modes of operation:
 - a. Restricted Access—Does not permit beam operation in the segment. Critical devices are configured to prevent beam production or beam transport into the segment. Access doors are locked. Worker access is permitted. Doors may be controlled by the operator or by the radiation worker permit badge reader system (part of WBS 1.9.9.3) or both.
 - b. Search—Supports clearing of tunnels before beam operation. Beam operation is not permitted. Features shall be provided to support proper search techniques. Access doors are locked and under operator control to ensure that unauthorized workers do not enter the tunnel during or after a search procedure.
 - c. Controlled Access—Allows limited worker entry into a tunnel after a search has been completed. Access doors are locked and under operator control. Features shall be provided to ensure that beam operation is not permitted while workers remain in the tunnel.
 - d. Power Permit—Beam operation is not permitted. Access doors are locked and cannot be opened (emergency exit is allowed at all times). RF klystrons can be operated, and exposed electrical conductors can be energized.
 - e. Beam Permit—Permits beam operation. Access doors are locked and cannot be opened from the outside (see item 10).

The operator controls mode selection from the control room. Security features shall be provided to ensure that only authorized personnel can select or change operating modes.

8. The APPS shall continue to function during electrical power disruptions to the facility. APPS power shall be provided by diesel-backed uninterruptible power supplies.
9. Locks shall be provided on tunnel entrance doors to prevent unauthorized personnel access. These locks shall allow emergency egress from the primary beam lines under all conditions. Emergency exit and equipment access doors or gates will have conventional locks but will not be locked by the APPS. These doors and gates will be monitored, and the APPS shall shut off the beam if an access violation is detected.
10. Emergency entrance mechanisms shall be provided at each entrance door. These devices will allow emergency entrance in any operating mode by preventing beam operation and unlocking the access door. Deliberate action (i.e., break glass) shall be required to use this function.
11. Each entrance to the primary beam lines shall have a status display to indicate when the area is safe to enter.
12. In areas that must not be occupied during beam operation, visual and audible indications shall be given before beam startup. The APPS shall dim tunnel area lighting before beam operation.
13. Means shall be provided for personnel to manually shut off the beam. Beam shutdown stations (BSSs) shall be installed in the beam lines. At least one BSS should be visible from

anywhere in a normal walkway. The BSSs shall be spaced to allow a person to reach the BSS and remove the beam permit before the timeout of the time delay between beam permit and beam operation. BSSs shall be located to facilitate the sweep function. Emergency stop shutdown switches shall be provided in each control room and at each entrance door to the primary beam lines.

14. The APPS shall monitor radiation levels (1) in occupied beam lines when upstream accelerator equipment is in operation and (2) outside beam-line shielding at points of potential high radiation. The APPS shall automatically shut off the beam if high radiation levels are detected.
15. The APPS shall be designed to facilitate periodic testing in an efficient manner, requiring minimal time inside the beam-line tunnels.
16. Control cables and wiring used for APPS shall be run separately from “nonsafety” cabling. If APPS conductors are run in the same raceway with other safety-related cabling, a physical barrier shall separate the APPS cable from other safety cabling.
17. Programmable logic controllers (PLCs) may be used for implementing the detection and control functions of the APPS. PLCs used for the APPS shall meet the following requirements:
 - PLCs shall have provisions for locking memory to prevent unauthorized or inadvertent modification.
 - PLCs shall have a means of communicating information to the EPICS systems. The EPICS system shall have read-only access and shall not be able to change PLC programming or data. The APPS shall provide all available information on APPS inputs, outputs, and mode information.
 - Remote input/output modules may be used.
 - PLC programs for redundant units shall be developed by separate programmers from a common software functional requirement document.
18. Dedicated operator interfaces shall be located in the control room. These operator interfaces shall display sufficient information to allow operation, programming, and maintenance of the APPS. The operator interface shall be capable of recording sequences of events, such as mode selection, controlled entry, and automatic shutdowns, including initiating events. The operator interface shall also record radiation levels from tunnel and area radiation monitors.

4. INTERFACES

The APPS will interface with the following systems:

Front End	The APPS will inhibit beam when the tunnels are in an unsafe state by controlling or de-energizing selected front-end components.
LINAC	The APPS will control RF klystrons and exposed electrical conductors inside the beam-line tunnel.
Ring	The APPS will control turning magnets (critical devices) and exposed electrical conductors inside the beam-line tunnel.
Target	Inputs are required from the target to the APPS to determine when the target plug is configured to allow beam on target.
Global Controls	The APPS will supply information to the EPICS system.
Conventional Facilities	Conventional facilities will provide the following parts of the APPS: <ul style="list-style-type: none">• AC power• Non-safety-related cabling• Cable trays for APPS signal cables• Control equipment to allow the APPS to dim tunnel lighting before beam operation• Personnel entrance, emergency exit, and equipment doors and gates• Public address system in the tunnels capable of playing prerecorded messages based on inputs from the APPS