

	PRINCETON PLASMA PHYSICS LABORATORY ES&H DIRECTIVES		
	ES&HD 5008 SECTION 2, CHAPTER 5 Personnel-Safety-Interlock (PSI) Systems		
Approved	Date: 7/07/05	Revision 7	Page 1 of 5

CHAPTER 5 PERSONNEL-SAFETY-INTERLOCK (PSI) SYSTEMS

5.1 PURPOSE

The purpose of personnel-safety-interlock systems shall be to limit the possibility of injury to personnel and damage to equipment.

5.2 CONTROLS AND PROCEDURES

Elements of personnel-safety-interlock systems consist of the following in order of importance:

- 5.2.1. Kirk ® -type key-Interlock Devices and Controls
- 5.2.2. E-STOPS and Controls
- 5.2.3. Personnel-Access Door Interlock Devices and Controls
- 5.2.4. Search and Secure Procedures
- 5.2.5. Hot-Access Procedures
- 5.2.6. Temporary-Modification Procedures

These controls and procedures shall be approved for their intended use by Electrical Safety. Technical requirements for these devices and controls may be found in PPPL ES-COMP-003 and PPPL ES-ELEC-004.

5.3 POWER SOURCE

Power supplies for personnel-safety-interlock electrical systems shall originate at uninterruptable power supplies or rechargeable batteries when loss of normal power could result in an unsafe condition. Circuits so supplied shall be run in separate raceways and enclosures to prevent common-mode failure with ac powered circuits. When PSI circuits are supplied from 120 V ac power sources, separate raceways and enclosures need not be used; however, failure of the ac power source shall cause a shutdown signal to exist in all interlocked power supplies.

5.4 AUTOMATIC SHUTDOWN

Whenever a door to an operating Interlocked-Access area is opened, the PSI system shall automatically disable all hazardous equipment in the area being accessed and shall provide the system operator visual and audible annunciation of the unauthorized access. See Hot-Access Procedures in paragraph 5.8.2 for exception.

5.5 SEQUENTIAL KEY CONTROLS

Kirk ® -type key PSIs are used extensively to control access to hazardous areas and to assure that controls and switches are operated in proper sequence and secured in the desired position. Authorized personnel shall use approved operations procedures to control the access to hazardous areas. These PSIs along with their approved procedures shall assure that:

5.5.1. Controls are de-energized to provide a complete, safe shutdown.

5.5.2. All incoming power circuits are open, or open and grounded.

5.5.3. Backfeeds from load circuits, through induced voltages or faults on experimental devices, cannot result in harmful energization.

5.5.4. Energy-storage inductors or capacitors in the area are de-energized by shorting and grounding switches.

5.5.5. In addition to the above requirements, high-energy-storage systems, i.e., those systems operated at or above 300 V and 50 J, require an interlocked manual discharge and grounding device.

5.5.6 When potentially hazardous systems are equipped with both "local-control" and "remote-control" capability, the delegation of permission to operate in "local control" shall be by means of a Kirk ® key.

5.5.7 Storage and Replacement of Interlock Keys (Kirk ®-type keys)

The use of keys for safety-interlocked systems is controlled by PPPL Engineering Procedure No. ENG-011, "Interlock Key Control." This procedure includes guidelines to assure that safety-interlocked systems are not compromised or defeated by unauthorized availability of single or duplicate keys. This procedure defines the system that is used for securing, storing and controlling duplicate keys, and replacing broken, worn, or lost keys.

5.6 EMERGENCY-SHUTDOWN PUSHBUTTON STATIONS (E-STOPS)

Clearly visible, manually operated emergency-shutdown pushbutton stations shall be furnished with a "RESET" function and shall be installed at entrance doors and other strategic locations.

5.6.1 Personnel within an interlocked area shall not have to travel more than 50 feet to reach an E-STOP.

5.6.2 The E-STOP shall initiate de-energization of all the high-voltage power supplies feeding the associated equipment or any other hazardous equipment as determined by cognizant personnel and Safety during the pre-operations safety review of the experiment.

5.6.3 E-STOPS shall be guarded against accidental operation and be clearly labeled indicating both “EMERGENCY SHUTDOWN” and the name(s) of the affected system(s). Lettering shall be sized appropriately for the location.

5.6.4 There shall also be at least one E-STOP operable from outside an interlocked-access area.

5.7 Personnel-Access Door Devices

Unless otherwise specified in the project’s SAR or SAD (reference paragraph 3.1.1 in Chapter 3), personnel-access doors to an Interlocked-Access area shall have the following devices:

5.7.1 Kirk ®-type key sequencing and access control to assure adequate isolation of Interlocked-Access areas from power supplies operated above 600 V.

5.7.2 Access PSIs of a positive, mechanical type (limit switches) to de-energize high-voltage power supplies.

5.7.3 A key, for emergency access, in a locked box having a clear glass face. Breaking the glass shall cause the emergency-shutdown system to function.

5.7.4 Panic hardware, conforming to the requirements of NFPA-101; Section 5.2 -“Means of Egress - Components,” installed on each exit door.

Exception: where Kirk ®-type keys are used, kick-out panels may be installed in lieu of panic hardware if the panels are used to augment—but not replace—the required exits.

5.8 PERSONNEL-SAFETY-INTERLOCK (PSI) PROCEDURES

The following procedures shall be furnished by the engineer or physicist in charge of an Interlocked-Access area to the Head of ES&H or designee for review and approval. A Hazard Analysis shall be performed and the necessary PPE (Personal Protective Equipment) shall be listed in the procedures (if required) and the approach boundaries (if any) shall be specified.

5.8.1 Search and Secure Procedures

These procedures shall describe the visual inspection that is to be performed prior to operation of the equipment in an Interlocked-Access area to assure that personnel have left the area and that an unusual status of equipment does not exist.

5.8.2 Hot-Access Procedures

These procedures shall permit Qualified Personnel to be present in Interlocked-Access areas for observational purposes. Except where permitted by the project’s SAR or SAD, the formation of a

plasma shall be prevented by disarming all subsystems capable of producing a plasma. Hot-access procedures shall allow a hot-access team to enter and exit an Interlocked-Access area while the search and secure status is maintained.

5.8.3 Temporary-Modification (T-Mod) Procedures

Bypassing of PSIs shall be prohibited unless the following requirements are met:

- A. Each project shall maintain a log of bypassed PSIs. The log book shall contain the location, modification, tag number, responsible person, and times of installation and removal. Both the cognizant engineer and/or physicist and the responsible technician shall sign the log book and the identification tag.
- B. Every temporary modification shall have an identification tag. Each project shall have a unique numbering system for identifying these tags.
- C. The above requirements do not replace or alter any of the requirements of the Lockout/Tagout procedures in PPPL ESH-016 and-paragraph 3.3.2 in Chapter 3.

5.8.4 Personnel-Safety-Interlock (PSI) Testing Procedures

- A. These procedures shall verify the correct electrical and mechanical operation of warning systems (audible and visual), access-control systems (doors and key interlocks), and emergency-shutdown systems. These procedures shall simulate a running configuration and/or mock-up mode.
- B. All operable elements of the PSI system, including power-resistor enclosures, shall be tested annually for proper operation.
- C. All PSIs that control access areas or equipment for the purpose of protecting personnel from ionizing radiation will be tested at intervals not to exceed six months. An exception may be granted if the protected area is declared a General-Access (non-radiation) area during the systems regularly scheduled six months test, in which case its PSIs shall be tested prior to start-up.
- D. All experimental devices and their subsystems shall be de-energized before PSI testing begins. PSIs shall not be tested while related experimental devices are running.
- E. The cognizant engineer or physicist shall appoint trained operating personnel to direct the PSI tests and document the results.
- F. The cognizant engineer or physicist shall schedule sufficient time for operating personnel to perform the PSI tests in a safe and orderly fashion and document the results.
- G. A "Run Copy" of each completed PSI test procedure shall be filed by the cognizant engineer or physicist in the projects files or Central Files with a copy forwarded to Electrical Safety. The Electrical Safety Representative will verify the initial-installation, modification, and testing of every new Personnel Safety Interlock System (P.S.I.) at PPPL. After initial verification, the systems revert to the Operations personnel for routine maintenance testing at a frequency specified in Chapter 5, paragraphs

5.8.4.B and 5.8.4.C. Using the due dates on the Preventative Maintenance data-base cards(if used), the Operations personnel will ensure that the testing is completed in a timely fashion.—Operations personnel are to maintain their P.S.I. run copies of test data and forward a copy to Electrical Safety. The testing will be subject to auditing periodically.

H. Reserved

I. The “Run Copy” of each completed PSI test will be kept at the document control center for the project. If a project does not have a centralized document control center, the Project Safety Interlock Coordinator shall retain the run copy of all completed PSI tests in the Project files. The records shall be retained for one year in accordance with DOE Order 200.1.—In all cases, Electrical Safety representative will keep copies of all test results that are received.