Policy on Design, Installation, and Maintenance of Radiation Safety Systems

Changes made in this revision:

- Changed author from John Quintana to Geoff Pile.
- Clarified second sentence in Section 1.3

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Policy on Design, Installation, and Maintenance of Radiation Safety Systems

1. Introduction

1.1 Purpose

This policy describes requirements and authorizations necessary to initiate and perform work on radiation safety systems.

1.2 Scope

Radiation safety systems prevent unintentional exposure to ionizing and non-ionizing radiation. They consist of hardware to shield radiation, interlock devices, and software to control the device when a hazard is detected. This policy applies to groups working on systems that shield downstream personnel from radiation.

The policy covers requirements for design, fabrication, installation, and work on radiation safety systems that includes troubleshooting, testing, maintenance, one-for-one replacement, engineering changes, new installation of proven design, and installation of new design.

APS has assumed oversight for safe operation of Radiation Safety Systems in beamlines. The AES Division Director insures appropriate review and approves new designs and new installations for all beamlines and front ends.

1.3 Background

The amount of control and level of authorization to perform work depend on two criteria, the consequence of device failure and the complexity of the device and the work. For example, beamline integral shutters and lead shielding directly protect any personnel from x-ray exposure in downstream enclosures. However, an integral shutter has many complex functions, while the lead bricks serve only one function—static shielding. As a result, the risk of failure for an integral shutter is much greater than that for lead shielding. The integral shutter requires a detailed work plan and engineering and administrative controls. The shielding requires simpler work plans and administrative controls.

This policy defines a risk matrix for the consequence and complexity of the radiation safety systems and defines requirements to perform work on radiation systems as a result of the risk assessment.

In addition, work on the systems comes in a number of formats, from new installations through troubleshooting. The types of work and the requirements to perform the work are also developed in this policy.

1.4 Applicability

The policy applies to all work performed to design, fabricate, and install new radiation safety systems and all work performed to modify troubleshoot, maintain, and repair radiation safety systems in the APS accelerators, front ends, and beamlines.

1.5 References

APS Design Review Procedure, Procedure 3.1.01

Configuration Control Work Permit Procedure, Procedure 3.1.06

ANL ESH Manual, Section 5.16: Radiation Safety Interlock Systems

Gibson, J.M. "APS Responsible for All Work on Beamline Radiation Components" June 28, 2006 (APS_1183117)

DOE G 420.2-1 - Accelerator Facility Safety Implementation Guide for DOE O 420.2B: Safety of Accelerator Facilities

LMS-PROC-64: Non-Experimental Work Planning and Control

2. Classifications

2.1 Classifications for Consequence of Failure

APS management will categorize radiation safety equipment and software into three consequence classifications: HIGH, MEDIUM, and LOW.

2.1.1 HIGH Consequence

For example, systems and devices that are vital to shield prompt radiation in a downstream controlled area that may be occupied.

2.1.2 MEDIUM Consequence

For example, systems and devices that are vital to maintaining safe operation of the radiation safety system and the physical devices that connect to ACIS and PSS.

2.1.3 LOW Consequence

For example, systems and devices that are required for safe operation of the radiation safety system.

2.2 System Complexity

The system complexity can be categorized in two ways, device complexity and work complexity. The system complexity is also defined using High, Medium, and Low descriptors. Technical groups will identify the device and work complexity in the procedures for working on the radiation safety device or system.

2.2.1 High Complexity

Devices: Complex interlocks and controls, multiple functions, multiple energy sources, such as electrical, pneumatic, vacuum, and water

Work: New installation requiring multiple groups, disassembly of limit switch circuits, removal of shield block

2.2.2 Medium Complexity

Devices: Single purpose function with possibly several energy sources, several interlocks and controls

Work: Replacement of components that do not change the alignment, limit switches etc., e.g., *in situ* replacement of a pneumatic cylinder on a front end photon shutter

2.2.3 Low Complexity

Device: Single function but only a static installation

Work: Maintenance that does not disturb the radiation safety assembly or system, such as flushing water lines in masks or photon shutters, replacement of pneumatic seals

2.3 Risk Matrix

A risk matrix can be developed from the consequence and complexity levels, as shown in Table 1.

Table 1: Risk Matrix Consequence

		Consequence		
		Low	**Medium**	**High**
Complexity	**High**	Low	High	High
	Medium	Low	Medium	High
	Low	Low	Low	Medium

2.4 Signage and Documentation

2.4.1 Signage

Radiation Safety Systems shall be labeled to alert employees that special authorization and procedures are needed before working on these devices. These signs shall be of red labels and contain a unique alphanumeric identification. The labels shall contain a recognizable international symbol for "No Access For Unauthorized Persons" similar to the figure below:

2.4.2 Documentation

The APS shall maintain a reference system that lists all of the listed/tagged Radiation Safety System components

3. Radiation Safety Systems Policy

3.1 Design Review

The design of new radiation safety systems and changes to existing radiation safety systems must be done in accordance with the APS Design Review Procedure, Procedure 3.1.01

The design of radiation safety systems shall have clear delineation of interfaces and responsibilities.

If the device will require survey and alignment, the designs must be reviewed by the Survey and Alignment group leader to insure that the device location and fiducials are consistent with the Survey and Alignment group's standards.

3.2 General Requirements for Working on Radiation Safety Systems

Construction projects that have their own project management and review process must be consistent with this policy. The responsible Division Director will attest to this with signature or electronic approval in the APS ICMS system.

The technical groups performing the work on the system will develop step-by-step procedures for working on the radiation safety systems. The work plan, procedures or work checklist, and validation procedures for HIGH and MEDIUM risk systems require Associate Division Director or higher approval before work can begin, as shown in the workflow tables (Tables 2 and 3). However, the work plan column should be completed well in advance of the start of work so there is ample time for the review and approvals. The content of the Work Authorization, Validation, and Close-out columns are specific to the immediate task.

The Division that initiates any work on a radiation safety system must insure that all work on the system is coordinated by a single individual (for example a division Radiation Safety System Engineer, RSSE) to insure that individual work tasks on the system are compatible. Unless otherwise dictated by Division work practices, the technical group requesting installation, maintenance, repair, or testing of radiation devices has the responsibility to coordinate the work performed, including insuring that proper work and hazard controls in accordance with LMS-PROC-64 or its approved local replacement are in place and the device is validated for return to service in accordance with a written verification plan that is referenced by or included in the work control documents (WCD). The responsible group leader has the assignment to insure that the work is performed according to written instructions that are part of the WCD.. The engineer initiating the work request is responsible for insuring his/her group's work on a subsystem has an approved WCD.. Each group is accountable to the responsible engineer that their work was performed properly. Validation and return to service are performed according to the written validation instructions that are part of the WCD under the oversight of the responsible engineer. Although the floor coordinator or the machine chief of operations often assists in facilitating work performed, the responsible engineer is the person in charge of the work and the coordination with other groups. If a Division has alternate work practices, those practices must be documented and incorporate the same level of coordination and independent validation as noted above.

The Associate Division Director, Group Leader, Chief of Operations, and the Critical Components Systems Manager may delegate their authority to a knowledgeable individual as required, and with the Division Director's written approval. The independent validator (i.e. the person who is tasked with performing the independent work validation in Tables 2 and 3) is appointed by the group leader and is typically the RSSE or another staff member who was not involved in the repair or installation, but is knowledgeable about the system that had the work done.

Before any work is performed, all drawings, schematics, technical specifications, and documents that describe the device and the work procedures must be current. Work Control Documents must be approved by division management according to the risk tables and the requirements of LMS-PROC-64 or approved local procedure. The work must be performed with strict adherence to the instructions in the Work Control Documents. If any deviation from the instructions is identified, work will be stopped until the problem is resolved. The APS will maintain a record of such problems and

follow up. The responsible engineer is authorized to resolve LOW Risk issues. The responsible group leader shall resolve deviations arising for HIGH and MEDIUM Risk.

In recognition of the potentially significant hazards associated with beamline radiation shielding, the APS Engineering Support (AES) Division is responsible for all work on beamline shielding. This responsibility encompasses the labor for alignment, commissioning, maintenance, repair, and any modification of any beamline shielding component. There may be specific cases where beamline management may seek to have beamline personnel assist with the work on radiation shielding. Beamline personnel may only work on the shielding with the written authorization of the AES Division Director or designee for a specific scope of work.

3.2.1 Authorization Conflicts and Exception Conditions

Conflicts between authorizing personnel will be resolved by the next higher level of management. Document and drawing deficiencies must also be adjudicated by the next higher level of management.

Any violation of this policy must be reported to the relevant Associate Division Director/Division Director and will result in immediate corrective action up to a stop work order. Work should be stopped immediately if any ambiguity exists in work authorization or work procedure.

3.3 Work Request System

All work on installed accelerator, front end, and beamline radiation safety systems must have a work request approved before the work can start. Work on uninstalled systems does not require a work request although technical groups are required to keep records of the work performed.

The work request must identify the engineer initiating the work, who becomes the responsible engineer for that particular work task. The request will identify the work to be performed and flag whether the work is on a radiation safety system.

3.4 Configuration Control Work Permits

The device used to record work authorization on deployed Radiation Safety Systems is the Configuration Control Work Permit (CCWP). The CCWP has a dual role. In addition to recording work authorizations, it is also part of the administrative control chain that prevents radiation from being propagated to/through the Radiation Safety System that is temporarily out of service. Unless there are special considerations (such as a radiation survey being required to confirm the functioning of the device), all CCWPs must be resolved and closed prior to generating or propagating radiation to/through the system.

All work on Radiation Safety Systems that affects the function of the system must be authorized using a properly executed Configuration Control Work Permit in accordance with the Configuration Control Work Permit Procedure 3.1.06. Division management may deem certain work on a radiation safety system as non-RSS work when the work can not affect the function of the device/system or takes the system out of service. Such examples might include touch up painting on the wall of enclosures where no shielding verification would be performed after the work is completed. This determination must be made in writing and approved by the appropriate Division Director or designee. In this case a Configuration Control Work Permit is not necessary.

The Configuration Control Work Permit may be used as part of an administrative control procedure when no work is being done but the procedure requires that radiation propagation is not allowed.

If the only work performed on a Radiation Safety System is being performed under a single approved procedure, then alternate authorization chains for the work are allowed in accordance with Section 3.2 provided that they are:

1. Specified in the procedure.
2. The procedure is reviewed or approved with the same authorization authority for the same risk of work as noted in Tables 2 and 3.
3. The procedure is approved by the relevant Division Director(s).
4. The procedure number is clearly noted on the CCWP along with a comment that an alternate authorization process is being used in accordance with the executed procedure
5. If during the course of work, the scope changes and the work to be done is not covered under a single work procedure then a new CCWP must be executed in accordance with Tables 2 and 3.

Alternatively, Divisions may specify specific classes of work to have an alternate CCWP authorization. Such authorization must be in writing and referenced on the CCWP. For example, the AES Division Director may provide an alternate authorization workflow for PSS and ACIS systems. Another example would be routine tasks that would be covered under a “skill-of-the-worker” designation.

If the work under a CCWP is partially completed and the Radiation Safety System is returned to service, then that CCWP is closed noting that the work is partially completed. If the remaining work is to be completed after the initial CCWP is closed, then a new CCWP must be issued and new authorization obtained.

The CCWP will reference the appropriate work control documents and checklists under which the work is being performed.

3.5 Troubleshooting, Testing, Maintenance, and Repair of Radiation Safety Systems in Accelerators, Front Ends, and Beamlines

The types of work required for operation of radiation safety systems include troubleshooting, testing, maintenance, one-for-one replacement, new installation of proven design, and installation of new designs.

3.5.1 Troubleshooting

Electrical or mechanical tests of the system are for diagnostic or monitoring purposes. The tests do not disrupt normal operation of the system. Test switches that change device state are included in troubleshooting.

Troubleshooting of radiation safety systems requires the approval of the responsible engineer, and an approved work request. Acceptable procedures include group handbook, written standard guidelines or practice, or written procedures that have been approved by the group leader and second level management (ADD, DDD, or DD as applicable).

3.5.2 Testing, Maintenance, and One-for-One Replacement

These categories of work have the same level of authorization and validation, which involve some level of dismantling of the equipment.

Testing:	Electrical or mechanical tests of the system for diagnostic purposes that require dismantling of some part of the system.
Maintenance:	Routine maintenance of devices or systems where the system is removed from service, maintenance performed, such as air cylinder gaskets removed or circuit cleaning, and then a revalidation of the device, including system level validation.
One-for-one replacement:	As implied, a failed part is replaced with an identical part, i.e., replacement same part number, revision level, etc.

The work flow for testing, maintenance and one-for-one replacement are identical, as defined in Table 2 unless alternative work authorization has been provided in the work procedure as noted in section 3.4. In all cases, an electronic work request must be completed. A Configuration Control Work Permit (CCWP) must be completed and posted before work can start. For beamlines and front ends, this posting is either in or referenced from the beamline end cabinet. For the APS Injectors and Storage Ring, the CCWP and Work Request must be completed and posted in the appropriate binder of the APS Main Control Room before work can start.

Table 2: Work Flow for Testing, Maintenance, and One-for-One Replacement

	← PRIOR TO WORK →	← AT START AND COMPLETION OF WORK →		
Risk Level	**Work Plan**	**Work Authorization**	**Validation**	**Close-out**
HIGH/ Medium	Written scope of work Written procedures, group checklists, and/or validation plans are required. The most current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedures and validation plan	Initiating responsible engineer and group leader authorize that work is ready to start utilizing the CCWP. If ACIS/PSS are affected, SI group leader authorizes that work is ready to start utilizing the CCWP CCSM or RSSE reviews work and authorizes utilizing the CCWP. ASD CO approves CCWP for accelerators; Floor Coordinator approves CCWP for beamlines and front ends	Independent validation required Initiating group leader is responsible for assuring validation is performed SI group leader assigns a responsible SI engineer to coordinate with initiating group and validates ACIS/PSS Signed validation of work and/or interlocks required	CCWP is signed off by same authorities that approved work to begin. ASD CO or Floor Coordinator verifies all validations are complete utilizing he CCWP CCWP entered into ICMS
LOW	Procedures and/or validation plan are required The most current drawings, schematics, and specifications are available Standard group practice followed Group leader approves procedures and/or validation plan Associate Division Director/Deputy Division Director approves procedures	Responsible engineer authorizes that work is ready to start utilizing the CCWP. If ACIS/PSS are affected, SI responsible engineer authorizes that work is ready to start utilizing the CCWP RSSE or CCSM reviews work and authorizes utilizing CCWP ASD CO approves CCWP for accelerator; Floor Coordinator approves CCWP for beamlines and front ends	Independent validation required Responsible engineer(s) is responsible for assuring validation is performed Signed validation of work and/or interlocks required	CCWP is signed off by same authorities that approved work to begin. ASD CO or Floor Coordinator verifies all validations are complete utilizing he CCWP CCWP entered into ICMS

3.5.3 Installing Engineering Changes, and New Installations of Radiation Safety Systems

Additional work flows include engineering changes, new installation of proven design, and new installation of new design. Before any of these work flows can be initiated, the system must be reviewed as described in the Design Review Procedure.

Engineering changes:	Replacement of existing systems or devices with equipment in which the design has been modified, e.g., replacing obsolete equipment.
New installation of proven design:	Installation of new equipment that has been demonstrated to be reliable, e.g., a new sector front end using components used successfully in other front ends.
New installation of new design:	Installation of new equipment that has been proven in prototyping and testing, but has no reliability record in operation.

For HIGH and MEDIUM Risk level work on RSS systems, a readiness review must be performed before and after installation. The group leader shall convene a review committee. It must include the Critical Component System Manager or the accelerator chief of operations and, for beamlines, the beamline system manager.

For LOW Risk work on RSS level systems, the readiness review can be internal to the responsible group**.**

All readiness reviews will be documented with written records that are recorded in the electronic Integrated Content Management System.

The work flow for installing engineering changes and new installations are identical, as defined in Table 3 unless alternative work authorization has been provided in the work procedure as noted in section 3.4. In all cases, an electronic work request must be completed. A Configuration Control Work Permit (CCWP) must be completed and posted before work can start. For beamlines and front ends, this posting is either in or referenced from the beamline end cabinet. For the APS Injectors and Storage Ring, the CCWP must be completed and posted in the appropriate binder of the APS Main Control Room before work can start.

Table 3: Workflow for Engineering Changes and New Installations

	← PRIOR TO WORK →	← AT START AND COMPLETION OF WORK →		
Risk Level	**Work Plan**	**Work Authorization**	**Validation**	**Close-out**
HIGH/ MEDIUM	Written scope of work Written procedures, group checklists, and /or validation plan are required The most current drawings, schematics, and specifications are available CCSM and/or RSSE reviews work plan and/or procedure CCSM or RSSE approves procedures used for the work. Associate Division Director/Deputy Division Director approves procedures and validation plan	Division management provides written authorization that work can begin. 6 Initiating responsible engineer and group leader authorize that work is ready to start utilizing the CCWP. If ACIS/PSS are affected, SI group leader authorizes that work is ready to start utilizing the CCWP CCSM or RSSE reviews work and authorizes utilizing the CCWP. ASD CO approves CCWP for accelerators; Floor Coordinator approves CCWP for beamlines and front ends	Independent validation required Initiating group leader is responsible for assuring validation is performed SI group leader assigns a responsible SI engineer to coordinate with initiating group and validates ACIS/PSS Signed validation of work and of interlocks required	Associate Division Director/Deputy Division Director verifies work completion utilizing the CCWP CCWP is signed off by same authorities that approved work to begin ASD CO or Floor Coordinator verifies all validations are complete utilizing he CCWP CCWP entered into ICMS
LOW	Procedures and validation plan are required The most current drawings, schematics, and specifications are available Standard group practice followed Group leader approves procedures and validation plan Associate Division Director/Deputy Division Director approves procedures CCSM and/or RSSE reviews work plan and/or procedure CCSM or RSSE approves procedures used for the work.	Responsible engineer authorizes that work is ready to start utilizing the CCWP. If ACIS/PSS are affected, SI responsible engineer authorizes that work is ready to start utilizing the CCWP CCSM or RSSE reviews work and authorizes utilizing CCWP ASD CO approves CCWP for accelerator; Floor Coordinator approves CCWP for beamlines and front ends	Independent validation required Responsible engineer(s) is responsible for assuring validation is performed Signed validation of work and of interlocks required	CCWP is signed off by same authorities that approved work to begin. ASD CO or Floor Coordinator verifies all validations are complete utilizing he CCWP CCWP entered into ICMS

4. Feedback and Improvement

If you are using this procedure and have comments or suggested improvements for it, please go to the APS Policies and Procedures Comment Form* to submit your input to a Procedure Administrator. If you are reviewing this procedure in workflow, your input must be entered in the comment box when you approve or reject the procedure.

Instructions for execution-time modifications to a policy/procedure can be found in the following document: Field Modification of APS Policy/Procedure (APS_1408152).

* http://centraldocs.aps.anl.gov/comment_form.php