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

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

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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. These systems include but are not limited to critical components. 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 of radiation safety systems, and fabrication, installation, and work on the systems that includes troubleshooting, testing, maintenance, one-for-one replacement, engineering changes, new installation of proven design, and new installation of new design.

APS has assumed oversight for safe operation of Radiation Safety Systems in beamlines. The APS Beamline Safety Design Review Steering Committee must review, and the AOD Division Director approve, 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 from x-ray exposure any personnel 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 troubleshoot, maintain, and repair radiation safety systems in the APS accelerators, front ends, and beamlines.

1.5 References

APS Design Review Procedure Procedure # x.3.1.1
APS Users Policy and Procedures

ANL ESH Manual, Section 5.16: Radiation Safety Interlock Systems

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

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.

Appendix A lists the Radiation Safety System equipment and associated consequence classes.

2.1.4 Signage

The HIGH CONSEQUENCE devices are labeled to alert employees working on these devices that they require special authorization and procedures to perform the work. In the beamlines, red labels are attached to devices that are exposed to direct radiation, and yellow labels are attached to devices that shield indirect scattered radiation. In the accelerator, devices that are controlled by ACIS have yellow labels warning that these are radiation safety devices. New installations should follow one of these practices.

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

COMPLEXITY	CONSEQUENCE: LOW	CONSEQUENCE: MEDIUM	CONSEQUENCE: HIGH
HIGH	Low	High	High
MEDIUM	Low	Medium	High
LOW	Low	Low	Medium

3.0 RADIATION SAFETY SYSTEMS POLICY

3.1 Design Review

Design of radiation safety systems in the HIGH and MEDIUM CONSEQUENCE categories require a division director review, as described in the APS Design Review Procedure. The review will include findings, commendable practices, comments, recommendations, and action items.

For the LOW CONSEQUENCE category, the group leader can perform internal design reviews. However the group leader shall inform division management of impending design changes, so the Division Director can request a more formal review if deemed necessary. In any event, the group leader must submit the report and responses to the report to the Division Director for archiving.

Beamline designs, including RSS equipment, are reviewed by the Beamline Safety Design Review Steering Committee (BSDRSC). The AOD Division Director must approve new beamline designs and any change to beamlines before installation can begin. The Beamline Commissioning Readiness Review Team (BCRRT) must perform an inspection to insure that the beamline is installed according to specifications and a radiation survey

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.

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

3.2 General Requirements for Working on Radiation Safety Systems

Construction projects which have their own project management and review process must be consistent with this policy. The responsible Division Director will attest to this with signature approval.

The technical groups performing the work on the system will develop a single, step-by-step procedure for working on the radiation safety systems. The work plan, procedures, work checklist, and validation procedures for HIGH and MEDIUM risk systems require Associate Division Director 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, even through the Associate Division Director. The content of the Work Authorization, Validation, and Close-out columns are specific to the immediate task.

The technical group requesting installation, maintenance, repair, or testing of radiation devices has the responsibility to coordinate the work performed, including insuring that proper procedures and hazard controls are in place, all work authorizations are secured, and the device is validated for return to service according to written procedures. The responsible group leader has the assignment to insure that the work is performed according to written procedures. The engineer initiating the work request is responsible for insuring each group's work on a subsystem has an approved work procedure. 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 procedures 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.

Before any work is performed, all drawings, schematics, technical specifications, and documents that describe the device and the work procedures must be current. Procedures must be approved by division management according to the risk tables. The work must be performed with strict adherence to the procedures. If any deviation from procedures is identified, work will be stopped until the problem is resolved. The APS will maintain a log of the 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.

Any violation of the policy may result in immediate corrective action up to a stop work order. Work should be stopped immediately if any ambuiguity exists regarding consequences of the violation.

Conflicts between authorizing personnel will be resolved by the next higher level of management. For example, if the chief of operations will not authorize the start of work, the AOD Associate Division Director for Operations will be consulted. Document and drawing deficiencies must also be adjudicated by the next higher level of management.

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 is appointed by the group leader and is typically a staff member who was not involved in the repair or installation, but is knowledgeable about the system that had the work done.

3.3 Work Request System

All work on accelerator, front end, and beamline radiation safety systems must have a work request approved before the work can start.

The work request must identify the engineer initiating the work, who becomes the responsible engineer for the work. The request will identify the work to be performed, flag that the work is on a radiation safety system or device, what groups are needed, the consequence level, and the complexity level. The work request system will have a work flow to select proper authorization personnel, validation, and close-out personnel. Work on a radiation safety system will generate an electronic image of an oversight checklist. If the system involves either the accelerator or front ends, the checklist must be closed out before APS machine operations can continue. A copy of the checklist is in Appendix B.

3.4 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 new installation of new design.

3.4.1 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).

3.4.2 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. In all cases, an electronic work request must be completed. For beamlines and front ends, a Configuration Control Work Permit (CCWP) must be completed and posted 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	Written scope of work Written procedures, group checklists, and validation plan are required The most current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedures and validation plan	Initiating group leader authorizes that work is ready to start If ACIS/PSS are affected, SI group leader authorizes that work is ready to start AOD CO approves work request for accelerators; CCSM approves work request for beamlines and front ends AOD ADD for Operations is informed of the work. The ADD has stop work authority for disruption to operation	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS Signed validation of work and of interlocks required	Associate Division Director/Deputy Division Director closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request Group checklists are saved in group archives
MEDIUM	Written scope of work Written procedures, group checklists, and validation plan The most current current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedures and validation plan	Initiating group leader authorizes that work is ready to start If ACIS/PSS are affected, SI group leader authorizes that work is ready to start AOD CO approves work request for accelerator; CCSM approves for beamlines and front ends AOD ADD for Operations is informed of the work. The ADD has stop work authority for disruption to operation	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS	Group leader closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request Group checklists are saved in group archives

LOW	Informal scope of work Procedures and validation plan The most current drawings, schematics, and specifications are available Standard group practice allowed Group leader approves procedures and validation plan	Responsible engineer authorizes that work is ready to start If ACIS/PSS are affected, SI responsible engineer authorizes that work is ready to start AOD CO approves work request for accelerator; CCSM approves work request for beamlines and front ends AOD ADD for Operations is informed of the work. The ADD has stop work authority for disruption to operation	Independent validation required SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS .	Responsible engineer closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request

3.4.3 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, one-for-one equivalent component replacement.
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.

Since these workflows have greater risks, the work has a higher level of review and authorization than repair or maintenance.

For HIGH and MEDIUM Risk level accelerator systems, a readiness review must be performed before 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 level accelerator systems, the readiness review can be internal to the responsible group**.**

All readiness reviews will be documented with written records that are sent to the division office for archiving.

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	Written scope of work Written procedures, group checklists, and validation plan are required Current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedures and validation plan	Associate Division Director/Deputy Division Director authorizes that the work is ready to start If ACIS/PSS are affected, the SI group leader authorizes that the work is ready to start AOD CO approves work request for accelerator; CCSM approves for beamlines and front ends AOD ADD for Operations is informed of the work. The ADD has stop work authority for disruption to operation	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS Signed, independent validation of work and of interlocks is required	Associate Division Director/Deputy Division Director closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request Group checklists are saved in group archives

MEDIUM	Written scope of work Written procedures, group checklists, and validation plan Current drawings, schematics, and specifications are available Associate Division Director/Deputy Division Director approves procedure and validation plan	Associate Division Director/Deputy Division Director authorizes that the work is ready to start If ACIS/PSS are affected, the SI group leader authorizes that the work is ready to start AOD CO approves work request for accelerator; CCSM approves for beamlines and front ends <u>AOD ADD for Operations is informed of the work. The ADD has stop work authority for disruption to operation</u>	Initiating group leader is responsible for validation SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS	Associate Division Director/Deputy Division Director closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request Group checklists are saved in group archives
LOW	Written scope of work Procedures and validation plan are approved by group leader Current drawings, schematics, and specifications are available Group leader approves plan	Group Leader authorizes that work is ready to start If ACIS/PSS is affected, SI group leader authorizes that work is ready to start AOD CO approves work request for accelerator; CCSM approves work request for beamlines <u>AOD ADD for Operations is informed of the work. The ADD has stop work authority for disruption to operation</u>	Independent validation required SI group leader assigns a responsible SI engineer to coordinate with initiating group and validate ACIS/PSS	Group leader closes out work completion Oversight checklist signed off For beamlines and front ends, CCWP is signed off AOD CO or CCSM closes out work request

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
ACCELERATOR					
Linac/PAR:					
Linac Laser Gate Valve Shutter	High	Bldg 411 at the beginning of the APS linac, and adjacent to the linac tunnel. Both the Laser Room (A103A) and the Linac Injector Test Stand (ITS) (A103B) are considered laser controlled areas (LCA).	ACIS Interface Yes. RSS Boundary = Gate valve, position switches & equipment RSS path.		
LINAC Laser Enable Power Supply	High	Laser Room (A103A)	ACIS Interface Yes. RSS Boundary = Monitor and control power to the laser via relay contacts.		
RF Gun 1 & 2 Kicker Supply (RG1 & 2:KIK)	Med.*	L1 Section of the Klystron Gallery	ACIS Interface Yes. RSS Boundary = Control relays and wiring associated with ACIS.	The Check out of RG1:KIK after ACIS components have been repaired. 2	Only for ACIS inside of equipment.1 *Defined as medium level not high because it is part of redundant RSS pair.
ACIS/Modulator Interface	Med.*	L1,L2,L3,L4,L5, & L6**	ACIS Interface Yes. RSS Boundary = Consists of an interface chassis, junction box and wiring which perform the following functions: [1] routes ACIS permit contact closures to the L1,2,3,4,5,6 both upper and lower EMI HVPS's utilizing an external contact interlock input to the HVPS that involves relays K11 and K12, connectors P10 and P11 in the modulator's junction box, and external interlock inputs of the EMI supplies; [2] sends the ACIS status to EPICS through the junction box connector P12. The interface chassis provides +15 VDC through connector P24. If ACIS is not in the linac "Beam Permit" mode, opened contacts in the modulator's ACIS chassis interrupts external interlocks in both EMI HV power supplies and shuts them off.	The Check out of RF 1 Amplifier. 2	1 *Defined as medium level not high because it is part of redundant RSS pair. ** L6 not interfaced to ACIS.
PAR dipole Power Supply (P:BM)	Med.*	Bldg. 411-B105	ACIS Interface Yes. RSS Boundary = Main Power contactor and wiring and control relays associated with ACIS. This MAY include the ACIS box outside the equipment.	The Check out of P:BM after ACIS components have been repaired. 2	Only for ACIS inside of equipment, & the ACIS box outside of equip. 1 *Defined as medium level not high because it is part of redundant RSS pair.

1. Only for equipment interlocks that interface to ACIS.
2. Shutdown validate if the equipment interlocks that interface to the ACIS have been serviced, or at machine startup.
3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
Injector Test Stand Wave Guide Switch Interface	High	Sw. #5 is located in the linac tunnel, gun end. Sw. #6 is located in the Injector Test Stand.	ACIS Interface Yes. RSS Boundary = Work on the S-band switches and associated cabling to and including the cable junction boxes.	3	Wave-guide switches numbered 5 and 6 are installed in the linac wave-guide that connects to the RF Gun Test Room.
L1 ACIS/BESOCM/ Modulator Interface	Low	L1 Section of the Klystron Gallery	ACIS Interface Yes. RSS Boundary = Consists of the Interface chassis (board AA, local/remote control board, connector P15 and wiring), the thyratron drive chassis (TTC), high-voltage coaxial cable between theTTC and the thyratron box, and a fiber optic cable between the BESOCM triggering chassis and the modulator interface chassis. The interface performs the following function: routes optical-analog-high-voltage triggering signal to the L1 thyratron switch. If ACIS decides to stop the modulator from triggering, the BESOCM disables its output, no optical triggering signal is received by board AA of the modulator interface chassis, and the thyratron does not fire.		
LINAC BESCOM Trigger Chassis	Low	Bldg. 412, Rm B107	ACIS Interface Type Yes. RSS Boundary = any work on the BESCOM Trigger Switch Chassis and the output fiber cables to the modulators and BESOCM devices.	3	The BESOCMs must be triggered by the particular linac rf system that is supplying rf to the guns
Linac/PAR Beam Shutoff Current Monitors	Low	Bldg. 412, Rm B107	ACIS Interface Yes. RSS Boundary = Beam shutoff monitors and equipment in RSS device path.	2	1

1. Only for equipment interlocks that interface to ACIS.
2. Shutdown validate if the equipment interlocks that interface to the ACIS have been serviced, or at machine startup.
3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
PAR RF	Med.*	Bldg. 412, Rm B107	ACIS Interface Yes. RSS Boundary = PAR RF and equipment in RSS device path. Consists of an interface chassis located in building 411, room B107 and routes ACIS permit contact closures to the fundamental par tube amplifier #1 and #2 and the harmonic par tube amplifier #1 and #2. For harmonic tube amplifiers, ACIS contact closure involves relay K3 and terminal block TB3 both located inside the tube amplifier chassis and when ACIS permission is denied will put both harmonic tube #1 and #2 in stand-by mode (no high voltage).The back door of these harmonic tube amplifier chassis are also interlocked and if the door opens, the unit will go into stand-by. For fundamental tube amplifier, ACIS contact closure involves K13 and terminal block TB4 on the interlock relay chassis located inside the fundamental tube amplifier racks. When ACIS permission is denied both fundamental tube amplifier will loose high voltage. Both fundamental tube amplifiers back doors are also interlocked.	2	1 *Defined as medium level not high because it is part of redundant RSS pair.
ACIS - Linac to PAR Bending Magnet Interface LTP:B1	Low	411	ACIS Interface Yes. RSS Boundary = Bending magnet interface and equipment in RSS path.	2,3	The Linac/PAR ACIS monitors the status of the Linac to PAR Bending Magnet. 1
Kylstron Lead Shielding	Medium	L1,L2,L3,L4,L5,L6	ACIS Interface No. RSS Boundary = Protection from klystron X-rays; consists of a number of lead plates, rings, etc.; is monitored by HP on a daily basis.		
LACIS: Laser Access Control	Medium	Laser Room (A103A)	ACIS Interface No. RSS Boundary =	2,3	LASER Access Control Interlock System
Synchrotron/ BOOSTER					
PAR to Booster Triple Beam Stopper	High	PAR Tunnel, NW corner	ACIS Interface Yes. RSS Boundary = Double radiation stopper and equipment in RSS device path.	2	ACIS monitors & controls two radiation stoppers. 3
Linac to Booster Double Radiation Stopper	High	PAR Tunnel, NW	ACIS Interface Yes. RSS Boundary = Double radiation stopper and equipment in RSS device path.	2	ACIS monitors & controls two radiation stoppers. 3
Booster to Ring Double Radiation Stopper	High	Booster Tunnel	ACIS Interface Yes. RSS Boundary = Double radiation stopper and equipment in RSS device path.	2	ACIS monitors & controls one radiation stopper. 3

1. Only for equipment interlocks that interface to ACIS.
2. Shutdown validate if the equipment interlocks that interface to the ACIS have been serviced, or at machine startup.
3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
Booster to LEUTL Single Radiation Stopper	Med	LEUTL Alcove in Injection side of the Booster Tunnel.	ACIS Interface Yes. RSS Boundary = Double radiation stopper and equipment in RSS device path.	2	ACIS monitors & controls one radiation stopper. 3
RF 5 HV modulator and RF 5 Amplifier)	Med.*	420	ACIS Interface Yes. RSS Boundary = Consists of an interface chassis and wiring which performs the following functions: [1] routes ACIS permit contact closures to the RF5 HVPS utilitzing an external contact interlock input to the HPVS, [2] switches 120v ac power to the RF5 klystron (Kalmus) rf driver amplifier, [3] routes a contact closure from the HVPS back to the ACIS system to indicate the off/on status of the HVPS, [4] provides a contact closure to the ACIS system that indicates the on/off status of the switched 120v ac power to the klystron (Kalmus) rf driver amplifier, [5] provides contact status outputs to the EPICS control system to indicate the interface box status, and [6] provides external reset capabilities of the ACIS/RF Interface Chassis from EPICS.		*Defined as medium level not high because it is part of redundant RSS pair.
BOOSTER Dipole Power Supply (B:BM)	Med.*	Bldg. 412 - West End.	ACIS Interface Yes. RSS Boundary = Main power contactor and wiring and control relays associated with ACIS. This MAY include the ACIS box outside the equipment.	The Check out of B:BM after ACIS components have been repaired. 2,3	Only for ACIS inside of equip., & the ACIS box outside of equipment. 1 *Defined as medium level not high because it is part of redundant RSS pair.
BOOSTER Dipole Power Supply (BTS:BX)	Med	420 - col# A7 (across form the truck dock).	ACIS Interface Yes. RSS Boundary = Shunt wiring and control relays associated with ACIS. This include the ACIS pannel in the realy rack.	The Check out of BTS:BX after ACIS components have been repaired. Check out PS comparison circuitry if serviced by the PS Group. Check response of gap switches in magnet if serviced.	Only for ACIS threshold detection, and the ACIS of equipment inside of the rack.
Synchrotron to Storage Ring High Energy Transport Line Steering	Med		ACIS Interface Yes. RSS Boundary = BX and AB steering magnet status and equipment in RSS path.	Check out PS comparison circuitry if serviced by the PS Group. Check response of gap switches in magnet if serviced.	The RF Area ACIS monitors the status of the steering magnets (BX and AB magnets) that direct the beam from the Synchrotron to the beam dump or to the Storage Ring.

1. Only for equipment interlocks that interface to ACIS.
2. Shutdown validate if the equipment interlocks that interface to the ACIS have been serviced, or at machine startup.
3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
Storage Ring:					
RF HV modulator and RF Amplifier)	Med.*	RF 1 HV, RF 2 HV, RF 3 HV, RF 4, HV & RF 1 Amplifier, RF2 Amplifier, RF3 Amplifier, RF4 Amplifier	ACIS Interface Yes. RSS Boundary = Consists of an interface chassis and wiring which performs the following functions: [1] routes ACIS permit contact closures to the RF1, 2, 3, 4 UVC HVPS system utilizing the "external 3" contact interlock input which involves relay #3 on relay card #11 in the UVC control system, [2] switches 120v ac power to the RF1,2,3,4 klystron (Kalmus) rf driver amplifier, [3] routes a contact closure generated by the "HVPS ACIS Status Relay" in the UVC SCR Control Cabinet back to the ACIS system to indicate the off/on status of the HVPS, [4] provides a contact closure to the ACIS system that indicates the on/off status of the switched 120v ac power to the klystron (Kalmus) rf driver amplifier, [5] provides contact status outputs to the EPICS control system to indicate the interface box status, and [6] provides external reset capabilities of the ACIS/RF Interface Chassis from EPICS. When RF1,2,3,4 is used to supply rf power to the 350MHz RF Test Stand, separate ACIS system for the 350MHz RF Test Stand utilizes this interface chassis to control RF1,2,3,4.	The Check out of RF 1 HV modulator. 2,3	*Defined as medium level not high because it is part of redundant RSS pair.
Storage Ring Dipole Power Supply (S:BM)	Med.*	Bldg 420-A004	ACIS Interface Yes. RSS Boundary = Main Power Supply contactor and wiring and control relays associated with ACIS.	Dipole shutdown validation after work. 2,3	Connected to ACIS equipment. *Defined as medium level not high because it is part of redundant RSS pair.
Storage Ring 6 GEV Interlock system.	Med	Bldg 420-A004	ACIS Interface Yes. RSS Boundary = Wiring to S.R. Dipole measuring current and voltage connected to ACIS.	6 GEV top-up interlock validation after work.	Connected to ACIS equipment.
ACIS - Storage Ring Current Monitors	Med	Sector 33: 36 current monitors	ACIS Interface Yes. RSS Boundary = SR current monitors and equipment in RSS device path.	2,3	Two Storage Ring beam current monitors interface to the RF Area ACIS. 1
ACIS - Storage Ring Dipole Power Supply Interface	High		ACIS Interface Yes. RSS Boundary = SR Dipole PS interface and equipment in RSS device path.	2,3	PS current and voltage > 6 Gev. 1
Storage Ring Gate Interfaces	High		ACIS Interface Yes. RSS Boundary = Each of the Storage Ring gates contains monitoring switches.	2,3	
Rachet and Super Door Interfaces	High		ACIS Interface Yes. RSS Boundary = Each ratchet door contains monitoring switches	2,3	
Global On/Off Line Key switch (asserted ON when "On Line")	High	ASIE	ACIS Interface Yes. RSS Boundary = ACIS	3	

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3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	**Consequence Level**	**Device/System Location(s)**	**Device/System Partition Description**	**Associated Work Flow Procedures**	**Comments**
Sector 39 View screen	Med	F Tunnel	ACIS Interface Yes. RSS Boundary = Work in the SR tunnel on any S39 Flag component or cable	2,3	The closed position of the Sector 39 view screen is monitored by the ACIS
ACIS - Radiation Monitor Interfaces	Med	APS Facility	ACIS Interface Yes. RSS Boundary = Radiation monitor and equipment in RSS device path up to ACIS connector.	2,3	All five ACISs interface to numerous radiation monitors in the APS facility. 1
ACIS - Building 420 Wave Guide Shutters	High	420	ACIS Interface Yes. RSS Boundary = Wave Guide shutters and equipment in RSS device path.	2,3	Two shutters are installed in the rf wave-guide that connects to the RF Test Stand. 1
ACIS - Maze Door Interfaces	High	APS Facility	ACIS Interface Type Yes. RSS Boundary = Doors - Mechs or facility, switches/lock	2,3	Each maze door contains monitoring switches & lock
ACIS - Chain A and B, PLC software and hardware and chain C hardware	High *	APS Facility	ACIS Interface Yes. RSS Boundary = ACIS	2,3	* Functional changes to the PLC software are considered High consequences. However, remedial changes to the PLC software may be considered meduim.
ACIS - Safety related devices	Medium	APS Facility	ACIS Interface Yes. RSS Boundary = ACIS access keys, Door Locks, Search and Secure stations, and tamper monitoring	2,3	Access keys, **Door Locks**, Search & Secure stations, and tamper monitoring
Shielding Components in APS Accelerator (LINAC, BOOSTER, SR)	High		ACIS Interface No. RSS Boundary = Critical Components (red tags) and Components Under Configuration Control (yellow tags) that are not interfaced to either the ACIS or PSS.		
ACIS - Front End Equipment Protection System	Low	Facility	ACIS Interface Yes. RSS Boundary = Closed switches		
ACIS - Controlled Access CCTV System	Low	Facility	ACIS Interface Yes. RSS Boundary = ACIS controlled access CCTV and equipment in RSS path.	2,3	A CCTV/intercom system is used by MCR Operations to allow personnel access to the five machines at the maze doors while the ACIS is in Controlled Access Mode

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3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
ACIS to PSS: shutter permit	Medium		ACIS Interface Yes. RSS Boundary = ACIS to PSS ICD	2,3	Shutter Permit (asserted ON when shutters may be opened)
RF: waveguide leakage monitors	Medium		ACIS Interface Yes. RSS Boundary = Waveguide leakage monitors and equipment in RSS path.		waveguide leakage monitoring
RF1,2,3,4,5 Klystron garages personnel access control interlocks	High	420	ACIS Interface No. PSS Boundary = RF1,2,3,4,5 Klystron garage interlocks consists of Protection from klystron X-rays; consists of door switches and a Kirk-keyed lock/keyswitch. These contacts serve as two separate and isolated inputs to the RF1,2,3,4,5 Personnel Safety System Interface chassis, which shuts down the RF1,2,3,4,5 HVPS and klystron rf drive if the garage is opened.		
RF3/5 Isolation Waveguide Shutters	High		ACIS Interface Yes. RSS Boundary = Two full-height WR2300 waveguide shutters that provide rf isolation in the waveguide run between waveguide switch #2 & waveguide switch #3. This configuration provides rf isolation between RF3 & RF5, which is equivalent to isolation between the Booster & SR rf distribution systems. The open/closed position of the waveguide shutters is monitored by the SR & Booster ACIS system, utilizing dedicated position indication switches installed inside each waveguide shutter. These position indication switches provide contact closures to the ACIS system through dedicated connectors & cabling from each shutter. The SR or Booster ACIS system monitors the psoition of both waveguide shutters and uses the shutter position to provide ACIS control of RF3 from the SR ACIS system or the Booster ACIS system, depending on which accelerator system RF3 is providing rf power to. Both of these waveguide shutters are equipped w/Kirk-interlock systems that allow the shutters to be locked in the closed position for LOTO purposes. The position of both waveguide shutters can be changed manually or by rem		

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RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
Waveguide Air Pressure Interlocks	Low		ACIS Interface Yes. RSS Boundary = Protection from rf radiation from opening in the rf waveguide system by detecting a drop in slight positive air pressure maintained inside the waveguide system by the rf cavity coupler air blowers. The system consists of 9 separate calibrated Photohelic air pressure guages installed at various positions in the waveguide system throughout Building 420. The alarm outputs of all Photohelic pressure guages (except for the Photohelic pressure gauge located at the 350MHz RF Test Stand, which is presently disabled) terminate at an interface chassis that routes shutdown commands to the RF Personnel Safety Interface Chassis all Storage Ring and Booster RF stations (RF1-TF5) in the event any single or comination of the Photohelic pressure guages rgisters an alarm. The RF Personnel Safety Interlock System at each rf station in turn disables the HVPS and klystron rf drive.		
350MHz RF Test Stand RF Radiation Monitor	Medium		ACIS Interface Yes. RSS Boundary = This rf radiation monitor provides an alarm contact closure to the 350MHz RF Test Stand ACIS system in the event the rf radiation level behind the test stand operator console exceeds approximately 0.10mW/sq-cm at 351.93MHz.		

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2. Shutdown validate if the equipment interlocks that interface to the ACIS have been serviced, or at machine startup.
3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
350 MHz RF Test Stand Bunker Isolation Waveguide	Medium		ACIS Interface Yes. RSS Boundary = Two full-height WR2300 waveguide shutters that provide rf isolation in the waveguide system for downstream personnel protection when the test cavity or connecting waveguide is disassembled for analysis, repair, or modification. The open/closed position of the waveguide shutters is monitored by the 350MHz RF Test Stand ACIS system utilizing dedicated position indication switches installed inside each waveguide shutter. These position indication switches provide contact closures to the ACIS system through dedicated connectors and cabling from each shutter. The 350MHz RF Test Stand ACIS system monitors the position of both waveguide shutters and uses the shutter position to either permit or inhibit the operation of RF1. Both of these waveguide shutters are equipped with Kirk-interlock systems that allow the shutters to be locked in the closed position for LOTO purposes. The position of both of these waveguide shutters can be changed manually or by remote control from the 350MHz RF Test Stand PLC Control System.		
350MHz RF Test Stand 1MW RF Test Load Isolation Waveguide Shutters	Medium		ACIS Interface Yes. RSS Boundary = Two full-height WR2300 waveguide shutters that provide rf isolation in the waveguide system for downstream personnel protection in the connecting waveguide run between switch #4, the device test circulator, and the 1MW rf test load is disassembled for analysis, repair, or modification. Both of these waveguide shutters are equipped with Kirk-interlock systems that allow the shutters to be locked in the closed position for LOTO purposes. The position of both of these waveguide shutters is changed manually, or electrically by the use of local control boxes that are temporarily connected to the shutters.		
LEUTL:					
BBBM1 Power Supply	High		ACIS Interface Yes. RSS Boundary = Contactor and other equipment in RSS path.	2,3	1
BBBM2 Power Supply	High		ACIS Interface Yes. RSS Boundary = Contactor and other equipment in RSS path.	2,3	1
LEUTL: End station access control	Medium		ACIS Interface Yes. RSS Boundary = Personnel access control interlock system		
Display computers and EPICS for ACIS	Low		ACIS Interface Yes. RSS Boundary = Display computers and EPICS interface		

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5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
BEAMLINES					
Front Ends					
Photon Shutters 1 & 2 (PS1, PS2)	Med	1BM, 1ID, 2BM, 2ID, 3ID, 4ID, 5BM, 5ID, 6BM, 6ID, 7ID, 8BM, 8ID, 9BM, 9ID, 10BM, 10ID, 11BM, 11ID, 12BM, 12ID, 13BM, 13ID, 14BM, 14ID, 15ID, 16BM, 16ID, 17BM, 17ID, 18ID, 19BM, 19ID, 20BM, 20ID, 22BM, 22ID, 23BM, 23ID, 24ID, 26ID, 30ID, 31ID, 32ID, 33BM, 33ID, 34ID, 35BM, 35ID	PSS Interface Type - 1 & 2. RSS Boundary = position switches, cylinders, pneumatics, DIW cooling up to the PSS wiring and alignment.	2,3	Open and Closed switches. 5 * New Front Ends being commissioned.
Safety Shutter 1 & 2 (SS1, SS2)	High	1BM, 1ID, 2BM, 2ID, 3ID, 4ID, 5BM, 5ID, 6BM, 6ID, 7ID, 8BM, 8ID, 9BM, 9ID, 10BM, 10ID, 11BM, 11ID, 12BM, 12ID, 13BM, 13ID, 14BM, 14ID, 15ID, 16BM, 16ID, 17BM, 17ID, 18ID, 19BM, 19ID, 20BM, 20ID, 22BM, 22ID, 23BM, 23ID, 24ID, 26ID, 30ID, 31ID, 32ID, 33BM, 33ID, 34ID, 35BM, 35ID	PSS Interface Type - 1 & 2. RSS Boundary = position switches, cylinders, pneumatics, DIW cooling up to the PSS wiring and alignment.	2,3	Open and Closed switches. 5 * New Front Ends being commissioned.
Fixed Mask 1,2,3	Med	1BM, 1ID, 2BM, 2ID, 3ID, 4ID, 5BM, 5ID, 6BM, 6ID, 7ID, 8BM, 8ID, 9BM, 9ID, 10BM, 10ID, 11BM, 11ID, 12BM, 12ID, 13BM, 13ID, 14BM, 14ID, 15ID, 16BM, 16ID, 17BM, 17ID, 18ID, 19BM, 19ID, 20BM, 20ID, 22BM, 22ID, 23BM, 24BM, 33BM, 33ID, 34ID	PSS Interface No. RSS Boundary = cooling, alignment		Open and Closed switches. 5 * New Front Ends being commissioned.
Fixed Mask 1,2	Med	11ID	PSS Interface No. RSS Boundary = cooling, alignment		
Fixed Mask 1,2,3 & 4	Med	16ID, 22ID, 31ID, 32ID	PSS Interface No. RSS Boundary = cooling, alignment		

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3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
Shielding Components	High		PSS Interface No. RSS Boundary = The general type of beamline shielding components include: Lead bricks, ratchet wall collimators.		* New Front Ends being commissioned.

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3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
Experimental Floor					
Collimator	High	1BM,1ID,2BM,2ID,3ID,4ID,5BM,5ID,6ID,7ID,8BM,8ID,10BM,10ID,12BM,12ID,13BM,13ID,14BM,14ID,15ID,16BM,16ID,17BM,17ID,18ID,19BM,19ID,20BM,20ID,22BM,22ID,23ID,24ID,31ID,33BM,33ID,34ID,35ID	PSS Interface No. RSS Boundary = collimator, cooling & alignment. Typical types are K5-20…		
Beamline Shutters	High	1BM,1ID,2BM,2ID,3ID,4ID,5BM,5ID,6ID,7ID,8BM,8ID,9BM,10ID,11BM,11ID,12BM,12ID,13BM,14BM,14ID,15ID,16BM,16ID,17BM,17ID,18ID,19BM,19ID,20BM,20ID,22BM,22ID,23ID,24ID,30ID,31ID,32ID,33BM,33ID,34ID,	PSS Type 3 & 4. RSS Boundary = Position switches, cylinders, pneumatics, DIW cooling up to the PSS wiring. Typical types are P6,P7,P8,P4,P5,P9,S2,SH1-C,SH2-D,S3,		Open and Closed switches
Lead Bricks	High	1BM,5BM,13ID,15ID, 16ID,27ID,	PSS Interface No. RSS Boundary = Lead bricks that have red configuration tags.		
Beam Stop	High	2BM,2ID,4ID,5BM,5ID, 8ID,9ID,10BM,11ID,13BM,13ID,14BM,14ID,15ID, 16BM,16ID,18ID,19ID, 20BM,22ID,23ID,24ID,26ID,30ID,31ID,32ID,33ID,34ID,35ID,35BM	PSS Interface in some cases. RSS Boundary = Either Synchrotron or Bremsstrahlung Stops		
Mask	High	2ID,4ID,8ID,10BM,11ID.13ID,16BM,16ID,20BM, 24ID,31ID,33BM,33ID,34ID,	PSS Interface No. RSS Boundary = Mask, cooling and alignment that have red configuration tags. Typical types are M9-30 mask.		
Bremsstrahlung Stop/Shielding	High	5ID,6BM,9BM,17BM27ID	PSS Interface No. RSS Boundary = Shielding for bremstrallung.		
Beamline Interlock	High	14ID	Type-4 Back to back copper canister at the downstream wall of 14-ID-B		
Photon Stop	High	16ID	Type-4 Photon Stop located downstream end of 16ID-C, directly upstream of S3-30 shutter		
White/Pink Beam Absorber	High	17BM	Type-3 White/Pink Beam Absorber (SCRRI Design) located downstream of Mono		
Monochromater	High	19BM	Type-3 Monochromater tank (only)		

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5. Closed switches fanned to PSS.

RADIATION SAFETY DEVICE LIST (Compressed List)

Names: By Machine	Consequence Level	Device/System Location(s)	Device/System Partition Description	Associated Work Flow Procedures	Comments
Monochromater	High	22BM	Type-3 Downstream wall of Monochromater tank (only)		
BEAMLINES					
PSS - In General	High	All Beamlines	PSS Safety critical hardware and software		
PSS - Safety Related Devices	Medium		Search and Secure stations, warning alarms and beacons, door magnetic locks, PSS USER Key		
PSS - Beam Line Shutters = Mode Locks	Medium		Kirk locks when installed on mode shutters		
PSS - BLEPS Interface	Low		PSS Interface Type - 5. RSS Boundary = Isolated relay contact		
PSS - Remote Shutter Interface and Chassis	Low		PSS Interface Type - 5. RSS Boundary = Isolated relay contact		
PSS - Pneumatic Door Interface	Low		PSS Interface Type - 5. RSS Boundary = Terminal strip in box		
PSS - FEEPS Interface	Low		PSS Interface Type - 5. RSS Boundary = Isolated relay contact		
PSS - Generation-3 PSS Chain-C I/O	Low		PSS Interface Type - 5. RSS Boundary = Electrically isolated.		

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3. Annual valid. or when serviced.
5. Closed switches fanned to PSS.