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APS Accelerator Safety Envelope (ASE)

Changes made in this revision:

- New ASE for 6 GeV 200 mA Storage Ring MBA lattice
- The ASE has been extracted from APS SAD V. 5.

Prepared by:

PSC Safety Manager

APS Associate Project Manager for Accelerators

APS-U Director

APS Director of Operations

Approved by:

DOE Argonne Site Office Field Element Manager

Accelerator Safety Envelope (ASE)

Advanced Photon Source

Table of Contents

Introduction

The Department of Energy (DOE) Order 420.2D, Safety of Accelerator Facilities establishes accelerator-specific safety requirements and approval authorities. This Accelerator Safety Envelope (ASE) document defines the bounding conditions, physical and administrative requirements and credited controls that are established for the Advanced Photon Source (APS) Accelerator Facility after completion of the APS Storage Ring Upgrade (circa 2024) to ensure safe operations and to minimize the potential accelerator-related risks to the public, workers, and environment. The basis behind each of the credited controls is described in Section 3 of the associated Safety Assessment Document.

Accelerator Safety Envelope

DOE O 420.2D defines the Accelerator Safety Envelope as a documented set of verifiable bounding conditions, physical and administrative requirements, and credited controls that ensure safe operation and address accelerator specific hazards and risks. The Accelerator Safety Envelope is the result of the Safety Assessment Document. The Advanced Photon Source has multiple levels of controls to ensure successful operation, with Credited Controls at the pinnacle of those controls. Credited Controls are those controls determined through Safety Analysis to be essential for safe operation of the accelerator protect the public, workers, and environment.

Bounding conditions are limits on operating parameters that bound safe operations and administrative requirements are specific protective administrative controls needed to assure appropriate mitigation of accelerator specific hazards.

Any activity and its affected operations which violate the ASE must be terminated immediately. Operations must then be put in a safe and stable configuration.

Affected operations must be terminated immediately and put in a safe and stable configuration for discovered conditions that create or reveal an ASE violation.

DOE Approval is required for any proposed activity that would create an ASE violation.

Bounding Conditions

Accelerator and/or Transport Line	Maximum Beam Power
Linac/Linac to PAR Transport Line	1,000 W
LEA	1,000 W
PAR/ PAR to Booster Transport Line	20 W
Booster Synchrotron	308 W
Booster to Storage Ring Transport Line	126 W

Operability Condition	Parameter	Requirement
Storage Ring - Injection	Injected Charge / Hour	Maximum of 72 microCoulombs averaged over 1 Hour.
Storage Ring - Injection	Injected Beam Power	Maximum of 126 W
Storage Ring – Stored Beam	Beam Current	Minimum Current of 1 mA to be considered "Stored Beam" Maximum Current: 225 mA
Storage Ring – Stored Beam	Stored Energy	Maximum of 5200 J
Storage Ring – Stored Beam	Beam Energy	Minimum Beam Energy: 5.5 GeV Maximum Beam Energy: 6.3 GeV
Swap Out Operations	Storage Ring Conditions	Swap Out Operations (i.e., swap out injection with beamline shutters open) allowed only with Storage Ring - Stored Beam present.
Swap Out Operations	Extracted Energy Range between Booster and Storage Ring	Beam extracted from the booster shall be restricted to be within +/- 11% of the nominal 6.0 GeV.
Swap Out Operations	Current from unipolar power supplies	Currents must be within + or – 8% of their design currents.

Credited Controls (Passive)

Radiation Shielding

Radiation shielding is installed to maintain doses consistent with the Argonne Shielding Policy and to mitigate the consequences of scenarios identified in the Safety Assessment Document. Shielding for the accelerators includes the walls and roofs of the storage ring, booster synchrotron, and Linac/PAR tunnels, and all shielding required per the shielding logbook. Shielding for the x-ray beamlines includes the shielding enclosures and beampipe and all shielding required per the shielding logbook.

Operability Criteria:

- Shielding shall be assigned an identification number that is affixed to the shield after installation.
- The configuration of each shield shall be documented in a controlled shielding logbook.
- Shielding will be secured in place unless it is immovable by design such as the walls and roofs of the accelerator or the x-ray beamline enclosures.
- Written procedures shall be prepared and followed for un-securing, removing, replacing, and re-securing shielding.
- Beam will not be permitted in an associated area if shielding has been reported to be compromised for that area.
- Shielding as documented in a controlled shielding logbook for each accelerator and x-ray beamline must be in place prior to allowing beam in the respective accelerator or x-ray beamline.

Frequency of Surveillance:

- Shielding shall be inspected every twelve months to identify changes that could affect the shielding for degradation, damage or unauthorized modification that could adversely affect the shielding configuration or performance.
- Shielding shall be inspected every twelve months and after completion of work that involved removing any shielding to verify that such shielding is in place and secured.

Credited Controls (Active)

ACIS – Access Control Interlock System Features

ACIS – The Access Control Interlock System is an engineered system based on programmable logic controllers (PLCs) and is designed to prevent personnel from being exposed to accelerator produced radiation while inside one of the APS accelerator tunnels (LINAC/PAR, Booster, or Storage Ring) and to prevent x-ray beamlines from accepting beam from the Storage Ring either in the absence of a beamline Personnel Safety System (PSS) or when triggered by a beamline's Personnel Safety System. Features of the ACIS that directly protect personnel include the door switches, access control gates and doors, the programmable logic controllers and the beam shutdown interfaces.

Operability Criteria:

The Access Control Interlock System safety features must be operable when beam is in the associated area as demonstrated by the following operability criteria:

- All personnel access points to the accelerator area in question are protected by ACIS.
- Triggering of an interlock at any access point stops / inhibits beam in the accelerator area thus limiting any potential exposure when prompt radiation may be present.
- All beamline safety shutters must be closed when the beamline PSS is not present, or the PSS removes Storage Ring beam permit to the Storage Ring ACIS system.
- Triggering of a beamline's PSS to ACIS interlock disables Storage Ring beam thus limiting any potential exposure when prompt radiation may be present.
- Will shut down accelerator beam when improper access is gained.

Frequency of Surveillance:

- Operability is verified by performing a validation test for each ACIS sub-system once every twelve months, and after any maintenance on or change to an ACIS sub-system or PLC code.

ACIS – Area Radiation Monitors

ACIS – Area Radiation Monitors are positioned external to the accelerator tunnels and must be operable when accelerator beam is in an associated accelerator area except as noted below in the limiting condition of operation. These monitors are placed with the input of subject matter experts and Argonne's Radiation Protection Program.

Operability Criteria:

- All radiation monitors operate continuously when accelerator beam is present and provide assurance that radiation levels are consistent within set parameters determined with the Radiation Protection Program.
- Triggering of an interlock due to a radiation monitor reading stops / inhibits beam in the accelerator area thus limiting any potential exposure when prompt radiation may be present
- Shuts down or inhibits beam generation devices when a radiation trip limit is exceeded for the associated accelerator area.

Frequency of Surveillance:

- Operability is verified by performing a calibration test for each Area Radiation Monitor every twelve months, and after any maintenance on or change to an Area Radiation Monitor.
- Operability is verified by a source check on each Area Radiation Monitors every six months.

PSS – Personnel Safety System Access Control Features

PSS – The Personnel Safety System is an engineered system based on programmable logic controllers (PLCs) and designed to prevent personnel from being exposed to accelerator produced radiation (e.g. x-rays) while being inside a beamline radiation enclosure. Triggering of an interlock at any access point stops / inhibits x-ray beam in the beamline area thus limiting any potential exposure when prompt radiation may be present. Prevents entry into a beamline enclosure when prompt radiation may be present. Features of the PSS that directly protect personnel include the door switches, the programmable logic controllers and the beam shutdown interfaces.

Access control features for x-ray beamlines must be operable when x-ray beam is in the associated beamline enclosure.

Operability Criteria:

- All beamline enclosures that require frequent, controlled personnel access are protected by the PSS – Access Control System.
- Each beamline is protected by shutters monitored by the PSS system where each shutter protects downstream areas from radiation dose.
- Access to beamline enclosures is monitored through the PSS system.
- Shuts down x-ray beam when improper access is gained.

Frequency of Surveillance:

- Operability is verified by performing a validation test for each PSS sub-system every twelve months, and after any maintenance on or change to an PSS sub-system or PLC code.

Oxygen Deficiency Alarm (ODH) System – Monitor and Alarm Features

ODH monitors with visual and audio alarms alert personnel to ODH conditions to help ensure that people do not enter ODH environments. ODH monitors are installed inside each experimental enclosure at the APS that receives liquid nitrogen directly from the Liquid Nitrogen Distribution System.

Operability Criteria:

- ODH monitors must alert personnel when oxygen concentrations inside an enclosure fall below 19.5% oxygen.
- All beamline enclosures that are receiving liquid nitrogen from the liquid nitrogen distribution system will have an ODH monitor with audio and visual alarms.

Frequency of Surveillance:

- Oxygen Deficiency monitors with visual and audio alarms will be maintained, tested, and calibrated in accordance with manufacturer instructions with a frequency not to exceed twelve months.

Administrative Requirements

Main Control Room Operators

Minimum staffing required to ensure safe operations.

- Either the Crew Chief or a qualified control room operator shall be present either in the main control room or in an alternate prespecified control location. Any alternate location must have the ability to safely operate the accelerator complex when electrons are being accelerated and will only be used during emergency and emergency training situations.
- Incidental use of restrooms and breakrooms while electrons are being accelerated that leaves the main control room/control location unattended for short (< 30 minutes) of time is permitted provided that the accelerator systems are operating reliably.

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March 19, 2024

VIA ELECTRONIC MAIL

Mrs. Nazia Zakir
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SUBJECT: APPROVAL OF ADVANCED PHOTON SOURCE (APS) ACCELERATOR SAFETY ENVELOPE (ASE)

Reference: 1) Letter from N. Zakir to W. Begner, dated March 12, 2024, Subject: Revised Accelerator Safety Envelope (ASE) and Safety Assessment Document (SAD)

2) Argonne Site Office Comment Resolution Sheet, dated March 4, 2024, "3_2024 APSU ASE and SAD Comment Resolution Form". Updated March 12, 2024.

Dear Mrs. Zakir:

The Argonne Site Office (ASO) completed a review of Reference (1) and verified that all comments in Reference (2) were adequately addressed, and is hereby approved.

If you have any questions, please contact James Piatek of my staff at (630) 252-2323 or by email at James.Piatek@science.doe.gov.

Sincerely,

Whitney S. Begner
Manager

cc: N. Zakir, ANL/ESH
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