- Level A Training for : Duty Operators, BDO Supervisor, RP Field Ops, NOA personnel, BL Responsible Staff, and other personnel who have a responsibility to operate a beamline

- Goals
  - Understand Responsibilities, Awareness, Communication
  - Beamline phases
    - Design, Implementation, Commissioning, Operation
  - Configuration Control
    - Working within ISEMS

Presentation Outline:

- x-ray, soft x-ray and VUV BL overview
- radiation characteristics
- personnel protection, shielding, and beam containment
- BL engineer responsibilities
- BL commissioning radiation surveys

Soft X-ray & VUV BL

SSRL

VUV and soft x-ray beam lines are characterized by the low energy of the photons delivered to the experimental stations (typical energies <2 keV). The associated optics and beam transport systems manipulate the beam characteristics and deliver the beam to the experimental stations.

Sources:

- Longer Period Undulators
- Wigglers (off axis radiation)
- Bend Magnets

Optics:

- Larger incident angle mirrors
- Grating monochromators (or multilayer monochromators in soft x-ray)
- Beam transport includes masks, slits, stoppers, and beam drift tubes.
- Generally the optics are not enclosed in hutches

VUV beam lines cover the energy range from ~6eV to ~200eV

- BL's 5-4 and 8-1

Soft x-ray beam lines cover the energy range from ~100eV to 2000eV.

- BL 8-2, 10-1, 13

X-ray BL

X-ray beam line sources are designed to produce hard x-rays (typical energies >2 keV). The associated optics and beam transport systems manipulate the beam characteristics and deliver the beam to the experimental stations.

Sources:

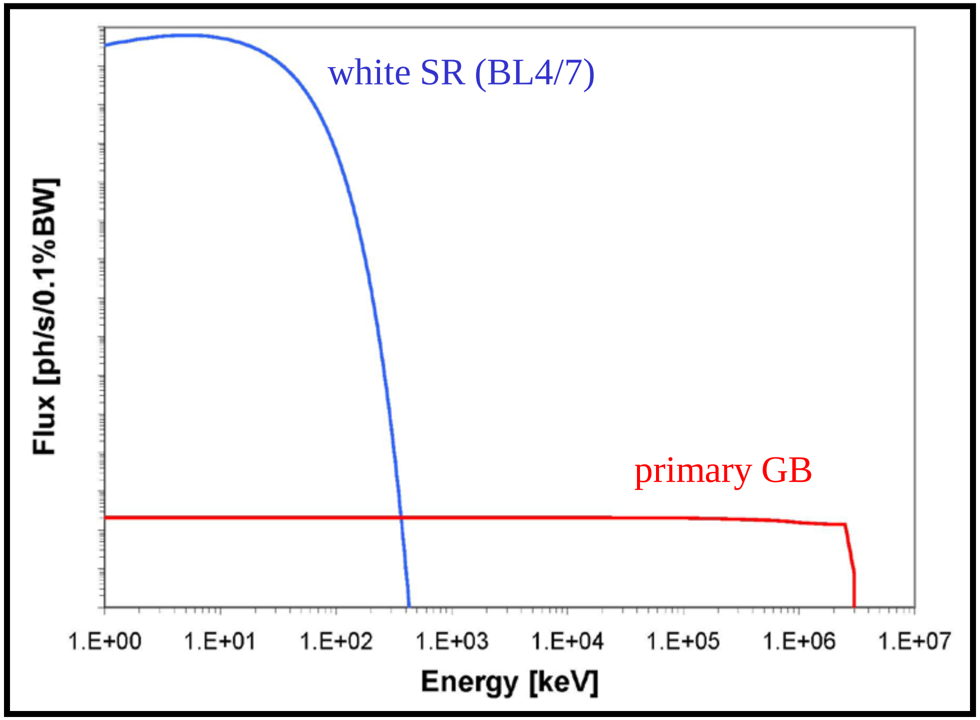
- Wigglers
- Short Period Undulators
- Bend Magnets

Optics:

- Grazing incidence mirrors
- Crystal and multilayer monochromators
- Beam transport includes masks, slits, windows, filters, stoppers, and beam drift tubes.
- Generally optics are enclosed in hutches

Two Radiation Types

- Synchrotron Radiation (SR) – high power, lower energy → less penetrating
  - ➢ white or pink SR – broad bandpass, high flux
  - ➢ monochromatic SR – flux typically ~1e-4 of white or pink flux
- Bremsstrahlung – low power, higher energy → more penetrating
  - ➢ primary Gas Bremsstrahlung (GB) - un-attenuated Bremsstrahlung originating from e- beam interaction w/ storage ring residual gas
  - ➢ secondary GB - partially attenuated GB
  - ➢ scattered GB - GB scattered out of the forward cone through interaction with BL components
  - ➢ Bremsstrahlung can also originate from electron beam losses on physical apertures such as ID vacuum chambers



- Personnel Protection Systems (PPS) – systems composed of such elements as hutch door interlocks, key enforced search systems, beam stoppers, etc that prevent people from entering places where there is a radiation hazard present; hutch protection systems (HPS) are a common subset of PPS on the SSRL experimental floor
- shielding generally falls into the following categories:
  - SR shielding which typically consists of steel hutch or vacuum system walls and/or 1/16”-3/8” lead sheets such as employed on hutch walls or local shielding panels
  - Bremsstrahlung shielding which typically consists of much thicker shielding such as lead bricks, tungsten alloy plates, and concrete walls; photo-neutrons generated by Bremsstrahlung interaction with lead are shielded with polyethylene plates
  - sometimes “shielding” consists of access barriers that create a Radiation Exclusion Area which prevents personnel from entering a zone with potentially unacceptable radiation levels

Personnel Protection Systems, Shielding, and Beam Containment Systems, cont.

SSRL

- Beam Containment Systems (BCS) – systems designed to prevent beam from deviating from the design beam channel into spaces occupied by personnel; typical BCS components include:
  - water-cooled apertures, slits, and masks which collimate white or pink SR beam to limit the beam mis-steer envelope
  - monochromators and mirrors which limit the beam energies or energy distribution (x-ray mirrors often function as GB filters which down rate primary GB to secondary GB)
  - sensors designed to monitor the integrity of the beam channel such as vacuum sensors, pressure switches, and/or LCW flow switches

Personnel Protection Systems, Shielding, and Beam Containment Systems, cont.

PPS, HPS, shielding, and BCS are controlled systems:

- typically local shielding elements, PPS, and HPS are identified with labels denoting them as PPS elements; more generally, if a component is listed in the SPEAR Beam Authorization Sheet (BAS) or Beam Line Authorization (BLA) then it is a controlled component
- removal or any modification, temporary or permanent, of these controlled systems requires the opening of a Radiation Safety Work Control Form (RSWCF)
  - modifications that require a RSWCF include changing the trip point of a BCS system, removing crystals from an LN monochromator, etc; if in doubt regarding the need for a RSWCF consult the SSRL SO
  - RSWCF template link http://www-ssrl.slac.stanford.edu/safety/index.html
  - when opening a RSWCF for the main line communicate with the responsible engineer(s) for affected experimental station(s)

Beam Line Engineer Responsibilities
Main Line (eg., BLxx-0) Responsible Engineer

- Exercise proactive “ownership” of your beam line.
- Understand the entire BL optical functionality and associated radiation hazards.
- Understand the fundamentals of the PPS, HPS, BCS, and Machine Protection System (MPS) as apply to your beam line.
- Exercise control over BL modifications and work with system managers to ensure PPS, HPS, BCS, and MPS properly protect personnel and the beam line itself.
- Maintain BL BCS component alignment and functionality.
- Utilize RSWCF to document and control modifications to controlled systems.
- Document changes to the BL by ensuring revisions are made in the BL ray trace, shielding implementation engineering note, BLA, etc.
- Assist RP and RPFO in beam line commissioning (see below).

Beam Line Engineer Responsibilities
Branch Line (eg., BLxx-1) Responsible Engineer

- Exercise proactive “ownership” of your branch line.
- Understand your branch line optical functionality and associated radiation hazards.
- Understand the fundamentals of the PPS, HPS, BCS, and Machine Protection System (MPS) as apply to your branch line.
- Exercise control over branch line modifications and work with system managers to ensure PPS, HPS, BCS, and MPS properly protect personnel and the branch line itself.
- Maintain branch line BCS component alignment and functionality.
- Utilize RSWCF to document and control modifications to controlled systems.
- Document changes to the branch line by ensuring revisions are made in the BL ray trace, shielding implementation engineering note, BLA, etc.
- Assist RP and RPFO in branch line commissioning (see below).

BL RP Commissioning Tasks Before Starting

SSRL

- Identify BL changes that may pose new radiation concerns.
  - Modified source properties (eg., high B field, more poles, etc)
  - New optics parameters (eg., altered mirror cutoffs or different monochromator operating energies or bandpasses)
  - New radiation scatter sources (eg., new masks, slits, filters or modified beam pipe apertures)
  - Modified shielding configurations (eg., new feedthrough)
- Does the change require new or modified shielding?
  - Contact the SSRL safety officer for review of the change and if a new or revised shielding design will have to be developed by Radiation Physics.
  - If a new shielding design is required, a revised shielding implementation plan must be developed and documented through revisions to the beam line shielding implementation engineering note.
  - Revise the beam line ray trace appropriately.

BL RP Commissioning Tasks Before Starting, cont.

- Does the change require BLA modification?
  - Contact the SSRL safety officer to review change for BLA modification.
  - Most changes in function or location of a components up stream of the monochromator will require changes to the BLA.
- Make sure all shielding, BCS systems, etc required by the BLA are in place and the BLA is current and signed off before starting commissioning new components.
- Work with RP and the SSRL SO to develop a beam commissioning plan.
  - Determine area access barriers/postings and associated access control requirements.
  - Determine beam line configurations for RP commissioning survey.
  - Develop radiation survey plan including required frequency and/or beam condition triggers for radiation surveys during optics tuning effort prior to final RP commissioning survey.

BL RP Commissioning
Optimization & Characterization

- Objective:
  - Out gas slits, masks and optics. Develop and characterize the performance of optics and ID in the optimized configuration or configurations.
  - Develop BL ID and optical configurations that represent greatest radiation concerns. RP commissioning requires the BL flux within ~2x of optimal. The specifics of the focus quality are generally not RP commissioning concerns except as relates to flux (eg., VUV / soft x-ray beam line with mono slits at focus).
- Optics tuning:
  - Conservatively develop optics configuration progressively down the beam line. Employ slits and/or reduced ID field to maintain conservative power levels and control outgassing until optical configuration is well developed.
  - For maximal safety keep branch line stoppers closed until beam is developed sufficiently to require open branch line stoppers for further progress.
  - Observe area access control and radiation survey requirements.
  - If a radiation survey detects higher radiation than expected (eg., >100urem/hr), then locate leak and use ~0.25” Pb filter to differentiate SR from GB
- Beam characterization:
  - Employ appropriate flux characterization diagnostics to ensure beam flux is within 2x of optimal conditions before RP commissioning survey. Verify photon energy.

BL RP Commissioning
Commissioning Radiation Survey

- Objective –
  - Ensuring radiation surveys properly characterize dose under both steered beam and potential mis-steered beam conditions.
- Assist in beam line commissioning survey (~full stored current) -
  - Tune optics to optimal configuration with greatest radiation hazard (ie., highest critical energy of ID, highest energy cut off of any variable angle mirrors, crystal monos tuned to highest energy appropriate for mirror cutoff or grating monos tuned to zero order light (if mono is designed to transmit zero order) for RP/RPFO commissioning survey.
  - Following steered beam commissioning, simulate mis-steered beam conditions by pitching mirrors such that beam strikes masks and/or insert appropriate slits to intercept beam for RP/RPFO mis-steered beam commissioning survey (*do not mis-steer beam into uncooled components unless you are confident they can accept the power without damage…if in doubt be conservative and consult staff with greater familiarity with the BL*)

Beamline Radiation Protection Program

- Beam Line Authorization Sheet (BLA)
- Control of Radiation Safety Items
- Area Classification (Roping and Posting)
- Training and Personnel Dosimetry
- Occupied Area Dosimetry
- Active Radiation Monitoring
- Radiation Surveys
- Detailed Description of BLA

Beam Line Authorization Sheet (BLA)

- This document, when signed, authorizes synchrotron radiation beam to enter the beam line
- One BLA per branch line
- Created by SSRL Safety Officer & Radiation Physics Group
- Responsible parties/signatories:
  - Beamline Engineer
  - SSRL Safety Officer (SSO)
  - SLAC Radiation Physics Group
  - Beamline Duty Operator (BDO)
  - Hutch Protection System (HPS) Group
  - SLAC Radiation Protection Field Operations Group (RPFO)
- Contents: Signature lines for verification of the following items
  - Source Parameters (*e.g.*, magnetic field, number of poles, critical energy, fan width)
  - Hutch Protection System (HPS) certification
    - The HPS prevents hutch entry when beam is on, and inhibits beam when the hutch is in access
  - Inspection Checklist of Radiation Safety Items
    - Apertures
    - Beam Stops
    - Burn-through Monitors
    - Beam Filters (*e.g.*, Mirrors, Monochromators)
    - Radiation Shielding
    - HPS Components
    - *etc.*
  - Completion of Radiation Surveys
  - Completion of Mid-run Tests & Inspections
- 2nd half of this presentation discusses BLA in greater detail

Control of Radiation Safety Items

- Responsible Party: Beamline Engineer (assisted by Radiation Physics, SSO & BDO)
- How to Recognize Radiation Safety Items
  - Lead shielding usually painted white
  - Shielding and other safety items exterior to the vacuum chamber are labeled with stickers that say "Warning: Radiation Safety Device"
  - Items inside the vacuum chamber, plus the vacuum chamber itself: consult the Beamline Engineer to find out if the item serves a radiation safety function
- Inspections of Radiation Safety Items Take Place
  - At the beginning of the run (via checklist in BLA)
  - Mid-run
  - After maintenance activities
  - Between experiments
- Work Authorization for Modification or Maintenance Affecting Radiation Safety Items
  - Obtain approval from Beamline Engineer
  - Open a Radiation Safety Work Control Form (the SSO can assist with this)

Area Classification (Roping and Posting)

- Responsible Parties
  - Radiation Protection Field Operations (RPFO)
  - Personnel entering posted areas
- Experimental floor is posted (via signs on doors) as a Radiologically Controlled Area (RCA) -- GERT and dosimeter are required for entry
- Upon initial operation (after construction or after extended downtime), but before a comprehensive radiation survey has been conducted, each beam line is roped and posted with a sign
  - Reason: there is a potential for unknown radiation leaks
  - Sign reads "Beamline Commissioning in Progress. Authorized Personnel Only."
  - Sign lists personnel authorized to enter roped area
  - Others must obtain permission from Beamline Engineer.

Training and Personnel Dosimetry

- Responsible Parties:
  - Personnel entering Experimental Floor
  - Personnel operating beam line with authority greater than an outside user
- GERT training and Personal Dosimeter required for Entry to Experimental Floor
- Radiation Safety Orientation (This Training Module) required for operation of beam line in any capacity beyond that of an outside user

Occupied Area Dosimetry

- Responsible Party: RPFO
- Passive dosimeters monitor radiation at the following locations
  - User desks & workstations
  - Hutch control panels
  - Side walls of transport hutches
- Dosimeters deployed at beginning of run; collected and read at end of run

Active Radiation Monitoring

- Responsible Parties
  - SSRL PPS/BCS Group
  - Radiation Physics
- One ion chamber (radiation monitor) per beamline
  - Located on wall of transport hutch (or ratchet wall, if no transport hutch)
  - Interlocked to BCS during top-off operation (will shut off SPEAR beam if excess radiation detected during top-off)

Radiation Surveys

- Responsible Parties:
  - RPFO
  - Radiation Physics
  - BDO
  - Beamline Engineer
- Surveys are required
  - At first light
  - On each day of tuning
  - At completion of tuning (Comprehensive survey at optimum beam)
  - Quarterly during user run
- Beamline can be released to users after completion of Comprehensive survey at end of tuning period

Surveys must be performed by trained personnel. Contact SSRL SO or RP for training information.

Dose Rate	Action	Run Actions
<0.05 mR/h	Initial checklist	Can continue
>0.05-5.0 mR/h	- Notify SSRL beamline engineer, who will ensure the hazard control - Notify SSRL Safety Officer. - Notify RP and Field Operations -Remedy situation at earliest availability. -Document location of increased dose rate on checklist. -RPFO conducts documented detailed radiation survey at next normal working shift. -Initial Checklist	-May continue to run, or may cease running. -Remedy shall take dose rates to <0.05 mR/h.
5.0-100 mR/h	- Notify SSRL beamline engineer, who will ensure the hazard control - Notify SSRL SO - Notify RP and FO -Must remedy situation before continuing to run. -Document location of increased dose rate on checklist. -RPFO conducts detailed radiation survey, may be called in. - Initial Checklist	-Stop run, unless to locate location of dose rate. -Shall remedy to <0.05mR/h to continue run.

Details of the Beam Line Authorization Sheet (BLA)

- BLA Validation (sign-off) required prior to beam operation
- The BLA is a Compendium of:
  - Inspections (*e.g.*, of shielding)
  - Tests (*e.g.*, of HPS system)
  - Radiation surveys
  - Allowed beam parameters

- The First Page Specifies
  - Dates of validity
  - Which items must be signed off to validate BLA
  - Personnel authorized to validate BLA
  - Which items must be signed off after validation (*e.g.*, radiation surveys, mid-run inspections)
  - Personnel authorized to approve changes/additions to the BLA
- The First Page also Includes
  - Signature lines for the SSRL Safety Officer, Radiation Physics and the Beamline Engineer, indicating their approval of the BLA

Click here for an example of the first page of a BLA

Details of the Beam Line Authorization Sheet (BLA)

- The Second Page Contains Signature Lines for Completion of the Following:
  - Verification of Operational Modes / Beam Parameters (signed by Beamline Engineer)
  - HPS Certification
    (signed by HPS System Manager)
  - Checklist for Non-visible (*e.g.*, in-vacuum) Radiation Safety Items
    (signed by Beamline Engineer)
  - Inspection Checklist for Visible Radiation Safety Items
    (signed by SSO or Radiation Physics)
  - Review of Radiation Safety Work Control Forms that affect the Beamline
    (signed by Beamline Engineer, Radiation Physics or SSO)
  - Radiation Survey upon Initial Operation
    (signed by RPFO or BDO)
  - Comprehensive Radiation Survey at Optimum Beam (end of tuning period)
    (signed by Radiation Physics or RPFO)
  - Mid-run Inspection Checklist for Visible Radiation Safety Items
    (signed by BDO)
  - 6-month HPS Interlock Checks
    (signed by HPS Group or BDO)

Click here for an example of the second page of a BLA

Details of the Beam Line Authorization Sheet (BLA)

- The Third and Subsequent Pages Contain
  - Attachment A
    - Operational Modes and Beam Parameters
  - Attachment B (signed by Beamline Engineer)
    - List of Non-Visible Radiation Safety Items
    - Date of Last Ray Trace Revision
    - Limit Switch & Hard Stop Settings
  - Attachment C (signed by SSO or Radiation Physics)
    - List of Visible Radiation Safety Items

Click here for an example of attachments A, B &C of a BLA

Details of the Beam Line Authorization Sheet (BLA)

- The Last Two Pages Contain
  - Space to Specify Changes or Additions
    (These must be approved by the SSO, BDO, Beamline Engineer and Radiation Physics)
  - A Plan-View Diagram of the Beamline

Click here for an example of the last two pages of a BLA

Configuration Control of Radiation Safety Systems

- Shielding
  - Bulk – Concrete blocks, lead bricks, lead sheet, hutch walls etc.
  - Exclusion Barriers – (distance) BL4, BL5, BL7 Radiation Exclusion Areas.
- Personnel Protection System/Hutch Protection System PPS/HPS
  - Control entry and exit into beam housings.
  - All doors interlocked.
  - Turns off prompt radiation hazard if someone tries to break into the housing while beam is on.
- Beam Containment System BCS
  - Prevents accelerated beam from diverging from desired channels.
  - And, from exceeding levels of energy or intensity which may cause excessive radiation in occupied areas.
- Beam Shut Off Ion Chambers BSOIC's
  - Provides radiation monitors external to the shielding barrier.

Beam Authorization Sheets (BAS) – Accelerator
Beamline Authorization Sheets (BLA) – Beamline

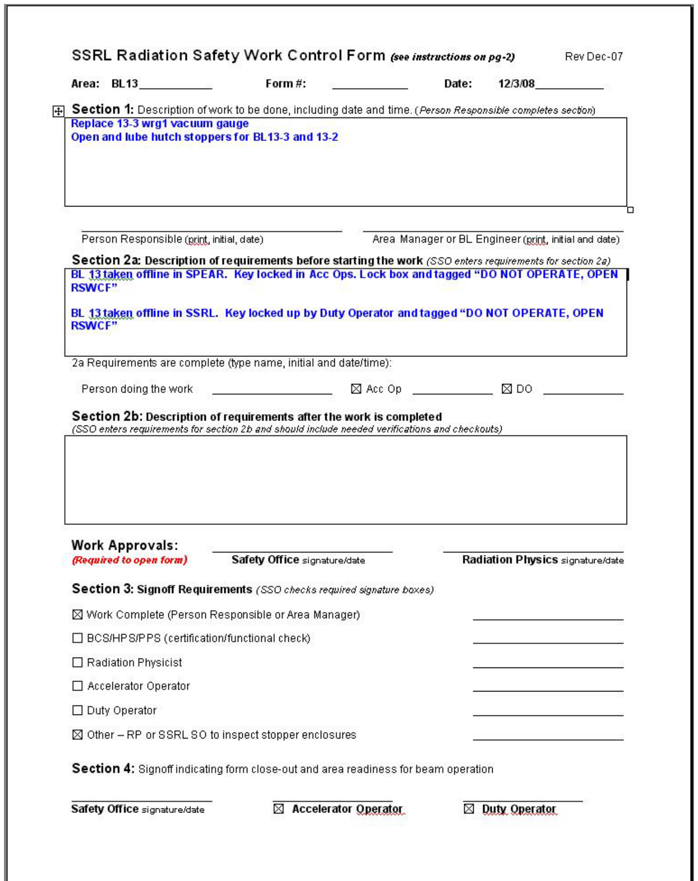
- These documents contain the critical elements of the Beamline (componets, local shielding, HPS/PPS) that MUST be in place to operate.

- State and condition of these systems are important aspects of the facility's safety status, and the configuration of each of these systems (or sub-systems) must be rigidly controlled.

  - **No removal of shielding**
  - **No repair or modification to the PPS/HPS systems**
  - **No repair or modification to the BCS systems**
  - **No repair or modification to the BSOIC system.**

Radiation Safety Work Control Forms

- Open a Radiation Safety Work Control Form (RSWCF) which addresses the components of Integrated Safety & Environmental Management System (ISEMS) that we work with on a day to day basis.


SSRL Radiation Safety Work Control Form *(see instructions on pg-2)* Rev Dec-07

Area: BL13________ **Form #:** ________ **Date:** 12/3/08________

Section 1: Description of work to be done, including date and time. (*Person Responsible completes section*)

Replace 13-3 wrg1 vacuum gauge
Open and lube hutch stoppers for BL13-3 and 13-2

Person Responsible (print, initial, date) ________ Area Manager or BL Engineer (print, initial and date) ________

Section 2a: Description of requirements before starting the work *(SSO enters requirements for section 2a)*

BL 13 taken offline in SPEAR. Key locked in Acc Ops. Lock box and tagged "DO NOT OPERATE, OPEN RSWCF"

BL 13 taken offline in SSRL. Key locked up by Duty Operator and tagged "DO NOT OPERATE, OPEN RSWCF"

2a Requirements are complete (type name, initial and date/time):

Person doing the work ________ ☒ Acc Op ________ ☒ DO ________

Section 2b: Description of requirements after the work is completed
(SSO enters requirements for section 2b and should include needed verifications and checkouts)

Work Approvals: *(Required to open form)* ________ **Safety Office** signature/date ________ **Radiation Physics** signature/date

Section 3: Signoff Requirements *(SSO checks required signature boxes)*

☒ Work Complete (Person Responsible or Area Manager) ________
☐ BCS/HPS/PPS (certification/functional check) ________
☐ Radiation Physicist ________
☐ Accelerator Operator ________
☐ Duty Operator ________
☒ Other – RP or SSRL SO to inspect stopper enclosures ________

Section 4: Signoff indicating form close-out and area readiness for beam operation

________ **Safety Office** signature/date ☒ **Accelerator Operator** ☒ **Duty Operator**

Radiation Safety Work Control Forms

SSRL

SSRL Radiation Safety Work Control Form *(see instructions on pg-2)* Rev Dec-07

Area: BL13__________ **Form #:** __________ **Date:** 12/3/08__________

Section 1: Description of work to be done, including date and time. (*Person Responsible completes section*)

Replace 13-3 wrg1 vacuum gauge
Open and lube hutch stoppers for BL13-3 and 13-2

Person Responsible (print, initial, date) Area Manager or BL Engineer (print, initial and date)

Section 2a: Description of requirements before starting the work *(SSO enters requirements for section 2a)*

BL 13 taken offline in SPEAR. Key locked in Acc Ops. Lock box and tagged "DO NOT OPERATE, OPEN RSWCF"

BL 13 taken offline in SSRL. Key locked up by Duty Operator and tagged "DO NOT OPERATE, OPEN RSWCF"

2a Requirements are complete (type name, initial and date/time):

Person doing the work __________ ☒ Acc Op __________ ☒ DO __________

Section 2b: Description of requirements after the work is completed
(SSO enters requirements for section 2b and should include needed verifications and checkouts)

Work Approvals:
(Required to open form)

Safety Office signature/date **Radiation Physics** signature/date

Section 3: Signoff Requirements *(SSO checks required signature boxes)*

☒ Work Complete (Person Responsible or Area Manager) __________
☐ BCS/HPS/PPS (certification/functional check) __________
☐ Radiation Physicist __________
☐ Accelerator Operator __________
☐ Duty Operator __________
☒ Other – RP or SSRL SO to inspect stopper enclosures __________

Section 4: Signoff indicating form close-out and area readiness for beam operation

Safety Office signature/date ☒ **Accelerator Operator** ☒ **Duty Operator**

- DEFINE THE SCOPE OF WORK – WHAT IS THE JOB?
  - SUPERVISORS/MANAGERS/RESPONSIBLE PERSONS DEFINE WHAT WORK NEEDS TO BE DONE TO ACHIEVE THE MISSION OF THE LAB. WITHIN THIS THEY SET EXPECTATIONS, PRIORITIZE TASKS AND ALLOCATE RESOURCES.
- ANALYZE THE HAZARD – WHAT SAFETY HAZARDS ARE PRESENT OR POSSIBLE?
  - DURING THIS STEP THE HAZARDS ASSOCIATED WITH A PARTICULAR JOB, TASK OR PROJECT ARE IDENTIFIED AND ANALYZED TO determine regulatory and compliance needs.
- DEVELOP AND IMPLEMENT HAZARD CONTROLS – HOW CAN THIS JOB BE PERFORMED SAFELY?
  - AFTER IDENTIFYING THE STANDARDS OR REGULATIONS PERTAINING TO A HAZARD OR CATEGORY OF HAZARDS, Solutions are proposed to minimize risks, allowing for a safe and healthful work place. Implementation of the safety controls that mitigate or reduce hazards to acceptable levels are employed and the safety envelope is established.
- PERFORM WORK WITHIN CONTROLS – DON'T TAKE CHANCES, CUT CORNERS OR RUSH TO FINISH A JOB
  - CONFIRM THE READINESS OF THE SAFETY CONTROLS TO DO THEIR JOB (SUCH AS SHIELDING FOR RADIATION, OR PROVIDING EYE PROTECTION IN A MACHINE SHOP) AND PERFORM THE WORK SAFELY.
- PROVIDE FOR FEEDBACK AND CONTINUOUS IMPROVEMENT – MAKE A NOTE IF THE JOB COULD HAVE BEEN DONE IN A BETTER WAY OR MORE SAFELY, AND MAKE THE CHANGE HAPPEN.

Beamline Duty Operator Responsibilities

•responsible for the safety program while we are operating.
•is a conduit for information from User to staff and vice-versa.
•completes BLA's
•perform radiation safety item inspections
•control Beamline Operation (On/Off line key)
•implement User/Staff Safety Check Lists
•radiation surveys as needed
•primary resource to Users/Staff during operations, towards getting experiments working, beamlines on-line, fixing "stuff" and ensuring the SSRL experimental floor remains in a safe condition.

•**They have the authority to stop operations if they see the need.**

Resources & Signature Page

Questions, Comments or Concerns? Contact:

- SSRL Safety Office –
  - Matthew Padilla x3861
  - Behzad Bozorg-Chami x3872
- Radiation Protection
  - Alyssa Prinz x4062
- Radiation Protection Field Ops
  - Jim Allen x4064

Signature Page – print, sign and send to SSRL SO