Brookhaven National Laboratory/ Photon Sciences Directorate

Subject:	NSLS-II USI #4 – Reduction of NSLS-II LCSAD Supplementary Shielding Thicknesses				
Number:	LT-ESH-USI-004	**Version:** 1	**Effective:** 21Mar2012		**Pages** 1 - 7
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*Approval signatures on file with master copy.

VERSION	DESCRIPTION OF ANY CHANGES	DATE	PREPARER	APPROVED BY
1	Original document	21Mar2012	Nicholas Gmür	See signatures above

EMS, FUA and SAD/ASE Checklist for Photon Sources Directorate Reviews

(Photon Sources Directorate ES&H personnel and the Environmental Compliance Representative can assist in completing this form)

Review Committee: Laboratory ESH Committee **Date: 21Mar2012**

Project Name (and # if any): NSLS-II USI #4

This checklist identifies issues associated with this project that may impact the Directorate Environmental Management System, Occupational Health & Safety Management System, Facility Use Agreements, Safety Assessment Documents & Accelerator Safety Envelopes, and NEPA documents. This checklist will be completed during a review process, if needed, and form part of the documentation of that review.

SIGNIFICANT ENVIRONMENTAL ASPECTS ASSOCIATED WITH THIS PROJECT:

Check off any environmental aspects that are associated with this project (Photon Sciences Directorate Environmental Management System aspects matrices show the significant aspects). For criteria, go to the SBMS Subject Area titled Identification of Environmental Aspects and Impacts

☐	Industrial Waste Generation	☐	Work with Engineered Nanomaterials	☐	Power Consumption	☐	Historical Contamination (groundwater, soil)
☐	Hazardous Waste Generation	☐	Atmospheric Emissions	☐	Engineered Nanomaterials	☐	Soil Activation
☐	Radioactive Waste Generation	☐	Liquid Effluents	☐	Historical Monuments/Cultural Resources	☐	Transuranic Waste Generation
☐	Mixed Waste Generation	☐	Storage or Use of Chemicals or Radioactive Materials*	☐	Sensitive/Endangered Species and Sensitive Habitats (including Pine Barrens)		Other Regulatory Requirements - recycling
☐	Medical Waste Generation	☐	Water Consumption	☐	Environmental Noise	☐	NONE

*Art 12 registered area, spill potential, transportation of hazmat or rad, backflow devices, PCBs.

Any environmental aspects new to the Photon Sciences Directorate: ☐Y or ☒N? Any aspects associated with new activities: ☐Y or ☒N? If yes, describe below and issue a memo to the appropriate Photon Sciences Directorate ESH Manager:

APPLICABLE REGULATORY REQUIREMENTS:

Check off any BNL Subject Areas that are applicable to this process:

Note: PI's should consider subscribing to the Subject Area Subscription Service as a means of staying informed of changes to the Subject Area requirements.

☐	Drinking Water	☐	Radioactive Waste Management
☐	Environmental Monitoring	☐	Regulated Medical Waste Management
☐	Hazardous Waste Management	☐	Spill Response
☐	Liquid Effluents	☐	Storage and Transfer of Hazardous & Non-hazardous Materials
☐	Mixed Waste Management	☐	Transfer of Hazardous or Radioactive Materials On-Site
☐	National Environmental Policy Act (NEPA) and Cultural Resource Evaluation	☐	Transport of Hazardous or Radioactive Materials Off-Site
☐	Non-Radioactive Airborne Emissions	☐	Underground Injection Control
☐	PCB Management	☐	Regulated Industrial Waste Management
☐	Pollution Prevention and Waste Minimization	☐	Working with Nanomaterials ES&H
☐	Radioactive Airborne Emissions	☐	None

Facility Use Agreement (FUA)

Answer "Yes" or "No" for each category below.

Category	Applicable		Elements and Details
	Yes	No	

Radiological Source Terms	☒	☐	*See FUA Table 4.1.1 for details.*
Chemical, Toxic, Biological & Hazardous Source Terms	☐	☒	*See FUA Table 4.1.2 for details.*
Physical Source Terms	☐	☒	*See FUA Table 4.1.3 for details.*

If yes, do any terms require an update to the FUA: ☐Y or ☒N? If yes, describe below and issue a memo to the appropriate Photon Sciences Directorate ESH Manager: **Note: The FUA for building 740 will be written once construction has been completed. Radiological information would be included at that time.**

<u>Safety Assessment Document (SAD)/Accelerator Safety Envelope (ASE)</u>

Does this project include components that exceed or are not included in the safety boundaries described in the SAD or the ASE: ☒Y or ☐N? If yes, describe below and issue a memo to the appropriate Photon Sciences Directorate ESH Manager: **Activities that may increase the level of a known hazard or may introduce a new type of hazard not examined in a Safety Assessment Document, and therefore may impact the items below must be evaluated through the PSD USI determination process:**

- The radiation hazard personnel protection system (PPS)
- ✓Radiation shielding for personnel protection
  - Shielding thickness requirements for polyethylene are reduced
- Radiation monitoring for personnel protection
- Radiological source terms identified in the SAD
- Hazards identified in the SAD

<u>Job/Facility Risk Assessments (JRA/FRA)</u>

Does this project include components that exceed or are not included in the jobs, hazards, controls or risks described in the JRA/FRAs: ☐Y or ☒N? If yes, describe below and issue a memo to the appropriate Photon Sciences Directorate ESH Manager:

NEPA Environmental Assessment (EA)

Does this project include components that exceed or are not included in the NEPA EA:

☐Y or ☒N? If yes, describe below and issue a memo to the Photon Sciences Directorate ESH Manager:

NSLS-II Unreviewed Safety Issue #4

Reduction of NSLS-II LCSAD Supplementary Shielding Thicknesses

Introduction
This document is prepared as an addendum to the existing National Synchrotron Light Source II (NSLS-II) Linac Commissioning Safety Assessment Document (LCSAD); dated May 11, 2011. Reductions in the thicknesses of some supplementary shielding polyethylene thicknesses are explained. This change is analyzed as an Un-reviewed Safety Issue (USI) as defined in DOE Order 420.2C, *Accelerator Safety*.

Executive Summary
The NSLS-II Linac is being constructed as part of the injection system for the new NSLS-II Storage Ring. The LCSAD currently lists the following supplementary shielding information in section 4.15.2.1.4:

Linac

- Downstream wall, 25 cm thick 2-ft x 2-ft lead collimator through Linac-to-Booster wall
- Energy slit downstream of first dipole, lead (15 cm thick in forward direction, 10 cm thick at 90 degrees), polyethylene (10 cm at 90 degrees)
- Beam dumps (2), forward direction, 30 cm Pb, 25 cm poly; and in the transverse direction 20 cm lead and 25 cm poly
- 15 cm thick lead shields centered on the beamline downstream of the first dipole protecting the forward wall against miss-steered beam

This table is revised to read as follows:

Linac

- Downstream wall, 25 cm thick 2-ft x 2-ft lead collimator through Linac-to-Booster wall
- Energy slit downstream of first dipole, lead (15 cm thick in forward direction, 10 cm thick at 90 degrees), polyethylene (10 cm on top and on non-berm side; 0 cm on berm side)

- Beam dumps (#1 and #2), forward direction, 30 cm Pb, 25 cm poly; in the transverse direction for beam dump 2, 20 cm lead and 25 cm poly; in the transverse direction for beam dump 1, 20 cm lead, 25 cm poly on the non-berm side and 0 cm poly on the berm side
- 15 cm thick lead shields centered on the beamline downstream of the first dipole protecting the forward wall against miss-steered beam

Discussion

Supplemental shield thicknesses were recalculated in a revised NSLS-II Technical Note #0088 by P.K. Job, "Supplementary Shielding Specifications for the NSLS-II Linac Enclosure –Rev 3", March 13, 2012.

➔For the energy slit supplementary shielding, Technical Note 0088 reads as follows:

2.4 Linac Energy Selector Slit: A maximum probable beam loss of 11 nC/s, at beam energy of 230 MeV, is assumed at the energy selector slit. The shielding thickness has been calculated for total photon and neutron dose rates of 0.5 mrem/h at the exterior of the concrete bulk shielding. The required shielding for the slit is 15 cm-thick lead in the forward direction; and 10 cm-thick lead and 10-cm thick polyethylene in the transverse directions (lateral and top). The neutron shield (poly) is not necessary at the berm side, because the probability for soil activation is negligible (Appendix 2) and the berm is not accessible during linac operation.

Appendix 2: Saturation Activity* in Soil at Lateral Berm near Linac Beam Dump 1

P.K. Job, February 17, 2011

Soil location	Electron loss (nC/s)	Electron loss (e/s)	Neutron flux ($n/cm^2.s$)	Neutron flux (Av) ($n/cm^2.s$)	^{3}H (pCi/L)	^{3}H Leach-Able (pCi/L)	^{22}Na (pCi/L)	^{22}Na Leach-Able (pCi/L)
Linac Dump 230MeV	22	1.37E11	171	35.4	0.21	0.23(1)	2.00	0.15(2)

(1) BNL Action Level = 1000 pCi/L; (2) BNL Action Level = 20 pCi/L

- **50 cm** of concrete lateral wall and **20 cm** of lead supplementary shield is present between the berm and the dump 1
- 200 times Linac operates to fill the booster from scratch, 3 minutes for each fill from scratch. Total operating time is 200x3 min= 10 hours
- 500 hours of Linac study (fill and dump) = 500 hours
- 5000 hours of top-off operation, 3 Hz a minute operation, effective hours of operation = 5000* 180/3600 = 250 hours

**500 hours per year of continuous operation for beam dumps and 760 hours for Linac slit.*

➔For the beam dumps 1 and 2 supplementary shielding, Technical Note 0088 reads as follows:

2.2 Linac Beam Dumps 1 & 2: A 100% beam loss of 22 nC/s, at the energy of 230 MeV, is assumed at the beam dumps. The shielding thickness has been calculated for total photon and neutron dose rates of 0.5 mrem/h at the exterior of the concrete bulk shielding. The core dump is iron of thickness 15 cm with transverse dimensions of 20 x 20 cm^2. The required shielding for the dumps is; 30 cm thick Pb, and 20 cm-thick polyethylene in the forward direction; and 20 cm -thick lead and 25-cm thick polyethylene in the transverse directions (lateral and top). The neutron shield (poly) is not necessary at the berm side of dump 1, because the probability for soil activation is negligible (Appendix 2*) and the berm is not accessible during linac operation.

***See above for Appendix #2.**

Conclusion

The thickness of polyethylene (neutron) shielding required on the berm side of both the Linac energy slit and Linac beam dump 1 has been reduced to 0 cm. Calculations show that the probability of berm soil activation is negligible. The dose at the outside of the berm fence under the above conditions is calculated to be 0.037 mrem/h; an increase of ~30% compared to conditions with the polyethylene shields in place. The berm is not a routinely occupied area due to the locked fence (with the exception of a Radiological Control Division procedure allowing access for survey purposes). Personnel outside the fence are subject to the 25 mrem/yr administrative control level (ACL). If we conservatively estimate the likely occupancy outside the fence as 1/16* of 2000 hours (125 hrs) and use the 0.037 mrem/h calculated dose, this results in an annual dose of 4.6 mrem; this is well under the 25 mrem/yr ACL. The non-berm sides of the Linac energy slit and Linac beam dump 1 continue to be shielded by polyethylene in order to protect the occupied spaces outside the Booster tunnel on that side, reducing the radiation levels in the occupied areas to 0.5 mrem/h.

*NCRP Report No. 144. *Radiation Protection for Particle Accelerator Facilities*. National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue - Suite 400, Bethesda, MD 20814-3095. December 31, 2003. Page185.