

National Synchrotron Light Source II, Brookhaven National Laboratory			
Doc No. PS-C-XFD-PRC-060	Author: T. McDonald	Effective Date: 08Jul2016 Review Frequency: 3 yrs	Version 1
Title: Beamline 8-BM Radiological Interlock Test			Technical

Attachment A

NSLS-II Beamline 8-BM Radiological Interlock Test Checklist

Test Reason: <i>Initial Test</i>	Test Result: <input checked="" type="checkbox"/> Passed <input type="checkbox"/> Failed
Test Date: <i>7/13/2016</i>	Test Type: <input type="checkbox"/> Pre-Certification <input checked="" type="checkbox"/> Certification <input type="checkbox"/> Partial
Tester 1: <i>Thomas McDonald, Brian Honeveld</i>	Start Time: _____ Finish Time: _____
Tester 2: <i>Robert Chmiel, Gabrielle Stone</i>	Assistant 1: <i>Accelerator Operations Staff</i>
Tester 1 Signature: <i>Thomas P. McDonald</i>	Assistant 2: _____
*Reviewer 1:	Tester 2 Signature: <i>Robert Chmiel</i>
Reviewer 2:	Reviewer 1 sig.: _____
** Safety Signature 8-BM (Beamline HMI) A Chain: <i>DF85 E8A5</i> B Chain: <i>E4345A65</i>	Previous 8-BM SS# _____ Date: / / A Chain: _____ B Chain: _____
** Safety Signature Pentant 3 Beamline (SR HMI) A Chain: <i>68D3CE10</i> B Chain: <i>98124257</i>	Previous Pentant 3 SS# _____ Date: / / A Chain: _____ B Chain: _____

* A review by an Accelerator Safety Systems Engineer and a designated specialist (Reviewer 2) is only required upon a Test failure.
 **If Current Safety Signature number (found in top left corner on HMI) is different from previous number, contact the Accelerator Safety Systems Cognizant Engineer.

PREPARATION:

I. All hutch door switches have been evaluated by Mechanical Engineering for proper positioning	✓
II. Inform Control Room Lead Operator that testing will be done	✓
III. Obtain Beamline enable and PPS reset keys from Control Room	✓
IV. Verify that beamline vacuum and water interlocks are satisfied	✓
V. Place muffler on beam imminent sounder	✓
VI. Request Lead Operator enable Master shutters	✓

A1 **Verify System Lockouts**

7.M. 7/13/2016

- Gun HVPS output cable connector *OR Gun HVPS Enable Switch (No FOE ARM)* ✓
- Linac modulator line cords (3) *OR* Booster Dipole F PS 480 V ✓
- Booster RF HVPS 480 V *OR* Booster low level RF drive termination ✓
- SR System C low level RF drive termination *OR* SR System C RF output connection to cavity ✓
- SR System D low level RF drive termination *OR* SR System D RF output connection to cavity ✓

A2 **Verify Search and Time Beam Imminent Alarm**

- Verify that search path is free from obstacles and line of sight is clear in search mirrors in accordance with PS-C-XFD-PRC-010, *Beamline Enclosure Search and Secure and Breaking Security Procedure* ✓

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	<u>A</u>
<i>Close the Right door</i>	<u>✓</u>
"Entry Permitted" sign is ON	<u>✓</u>
<i>Using the keypad, lock the closed doors</i>	<u>✓</u>
<i>Press SB1</i>	<u>✓</u>
SB1 illuminates	<u>✓</u>
Search sounder sounds	<u>✓</u>
Search yellow beacon flashing	<u>✓</u>
<i>Press SB2</i>	<u>✓</u>
SB2 illuminates	<u>✓</u>
<i>Exit hutch and close main door</i>	<u>✓</u>
<i>Press SBE and begin timing</i>	<u>✓</u>
Beam imminent alarm sounds for 30 seconds	<u>✓</u>
After warning, FOE Interlocked A and B ON (green), HMI	<u>✓</u>
"Interlocked" sign is ON	<u>✓</u>
Maglock A and B ON, HMI	<u>✓</u>
<i>Press the SBE/Access Button</i>	<u>✓</u>
"Interlocked" sign OFF, "Entry Permitted" sign is ON	<u>✓</u>
FOE Interlocked A and B OFF, HMI	<u>✓</u>
Maglock A OFF	<u>✓</u>
<i>Open door</i>	<u>✓</u>
Door opens, Maglock B OFF	<u>✓</u>

A3 **Out of Sequence Search in the FOE (A Hutch)**

	<u>A</u>
<i>Press SB2</i>	<u>✓</u>
SB2 does not illuminate	<u>✓</u>
<i>Press SB1</i>	<u>✓</u>

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	SB1 illuminates			<u>✓</u>
	<i>Close hutch door and press SBE</i>			<u>✓</u>
	Hutch does NOT secure			<u>✓</u>
A4	Search Timeout			<u>A</u>
	<i>Press first search button and begin timing</i>			<u>✓</u>
	<i>Complete search without pressing Final Search button</i>			<u>✓</u>
	Search sounders off in 2 minutes			<u>✓</u>
	<i>Press Final Search button</i>			<u>✓</u>
	Search does not complete			<u>✓</u>
A5	Shutter Enable			
	Place actuators on FOE door switches and attach Maglock devices			<u>✓</u>
	Beamline Online A and B OFF			<u>✓</u>
	Enable beamline with key and perform a reset	Beamline Online A and B ON (green)		<u>✓</u>
	Search the FOE	FE Shutter Permits A and B ON <i>after</i> Beam Imminent Warning		<u>✓</u>
	Open FE shutters	FE Shutters A and B indicate open (green)		<u>✓</u>
		"Beam On" sign is ON		<u>✓</u>
	Close FE shutters	FE Shutters A and B indicate closed (red)		<u>✓</u>
A6	Emergency Stops (ES) FOE (A Hutch)			
	For each ES search hutch	ES1	ES2	ES3
	<i>Open FE Shutters from keypad</i>	<u>✓</u>	<u>✓</u>	<u>✓</u>
	FE Shutters A and B open (green)	<u>✓</u>	<u>✓</u>	<u>✓</u>
	FOE Interlocked A and B ON (green)	<u>✓</u>	<u>✓</u>	<u>✓</u>
	FE Shutter Permit A and B ON (green)	<u>✓</u>	<u>✓</u>	<u>✓</u>
	FE Critical Device Permits A and B ON	<u>✓</u>	<u>✓</u>	<u>✓</u>
	Right Maglock A ON (green)	<u>✓</u>	<u>✓</u>	<u>✓</u>
	Left Maglock A ON (green)	<u>✓</u>	<u>✓</u>	<u>✓</u>
	<i>Press ES</i>	<u>✓</u>	<u>✓</u>	<u>✓</u>
	FE Shutters A and B closed (red)	<u>✓</u>	<u>✓</u>	<u>✓</u>
	FOE Interlocked A and B OFF	<u>✓</u>	<u>✓</u>	<u>✓</u>

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FE Shutter Permit A and B OFF	✓	✓	✓
FE Critical Device Permits A and B OFF	✓	✓	✓
Right Maglock A OFF	✓	✓	✓
Left Maglock A OFF	✓	✓	✓
<i>Pull out ES</i>	✓	✓	✓
ES Sum Latch OFF	✓	✓	✓
<i>Reset fault</i>	✓	✓	✓
ES Sum Latch ON (green)	✓	✓	✓

A7 FOE Right Door Switches

Place actuators on the door switches and Maglock. ✓

Check the corresponding Permits for each switch tested (e.g., A Permit for switch A1).

	<u>A</u>	<u>B</u>	<u>Reed</u>
<i>Search hatch</i>	✓	✓	✓
<i>Open FE Shutters from keypad</i>	✓	✓	✓
FE Shutters A and B open (green)	✓	✓	✓
FOE Interlocked A and B ON (green)	✓	✓	✓
FE Shutter Permit A and B ON (green)	✓	✓	✓
FOE Door Switch Sum A and B ON (green)	✓	✓	✓
FE Critical Device Permits A and B ON	✓	✓	✓
<i>Remove one switch actuator</i>	✓	✓	✓
FE Shutters A and B closed (red)	✓	✓	✓
FOE Interlocked OFF	✓	✓	✓
FE Shutter Permit OFF	✓	✓	✓
FOE Door Switch Sum OFF	✓	✓	✓
FE Critical Device Permits A and B OFF	✓	✓	✓
<i>Replace switch actuator and reset fault</i>	✓	✓	✓

Remove actuators and close door ✓

A8 FOE Left Door Switches

Place actuators on the door switches and Maglock. ✓

Check the corresponding Permits for each switch tested (e.g., A Permit for switch A).

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	A	B	Reed	
<i>Search hutch</i>	✓	✓	✓	
<i>Open FE Shutters from keypad</i>	✓	✓	✓	
FE Shutters A and B open (green)	✓	✓	✓	
FOE Interlocked A and B ON (green)	✓	✓	✓	
FE Shutter Permit A and B ON (green)	✓	✓	✓	
FOE Door Switch Sum A and B ON (green)	✓	✓	✓	
FE Critical Device Permits A and B ON	✓	✓	✓	
<i>Remove one switch actuator</i>	✓	✓	✓	
FE Shutters A and B closed (red)	✓	✓	✓	
FOE Interlocked OFF	✓	✓	✓	
FE Shutter Permit OFF	✓	✓	✓	
FOE Door Switch Sum OFF	✓	✓	✓	
FE Critical Device Permits A and B OFF	✓	✓	✓	
<i>Replace switch actuator and reset fault</i>	✓	✓	✓	
Remove actuators and close door				✓
A9 Experimental Enclosure Switches and Kirk Key				
Place actuators on the enclosure door switches and place latch device on Kirk Key (KK) assembly				✓
Remove KK and cycle into SRU				✓
Attempt to remove KK without pressing button				✓
Key cannot be removed				✓
Key cannot be removed pressing button with photon shutter open				✓
Check the corresponding Permits for each switch tested (e.g., A Permit for switch A). KK drops both chains				
	A	B	KK	
<i>Open FE and LIS1 Shutters from keypad</i>	✓	✓	✓	
FE Shutters A and B open (green)	✓	✓	✓	
LIS1 Shutter A and B open (green)	✓	✓	✓	
LIS1 Shutter Permit A and B ON (green)	✓	✓	✓	
FE Critical Device Permits A and B ON	✓	✓	✓	
<i>Remove one switch actuator/Cycle "cheated" KK</i>	✓	✓	✓	
LIS1 Shutter A and B Closed (red)	✓	✓	✓	

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L1S1 Shutter Permit OFF

✓ ✓ ✓

FE Critical Device Permits A and B OFF

✓ ✓ ✓

Replace switch actuator and reset fault

✓ ✓ ✓

Remove actuators and latch device, close door and cycle KK in place

✓

A10 Magnetic Lock Test (FOE)

Connect the FOE test box (Attachment B Figure B4) to the PPS cabinet (Attachment B Figure B7). Use the box to turn ON the Maglocks (set switches to "Normal").

✓

Repeat steps for each door: Right (R), Left (L)

	<u>R</u>	<u>L</u>
<i>Search hutch</i>	<u>✓</u>	<u>✓</u>
FOE Interlocked A and B ON (green)	<u>✓</u>	<u>✓</u>
FE Shutter Permit A and B ON (green)	<u>✓</u>	<u>✓</u>
Door Maglock A and B ON (green)	<u>✓</u>	<u>✓</u>
<i>Open FE Shutters</i>	<u>✓</u>	<u>✓</u>
FE Shutters open (green)	<u>✓</u>	<u>✓</u>
<i>Using FOE test box, turn OFF Maglock</i>	<u>✓</u>	<u>✓</u>
Door Maglock A OFF	<u>✓</u>	<u>✓</u>
FE Shutters closed (red)	<u>✓</u>	<u>✓</u>
FOE Interlocked A OFF	<u>✓</u>	<u>✓</u>
FE Shutter Permit A OFF	<u>✓</u>	<u>✓</u>
<i>Turn On Maglock and reset fault</i>	<u>✓</u>	<u>✓</u>
<i>Search hutch</i>	<u>✓</u>	<u>✓</u>
<i>Using FE Shutter test fixture, Open FE Shutters</i>	<u>✓</u>	<u>✓</u>
FE Critical Device Permits A and B ON	<u>✓</u>	<u>✓</u>
<i>Using FOE test box, turn OFF Maglock</i>	<u>✓</u>	<u>✓</u>
<i>Within 3 seconds: FE Critical Devices Permits A Chain OFF</i>	<u>✓</u>	<u>✓</u>

Disconnect the FOE test box and reset fault

✓

A11 Observe Beamline Photon Shutter Operation

Close Beamline Photon Shutter

Shutter indicates closed A and B (**red**), HMI

✓

✓

Open Beamline Photon Shutter

✓

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	Shutter opens smoothly without hesitation	✓
	Shutter indicates open A and B (green), HMI	✓
	<i>Close Beamline Photon Shutter</i>	✓
A12	Observe FE Safety Shutter(s) Operation	
	With Maintenance Door open, connect FE Shutter test fixture (Attachment B Figure B5).	✓
	Shutters are in the closed (down) position	✓
	FE Shutter Closed A and B (red), HMI	✓
	<i>Turn the "Air" switch ON</i>	✓
	<i>Open FE Photon Shutter and SSs A and B</i>	✓
	Shutters open freely without hesitation	✓
	Shutters are in the open (up) position	✓
	FE Shutter Open A and B (green), HMI	✓
	<i>Actuate Shutters closed</i>	✓
	FE Shutter Closed A and B (red), HMI	✓
A13	FE Safety Shutters can only be Closed if FE Photon Shutter is Closed	
	<i>Search hutch</i>	✓
	FOE Interlocked A and B ON (green), HMI	✓
	FE Critical Devices Permits A and B ON (green), HMI	✓
	<i>Open FE SSA</i>	✓
	SSA Open	✓
	<i>Open FE Photon Shutter</i>	✓
	FE Critical Devices Permits A and B OFF, HMI	✓
	<i>Close Shutters</i>	✓
	<i>Reset fault</i>	✓
	FE Critical Devices Permits A and B ON (green), HMI	✓
	<i>Open FE SSB</i>	✓
	SSB Open	✓
	<i>Open FE Photon Shutter</i>	✓
	FE Critical Devices Permits A and B OFF, HMI	✓
	<i>Close Shutters</i>	✓
	<i>Reset fault</i>	✓
	FE Critical Devices Permits A and B ON (green), HMI	✓
A14	Beamline Enable Key (Opening Hhutter without Key Trips SR RF and Dipole PS)	
	<i>Remove beamline enable key</i>	✓
	Beamline Online A and B OFF	✓
	<i>Search FOE</i>	✓
	FOE Interlocked A and B ON (green), HMI	✓
	FE Critical Devices Permits A and B ON (green), HMI	✓
	<i>Using FE Shutter test fixture, Open FE Shutters</i>	✓
	FE Critical Devices Permits A and B OFF	✓
	<i>Replace beamline enable key and reset faults</i>	✓
	Beamline Online A and B ON (green)	✓

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Live Testing

A15 Reach Back FOE Door Switches

<i>Secure P1 through P5</i>	SR Secure, A and B chain, SR HMI	✓
<i>Place actuators on FOE hutch downstream left door switches and Maglock</i>		✓
<i>Search hutch</i>	FOE Interlocked A and B ON (green), HMI	✓
	FE Critical Devices Permits A and B ON (green), HMI	✓
<i>Check Control Room SR HMI (MCR beamline 1)</i>	FE Critical Device Permit A and B ON (green), SR HMI	✓
<i>Check I/O Box 8BM Beamline Enable Panel</i>	FE Critical Devices Permits A and B LEDs ON	✓
<i>Check I/O Box 28 Beamline Enable Panel</i>	FE Critical Device Permit Sum A and B LEDs ON	✓
	FE Shutters Closed A and B LEDs ON	✓
<i>Check Dipole PS (positive) Beamline Interface</i>	A and B Permits ON, Dipole PS Pos. Interface	✓
<i>Check Dipole PS (negative) Beamline Interface</i>	A and B Permits ON, Dipole PS Neg. Interface	✓
<i>Check SR RF System C HVPS Beamline Interface</i>	A and B Permits ON, SR RF System C HVPS Interface	✓
<i>Check SR RF System D HVPS Beamline Interface</i>	A and B Permits ON, SR RF System D HVPS Interface	✓
<i>Operator enables SR Dipole PS</i>	SR Dipole PS is ON	✓
<i>Operator enables SR RF System C HVPS</i>	SR RF System C HVPS is ON	✓
<i>Operator enables SR RF System D HVPS</i>	SR RF System D HVPS is ON	✓
<i>Using FE Shutter test fixture, open the FE Shutters (SSA, SSB and Photon)</i>		✓
	FE Shutters Open	✓
<i>Remove an "A chain" door switch actuator from beamline hutch door</i>		✓
	FOE Interlocked A OFF, HMI	✓
	FE Critical Devices Permits A chain OFF, HMI	✓
<i>Check I/O Box 8BM Beamline Enable Panel</i>	FE Critical Devices Permit A LED OFF	✓
<i>Check I/O Box 28 Beamline Enable Panel</i>	FE Critical Device Permit Sum A LED OFF	✓
<i>Check Control Room SR HMI (MCR beamline 1)</i>	FE Critical Device Permit A OFF (red), SR HMI	✓
<i>Check SR RF System C HVPS Beamline Interface</i>	A Permits OFF, SR RF System C HVPS Interface	✓
<i>Check SR RF System D HVPS Beamline Interface</i>	A Permits OFF, SR RF System D HVPS Interface	✓
<i>Check Dipole PS (positive) Beamline Interface</i>	A Permits OFF, Dipole PS Pos. Interface	✓
<i>Check Dipole PS (negative) Beamline Interface</i>	A Permits OFF, Dipole PS Neg. Interface	✓

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	SR RF System C HVPS is OFF	✓
	SR RF System D HVPS is OFF	✓
	SR Dipole PS is OFF	✓
<i>Close Shutters</i>	Shutters closed	✓
Replace " A chain " door switch actuator and reset fault(s)		✓
<i>Search hutch</i>		✓
	FOE Interlocked A and B ON (green), HMI	✓
	FE Critical Devices Permits A and B ON (green), HMI	✓
<i>Check Control Room SR HMI (MCR beamline 1)</i>	FE Critical Device Permit A and B ON (green), SR HMI	✓
<i>Check I/O Box 8BM Beamline Enable Panel</i>	FE Critical Devices Permits A and B LEDs ON	✓
<i>Check I/O Box 28 Beamline Enable Panel</i>	FE Critical Device Permit Sum A and B LEDs ON	✓
	FE Shutters Closed A and B LEDs ON	✓
<i>Check Dipole PS (positive) Beamline Interface</i>	A and B Permits ON, Dipole PS Pos. Interface	✓
<i>Check Dipole PS (negative) Beamline Interface</i>	A and B Permits ON, Dipole PS Neg. Interface	✓
<i>Check SR RF System C HVPS Beamline Interface</i>	A and B Permits ON, SR RF System C HVPS Interface	✓
<i>Check SR RF System D HVPS Beamline Interface</i>	A and B Permits ON, SR RF System D HVPS Interface	✓
<i>Operator enables SR Dipole PS</i>	SR Dipole PS is ON	✓
<i>Operator enables SR RF System C HVPS</i>	SR RF System C HVPS is ON	✓
<i>Operator enables SR RF System D HVPS</i>	SR RF System D HVPS is ON	✓
<i>Using FE Shutter test fixture, open the FE Shutters (SSA, SSB and Photon)</i>		✓
	FE Shutters Open	✓
Remove a " B chain " door switch actuator	FOE Interlocked B OFF, HMI	✓
	FE Critical Devices Permits B chain OFF, HMI	✓
<i>Check I/O Box 8BM Beamline Enable Panel</i>	FE Critical Devices Permit B LED OFF	✓
<i>Check Control Room SR HMI (MCR beamline 1)</i>	FE Critical Device Permit B OFF (red), SR HMI	✓
<i>Check I/O Box 28 Beamline Enable Panel</i>	FE Critical Device Permit Sum B LED OFF	✓
<i>Check SR RF System C HVPS Beamline Interface</i>	B Permits OFF, SR RF System C HVPS Interface	✓
<i>Check SR RF System D HVPS Beamline Interface</i>	B Permits OFF, SR RF System D HVPS Interface	✓
<i>Check Dipole PS (positive) Beamline Interface</i>	B Permits OFF, Dipole PS Pos. Interface	✓
<i>Check Dipole PS (negative) Beamline Interface</i>	B Permits OFF, Dipole PS Neg. Interface	✓

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	SR Dipole PS is OFF	✓
	SR RF System C HVPS is OFF	✓
	SR RF System D HVPS is OFF	✓
	<i>Close FE Shutters with test fixture</i>	✓
	<i>Remove hutch switch and Maglock actuators</i>	✓
A16	Observe All Shutters Closed Sum	
	<i>Check I/O Box 28 Beamline Enable Panel</i>	
	FE Shutters closed A chain light ON	✓
	FE Shutters closed B chain light ON	✓
	<i>Using FE Shutter test fixture open both FE SSs and then Photon Shutter</i>	✓
	FE Shutters open (green), HMI	✓
	<i>Check I/O Box 28 Beamline Enable Panel</i>	
	FE Shutters closed A chain light OFF	✓
	FE Shutters closed B chain light OFF	✓
	<i>Close FE Shutters and remove FE Shutter test fixture</i>	✓
A17	Test Completion	
	Inspect all hutch doors and labyrinths to ensure all PPS switch and Maglock actuators have been removed	✓
	Return Beamline enable key and Beamline PPS reset key to the Control Room	✓
	Remove muffler from beam imminent sounder	✓
	Ensure PPS cabinets are secure and locked; challenge locks	✓
	Remove all LOTO	✓
	Inform Lead Operator that testing is complete	✓

- END ATTACHMENT A -