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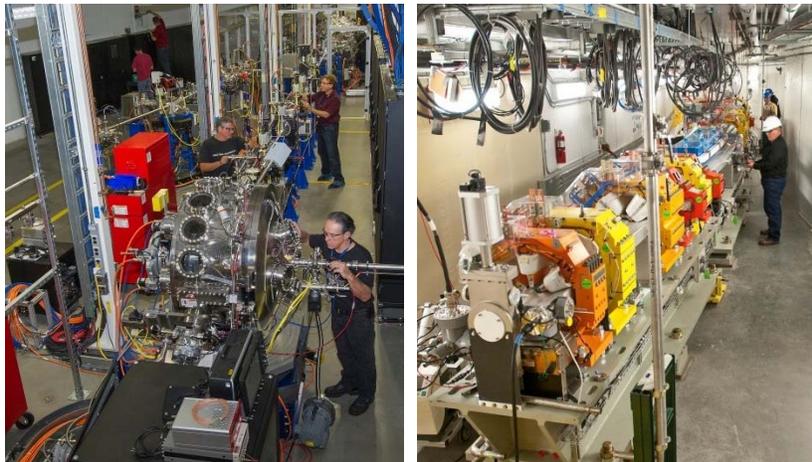
Doc No: NSLSII-ID-PRC-002

## **NSLS-II PROCEDURE: MEZZANINE-IMPLEMENTED LOTO FOR ALL AXES OF ELLIPTICALLY POLARIZED UNDULATORS AT RING CELLS 2 AND 21**

October 17, 2016

Rev. 2

H. Fernandes



 **Think Safety. Act Safely.**

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Title: Mezzanine-implemented LOTO for All Axes of Elliptically Polarized Undulators at Ring Cells 2 and 21			Effective Date: 17OCT2016

### ESH Review:

10/14/2016

X 

Robert Lee  
ESH Manager  
Signed by: Lee, Robert J

By signing this Procedure I acknowledge that it complies with all ESH requirements and if performed correctly, will not present a significant hazard to personnel or equipment.

### Authorization Basis Review:

10/17/2016

X 

Steve Moss  
Authorization Basis Manager  
Signed by: Moss, Steven H

By signing this Procedure I acknowledge that a USI Screening/Evaluation has been performed and this Procedure does not adversely impact the NSLS-II Authorization Basis Documents.

### Approved:

10/17/2016

X Toshiya Tanabe

Toshiya Tanabe  
Insertion Devices Group Leader  
Signed by: Tanabe, Toshiya

By approving this Procedure I agree that the appropriate personnel have reviewed this document and I authorize this work to commence as written.

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### REVISION HISTORY

REVISION	SECTION(S)	PAGE #	DATE	List of Reviewers	DESCRIPTION
1	All	All	21JUN2016	See cover	First Issue.
2	All	All	17OCT2016	G. Ganetis B. Lein C. Porretto J. Rank K. Rubino	Made the procedure applicable for the 2-ID (SIX) EPU (added 2-ID SIX throughout procedure anywhere 21-ID is mentioned); reformatted procedure and changed document number from PS-C-ASD-PRC-213 in accordance with NSLSII-DPT-PDN-001, <i>Management of NSLS-II Documents</i> . Validated by H. Fernandes, J. Rank and K. Rubino on 10/14/16.

### ACRONYMS

BNL	Brookhaven National Laboratory	ID	Insertion Device
CSS	Controls System Studio	lb	Pound
ESM	Electron Spectro-Microscopy	LOTO	Lockout/Tagout
EPU	Elliptically Polarized Undulator	NSLS-II	National Synchrotron Light Source II
EPS	Equipment Protection System	PMAC	Program Multi-Axis (motor) Controller
ESH	Environment, Safety & Health	PPE	Personal Protective Equipment
GUI	Graphic User Interface	VAC	Volts Alternating Current
SIX	Soft Inelastic X-ray Scattering	VDC	Volts Direct Current

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## 1 PURPOSE AND SCOPE

The purpose of this procedure is to provide instructions for LOTO of the NSLS-II 2-ID SIX and 21-ID ESM EPUs from the mezzanine rack, at the “open gap” position, to protect against radiation when the EPU is not in use. The method outlined below continues to power all instrumentation useful for readback of the state (position) of each of the driven axis.

The scope of this procedure includes 1) performing Centrally Controlled LOTO on both 2-ID and/or 21-ID EPUs for beam testing and/or ring commissioning absent IDs and 2) performing Centrally Controlled LOTO to safely take a single EPU out of service prior to beginning ring operations.

## 2 PREREQUISITES

- 2.1 Personnel performing this procedure have prior experience and training with implementation of LOTO on similar EPUs (like the 21-ID EPU) shown in Figure 2-1.



**Figure 2-1:** ESM Cell 21-ID EPU

- 2.2 Primary Authorized Employees performing this procedure have completed training for PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.

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- 2.3 Each Primary Authorized Employee performing this procedure has facility specific PPE available.
- 2.4 Refer to Figure 2-2, when necessary, for a wiring diagram depicting the switch that would be turned OFF (circled in blue) for LOTO of the EPU rack and cell 2-ID and cell 21-ID.

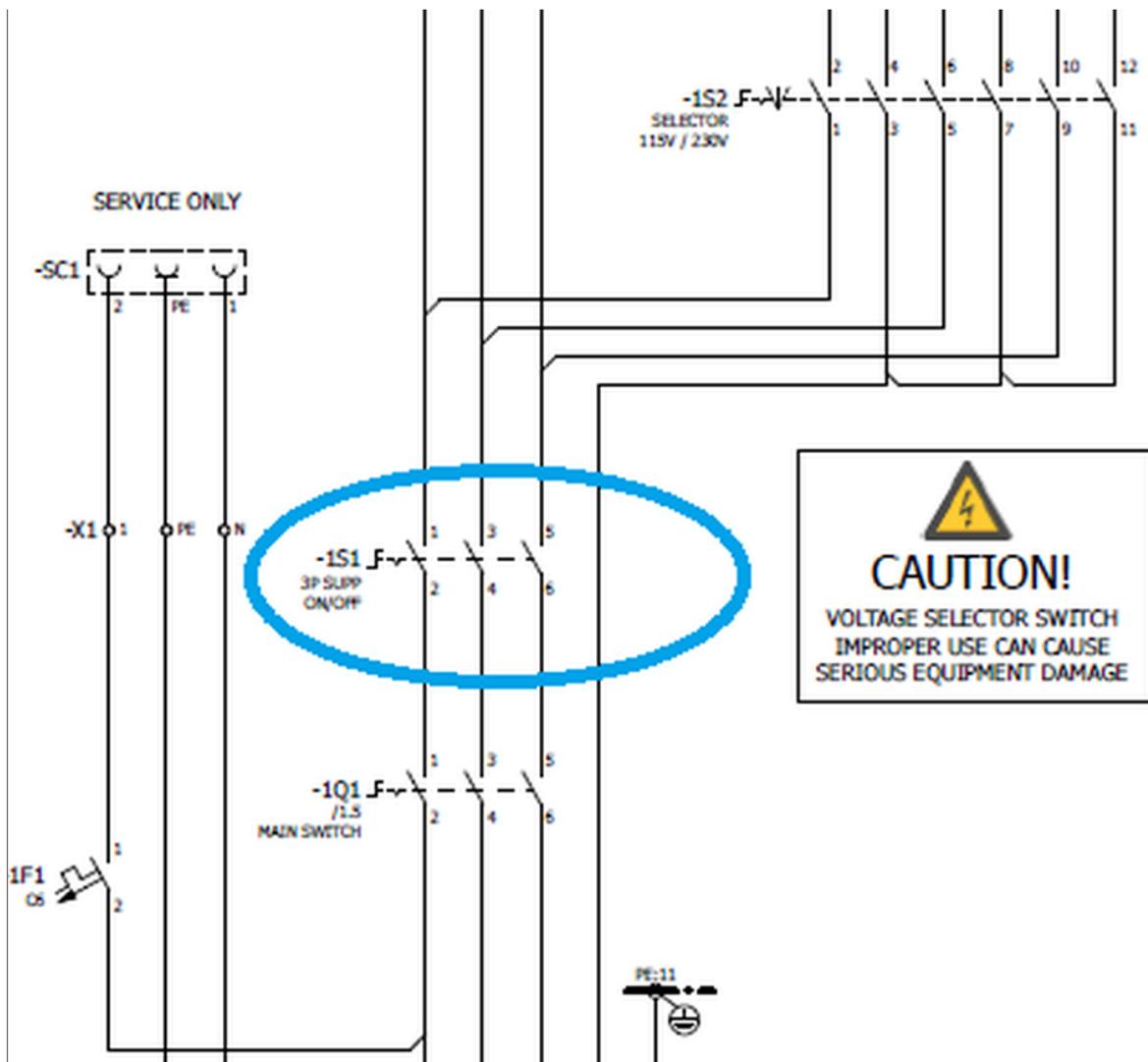


Figure 2-2: Typical Control Rack to EPU Motor Cabling

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- 2.5 The following equipment/tools are required and available to LOTO the 2-ID and/or 21-ID EPU:
- A red-banded padlock (Master series 31, BNL stock number I65062)
  - A solid red lockout tag (BNL stock #S81046) for Centrally Controlled LOTO
  - Lockout key Lock Box, (Emedco MGB11, size: 6"h x 9"w x 3-1/2"d or equivalent)
  - Manufactured Cell 2 and 21 "gap gauge" (BNL Drawing # ID-ML-7200, See Figure 2-3)
- 2.6 The gap gauge has been internally inspected within the past 12 months and documented with an inspection report.
- 2.7 Contact Operations Staff or ESH Staff to confirm availability to assist with the LOTO.
- 2.8 Notify the Control Room, Mechanical Engineering Group Leader and Lead Beamline Scientist of the impending LOTO.

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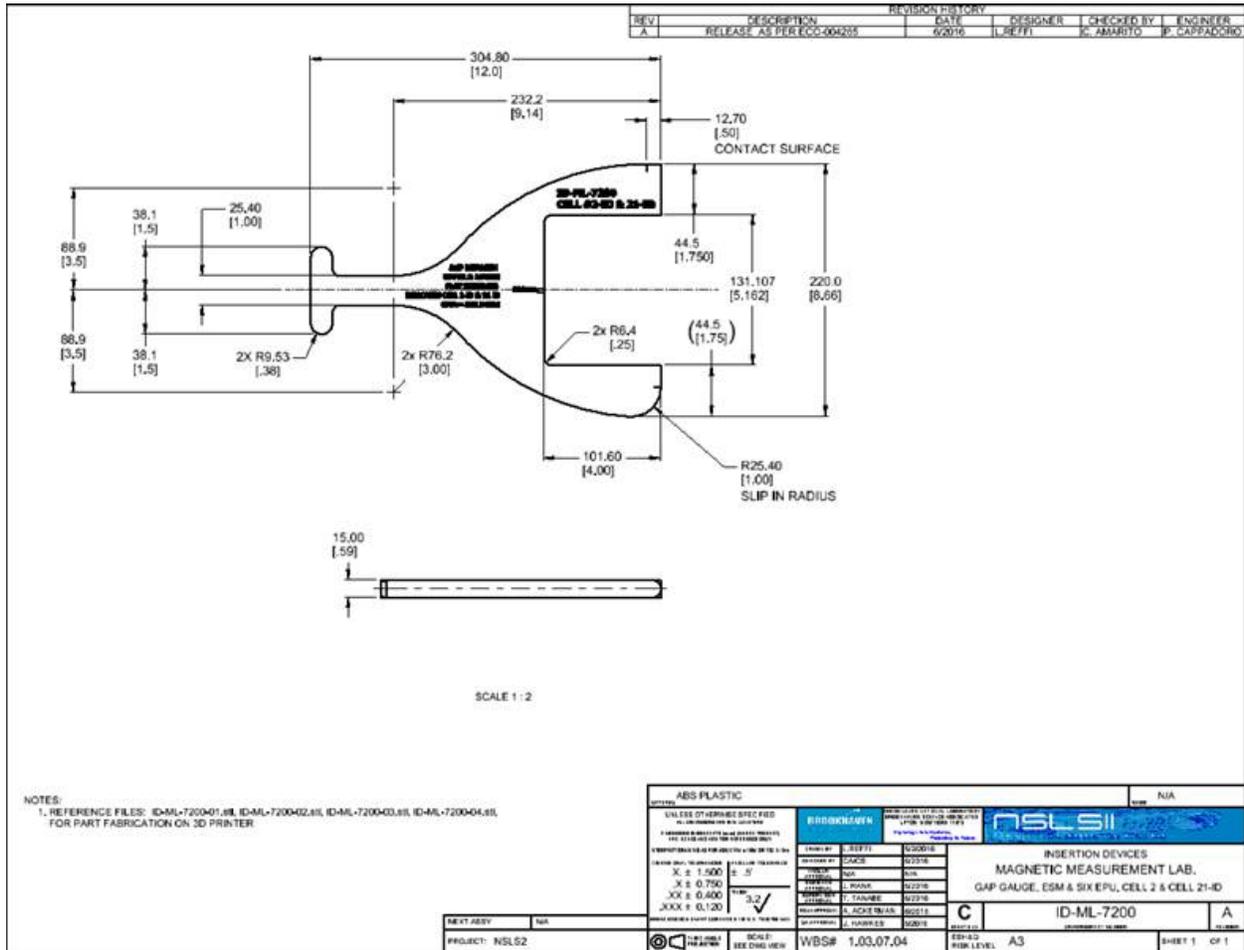


Figure 2-3: BNL Drawing # ID-ML-7200: Gap Gauge, 2-ID and 21-ID EPU

### 3 HAZARDS, CONTROLS AND LIMITS

- 3.1 IDs are constructed with permanent magnets that do not have an on/off switch. Internal magnetic loads of several tons may be present. Though the magnetic gap is guarded, magnetic materials shall be kept clear of the “beam centerline” area. A selection of non-magnetic tools is available from the ID Group.
- 3.2 All steps in this procedure require that Centrally Controlled LOTO shall be performed in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout*

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*(LOTO) Procedure.* LOTO for any other purpose shall not be performed as part of this procedure.

- 3.3 Only a person that is identified as a Primary Authorized Employee may perform Centrally Controlled LOTO on the EPU and Control Rack.
- 3.4 The following equipment remains powered during the performance of this procedure:
  - The PMAC motor controllers (24 VDC output; motor amplifier is turned off and on throughout procedure, as necessary, to perform LOTO)
  - The 2-ID EPU Control Rack for straight section at cell 2, resides in the mezzanine level above cell 1-ID and the 21-ID EPU Control Racks for straight sections at Cell 21 resides on the mezzanine level above Cell 20; are powered by a floor-mounted 208 VAC junction box (to the coil power supplies only) and 110 VAC power strip outlets on one side per bay
  - 2-ID and 21-ID EPU-resident correction coils
  - Absolute gap encoders (for readback of true gap to the EPU Control System)
  - All limit switches
- 3.5 Deviations from expected configuration(s) require a halt to this procedure for evaluation by the ID Group Cognizant Engineer.

## 4 PROCEDURE

### 4.1 Apply Centrally Controlled LOTO

**Caution:** During and after completion of this procedure, the 2-ID and/or 21-ID EPU and its Control Rack remain energized possible resulting in a shock hazard; only the motor controller switch which energizes each of the motors is powered off.

- 4.1.1 Obtain the appropriate LOTO padlocks and solid red lockout tags.
- 4.1.2 IF the ring is accessible, THEN visually verify the position of the ID Gap Drive System and Elevator Base System (High or Low).
- 4.1.3 Switch to Engineering Mode from the GUI control screen.

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**Beamline Control**    DISABLE    ENABLE    **Enabled**    **Beamline Control**    Restrict    Permit

**Beamline Control**    **FE Status - ID Gap, FE Flag, Shutters and Valves**    **ID Gap (mm)**

	ID Gap	GV1	Flag	Shutters	IDPS	FV	SSA	SSB	GV2&BL	Detail	ID 1	ID 2	Slits & Gap
3 HXN	Closed	Open	Open	Out	Enabled	Open	Open	Open	Open	IVU20	5.88		Restricted Permitted
4 ISR	Open	Open	Open	Out	Disabled	Closed	Open	Closed	Closed	IVU23	40.00		
5 SRX	Closed	Open	Open	Out	Enabled	Open	Open	Open	Open	IVU21	6.80		Restricted Permitted
8 ISS	Closed	Open	Open	Out	Enabled	Closed	Open	Closed	Closed	DW100	15.0	15.0	
10 IXS	Closed	Open	Open	Out	Enabled	Open	Open	Open	Open	IVU22	7.74		Restricted Permitted
11 CHX	Closed	Open	Open	Out	Enabled	Open	Open	Open	Open	IVU20	6.68		Restricted Permitted
12 SMI	Open	Open	Open	Out	Disabled	Closed	Closed	Closed	Closed	IVU23	40.00		
16 LIX	Closed	Open	Open	Out	Enabled	Open	Open	Open	Open	IVU23	6.21		Restricted Permitted
17 AMX/FMX	Open	Open	Open	Out Out	Enabled	Closed	Open	Closed	Closed	IVU21	40.00	40.00	Res. Per. Res. Per.
18	Open	Open	Open	None	Disabled	Closed	Closed	Closed	Closed	DW100	15.0	15.0	
21 ESM	Open	Closed	Open	Out	Disabled	Closed	Open	Closed	Closed	EPU105	220.0		
23 CSX	Open	Open	Open	Out	Enabled	Open	Open	Open	Open	EPU49	31.1	30.9	Restricted Permitted
28 XPD	Closed	Open	Open	Out	Enabled	Open	Open	Open	Open	DW100	15.0	15.0	Restricted Permitted

IOC status/reboot    ID&FE Limits    Front-end Flags    Temp Monitoring

Figure 4-1a: EPS Switch Status for Cell 21 EPU

STORAGE RING ID FRONT END

MASTER SHUTTER ENABLE COMMAND: ID1 ID2    GLOBAL MASTER SHUTTER SIGNAL:     Reset

STORAGE RING ID FRONT END COMPONENT STATUS

LOCATION	BMP5	GV1	PS	FV	SSA	SSB	GV2	ID GAP	BEAM
CELL 23	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 28	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 03	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 05	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 10	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 11	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 08	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 18	Open	Open	NA	NA	NA	NA	NA	Closed	Normal
CELL 16	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 17	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 04	Open	Open	Closed	Open	Closed	Closed		Closed	Normal
CELL 12	Open	Open	Closed	Open	Closed	Closed	Open	Open	Normal
CELL 21	Open	Open	Open	Open	Open	Open	Open	Closed	Normal
CELL 19	Closed	Open	Closed	Open	Closed	Closed	Closed	Open	Normal
CELL 02	Closed	Closed	NA	NA	NA	NA	NA	Open	Normal

EPS SWITCH STATUS

Figure 4-1b: EPS Switch Status for Cell 2 EPU

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4.1.4 In Operational Mode, command the Gap Drive System to drive to a mid-gap position (i.e., 110,000  $\mu\text{m}$ ):

- a. Type 110,000  $\mu\text{m}$  in the Gap Drive Set Point field (see Figure 4-1a and b).
- b. Press Enter on the screen.

4.1.5 Check that the commanded gap has been reached as follows:

- a. Confirm that the readout on the encoder "Actual" position has reached the setpoint of 110,000  $\mu\text{m}$ .

AND

**Note:** Gap should be at the mid gap markings on the gap gauge.

- b. IF the ring is accessible, THEN confirm that mid gap is reached by attempting to insert the gap gauge ID-ML-7200.

4.1.6 In Operational Mode, command the Gap Drive System to drive to open gap (i.e., 220,000  $\mu\text{m}$ ):

- a. Type 220,000  $\mu\text{m}$  in the Gap Drive Set Point field.
- b. Press Enter on the screen.

4.1.7 Check that the commanded gap has been reached as follows:

- a. Confirm that the readout on the encoder "Actual" position has reached the setpoint of 220,000  $\mu\text{m}$ .

AND

- b. Check the EPS switch status in CSS and ensure that EPS indicates that gap is open (Figure 4-1a and b).

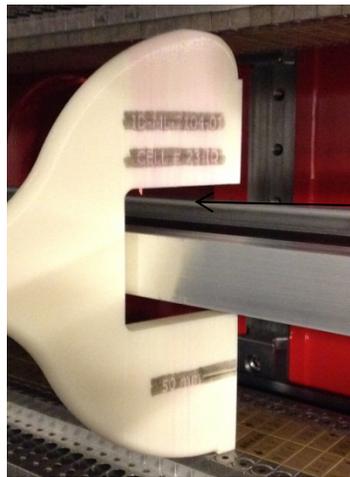
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**Note:** Gap gauge should slide inside gap (see Figure 4-2).

- c. IF the ring is accessible, THEN confirm that fully open gap is reached by inserting the gap gauge ID-ML-7200.



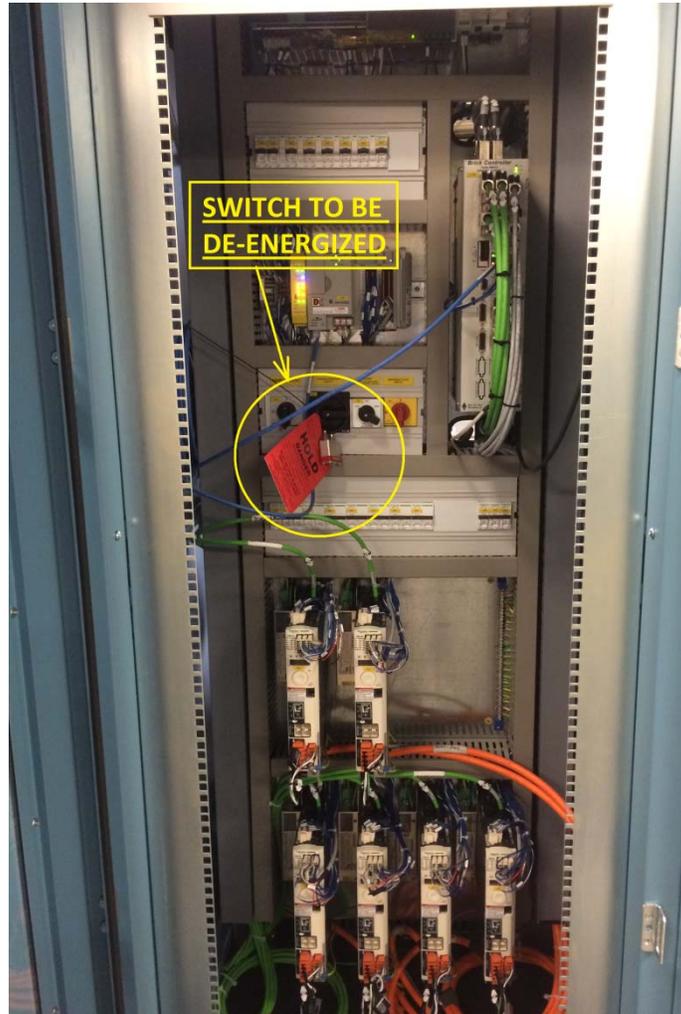
Insert "Gap Gauge" in gap clearing the vacuum chamber.

**Figure 4-2:** Gap Gauge Inserted in EPU Gap

- 4.1.8 Notify the Control Room and all Affected Employees of the intent to LOTO the 2-ID and/or 21-ID EPU.
- 4.1.9 Confirm that the 2-ID and/or 21-ID EPU in the affected straight section AND its Control Rack are safe to shut down.

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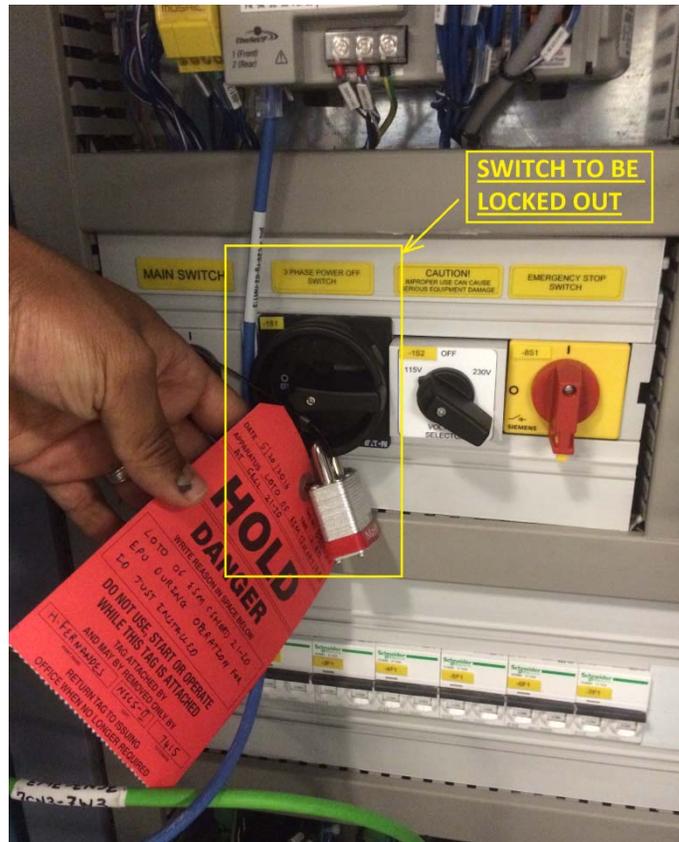
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**Figure 4-3:** EPU Control Rack

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**Figure 4-4:** EPU Switch to be Locked Out

- 4.1.10 At the rack (see Figures 2-2, 4-3 and 4-4), identify the switch for all the motors (named “3 PHASE POWER OFF SWITCH”).
- 4.1.11 De-energize the switch (see Figure 4-4) by turning to the off position.
- 4.1.12 Complete all information required on the face of the solid red lockout tag.
- 4.1.13 Apply a padlock to the de-energized switch as indicated in Figure 4-4, in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.
- 4.1.14 Hang the solid red lockout tag using a 50 lb. rated zip-tie from the padlock.
- 4.1.15 Challenge the padlock to ensure it is installed securely.

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## 4.2 Test Centrally Controlled LOTO

4.2.1 In Operational Mode (i.e., Manual), attempt to close the gap to confirm proper LOTO by commanding the Gap Drive System to drive to mid gap position (i.e., 110,000  $\mu\text{m}$ ).

4.2.2 To confirm that the Gap Drive motors were not actuated:

- a. Ensure that the EPS switch status in CSS shows that the EPU gap is fully open (see Figure 4-1a and b).

**Note:** Gap gauge should slide inside gap (see Figure 4-2).

- b. IF the ring is accessible, THEN contact Operations Staff OR ESH Staff to witness and confirm that the position of the 2-ID and/or 21-ID EPU remains at open gap using the gap gauge.

4.2.3 Place all padlock keys in the Lockout key Lock Box.

4.2.4 Apply a padlock AND solid red lockout tag to the Lockout Key Lock Box.

4.2.5 Operations Staff OR ESH Staff apply a padlock and solid red lockout tag to the Lockout Key Lock Box.

**Note:** After the Operations Staff or ESH Staff apply their padlock to the Lockout Key Lock Box, it will be kept in the Control Room for the duration of the LOTO.

4.2.6 Notify the Control Room that LOTO has been successfully applied.

4.2.7 Document Centrally Controlled LOTO in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.

## 4.3 Restoring Equipment to Service - Clear LOTO

4.3.1 Verify that the reason for the LOTO is complete.

4.3.2 Confirm that the 2-ID and/or 21-ID EPU and Control Racks in the affected straight section are safe to enable.

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- 4.3.3 Contact Operations Staff OR ESH Staff for removal of their padlock from the Lockout Key Lock Box.
- 4.3.4 Notify the Control Room, Mechanical Engineering Group Leader and Lead Beamline Scientist of the intent to return to service.
- 4.3.5 Recover the LOTO padlock keys from the Lockout Key Lock Box in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.
- 4.3.6 Remove the following from the rack for the 2-ID and/or 21-ID EPU:
- Solid red lockout tag
  - Padlock
- 4.3.7 Energize the motors by turning the switch marked “3 PHASE POWER OFF SWITCH” to on (see Figure 4-4).
- 4.3.8 In Operational Mode (i.e., Manual), command the Gap Drive System to drive to a mid-gap position (i.e., 110,000  $\mu\text{m}$ ).
- 4.3.9 Check proper gap drive function by performing the following:
- a. Confirm that the CSS readout on encoder position of gap has reached the set point.  
  
AND  
  
**Note:** Gap should be at the mid-gap markings on the gap gauge.
  - b. IF the ring is accessible, THEN confirm that mid gap is reached by attempting to insert the “gap gauge” ID-ML-7200.  
  
AND
  - c. Ensure that in CSS, the EPS switch status indicates that the gap is no longer open (Figure 4-1).

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4.3.10 Notify Affected Employees that the work is complete and equipment is ready for use.

4.3.11 Notify the Control Room, Mechanical Engineering Group Leader and Lead Beamline Scientist that LOTO has been successfully removed.

4.3.12 Return group LOTO padlocks and solid red tags to the LOTO station.

4.3.13 Document the clearing of Centrally Controlled LOTO in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.

## 5 REFERENCES

5.1 PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*

## 6 ATTACHMENTS

None.

## 7 DOCUMENTATION

None.

## 8 DEFINITIONS

8.1 Centrally Controlled LOTO: LOTO of systems or equipment to prevent personnel injury and/or exposure to hazardous energy, for operational reasons.

8.2 Equipment Protection System (EPS): The engineered interlocks that protect ring-resident equipment during NSLS-II operations.

8.3 Affected Employees: Employees who are required to use machines or equipment on which a servicing and maintenance LOTO is being performed. For the NSLS-II, this is typically the Operations Staff.

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- 8.4 Primary Authorized Employee: An Authorized Employee who is designated by their department/division to coordinate complex-group LOTO procedures. The Primary Authorized Employee coordinates workforces and ensures continuity of LOTO protection for all involved (both Authorized and Affected Employees). They are the first to apply their lock and the last to remove their lock from a group LOTO. At the NSLS-II, Primary Authorized Employees apply Centrally Controlled LOTO for the protection of other workers as well.

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