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Photon Sciences Directorate, Brookhaven National Laboratory			
Doc No. PS-C-ASD-PRC-176	Author: J. Rank	Effective Date: 17Nov2014 Review Frequency: 3 yrs	Version 2
Title: Mezzanine-implemented LOTO for Damping Wigglers at Ring Cells 8, 18 and 28			Technical

Reviewed by:		
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VERSION HISTORY LOG

VERSION	DESCRIPTION	DATE
1	First Issue.	03Oct2014
2	Give Operations Staff personnel the ability to apply Centrally Controlled LOTO, minor editorial changes. Validation waived by Author, J. Rank and Acting Conduct of Operations Manager, S. Moss.	17Nov2014

ACRONYMS

BNL	Brookhaven National Laboratory	LOTO	Lockout/Tagout
D/S	Downstream End of ID	NSLS-II	National Synchrotron Light Source II
DVM	Digital Voltmeter	PMAC	Program. Multi-Axis (motor) Controller
DW	Damping Wiggler	PPE	Personal Protective Equipment
EPS	Equipment Protection System	PC	Pieces (Quantity)
ESH	Environment, Safety & Health	PS	Photon Sciences
FLOCO	Floor Coordinator	SBMS	Standards Based Management System
GUI	Graphic User Interface	VAC	Volts Alternating Current
ID	Insertion Devices (generic term)	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 Damping Wigglers from the mezzanine-resident rack, at their "open gap" position to protect against radiation when the DWs are not in use. This procedure differs from PS-C-ASD-PRC-122 in that lockout is applied to the cables for each of the motors (for both Gap Drive and Elevator Base) at the mezzanine, rather than at the ring-resident insertion device. 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 all DWs for beam testing and/or ring commissioning absent Insertion Devices, 2) performing Centrally Controlled LOTO to safely take a single DW out of service before ring operations.

2 DEFINITIONS

- 2.1 Centrally Controlled LOTO: LOTO of systems or equipment to prevent personnel injury and/or exposure to hazardous energy, for operational reasons.
- 2.2 Equipment Protection System (EPS): The engineered interlocks that protect ring-resident equipment during NSLS-II operations.
- 2.3 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.

3 RESPONSIBILITIES

- 3.1 Authorized and Qualified ID Group Personnel
 - 3.1.1 Perform the following procedure using proper PPE per the BNL SBMS Subject Area, *Electrical Safety* and the Arc Flash Warning label posted on the disconnect or circuit breaker that powers the equipment to be de-energized.
 - 3.1.1 Apply Centrally Controlled LOTO, as described in this procedure.

Photon Sciences Directorate, Brookhaven National Laboratory			
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- 3.1.2 Notify the Control Room and Lead Beamline Scientist of the impending LOTO.
- 3.1.3 Communicate this procedure to all Affected Workers.
- 3.1.4 Address any concerns of employees who might be exposed.
- 3.2 ID Group Cognizant Engineer/Technical Authority
 - 3.2.1 Provides or directs system expert support for DW Systems operation.
 - 3.2.2 Provides clarification on any DW System related issues in this procedure.
- 3.3 ESH Staff/Operations Staff (e.g. Lead Operator or FLOCO)
 - 3.3.1 ESH Staff provides clarification and guidance on any ESH issues that arise during the execution of this procedure.
 - 3.3.2 Applies Centrally Controlled LOTO, as required.
 - 3.3.3 Ensure the DW remains at open gap using the "gap gauge," during testing of Centrally Controlled LOTO.

4 PREREQUISITES

- 4.1 Primary Authorized Employees performing this procedure have completed and have read PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.
- 4.2 Each Primary Authorized Employee performing this procedure has facility specific PPE.
- 4.3 For each DW to which LOTO will be applied the following equipment/tools are required:
 - Plug Lockout Boot (2 pc, Prinzing Enterprises # PL023 or equivalent, See Figure 4-3)
 - Red-banded padlock (3 pc, Master series 31, BNL stock number I65062)
 - Solid red lockout tag 3 pc, (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 "gap gauge" (BNL Drawing# ID-ML-7100, See Figure 4-2)

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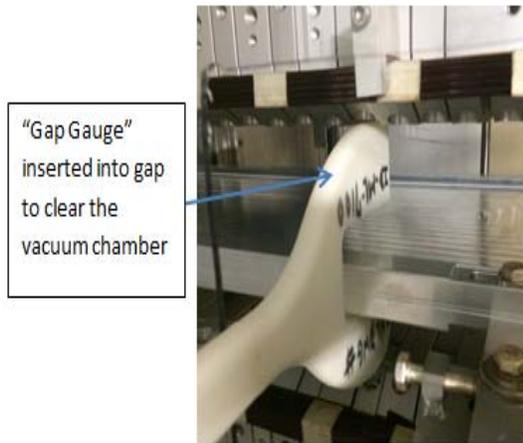


Figure 4-2: "Gap Gauge" Inserted in DW Gap

Figure 4-3: Plug Lockout Boot

- 4.4 The gap gauge has been internally inspected within the past 12 months and documented with an inspection report.
- 4.5 If the ring is accessible, ensure that guards are in place at the damping wiggler.
- 4.6 Contact Operations Staff or ESH Staff to confirm availability to assist with testing the LOTO.

5 PRECAUTIONS AND LIMITATIONS

- 5.1 Most ID are constructed with permanent magnets that do not have an on/off switch. Internal magnetic loads of many tons may be present. Though the magnetic gap is guarded, magnetic materials should be kept clear of the "beam centerline" area. A selection of non-magnetic tools are available from the ID Group.
- 5.2 All steps in this procedure require centrally controlled LOTO, and shall be performed in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*. LOTO for any other purpose shall not be performed as part of this procedure.
- 5.3 Only a person that is identified as a Primary Authorized Employee may perform Centrally Controlled LOTO on the DW and Control Rack.

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5.4 The following equipment remains powered during the performance of this procedure:

- The PMAC motor controllers (output voltage of 24 VDC, power is turned off and on throughout procedure, as necessary to perform LOTO)
- DW Control Racks for Straight Sections at Cells 8, 18 and 28 (located on the mezzanine level above Cells 7, 17 and 27); powered by a floor-mounted 208VAC junction box (to the coil power supplies only) and 110VAC power strip outlets on both sides.
- DW-resident correction coils
- Absolute gap encoders (for readback of true gap to the DW Control System)
- Elevation encoders (for readback of centering of magnetic midplane about the electron beam axis)
- All limit switches

5.5 Motor cables shall never be disconnected while energized.

5.6 Deviations from expected configuration(s) requires a halt to this procedure for evaluation.

6 PROCEDURE

6.1 Apply Centrally Controlled LOTO

Caution: During and after completion of this LOTO procedure, the DW Control Rack remains energized; only the cable connectors for each of the motors are disconnected.

6.1.1 Obtain the appropriate LOTO plug lockouts, padlocks and solid red tags.

6.1.2 IF the ring is accessible, THEN visually verify the position of the ID Gap Drive System (open or closed) and Elevator Base System (high or low).

6.1.3 View the control screen at the associated Control Rack on the mezzanine level

6.1.4 Confirm that the readout on the encoder position of gap and elevation is as expected, or consistent with the observations in step 6.1.2.

6.1.5 In Operations (or Manual) Mode, command the Gap Drive System to drive to a mid gap position (e.g., 50mm, see Figure 6-1.)

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6.1.6 Confirm that the gap set point has been reached by viewing the gap encoder readback at the control screen (see Figure 6-1).

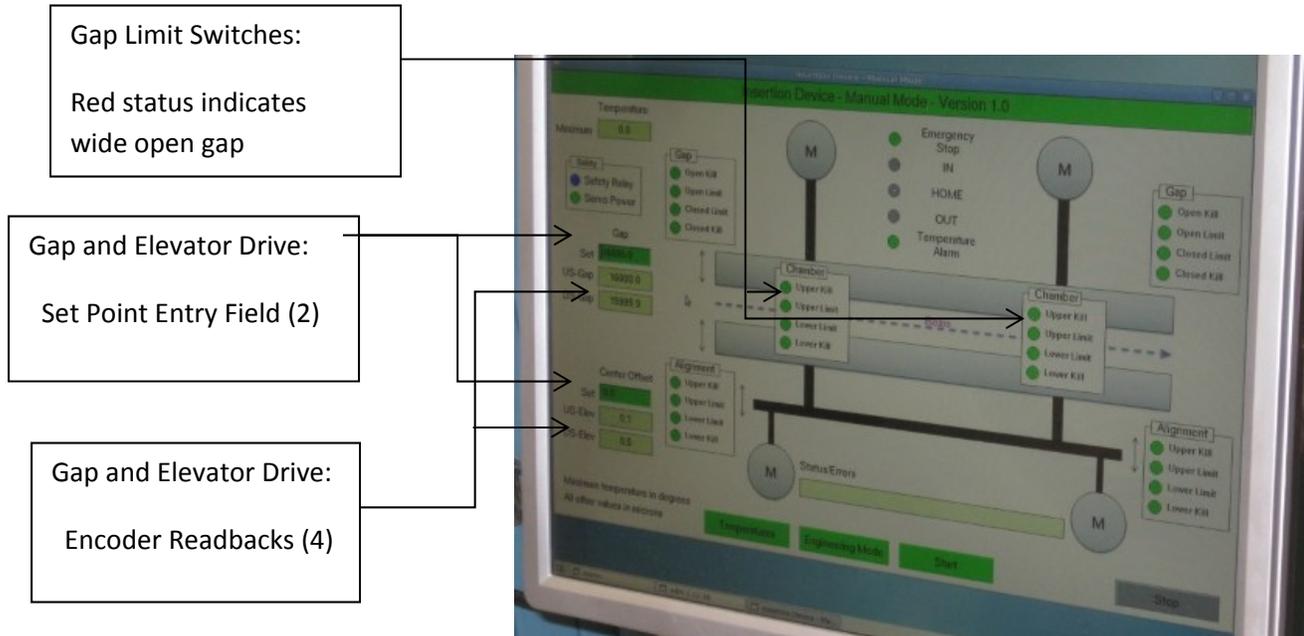


Figure 6-1: DW Control Screen

Note: The gap drive motors will be stopped upon triggering the outermost gap limit switches (nominally at 150.24mm gap, just inside of the “kill switches”).

6.1.7 In Operations Mode, command the Gap Drive System to drive to full open gap.

6.1.8 Confirm the GUI's soft switch status indicator by viewing the control screen as the gap drives open.

Note: At least one indicator light should change from green (closed) to red (wide open).

6.1.9 Confirm the fully open gap position (nominal 150mm) by viewing the gap encoder readback at the control screen (see Figure 6-1).

6.1.10 IF the ring is accessible, THEN confirm the fully open gap position of the effected DW.

6.1.11 Notify all Affected Employees of the intent to LOTO the DW.

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6.1.12 Ensure that the DW in the affected straight section and its Control Rack are safe to shut down.

6.1.13 Set up work boundaries in mezzanine to prevent unauthorized personnel from entering the area near the DW Control Rack set.

6.1.14 De-energize the PMAC motor controller by turning the red dial on its front panel to the Chassis Power "OFF" position (see Figure 6-2).

Note: Each of the four motor cables is labeled with respective termination symbol (e.g., DS_Y2_M2, DS_Y4-M4, etc.) as circled red in the schematic of Figure 6-4.

6.1.15 Identify the cable connectors for each of the four motors:

- Two Gap Drives
- Two Elevator Base

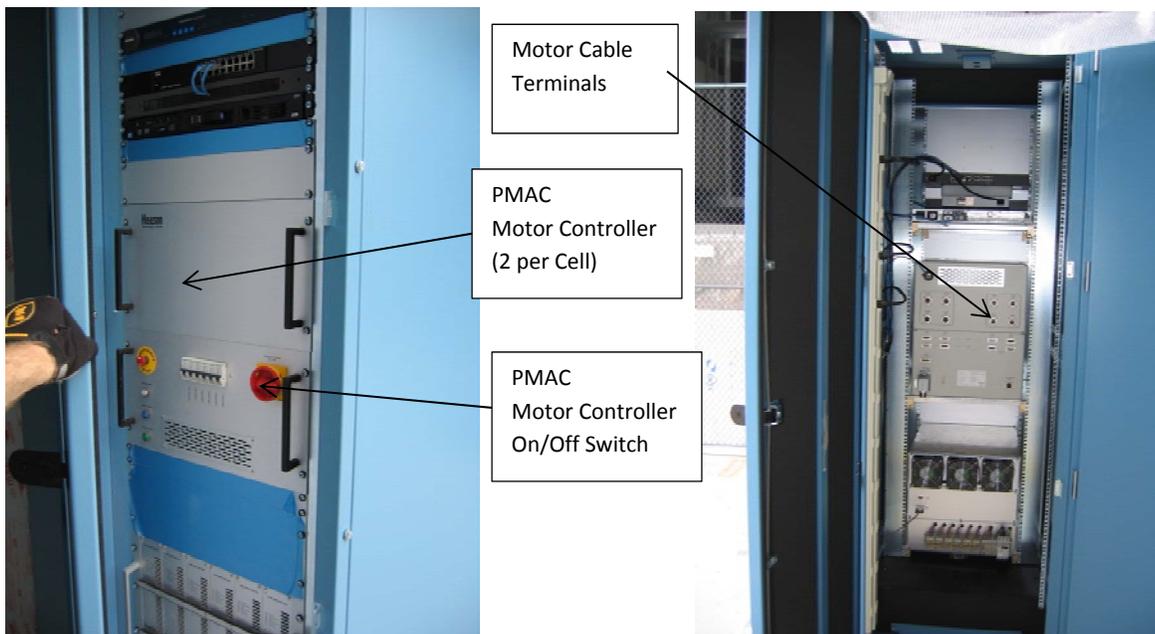


Figure 6-2: DW Control Rack front panel

Figure 6-3: DW Control Rack back panel

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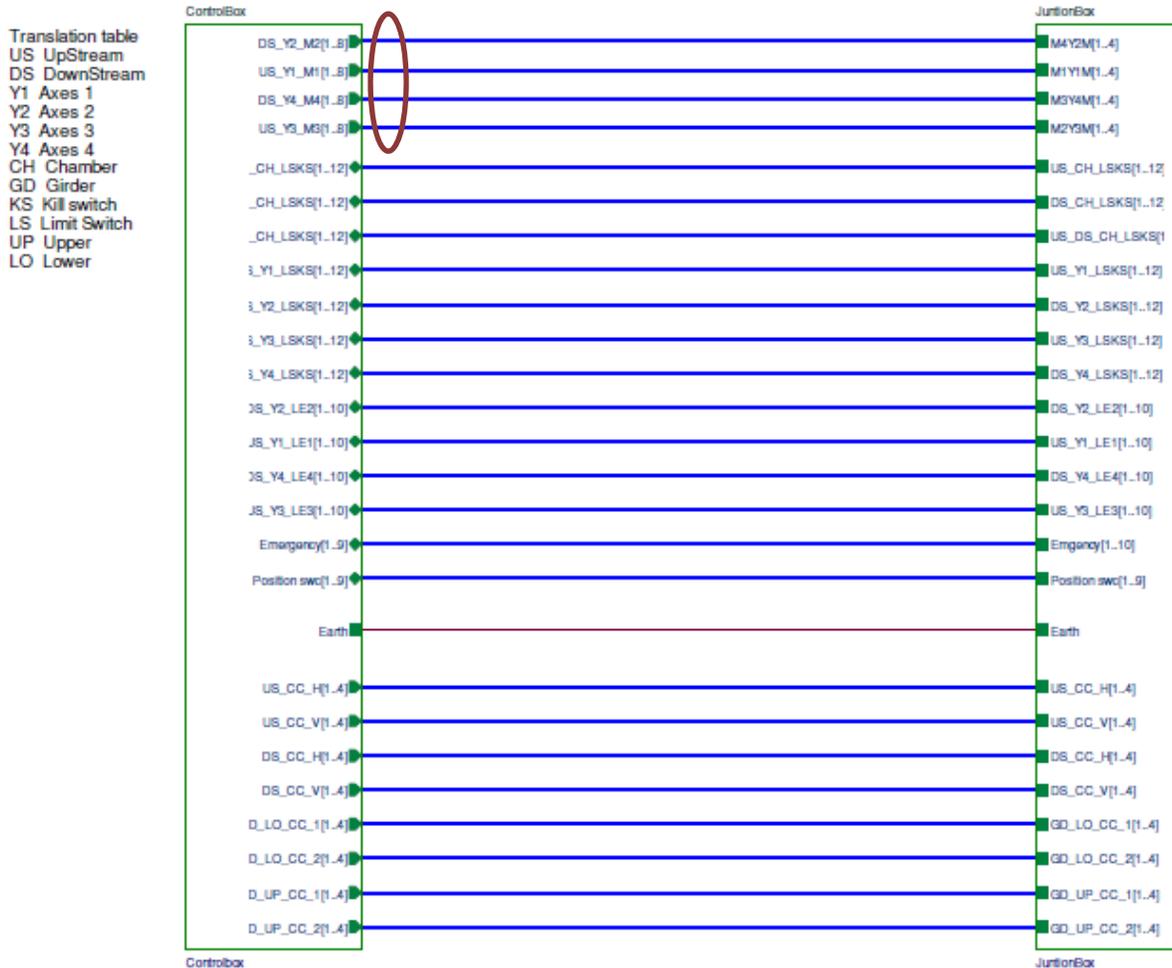


Figure 6-4: DW Control Rack to ID-resident Terminal Box Cabling

- 6.1.16 Disconnect the four cable connectors for each of the four motors (2 Gap Drive and 2 Elevator Base, points of disconnect are circled in red).
- 6.1.17 Gather the free ends for each pair of disconnected cables AND insert into the plug lockout boots (two cables in each of the two boots).
- 6.1.18 Close the plug lockout boots.
- 6.1.19 Complete all information required on the face of the red tags.

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6.1.20 Apply padlocks AND red tags to the Plug Lockouts in accordance with PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*.

6.1.21 Hang the solid red lockout tags (BNL stock number S81046) using a 50 lb. rated zip-tie from each padlock.

6.1.22 Challenge the plug locks and tags to ensure they are installed securely.

6.2 Test Centrally Controlled LOTO

6.2.1 Re-energize the PMAC motor controller by turning the red dial on its front panel to the Chassis Power "ON" position (see Figure 6-2).

6.2.2 In Operations Mode (i.e., Manual), attempt to close the gap to confirm proper disconnect by performing the following:

- a. Command the Gap Drive System to drive to mid gap position (e.g., 50mm, see Figure 6-1).

6.2.3 Confirm that neither the Gap Drive nor Elevation motors were actuated:

- a. Confirm the "open limit" soft switch remains red (open position status).

AND

- b. Confirm gap encoder readout remains at 150mm nominal gap (wide open).

AND

- c. IF the ring is accessible, THEN contact Operations Staff or ESH Staff to confirm that the position of the DW remains at fully open using the "gap gauge".

6.2.4 Place the labeled key to the padlocks in the lockout key Lock Box marked for all DW.

6.2.6 Operations Staff or ESH Staff to applies a lock and red tag to the Lock Box.

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

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

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

6.3 Restoring Equipment to Service - Clear LOTO

6.3.1 Verify that the reason for the LOTO is complete.

6.3.2 Ensure all DWs and Control Racks in the affected straight section are safe to enable.

6.3.3 Notify PS Control Room of the intent to return to service.

6.3.4 Contact the Operations Staff or ESH Staff to unlock the lock box in the Main Control Room AND obtain the key to the padlocks.

6.3.5 De-energize the PMAC motor controller by turning the red dial on its front panel to the Chassis Power "OFF" position (see Figure 6-2).

6.3.6 Remove the padlocks and the plug lockouts from the connectors on each of the free cable ends, (a total of four cables will be released for each DW).

Note: Each of the four motor cables is labeled with respective termination symbol (e.g., DS_Y2_M2, DS_Y4_M4, etc.) as circled red in the schematic of Figure 6-4.

6.3.7 Reconnect the cable connectors for each of the motors (for Gap Drive and Elevator Base) to the proper labeled terminal plug (See red circle in Figure 6-4).

6.3.8 Re-energize the PMAC motor controller by turning the red dial on its front panel to the Chassis Power "ON" position (see Figure 6-2).

6.3.9 Attempt to close the gap to confirm proper functionality:

- a. In Operations (or Manual) Mode, command the Gap Drive System to drive to a mid gap position (e.g., 50mm, see Figure 6-1.)

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- b. Confirm that the gap set point has been reached by viewing the gap encoder readback at the control screen (see Figure 6-1).

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

6.3.11 Notify the Control Room AND Lead Beamline Scientist that LOTO has been successfully removed.

6.3.12 Return group LOTO red tags to the LOTO station.

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

7 REFERENCES

- 7.1 SBMS Subject Area, *Electrical Safety*
- 7.2 PS-C-ASD-PRC-005, *Centrally Controlled Lockout/Tagout (LOTO) Procedure*
- 7.3 PS-C-ASD-PRC-122, *Lockout/Tagout of Damping Wiggler (DW) Insertion Device at Open Gap*
- 7.4 Gap gauge, BNL Drawing# ID-ML-7100

8 ATTACHMENTS

None.

9 DOCUMENTATION

None.

-END-