

BEAMS DIVISION DEPARTMENTAL PROCEDURE

ELECTRICAL/ELECTRONIC SUPPORT DEPARTMENT

BDDP-EE-9914

EQUIPMENT SPECIFIC LOCKOUT/TAGOUT PROCEDURE

of the NuMI Prototype Horn Test Power Supply

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Knowledgeable Employee

APPROVED BY _____ DATE _____
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ISSUE DATE: 1/3/01

REVIEW AND CONCURRENCE RECORD

REVIEWED BY _____ DATE _____
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1.0 PURPOSE AND SCOPE

The purpose of this Beams Division Departmental Procedure (BDDP) is to outline and detail the conduct of LOCKOUT/TAGOUT (LOTO) for the maintenance or transport of the NuMI Prototype Horn Test Power Supply. The Test Power Supply consists of two elements, a 240 kW PEI charging source and a separate enclosure housing banks of capacitors that could retain a lethal level of stored energy.

2.0 PERFORMANCE OF MAINTAINANCE ACTIVITIES

- 2.1 The Test Power Supply is designed as a temporary power source to pulse prototype NuMI horn and stripline designs until the replacement operational power supply is installed. The equipment is located in the MI-8 service building of the Main Injector accelerator.

One item of maintenance activity, in addition to repair and calibration, will be relevant to the preparation for transport of the capacitor bank enclosure from one location to another. Portability is accommodated by the use of an overhead crane for lifting via slings placed around the enclosure. As part of the re-location process, the output stripline and the electrical cabling from the PEI charging source must be disconnected. Disconnecting these items may require entrance to the high voltage section of the equipment, thus Lockout/Tagout procedures must be followed. A licensed crane operator working in concert with the authorized employee shall be the means for moving the unit between locations. The authorize employee and the licensed crane operator may be the same person.

3.0 AUTHORIZED PERSONNEL

A Beams Division employee is authorized to perform this LOTO procedure if he/she has the necessary knowledge and current training in electrical safety, has read and understands this LOTO procedure, possesses the requisite knowledge with respect to high power electronic equipment and the configuration of the horn load.

In the event that work not of an electrical nature is to be performed within the PEI or capacitor bank enclosure by persons not knowledgeable of the electrical hazards therein, the lead authorized employee defined in the above paragraph shall perform the Lockout/Tagout steps and shall be the first to place his/her lock on the disconnects during lockout and the last to remove his/her locks when work is completed.

The EE Support Department Head maintains a list of department personnel authorized to perform this procedure. This list is accessible on the web via the department's home page under "LOTO Compliance".

In times of emergency the Department Head or the Power Supply Group Leader may authorize other employees to perform this procedure. They shall assure themselves that the employee has read this procedure and can safely perform the necessary activities.

4.0 THE NECESSITY OF WRITTEN LOTO PROCEDURE

Written LOTO procedures apply to the NuMI Prototype Horn Test Power Supply for three reasons. First, the capacitor bank has the ability to retain lethal levels of stored energy. Second, to de-energize the PEI charging supply will require two sources of energy to be locked out. Finally, the maintenance and testing after repair may expose personnel to electrical hazards in the area of exposed stripline and horn connections.

5.0 THE STEPS OF LOCKOUT/TAGOUT PRIOR TO MAINTAINANCE ACTIVITY

The authorized employee shall perform the following steps prior to performance of any maintenance activity internal to the PEI, the capacitor bank enclosure, or the fenced area around the stripline and horn. Maintenance to the modules of the control section of the PEI can be performed at any time as there are no exposed hazardous voltages.

- 5.1 **Prepare:** The authorized employee shall understand the hazards involved and how to control them. If you do not have this knowledge, you are not qualified to perform this LOTO procedure. **Safety Glasses shall be worn at all times while performing this procedure. The two-man rule shall apply at all times maintenance work is performed on this equipment**

This equipment has large high voltage energy storage capacitors that may be charged to as much as 800 volts, with a maximum of 26 kilo-Joules of stored energy. The capacitor bank is capable of delivering high fault currents into a low impedance short.

- 5.2 **Notify:** The authorized employee should, as necessary, notify affected area personnel of the LOTO maintenance activity. Affected personnel includes those who might normally use the equipment or would be affected by the unavailability of the equipment. It may be necessary to notify the Crew Chief in the Main Control Room (Ext. 3721), particularly if maintenance work is to be done to the water cooling system.

- 5.3 **Shutdown:** The authorized employee shall shut down the Test Power Supply by pushing the DC OFF button on the front panel of the PEI charging source and rotating the front panel mounted disconnect switch to the OFF position.

Note: Pushing the DC OFF button will turn off the DC output of the PEI.

Rotating the front panel disconnect switch to the OFF position will remove 480 V to internal components within the PEI. Control power to the PEI is supplied by a separate 120 V_{AC} source.

5.4 **Isolate:** The authorized employee shall isolate the equipment from its energy sources.

- Open circuit breaker #5 in power panel PP-MI8-1A-5-A1 to isolate the 120 V_{AC} power to the PEI supply. Verify the 120 V_{AC} has been turned off by observing the front panel indicator lights before and after opening the circuit breaker.
- Open breaker #17 in power panel DHP-MI8-1 to isolate the 480 V_{AC} power from the PEI supply. Verify that the 480 V_{AC} power is off by testing with a voltmeter at the 480 V_{AC} circuit breaker terminals inside the PEI supply.

Note: All 120 V_{AC} wiring within the capacitor bank enclosure is guarded and protected by utility boxes, terminal strip covers, etc. No 480 V_{AC} power exists within the capacitor bank enclosure.

5.5 **Lock and Tag Out:** The authorized employee shall lock and tagout the energy isolating devices by applying locks and tags to appropriate circuit breakers.

5.6 **Relief of stored energy:** The capacitor bank circuitry includes redundant shorting relays, with respective resistors, to automatically discharge stored energy in the four groups of capacitors upon turn-off of the PEI via the "DC OFF" control.

The discharge time constant for each capacitor bank section is 5 seconds. Five time constants for full discharge is 25 seconds. Proceed with caution while performing the following steps. **Do not enter the fenced in (caged) area around the horn and stripline until this procedure is completed.**

- Open the disconnect switch on the front panel of the PEI charging supply by rotating its lever to the OFF position. Open the front door of the PEI and obtain the door key for the capacitor bank enclosure doors.
- Open the door on one side of the capacitor bank enclosure nearest the cage end and inspect the position of the shorting relay. The relay high voltage contacts should be closed.. Inspect the integrity and wiring of the discharge resistors.
- Close and re-lock the door(s).
- Open the door on the opposite side of the capacitor bank enclosure nearest the

cage end and inspect the position of the shorting relay. The relay high voltage contacts should be closed. Inspect the integrity and wiring of the discharge resistors.

- Using the resistive ground stick, located on the top of the enclosure, make contact with the ground stick test point located at eye level within the enclosure just inside the door opening. Listen for a pulsed audio tone for verification that the resistive ground stick is in proper working condition. If a continuous tone - shorted condition- or no tone -open condition- is the result, do not continue with this procedure but seek help from a system expert.
- Using the resistive ground stick, contact the high voltage buses above the upper SCRs and below the lower SCRs. If a spark occurs while performing this step do not proceed; close and lock all enclosure doors and seek help from a systems expert.
- Contact the same location with the hard ground stick. While holding the ground stick in place, attach the clip-lead to the bus. Repeat this procedure with the second capacitor group on this same side.
- Return to the first side of the enclosure and open the door nearest the cage. With the resistive ground stick, make contact with the capacitor bus above the upper SCRs and below the lower SCRs. If a spark occurs while performing this step do not proceed; close and lock all enclosure doors and seek help from a system expert.
- Contact the same location with the hard ground stick. While holding the ground stick in place, attach the clip-lead to the bus. Repeat this procedure with the second capacitor group on this same side.
- Install an instruction tag on the PEI rotary disconnect switch that says:
"Do not operate - Capacitors grounded."

5.7 **Verify:** Observe that the clip-lead on each group of capacitors is securely attached. The clip lead shorts will assure that the capacitors cannot re-accumulate any stored energy. If working in the PEI, verify the 120 V_{AC} and the 480 V_{AC} is off.

The equipment is now Locked out and Tagged out. Service or maintenance activity may now begin.

6.0 SHIFT AND PERSONNEL CHANGES

A lead authorized employee shall ensure that Lockout/Tagout procedures are followed

when the PEI and capacitor bank enclosure are locked out over a shift or personnel change. This same lead authorized employee shall ensure:

- that no unauthorized lock and tag removals have taken place.
- an orderly exchange of locks and tags from off-going to on-coming employees.
- an orderly transfer of responsibility and information about the equipment status from the off-going to on-going shift.
- if the equipment is left unattended with any doors removed, both circuit breakers will be Locked and Tagged out and all four grounding clip leads will be securely attached in the four capacitor groups after following proper grounding procedures.

7.0 THE FIVE STEPS FOR RETURN TO SERVICE

The authorized employee must perform the following five steps prior to returning the equipment to service after maintenance activity.

7.1 **Check Equipment:** Check the equipment and the immediate area around it to ensure that nonessential items and tools are cleared and that the equipment is ready for safe operation.

- Check high current components and all high current connections for tightness and integrity.
- Good housekeeping practices shall be followed to prevent compromising high voltage bus insulation. Any debris must be removed by the use of a vacuum cleaner, never by blowing or by the use of compressed air.
- Remove any remaining grounds from the four capacitor groups before returning the equipment to service.
- Stow resistive ground stick on top of enclosure and anchor the grounding clip leads to the recess location by each capacitor group support frame.
- Close and lock all doors on the capacitor enclosure. Return enclosure door key to location inside PEI charging supply. Close and latch all doors and panels on the PEI charging supply. Remove "Do Not Operate - Capacitors Grounded" tag

7.2 **Check Work Area:** Check the work area to ensure that all employees are safely positioned or removed from the area as necessary and/or appropriate.

7.3 **Verify:** Verify that all controls are in the OFF position.

7.4 **Remove Padlocks and Tags and Re-energize:** The authorized employee who installed the locks and tags shall remove them and reconnect the PEI charging supply to the energy sources from which it was isolated.

7.5 **Notify:** The authorized employee should, as necessary, notify affected area personnel of the completion of maintenance and LOTO activity. If the Crew Chief in the Main Control Room was notified prior to the activity, he/she should be notified of the completion of the activity.

This completes the requirements for returning the Power Supply to service.

8.0 PROCEDURE TRAINING REQUIREMENTS

Authorized employees are required to have had LOTO training (Level 1 and Level 2), and have read and understood this LOTO procedure.

Electrical/Electronic Department Personnel using this procedure shall be trained on the job. After reviewing this document, the employee shall perform the steps accompanied by an employee with previous experience. The authorized employee shall then complete a "Beams Division Electrical/Electronic Department Procedures Review Form" and turn it in to the department secretary.

Personnel from other departments shall be trained according to the requirements of their department.