

**BEAMS DIVISION DEPARTMENTAL PROCEDURE**

**BD/MECHANICAL SUPPORT**

**BDDP-ME-0703**

**ANTIPROTON SOURCE PULSED MAGNET CHANGEOUT PROCEDURE**

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## Table of Contents

1.0 PURPOSE AND SCOPE .....	1
2.0 RESPONSIBILITIES.....	1
3.0 SUPPORTING DOCUMENTS .....	1
3.1 DRAWING REFERENCES.....	1
3.2 ENGINEERING SPECIFICATION REFERENCES .....	2
4.0 INSTRUCTIONS .....	2
4.1 PRELIMINARY ACTIVITIES .....	2
4.1.1 HARDWARE CERTIFICATION .....	3
4.1.2 BD/RADIATION SAFETY SECTION INVOLVEMENT .....	3
4.1.4 TRAINING.....	4
4.1.5 RADIATION WORK PERMIT.....	4
4.1.6 GENERAL LOTO REQUIREMENTS.....	5
4.2 GENERAL MODULE LIFTING REQUIREMENTS.....	5
4.2.1 LOTO VAULT DEVICES .....	5
4.2.2 CRANE SAFETY .....	5
4.2.3 SHIELDING BLOCK REMOVAL.....	5
4.2.4 MODULE LIFTING FIXTURE.....	5
4.2.5 PULSED MAGNET LIFTING FIXTURE.....	6
4.3 DISENGAGING THE USED PULSED MAGNET ASSEMBLY .....	6
4.3.1 GENERAL PREPARATIONS.....	6
4.3.2 REMOVAL STEPS .....	7
4.4 SECURING THE USED PULSED MAGNET ASSEMBLY .....	9
4.4.1 GENERAL PREPARATIONS.....	9
4.4.2 SECURING STEPS.....	10
4.5 ENGAGING THE NEW PULSED MAGNET ASSEMBLY .....	10
5.0 CONTROLLED COPY DISTRIBUTION.....	12
Appendix A, Controlled Copy Distribution List.....	1 Page

## 1.0 PURPOSE AND SCOPE

The purpose of this procedure is to establish the necessary methods and outline the potential hazards associated with changing the antiproton source pulsed magnet assembly located in the vault area of the APO Target Hall Building. *Since the antiproton source pulsed magnet is subjected to direct interaction with secondary particles from the close upstream target collisions, exposed magnets typically exhibit high values of residual radioactivity (e.g., usually in excess of 20 R/hr on contact). Special precautions are therefore necessary to ensure the safety of personnel and minimize any potential for contamination.* This procedure outlines the steps for disengaging a used pulsed magnet assembly and engaging a new assembly. Also delineated are the safety hazards associated with pulsed magnet changeout and the proper storage method of the used radioactive assembly.

This procedure covers the changeout of all pulsed magnet types (single turn coil magnets and 200 turn coil bump magnets, water cooled and uncooled). Steps specific to a certain type of magnet will be so labeled (i.e. Water cooled magnets only).

## 2.0 RESPONSIBILITIES

At the request of the Antiproton Source Department, Mechanical Support Department personnel will coordinate all necessary pre-planning tasks, interface with appropriate Beams Division Radiation Safety personnel, and perform the pulsed magnet changeout. During the entire changeout procedure, the Antiproton Source Department Head or his/her designee shall be present.

## 3.0 SUPPORTING DOCUMENTS

### 3.1 DRAWING REFERENCES

The following list of drawings may be referred to should questions concerning hardware configuration arise:

- 3.1.1 Antiproton Source- Magnet Module Assembly: 8000-ME-254327.
- 3.1.2 Antiproton Source- Pulsed Magnet Module Mk. II: 8000-ME-254235 Rev. E.
- 3.1.3 Antiproton Source- Magnet Module (with water cooling) Upper Magnet Support Weldment: 8000-ME-254587.
- 3.1.4 Antiproton Source- Target Pulse Magnet #3 Main Assembly: 8055-ME-322170.

- 3.1.5 P-bar Pulsed Magnet- 200 Turn Magnet Assem. with Water Cooling System: 8000-MD-254570.
- 3.1.6 Tech. Support Conventional Magnets- 35"-200 Turn Bump Magnet Assem.: 0622-MD-225646 Rev. A.
- 3.1.7 P-bar Source- Pulse Magnet Coffin Cover Assembly: 8000-ME-254442.
- 3.1.8 P-bar Source- Pulse Magnet Coffin Base Assembly: 8000-ME-254443.
- 3.1.9 Antiproton Source Target Hall- Module Lifting Fixture Weldment and Assembly: 8000-ME-216293.
- 3.1.10 Antiproton Source Pulsed Magnet Crane Fixture: 8000-MD-254209.
- 3.1.11 Antiproton Source Pulsed Magnet Water Seal Test Plate: 8055-MD-254970.
- 3.2 ENGINEERING SPECIFICATION REFERENCES
  - 3.2.1 Design Review- AP0 Target Hall Module Lifting Fixture: 1323-ES-296153.
  - 3.2.2 Design Review- AP0 Target Hall Pulsed Magnet Lifting Fixture: 1323-ES-296154.
- 4.0 INSTRUCTIONS
  - 4.1 PRELIMINARY ACTIVITIES

Before executing a pulsed magnet changeout certain preliminary activities must be addressed. The pulsed magnet assembly hardware shall be thoroughly checked for proper operation, BD/Radiation Safety Section shall be notified of the impending pulsed magnet changeout, and all personnel involved in the changeout must attend a Pre-job Planning meeting (4.1.3), *the personnel performing the changeout shall have completed required radiation training (as specified by BD/Radiation Safety), and the task supervisor must obtain an approved radiation work permit from the BD/Radiation Safety Group.*

**NOTE: Any deviation from the following steps during the procedure will require an additional job planning meeting between all workers involved in the changeout and the Accelerator Division Radiation Safety Officer (AD/RSO) or her/his designee. The purpose of such a meeting is to estimate and minimize potential hazards and radiation exposure workers may encounter during the modified procedure.**

#### 4.1.1 HARDWARE CERTIFICATION

The new pulsed magnet assembly shall be checked to ensure that it is in good operating condition both mechanically and electrically.

- a. (Water Cooled Magnets Only) The water cooling system shall be leak checked by charging the cooling manifolds with 40 psi dry nitrogen gas and checking all seal interfaces and welded/brazed joints with Snoop. The water cooling system shall also pass a 125 psi hydrostatic test. Both tests will employ the use of the Water Seal Test Plate (Dwg. Ref. 3.1.11) to interconnect to the CERN Cu Water Seals on the top of the magnet mounting plate.
- b. (All Magnets) The new magnet assembly shall pass a high-pot test of at least 3,000 volts to ground with 0.1 micro amp leakage.

#### 4.1.2 BD/RADIATION SAFETY SECTION INVOLVEMENT

*Since the level of residual radioactivity on a used pulsed magnet assembly is typically Class 4 or higher, Beams Division/Radiation Safety Section personnel must be present during all phases of the pulsed magnet changeout to properly monitor and supervise activities relevant to personnel radiation safety. All personnel entering the vault enclosure will be monitored with film badges, personal dosimeters, and digital dosimeters.* Radiation Safety Personnel will specify additional precautions as discussed in the pre-job planning meeting (4.1.3) or as deemed necessary on site during the changeout activity. All radioactive waste leaving the vault enclosure except for the radioactive pulsed magnet assembly must be disposed of in accordance with Beams Division Radioactive Waste Disposal, BDRS06. *All personnel and tools leaving the vault enclosure must be frisked for contamination upon every exit of the vault enclosure.* The securing and disposal of the radioactive pulsed magnet assembly shall be closely monitored by Radiation Safety personnel as outlined in section 4.4. Additional functions of Radiation Safety include monitoring vault access, specifying clothing requirements, unlocking and securing appropriate radiation security padlocks (i.e., Pad 118 locks controlled by the Radiation Safety Section), specifying special dosimetry requirements and performing radiation surveys and contamination checks.

(Water Cooled Magnets Only) The pulsed magnet changeout requires access to the water system caged area along the east wall of the Target Hall. *Workers in this area may be exposed to irradiated water from the various target components' water cooling systems. Therefore, all access to the water system caged area will be monitored by appropriate Radiation Safety personnel as discussed in the Pre-job Planning Meeting (4.1.3).* All radioactive waste leaving the water system caged area must be disposed of in accordance with Beams Division Radioactive Waste Disposal Procedure, BDRS06. In addition, Radiation Safety will specify clothing

requirements for any work requiring access to the water system caged area as discussed in the Pre-job Planning Meeting (4.1.3).

#### 4.1.3 PRE-JOB PLANNING MEETING

Prior to performing a pulsed magnet changeout, all Mechanical Support Department personnel involved in the activity and the BD/RSO or his designee must have a meeting to examine the steps required for the changeout and to estimate the integrated exposure that workers are expected to receive during each phase of activity.

- a. This BDDP procedure and the steps outlined within to ensure that the level of radiation which each individual is expected to receive is as low as reasonably achievable (ALARA).
- b. Additional radiation monitoring required during specific phases of the changeout activity (e.g. use of digital dosimeters, monitoring radiation levels using a teletector, check of surface contamination, etc.).
- c. Clothing, time, distance, and shielding requirements for personnel during critical phases of the target assembly changeout.
- d. Discussing special topics or requests which are (or will be) outline in the Radiation Work Permit (4.1.5).
- e. Proposed activities that deviate from the normal target assembly changeout procedure outlined herein. Such activities shall be discussed and modified, if required, to comply with applicable Fermilab Standards.

#### 4.1.4 TRAINING

***All personnel participating in the pulsed magnet changeout activity shall have current Radiological Worker and Radioactive Waste Disposal training.*** Verification may be found on the monthly Beams Division Safety Training printout, the TRAIN database, or by contacting the Beams Division ES&H Department. If required, the BD/Radiation Safety Group will specify additional training prior to performing the target changeout.

#### 4.1.5 RADIATION WORK PERMIT

Prior to initiating any work associated with the target changeout, a Radiation Work Permit must be completed by the task supervisor, approved by the Radiation Safety Officer, or his designee, and signed by all workers involved in the changeout. The task supervisor may contact the BD/Radiation Safety Group for the proper format to follow in completing the permit.

#### 4.1.6 GENERAL LOTO REQUIREMENTS

The following list of devices are to be locked out and/or tagged out during the pulsed magnet chagneout:

- a. the collection lens main power supply (4.2.1)
- b. The collection lens bias power supply (4.2.1)
- c. The pulsed magnet power supply (4.2.1)
- d. The pulsed magnet water system pump water supply (4.3.1.e).
- e. The pulsed magnet water system supply and return ball valves (4.3.2.c) (caution tag only)

#### 4.2 GENERAL MODULE LIFTING REQUIREMENTS

##### 4.2.1 LOTO VAULT DEVICES

***Before accessing the vault enclosure, the collection lens main power supply, bias supply, and pulse magnet power supply must be locked out and tagged out (LOTO) per Laboratory Standard 5120 of the Fermilab ES&H Manual.***

##### 4.2.2 CRANE SAFETY

***Any person(s) operating the 20 ton crane located in the AP0 target hall enclosure must be a licensed and certified crane operator.*** Verification may be found on the monthly Beams Division Safety Training printout, the TRAIN database, or by contacting the Beams Division ES&H Department. The prior to use inspection of the crane and rigging components shall be conducted by the certified operator.

##### 4.2.3 SHIELDING BLOCK REMOVAL

Subsequent to LOTO, the vault shielding blocks must be unlocked by Radiation Safety personnel, removed from the vault enclosure, and placed on the floor of the AP0 enclosure at the north end of the building near the hi-bay entrance. ***All lifting hooks and chains will be inspected prior to lifting the shielding blocks and operations will comply with Laboratory Standard 5021 of the Fermilab ES&H Manual.***

#### 4.2.4 MODULE LIFTING FIXTURE

*The lifting fixture used for pulling modules is rated for 25,000 lb. and has the load rating legibly marked (see engineering spec. ref. 3.2.1 and dwg. ref. 3.1.9). The weight of the steel pulsed magnet module block alone accounts for approximately 15,000 lb. (module dimensions are 72"x32"x22.75"). Support hardware and a pulsed magnet assembly could account for an additional 2000 lb. load. **Prior to lifting, the fixture and associated lift hardware shall be visually checked for signs of damage.***

#### 4.2.5 PULSED MAGNET LIFTING FIXTURE

The lifting fixture used for transporting pulsed magnet assemblies within the APO Target Hall is rated for 3,000 lb. and has the load rating legibly marked (see engineering spec. ref. 3.2.2 and dwg. ref. 3.1.10). The average weight of a pulsed magnet assembly is less than 2,000 lb. Prior to lifting, the fixture and associated lift hardware shall be visually checked for signs of damage.

### 4.3 DISENGAGING THE USED PULSED MAGNET ASSEMBLY

#### 4.3.1 GENERAL PREPARATIONS

Prior to lifting a module from the vault, the following must be accomplished:

- a. Check that the alcove moveable stage and lights are operational and that the top of the stage is below the floor of the alcove. All manipulation of the moveable stage will be done behind the alcove shielding barriers (i.e., lead viewing glass and concrete shielding blocks.)
- b. Since the pulsed magnet is longer than the alcove movable stage pit, the magnet will actually rest on the edges of the stage pit when the stage is lowered completely. To level the edges of the stage pit, place a 4"x4"x32" piece of wood cribbing lengthwise (east to west) on the floor directly south of the alcove movable stage.
- c. Place herculite or masselin cloth over the alcove floor area and moveable stage to contain any possible contamination.
- d. Ensure that space is available in the storage rack for the pulsed magnet module and three additional filler modules. If storage rack space is not available for temporary storage of all the modules, the original vault position for the pulsed magnet module may be used as temporary storage space for the magnet module (see step 4.3.1(u)).
- e. (Water Cooled Magnets Only) After Radiation Safety personnel unlock the water system caged area along the east wall of the Target Hall, turn off the pulsed magnet water cooling system (first system on the left after entering the water system caged

area) by pushing the off button on the pump power supply. LOTO the pump power supply breaker box located directly behind the water system on the east wall of the Target Hall. Radiation Safety may now resecure the water system caged area.

#### 4.3.2 REMOVAL STEPS

BD/Radiation Safety personnel will provide digital dosimeters for each person accessing the vault enclosure and specify clothing requirements for all subsequent operations as discussed in the Pre-job Planning meeting. The following sequence is to be followed for pulsed magnet disengagement:

- a. Disconnect the stripline electrical connection at the top of the pulsed magnet module and at the stripline feed can connection on the west wall of the vault. Remove the stripline extension and set aside in the pit for use when reinstalling.
- b. Disconnect the module grounding cable at the top of the pulsed magnet module.
- c. Disconnect the instrumentation read back wires at the top of the pulsed magnet module.
- d. (Water Cooled Magnets Only) Close the 1/2" water supply and return ball valves in that order (located on the east wall of the vault). Tag out the valves with caution tags to prevent the accidental release of irradiated water.
- e. (Water Cooled Magnets Only) Place the drain hose located on the return line drain valve (tee valve) into a 2000 ml plastic bottle. Open the drain valve slowly, releasing any residual line pressure in the system.
- f. (Water Cooled Magnets Only) Attach the nitrogen line from a nitrogen cylinder (with regulator) to the quick disconnect fitting on the supply line drain valve (tee valve). With the regulator set at 15 psi, open the supply drain valve slowly. This will force the contaminated water from the module and into the plastic bottle. Use care to avoid splashing in the bottle. If water does not flow from the drain hose, slowly increase the pressure of nitrogen via the regulator until water does drain from the system. Amount of water drained should be about 1200 to 1400 ml.

***NOTE: Use extreme caution when handling drain water. Any spilled irradiated water should be treated as a contamination spill and cleaned immediately under the supervision of the present Radiation Safety personnel. Contaminated drain water will be disposed of in accordance with Beams Division Radioactive Waste Disposal Procedure, BDRS06.***

- g. (Water Cooled Magnets Only) When the return line drain hose is clear of any remaining water, shut off the nitrogen flow and disconnect the nitrogen line from the supply line drain valve. Close the supply and return drain valves (tee valves).

- h. (Water Cooled Magnets Only) Disconnect the water supply and return line tubes from the top of the magnet module (Swage-lok fittings).

NOTE: In order to provide clearance for the removal of the pulsed magnet, two upstream filler blocks (south of magnet module) and one downstream filler block (north of the magnet module) must be removed. Do not attempt to remove the pulsed magnet module until all filler blocks are removed.

- i. Using an appropriate lifting sling, remove the filler plates from each side of all modules to be removed (see above note) and place at the north end of the vault. The approximate weight of the heaviest plate is 100 lb.
- j. After Radiation Safety personnel unlock the padlocks on the filler modules to be removed, the module lifting fixture and pins may be secured to one of the filler modules. ***All personnel with the exception of Radiation Safety and the crane operator must then exit the vault enclosure area.***

NOTE: Since the guide daggers on the bottoms of the filler modules are different lengths to provide proper clearance for the pulsed magnet (upstream module daggers are shorter than downstream module daggers), it is necessary to note the original locations of the filler modules removed. This information will be needed in order to return the filler modules to their proper locations when the changeout is completed (4.5.j).

- k. Remove the filler module from the vault and place in the storage rack.
- l. Repeat steps (j) and (k) to remove all three filler modules from the vault and place them in the storage rack. Do not attempt to remove the pulsed magnet module until all filler blocks are removed.
- m. After Radiation Safety personnel unlock the padlock on the pulsed magnet module, the module lifting fixture and pins may be secured to the magnet module. ***All personnel with the exception of Radiation Safety, the crane operator, and one technician must then exit the vault enclosure area.***
- n. Lift the pulsed magnet module approximately 7" from its resting position on the vault rail. Then move the module upstream (south) until the module is roughly centered in the opening created by the removal of the filler blocks.
- o. Remove the pulsed magnet module and magnet assembly from the vault and place on the alcove rails. Position according to the black markings on the west crane rail and the south crane trolley rail. Leave the module lifting fixture secured to the magnet module for later use. Close the alcove lead door. The module and pulsed magnet assembly are now secured for magnet removal.

- p. All subsequent work to be performed will be accomplished from the top of the module or behind the lead viewing glass and concrete alcove shielding. Secure lead shielding blankets over any line of sight cracks between the top of the module and the alcove walls.
- q. CAUTION: On all subsequent stage movement operations, monitor the stage force transducer output. The transducer voltage must never exceed 1.5 volts or damage to the transducer or hardware may result. A reading in excess of this value indicates a binding or interference condition. Should such a condition occur, stop and investigate the cause before proceeding further!

Raise the moveable stage while visually monitoring the position of the components through the lead glass. The stage shall be raised until it just touches the bottom braces of the magnet and some small force voltage is read on the stage force transducer.

- r. Working at the top of the module, turn the stripline clamp screw clockwise to the "O" mark. This opens the stripline connection at the bottom of the module.
- s. Unscrew the central magnet draw screw. Confirm that the draw screw is completely unscrewed from the magnet assembly by lifting the screw a few inches by hand.
- t. The magnet should now be resting completely on the movable stage. While visually monitoring the position through the alcove lead viewing glass, lower the stage until the magnet is resting on the movable stage pit edge at the north end and the wood cribbing (from step 4.3.1(b)) at the south end. Continue lowering the stage until the magnet is entirely supported by the pit edge and wood cribbing.
- u. CAUTION: During this step, only Radiation Safety personnel, one technician, and one crane operator are allowed in the vault enclosure.

Open the alcove lead door. Remove the magnet module from the alcove rails and place in the storage rack using the storage rack marks on the south crane trolley rail for guidance. (If space is unavailable in the storage rack, place the magnet module back in its original position in the vault. Position the magnet module in the north/south direction by using the tongue on the west side of the module.) Close the alcove lead door.

#### 4.4 SECURING THE USED PULSED MAGNET ASSEMBLY

The following steps are used to secure a radioactive pulsed magnet assembly in a lead-lined, steel shell coffin for storage in the AP0 Target Hall:

#### 4.4.1 GENERAL PREPARATIONS

- a. Using the crane, move the pulsed magnet coffin (cover and base) into the vault enclosure and place in front of alcove lead door.
- b. Remove the coffin pins from the coffin and set aside for later use.
- c. Remove the coffin cover from the base and place it in the vault enclosure at a safe distance from the magnet and coffin base as determined by the Radiation Safety representative.
- d. Prepare coffin base by attaching or removing magnet guides. Single turn magnets require additional bolt on guides while 200 turn magnets do not (see dwg ref. 3.1.8).
- e. Attach the pulsed magnet lifting fixture (see engineering spec. ref. 3.2.2 and dwg. ref. 3.1.10) to the crane hook.

#### 4.4.2 SECURING STEPS

***CAUTION: During these securing steps, only Radiation Safety personnel, one technician, and one crane operator are allowed in the vault enclosure.***

- a. Open the alcove lead door.
- b. Using the pulsed magnet lifting fixture, remotely engage the pulsed magnet assembly lifting hooks. Remove the magnet from the alcove and place on the coffin base using the appropriate guides for assistance. Disengage the lifting fixture.
- c. ***Remove the pulsed magnet lifting fixture from the crane hook at a safe distance from the radioactive magnet as determined by the Radiation Safety representative.*** Radiation Safety personnel will do a survey at this time to document the dose rates. Lift the coffin cover and remotely place the cover over the magnet assembly and coffin base using the base end guidance bars for assistance. Insert coffin pins.
- d. Radiation Safety personnel will perform a contamination check of the alcove area. When the area is declared to be uncontaminated, Radiation Safety personnel will secure the coffin using a controlled 118 padlock.
- e. Move the target coffin from the alcove to the coffin storage area located at the southeast corner of the APO enclosure. Radiation Safety personnel will complete the contents list form affixed to the coffin.

## 4.5 ENGAGING THE NEW PULSED MAGNET ASSEMBLY

- a. Using the pulsed magnet lifting fixture move the new pulse magnet assembly into the vault enclosure and place on the moveable stage pit edge and wood cribbing as before using the red marks on the alcove floor for guidance.
- b. **CAUTION: During this step, only Radiation Safety personnel, one technician, and one crane operator are allowed in the vault enclosure.**

Remove the magnet module from the storage rack and place on alcove rails again using the black marks on the west crane rail and south crane trolley rail for guidance. Leave the module lifting fixture secured to the magnet module. Close lead alcove door.

- c. Raise the alcove stage slowly while visually monitoring the relative position of the pulsed magnet assembly and the module through the lead glass viewing window. Always monitor the stage force transducer to detect any binding. Position the stage so the three mounting pins on the module (upper support weldment) engage the three matching bushings on the magnet mounting plate. Be careful to observe the engagement of the stripline connection and the thermocouple connectors at the bottom of the module to ensure a good fit. Stop raising the stage when the clearance between the shoulders of the pins and bushings is approximately 1/8".
- d. Working at the top of the module, slowly tighten the central pulsed magnet draw screw to draw the magnet up to the module and fully engage the mounting pins. If necessary, slowly raise the stage while tightening to compensate for thread travel. Tighten the shaft from the top of the module to 150 - 180 ft-lb.
- e. Working at the top of the module, close the stripline clamp by turning the stripline clamp screw clockwise to the "C" mark.
- f. At this time a DC highpot test of the entire magnet/module assembly will be performed to ensure proper electrical assembly. Highpot the assembly at 3,000 volts with 0.1 micro amps leakage using the exposed stripline at the top of the module as 'hot' and the module itself as ground.
- g. After a successful highpot test, remove all tools and equipment from the top of the module to ready the module/magnet assembly for insertion into the vault.
- h. **CAUTION: During this step, only Radiation Safety personnel, one technician, and one crane operator are allowed in the vault enclosure.**

Open alcove lead door. Remove magnet module assembly from the alcove and center over available clearance space in the vault. Lower the magnet module into the vault (using the module daggers for guidance) until the module V-blocks are approximately 7" above the vault rails. Position the magnet module in the

north/south direction by using the tongue on the west side of the module. Slowly lower the module until the module is resting on the vault rails. Remove the module lifting fixture.

- i. ***CAUTION: During this step, only Radiation Safety personnel, one technician, and one crane operator are allowed in the vault enclosure.***

Secure the module lifting fixture to one of the module filler blocks in the storage rack. Remove the module filler block from the storage rack and carefully install in vault using the marks on the south crane trolley rail and the alignment tongue for guidance. Be sure to place the filler module back in its original location as noted during the removal process (4.3.2.j).

- j. Repeat step i until all three filler modules are installed in the vault.
- k. Using an appropriate lifting sling, replace all the filler plates removed in procedure step 4.3.2.h.
- l. (Water Cooled Magnets Only) Wearing appropriate clothing as specified by present Radiation Safety personnel, connect the water supply and return line tubes at the top of the magnet module (Swage-lok fittings).
- m. (Water Cooled Magnets Only) Check that the water supply and return drain valves (tee valves) are closed. Open the 1/2" water return and supply ball valves in that order (located on the east wall of the vault). Remove caution tags from the ball valves.
- n. Reconnect the instrumentation read back wires to the top of the pulsed magnet module.
- o. Connect the pulsed magnet module grounding cable at the top of the module.
- p. Connect the stripline extension to the top of the module and to the stripline feed can located on the west wall of the vault.
- q. Radiation Safety must now padlock the magnet module and the three filler modules in the vault.
- r. Remove all tools and equipment from the vault. Radiation Safety may now secure the vault enclosure by performing a contamination check.
- s. Replace the vault shielding blocks. ***Frisk all personnel and tools Radiation Safety personnel may now secure the vault enclosure gate.***
- t. Remove all locks and tags from electrical supplies.

NOTE: (Water Cooled Magnets Only) Radiation Safety must monitor access to the water system caged area to remove locks and tags from the pulsed magnet water cooling system pump breaker box located on the east wall of the Target Hall.

5.0 CONTROLLED COPY DISTRIBUTION

- 5.0.1 Reference Appendix A. The Mechanical Support Department Head is responsible for approving Appendix revisions.

APPROVED \_\_\_\_\_  
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**APPENDIX A: Controlled Copy Distribution List**

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