

BEAMS DIVISION DEPARTMENTAL PROCEDURE

BD/MECHANICAL SUPPORT

BDDP-ME-0701

**ANTIPROTON SOURCE LITHIUM COLLECTION LENS/TRANSFORMER
ASSEMBLY CHANGEOUT PROCEDURE**

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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 lithium collection lens/transformer assembly located in the vault of the APO Target Hall Building. *Since the collection lens is located downstream of the antiproton target, the assembly is directly exposed to the secondary particle shower that results from the interaction of the primary proton beam and the target. Assemblies that have been subjected to beam typically exhibit high values of residual radioactivity (e.g., usually in excess of 20R/hr on contact). Additionally, the closed loop water system utilized to cool the lithium core becomes radioactive and contains tritium. Special precautions are necessary to ensure the safety of personnel and minimize any potential for contamination.* This procedure outlines the steps for removing a used lens assembly and installing a new assembly. The proper storage method of the used radioactive assembly is also addressed.

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 collection lens assembly changeout. The Antiproton Source Department Head or his designee are to be present during the changeout operation.

3.0 SUPPORTING DOCUMENTS

3.1 DRAWING REFERENCE

The following drawings may be referenced should questions concerning hardware configuration arise:

- 3.1.1 Antiproton Source- Basic Block: 8000-ME-169051
- 3.1.2 Antiproton Source- Large Lithium Lens Module Sub-Assembly:
8000-ME-169058
- 3.1.3 Antiproton Source- Module Top Assembly: 8000-ME-169142
- 3.1.4 Antiproton Source- Lithium Lens Assembly: 8000-ME-216000
- 3.1.5 Antiproton Source- Lithium Lens Septum Welded Subassembly:
8000-MD-216006

- 3.1.6 Antiproton Source- Lithium Lens Transformer Assembly: 8000-ME-170328
- 3.1.7 Antiproton Source- Transformer Stand Assembly: 8000-ME-208547
- 3.1.8 Antiproton Source- Lens Module Stripline Assembly: 8000-ME-254441
- 3.1.9 Antiproton Source- Strip Line Clamp Eccentrics Crank Layout:
8000-ME-216582
- 3.1.10 Antiproton Source- Pallet Assembly and Weldment (Coffin): 8000-MD-216859
- 3.1.11 Antiproton Source- Coffin Cover Assembly: 8000-ME-216908
- 3.1.12 Antiproton Source- Target Hall Module Lifting Fixture
Weldment and Assembly: 8000-ME-216293

3.2 PROCEDURE REFERENCE

- 3.2.1 Procedure for Turning On/Off the Antiproton Source Lithium Lens Water
System: BDDP-ME-0702

3.3 ENGINEERING SPECIFICATION REFERENCE

- 3.3.1 AP0 Target Hall Module Lifting Fixture: 1323-ES-296153

4.0 INSTRUCTIONS

4.1 PRELIMINARY ACTIVITIES

Before executing a lens assembly changeout certain preliminary activities must be addressed. The lens/transformer assembly shall have been thoroughly tested to identify any anomalies, BD/Radiation Safety Section shall be notified of the impending lens/transformer changeout, *and all lead personnel involved in the changeout must attend a pre-job planning meeting, 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 that workers involved in the changeout procedure and the Beams Division Radiation Safety Officer (BD/RSO) or his designee meet and discuss the implications of the procedural change. 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 lens/transformer assembly shall have been thoroughly tested prior to installation. Certification is accomplished via operational life testing using the module assembly located in the test cage at the APO target hall enclosure. The assembly is electrically tested utilizing an excitation waveform similar to that encountered during beamline operation. Signals monitored during testing include but are not limited to the secondary current waveform (i.e., lithium core current), the lens body temperature, primary transformer housing temperature, water system temperature and flowrate, and the titanium septum cooling water conductivity.

4.1.2 BD/RADIATION SAFETY SECTION INVOLVEMENT

Since the level of residual radioactivity on a used lens assembly is typically Class 5, Beams Division/Radiation Safety Section personnel must be present during all phases of the changeout to properly monitor and supervise activities relevant to personnel radiation safety. All personnel entering the vault enclosure will be monitored with a minimum of 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 collection lens/transformer assembly must be disposed of in accordance with Beams Division Radioactive Waste Disposal Procedure, BDRS06. *All personnel and tools leaving the vault enclosure must be frisked for contamination upon every exit of the vault enclosure.* Radiation Safety personnel shall closely monitor the securing and disposal of the radioactive collection lens/transformer assembly as outlined in Section 4.4. Additional functions of Radiation Safety include supervising vault access, specifying clothing requirements, unlocking and securing appropriate radiation security padlocks (i.e., Pad 118 locks controlled by the Radiation Safety Section), and performing radiation surveys and contamination checks.

4.1.3 JOB PLANNING MEETING

Prior to performing a lens/transformer 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 changeout and to estimate the integrated exposure that workers are expected to receive during each phase of activity. Topics which shall be address at the meeting include but are not limited to:

- 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, check of dose rates using teletector, check of surface contamination, etc.).
- c. Clothing, time, distance, and shielding requirements for the personnel during critical phases of the pulsed magnet changeout.
- d. Discussing special topics or requests which are (or will be) outlined in the Radiation Work Permit (4.1.5).
- e. Proposed activities that deviate from the normal collection lens/transformer assembly changeout as described in this procedure. Such activities shall be discussed and modified, if required, to comply with Fermilab Standards.

4.1.4 TRAINING

All personnel participating in the collection lens/transformer 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 collection lens/transformer assembly changeout.

4.1.5 RADIATION WORK PERMITS

Prior to initiating any work associated with the collection lens/transformer 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.

4.2 GENERAL MODULE LIFTING REQUIREMENTS

4.2.1 LOTO VAULT DEVICES

Before accessing the vault enclosure, the collection lens main power supply, bias supply, and pulsed magnet power supply must be locked out and tagged out (LOTO) by each individual entering the vault enclosure 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 APO 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 concrete vault shielding blocks must be unlocked by Radiation Safety personnel, removed from the vault enclosure, and placed on the floor of the APO 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 depicted in drawing 8000-ME-216293 and has a load rating of 25,000 lbs. (ref. Engineering Spec 1323-ES-296153). The weight of the steel lens module block alone accounts for approximately 7500 lbs. (module dimensions are 72"x32"x11.375"). Support hardware and a lens/transformer assembly could account for an additional 600 lb. load. ***Prior to lifting, the fixture and associated lift hardware shall be visually checked for signs of damage.***

4.3 DISENGAGING USED LENS/TRANSFORMER ASSEMBLY

4.3.1 GENERAL PREPARATIONS

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

- a. Check that the alcove moveable table and lights are operational and that the top of the stage is below the floor of the alcove. All manipulation of the moveable table will be done behind the alcove shielding barriers (i.e., lead viewing glass and concrete shielding blocks.)
- b. Place herculite or masselin cloth over the alcove floor area and moveable stage to contain any possible contamination.
- c. Center the lens/transformer aluminum locating base on the moveable stage with the alignment pin of the locating plate oriented toward the northwest corner.

- d. Ensure that space is available in the storage rack for the lens module and vault filler block.

4.3.2 REMOVAL STEPS

BD/Radiation Safety personnel will specify and provide appropriate additional dosimetry (e.g., digital dosimeters and ring badges) for each person accessing the vault enclosure and specify clothing requirements for all subsequent operations as discussed in the pre-job meeting or as deemed necessary on site during the changeout activity. ***In addition to specified protective clothing, rubber gloves shall be worn for all lens water system operations.*** Due to the high levels of residual radioactivity, the lens/transformer assembly shall be stored in a steel shell/lead lined coffin and shall be checked by Radiation Safety for residual radioactivity level both on contact and at one foot. ***All other hardware removed from the vault enclosure (e.g., defective hardware removed from the top of the module which typically falls into Class 1 or Class 2 category) will be checked for radioactivity by the person removing the material, accordingly tagged if radioactive, and disposed of per BDRS06.*** The following sequence shall be followed for lens/transformer disengagement:

- a. Turn off the collection lens water and purge system (reference BDDP-ME-0702) and LOTO the system. If a water-cooled transformer is used on the assembly, similarly LOTO the pulsed magnet water system. Close the 1/2" supply and return ball valves located on the east wall of the AP0 vault. Close the supply valve first, then close the return valve. This isolates the appropriate water system located in the cage area from the module cooling lines in the vault.
- b. Place the drain hose located on the appropriate return line drain valve tee in the vault into a 5 gallon carboy. Open the drain valve slowly, releasing any residual line pressure in the system.
- c. Attach the argon line from an argon gas cylinder fitted with a regulator to the quick disconnect fitting on the supply line drain valve tee. With the regulator set at 15 psi, slowly open the supply drain valve located on the tee to introduce argon gas pressure in the isolated water cooling lines. This operation will force the water remaining in the lens module cooling lines into the plastic carboy. Use care to avoid excessive splashing in the carboy.
- d. When the return line drain hose is clear of any remaining water, shut off the flow of argon gas and secure the cap on the carboy. Repeat steps a through c for the transformer cooling loop if utilized on the assembly. The tubing connections on the top of the module may now be disconnected.

- e. Unlock a yellow 30 gallon liquid radioactive waste barrel and carefully empty the contaminated water from the catch container into the waste barrel. Replace the safety padlock on the barrel.
- f. Disconnect all read back cables, instrumentation lines, the ground strap, and stripline connections located on the top of the lens module.
- g. Using an appropriate lifting sling and the 20 ton overhead crane, remove the filler plates from each side of the lens module and place at the north end of the vault. The approximate weight of the heaviest plate is 100 lb.
- h. Radiation Safety personnel will then unlock the safety padlocks securing the lens module and the filler block immediately downstream of the lens module. Remove the filler block using the module lifting fixture and place in the vault storage rack.
- i. Secure the module lifting fixture (ref. 8000-ME-216293) to the lens module. ***Before lifting the lens module from the vault, all personnel with the exception of Radiation Safety and the crane operator must exit the vault enclosure area.***
- j. Lift the lens module upward approximately 7" off the locating rail and center the module with the vault opening where the removed filler block and lens module reside. Remove the lens module from the vault and place on the alcove rails. When lifting the lens module to or from the vault, position the crane trolley according to the blue markings on the west crane rail (for N-S orientation) and align with the black mark on the trolley rail (for E-W orientation). Place the lens module in the alcove by aligning the crane trolley with the black markings on both the west crane rail and the trolley rail. Close the alcove lead door. The module assembly is now secured for lens/transformer removal.
- k. Most of the following operations will be conducted from the top of the module or behind the lead viewing glass and concrete alcove shielding. ***If directed by Radiation Safety Personnel, secure lead shielding blankets at the top of the module over any line of sight cracks between the module and the alcove walls.***
- l. CAUTION: On all subsequent stage movement operations, monitor the table force transducer output. The transducer voltage should 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. If such a condition occurs, stop and investigate the cause before proceeding further!

Raise the moveable table while visually monitoring the position of the components through the lead glass. Position the stage to align the locating base pin and the lens/transformer assembly stand register ring. Raise the stage such that the lens/transformer assembly stand just contacts the locating base.

- m. Working at the top of the module, open the stripline clamp by turning the clamp screw clockwise to orientation mark "O". Unscrew the four water tube disconnecting sleeves (two for lens cooling, two for transformer cooling) and the lens/transformer draw screw. Verify that the draw screw is completely unfastened by lifting upward a few inches by hand.
- n. The lens/transformer assembly is now disengaged from the module. Lower the moveable stage to the lowest point of travel while visually monitoring the position of the lens/transformer assembly through the alcove lead viewing glass.

4.4 SECURING USED LENS/TRANSFORMER ASSEMBLY

The following steps are used to secure a radioactive lens/transformer assembly in a lead-lined, steel shell coffin for storage in the APO enclosure:

- a. Open the lead alcove door and remove the lens module using the overhead crane and attached lifting fixture. Once the module is clear of the alcove, close the lead door and place the module in the vault storage rack. ***The only personnel allowed in the vault enclosure during this step are Radiation Safety personnel and the crane operator.***
- b. The next operation involves attaching a 3/4" eyebolt to the top of the transformer/lens assembly. This step will be performed using specially designed long tools while working from the top of the alcove shielding blocks. Using the eyebolt assembly tube (i.e., a length of 1" dia. tubing with a machined slot into which the eyebolt lightly press fits) while receiving guidance instructions from a technician viewing through the alcove lead glass, thread the eyebolt completely into the transformer mounting block.
- c. Move the collection lens coffin into the vault enclosure using the overhead crane hook and hardened pin placed through the lifting tabs on the cover. Place the coffin assembly a few feet in front of the alcove door. Remove the coffin cover pin, lift the coffin cover off the base, and place it between the alcove and the coffin base. Remove the overhead crane hook from the cover assembly.
- d. Working from the top of the alcove shielding blocks and using a sling, attach one end to the overhead crane hook and the other end to a shackle which will be attached through the 3/4" eyebolt. After opening the alcove lead door, a technician must physically attach the shackle bolt through the 3/4" eyebolt prior to moving the len/transformer. The sling used to lift the lens/transformer assembly onto the coffin base must be capable of lifting approximately 600 lb.
- e. ***Only one technician, the crane operator, and Radiation Safety personnel are allowed in the vault during this step.*** Lift the lens/transformer assembly

from the stage in the alcove. Remove the assembly from the alcove and place on the coffin base aligning the transformer stand register ring and the coffin base pin. The technician may use a long piece of tubing to keep the assembly from rotating and help align the lens/transformer assembly on the coffin base. Remove the sling and shackle from the eyebolt and exit the vault enclosure.

- f. Pick up the coffin cover using the crane hook and hardened pin and lower it onto the coffin base on which the used lens/transformer assembly now resides. Align the base and cover and insert the coffin pins.
- g. Radiation Safety personnel will then perform a contamination check of the alcove and enclosure area. When Radiation Safety personnel determine that the area is free of potential radioactive contamination, they will padlock the coffin using a Radiation Safety controlled padlock.
- h. Move the lens coffin from the alcove to the coffin storage area located at the southeast corner of the APO enclosure. Radiation Safety personnel shall complete the contents list form affixed to the coffin.

4.5 ENGAGING NEW LENS/TRANSFORMER ASSEMBLY

- a. Using a new 3/4" eyebolt attached to the top of the new transformer/lens assembly, connect one end of the sling used in step 4.4.d. to the overhead crane and the remaining end to the eyebolt and move the lens/transformer assembly onto the stage in the alcove. Align the register ring of the transformer stand and the stage locating pin, then lower the moveable table to lowest position.
- b. Remove the lens module from the vault storage rack and place on the alcove rails. Position the module in the alcove according to the black marks on both the west crane rail and the trolley rail.
- c. Using the moveable table while visually monitoring the position of components through the alcove viewing window, line up the stripline connection, water tubes, and locating pins on the lens/transformer assembly with the corresponding connections on the module.
- d. Slowly raise the table until the locating pins and the stripline are engaged (i.e., raise to a point where an 1/8" gap exists between the locating pins and bushing shoulders).
- e. Slowly tighten the lens draw screw from the top of the module to engage the threads. Torque the draw screw to 150-180 ft-lbs. to fully engage the locating pins. Close the stripline clamp at the top of the module by turning clockwise to position "C". Tighten the water tube connecting sleeves.

- f. Check that the lens/transformer assembly is electrically isolated from the module by high potting the assembly to 3 kV. Connect the positive red wire of the high pot source to the stripline and connect the black ground wire to the module. No leakage of current should occur.
- g. The module water circuit shall now be leak checked to ensure no leaks are present. Connect the water leak test equipment to the water tube connections located at the top of the module. Completely fill the module assembly test circuit with deionized water. Be sure to open the outlet valve to allow entrapped it to escape. Close the outlet valve after filling and attach an argon bottle to the inlet fitting and pressurize the water circuit to 50 psi. Close the valve on the argon cylinder and wait 10 minutes to determine if any water leaks are present. When the system is determined to be free of leaks, remove the leak checking equipment from the top of the module.
- h. Following successful high pot and water leak testing, place the lens module assembly back into the vault using the appropriate marks on the crane rail for alignment.
- i. Place the filler block temporarily stored in the vault storage rack back into the vault location downstream of the lens module. Replace the filler plates on each side of the lens module.
- j. Remove the module lifting fixture and reconnect the water tubes, read back cables, instrumentation lines, ground strap, and stripline connections located at the top of the lens module. Radiation Safety personnel may now padlock the module and filler block in the vault.
- k. Turn on the lens water system (ref. ADDP-ME-0702) and check for possible leaks around the fittings. Should any water seepage be apparent after water system restart, further tighten the fittings or rectify the situation before securing the vault enclosure.
- l. Radiation Safety personnel may now secure the vault enclosure after performing a contamination check.
- m. Replace the vault shielding blocks. Frisk all personnel and tools. Remove all locks and tags from electrical supplies. Radiation Safety personnel may now secure the vault enclosure gate.

5.0 CONTROLLED COPY DISTRIBUTION

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

APPROVED _____
Mechanical Support Department Head

DATE _____

APPENDIX A: Controlled Copy Distribution List

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