

**BEAMS DIVISION DEPARTMENTAL PROCEDURE**

**BD/MECHANICAL SUPPORT**

**BDDP-ME-0700**

**ANTIPROTON SOURCE TARGET 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 target assembly located in the vault area of the APO Target Hall Building. *Since the antiproton source target is subjected to direct interaction with the primary proton beam, assemblies subjected to beam 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 the spread or ingestion of radioactive material.* This procedure outlines the steps for disengaging a used target assembly and engaging a new assembly. Also delineated are the safety hazards associated with target changeout and the procedure for securing the used radioactive assembly for storage.

## 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 target changeout. The Antiproton Source Department Head or his designee shall be present during the changeout procedure.

## 3.0 SUPPORTING DOCUMENTS

### 3.1 DRAWING REFERENCES

The following list of drawing references may be consulted should questions concerning hardware configuration arise:

- 3.1.1 Antiproton Source - Mark II Target Module Assemble: 8000-ME-254200
- 3.1.2 Antiproton Source- Target Module Lower Assembly Drawing: 8000-ME-254179
- 3.1.3 Antiproton Source- Target Module Assembly: 8000-ME-254137
- 3.1.4 Antiproton Source- Pbar Mark II Target Stand: 8000-ME-254191
- 3.1.5 Antiproton Source- Target Module Bearing Block: 8000-MC-254214
- 3.1.6 Antiproton Source- Target Coffin Cover Assembly: 8000-ME-254301
- 3.1.7 Antiproton Source- Target Coffin Pallet Assembly: 8000-MD-254300

3.1.8 Antiproton Source- Target Hall Module Lifting Fixture Weldment and Assembly: 8000-ME-216293

3.2 ENGINEERING SPECIFICATION REFERENCES

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

4.0 INSTRUCTIONS

4.1 PRELIMINARY ACTIVITIES

Before executing a target changeout certain preliminary activities must be addressed. The target assembly hardware should be thoroughly checked for proper operation, the BD/Radiation Safety Group should be notified of the impending target changeout, 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 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 target assembly should be thoroughly checked for proper operation of the rotation mechanism (ref. drawing 8000-ME-254137). The lead-in short shaft should easily turn by hand and exhibit no tight spots or binding. Additionally, the assembly should be checked for air leaks at all seal interfaces by using a 10 psi compressed air source and checking seal areas with Snoop or alternately by verifying that the airflow rate into the assembly equals the airflow rate out of the assembly.

4.1.2 BD/RADIATION SAFETY SECTION INVOLVEMENT

*Since the level of residual radioactivity on a used target assembly is typically Class 4 or higher, Beams Division/Radiation Safety Section personnel must be present during all phases of the target changeout to properly monitor and supervise activities relevant to personnel radiation safety. All personnel entering the vault enclosure are required to wear a film badge and a pocket*

*dosimeter.* 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 with the exception of the used target assembly shall be disposed of in accordance with the 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 monitor the procedure for securing the used target assembly for storage outlined in Section 4.4. Additional functions of Radiation Safety include monitoring vault access, specifying clothing and special dosimetry requirements, unlocking and securing appropriate radiation security padlocks (i.e., Pad 118 locks), and performing radiation surveys and contamination checks.

#### 4.1.3 PRE-JOB PLANNING MEETING

***Prior to performing a target changeout, all lead personnel involved in the changeout 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 addressed 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, 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 target 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.

#### 4.2 GENERAL MODULE LIFTING REQUIREMENTS

##### 4.2.1 LOTO VAULT DEVICES

***Before accessing the vault enclosure, the collection lens main power supply, bias power supply, pulsed magnet power supply, and the target air supply breaker box 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 concrete vault shielding blocks and 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 lifting 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 target module block alone accounts for approximately 7500 lbs. (module dimensions are 72"x32"x11.375"). Support hardware and a target assembly could account for an additional 500 lb. load to the module assembly. ***Prior***

*to lifting, the fixture and associated lift hardware shall be visually checked for signs of damage.*

#### 4.3 DISENGAGING USED TARGET 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. Place herculite or masselin cloth over the alcove floor area and moveable stage to contain any possible contamination.
- c. Center the target coffin base on the moveable stage with the alignment pin of the locating base oriented in the east most direction.
- d. Ensure that space is available in the storage rack for the target module if required.
- e. Ensure that the position of the target cantilever motion is centered. This may be accomplished remotely from the P-Bar Source control room.

##### 4.3.2 REMOVAL STEPS

BD/Radiation Safety personnel will provide digital dosimeters for persons requiring such monitoring and specify clothing requirements for all subsequent operations as discussed in the pre-job planning meeting or as deemed necessary on site during the changeout activity. *After the target module has been lifted from the vault, all personnel and tools leaving the vault enclosure during the changeout shall be frisked to check for possible contamination upon every exit of the vault enclosure. 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 is to be followed for target disengagement:

- a. Disconnect the air supply tube and the instrumentation read-back cables located at the top of the module.

- b. Using an appropriate lifting sling, remove the filler plates from each side of the target module and place at the north end of the vault. The approximate weight of the heaviest plate is 100 lb.
- c. After Radiation Safety personnel unlock the padlock on the target module, the module lifting fixture and pins may be secured to the module. ***All personnel with the exception of Radiation Safety and the crane operator must then exit the vault enclosure during the following step (4.3.2.d).***
- d. Remove the target module block and target assembly from the vault and place on the alcove rails. When lifting the target module to or from the vault, position the crane trolley according to the red 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 target 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 and target assembly are now secured for target removal.
- e. Subsequent work for target disengagement will be accomplished from the top of the module or behind the lead viewing glass and concrete alcove shielding. ***If directed by Radiation Safety personnel based on a dose rate survey of the area, secure lead shielding blankets over any line of sight cracks between the top of the module and the alcove walls.***
- f. Working at the top of the module, remove the target rotation motor, loosen the four target module bearing block bolts (ref. 8000-MC-254214), and remove the rotary air union and opto-interrupter assembly located on the inner target shaft. This will allow the target shaft to move freely upward for the next operation.
- g. 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. 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. Position the stage such that the coffin base locating pin and the target assembly stand register ring are aligned. Once the target stand is seated on the stage base, raise the assembly approximately 1 inch using the moveable stage. Rotate the inner target shaft from the top of the module to engage the spring loaded target rotation stop shaft in the stop plate register to allow the target assembly to be unscrewed.

- h. Loosen the three set screws that thread through the aluminum rotary air adapter at the top of the module. The purpose of the set screws is to restrain the target draw screw from rotating relative to the target module inner shaft. The draw screw

contains a left-hand thread and is located inside the inner target shaft. Completely unscrew the target draw screw and lift up by hand a few inches and secure in this position with the three set screws.

- i. Completely unscrew the inner target shaft. Verify complete disengagement by lifting the outer shaft a few inches by hand. The target assembly located at the base of the module is now disengaged. Lower the assembly approximately 4 inches using the moveable stage while visually monitoring the position through the alcove lead viewing glass.

#### 4.4 SECURING USED TARGET ASSEMBLY

The following steps are used to secure a radioactive target assembly in a lead-lined, steel shell coffin for storage in the AP0 enclosure:

- a. Open the lead alcove door and remove the two thermocouple connections located at the base of the steel module block approximately 1 foot from the target stack. ***The technician performing this task must have full protective clothing and monitoring devices specified by Radiation Safety personnel.*** This task nominally requires less than 5 seconds to perform. On highly activated targets (e.g., > 30 R/hr on contact), the thermocouple lines may be cut at the top of the module and rewired after securing the activated target assembly in the storage coffin.
- b. ***The only personnel allowed in the vault enclosure during this step are Radiation Safety personnel and the crane operator.*** Remove the target module block from the alcove using the overhead crane and attached lifting fixture. Once the module is clear of the alcove door, Radiation Safety personnel may choose to perform a survey of the used target assembly and/or the module to document dose rates. Close the door and place the module in the vault.
- c. CAUTION: Do not rest the target coffin cover on the alcove moveable table as excessive loading may damage the force transducer.

Pick up the target coffin cover using the overhead crane hook and hardened pin placed through the lifting tabs on the cover. Open the alcove lead door and move the cover into the alcove and align with the coffin base on which the used target assembly resides. Lower the cover over the base positioning the cover approximately 1 inch higher than the fully seated position.

- d. Raise the alcove lift table until the coffin locking pinholes align and insert the coffin pin. Monitor the force transducer during this operation to prevent overloading the transducer. At this time, Radiation Safety personnel may choose to perform a contamination check of the alcove area.

- e. Radiation Safety personnel will padlock the coffin using a controlled 118 padlock. 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 NEW TARGET ASSEMBLY

- a. Center the aluminum target locating base on the alcove moveable stage with the alignment pin of the locating base oriented in the east most direction.
- b. Place the new target assembly on the locating base such that the stand register ring is secured over the base locating pin. Lower the stage to position the top surface of the locating base below the floor of the alcove. Check to ensure that the target rotation stop rod is engaged in the rotation stop plate to prevent rotation and allow fastening to the module rotation shaft.
- c. Remove the target module block from the vault and place on the alcove rails. Position the module according to the red markings on the west crane rail. Close the alcove lead door. The module and new target assembly are now in place for installation.
- d. Raise the alcove stage slowly while visually monitoring the relative position of the target assembly and the module through the lead glass viewing window. Position the stage and new target assembly such that the target lead in short shaft and the module rotation shaft are aligned.
- e. Slowly tighten the target rotation shaft from the top of the module to engage the threads. If necessary, slowly raise the stage while tightening to compensate for thread travel. Tighten the shaft from the top of the module to 60 ft-lb.
- f. Loosen the set screws through the inner rotation shaft which secure the target draw screw. Torque the draw screw to approximately 20 ft-lb. (left-hand thread). Re tighten the set screws through the inner rotation shaft such that the draw screw is centered in the inner shaft.
- g. The new target assembly is now secured to the module. Lower the stage to disengage the base locating pin from the target stand while visually monitoring through the lead glass viewing window. The target should now rotate freely by hand from the top of the module.
- h. At this time a trial disengagement procedure should be performed to verify that the target assembly will freely disengage from the module. It is easier to remedy problems at this time with a new target than to work with a highly radioactive target assembly. Such a procedure can be performed by following Subsection 4.3.2, steps g through i.

- i. After the target assembly is refastened to the module, open the alcove lead shielding door and connect the two thermocouple connectors located at the base of the module to the new target assembly. Radiation Safety personnel will specify the protective clothing requirement.
- j. Prior to placing the target module assembly in the vault, all motion axes shall be exercised throughout the full range of motion to verify adequate clearance between all components and identify deficient LVDT read backs or stepper motors. This task is accomplished by visual and electronic monitoring from behind the alcove viewing glass and the module top.
- k. Replace the target rotation motor, target module bearing bolts (8000-MC-254214), rotary air union, and opto-interrupter assembly located at the top of the module on the inner target shaft.
- l. Replace the target module assembly into the vault, insert the module filler plates, reconnect the air supply line and the read back cables, and remove the lifting fixture. Radiation Safety personnel shall now padlock the module in the vault.
- m. At this time, Radiation Safety personnel may choose to conduct additional contamination surveys before securing the vault enclosure.
- n. Replace the vault concrete shielding blocks. Remove all tools and equipment from the vault. Radiation Safety personnel shall now secure the vault enclosure gate.
- o. Remove all locks and tags from electrical supplies.

## 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**

| <u>Controlled Copy No.</u> | <u>Recipient</u>                                   |
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