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**C-A OPERATIONS PROCEDURES MANUAL**

2.6.2 Procedure for Partial Lockout/Tagout (LOTO) for Maintenance, Repair, and Testing in the AGS and Booster Rings During Accelerator Operations/Maintenance

Text Pages 2 through 11

Attachments

Hand Processed Changes

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Approved: \_\_\_\_\_ *Signature on File* \_\_\_\_\_  
 Collider-Accelerator Department Chairman Date

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## 2.6.2 Procedure for Partial Lockout/Tagout (LOTO) for Maintenance, Repair, and Testing in the AGS and Booster Rings During Accelerator Operations/Maintenance

### 1. Purpose

- 1.1 This procedure provides authorization to Operations Coordinators (OC), the Maintenance Coordinator(MC), Technical Supervisors, and CAS Technicians, to not LOTO apparatus listed in [C-A-OPM 2.6.1](#) LOTO checklists, , AND permit personnel to work in the AGS and/or Booster Accelerator enclosures.
- 1.2 C-A Policy states that the preferred method to protect workers from energy sources is LOTO. However, this procedure is required to enable approved maintenance, repair and testing under conditions where apparatus is not LOTO or applied power conditions.
- 1.3 The following Alternate means to LOTO include:
  - 1.3.1 Moderate to high hazard Work Planning i.e. a “Green Work Permit”
  - 1.3.2 barriers to protect personnel from the hazards, and
  - 1.3.3 Energized Electrical Work Permits to advise personnel of the hazards.

<p><b><u>Caution:</u></b> This procedure is only to be applied to the AGS and Booster Rings.</p>
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- 1.4 This procedure shall be invoked when workers are required to:
  - 1.4.1 Work in the ring enclosure while some equipment remains energized during approved maintenance, repair and testing.
  - 1.4.2 Approved access to the ring enclosure for an inspection of apparatus that is not physically connected to or not on the inside of the accelerator.
  - 1.4.3 Except for the conditions stated in paragraphs 4.1.5 and 4.2
    - 1.4.3.1 this procedure may be used only on a Maintenance Day **OR** in daytime situations where reviewers are available to approve work plans for a repair.
    - 1.4.3.2 this procedure may not be used for off-hour or weekend repairs.

- 1.4.4 The “minimum LOTO” procedure cannot be used to begin work while full Controlled Access LOTO is being implemented in an attempt to save time.

## **2. Responsibilities**

- 2.1 The Maintenance Coordinator shall:
  - 2.1.1 inform the MCR Operators or CAS Technicians, which devices on the checklist are to be LOTO (see [C-A-OPM 2.6.1](#) attachments);
  - 2.1.2 designate two MCR Operators, or CAS Technicians, one as the Responsible Authorized Person (RAP) and the other as the Safety Watch Verifier (SWV);
  - 2.1.3 issue Energized Electrical Work Permit ([C-A-OPM-ATT 2.6.2.a](#));
  - 2.1.4 limit to two the number of simultaneous work permits or jobs permitted in the enclosures;
  - 2.1.5 require Technical Supervisors to write work plans, obtain approvals, and erect appropriate barriers before permitting the maintenance, repair, or testing of apparatus.

## **3. Prerequisites**

- 3.1 Before workers may enter the enclosure with equipment energized a work plan shall be written and approved by the Chief Electrical Engineer or his designee.
  - 3.1.1 Before issuing approval to keep equipment energized with workers in the enclosure, the Chief Electrical Engineer (CEE) or designee, the Technical Supervisor, and the Maintenance Coordinator shall evaluate the work plan, including the proposed LOTO, and the number and training of personnel working in the enclosure.
- 3.2 Before issuing an energized Electrical Work Permit the Maintenance Coordinator shall inspect or designate an MCR Operator or CAS Technician to inspect the barriers or three foot clearance zone boundary lines for any apparatus that is to remain energized when personnel enter the accelerator enclosure.
- 3.3 The Maintenance Coordinator, with the approval of the CEE, may authorize the energizing of apparatus for testing when the AGS or Booster rings are in controlled access.
  - 3.3.1 The Maintenance Coordinator may authorize the energizing of apparatus for testing when the AGS or Booster rings are in restricted access.
- 3.4 Training prerequisites of importance for all workers:

- 3.4.1 Valid C-A Access Training on [BTMS Listing](#) is the minimum training requirement for workers who wish to enter the Booster or AGS ring enclosures under the following Controlled Access Conditions:
  - 3.4.1.1 any of the Controlled Access Checklists from [C-A-OPM 2.6.1](#) are used for LOTO AND every item on the list is LOTO,
  - 3.4.1.2 entrants will only observe or advise other workers,
  - 3.4.1.3 entrants will not work on apparatus physically attached to the accelerator, or connected to the vacuum chamber (except for the rf system).

Under these conditions, a lock need not be applied to the Token Box by the ring entrant.

- 3.4.2 Valid Authorized Lockout/Tagout training, valid Electrical Safety training and, valid C-A Access training on [BTMS Listing](#), are the minimum training requirements for workers entering the Booster or AGS ring enclosures under the following conditions:
  - 3.4.2.1 Any of the Controlled Access Checklists from [C-A-OPM 2.6.1](#) are used for the LOTO AND every item on the list is LOTO.
  - 3.4.2.2 Entrants will work on apparatus attached to the accelerator or vacuum chambers.

Under these conditions, a lock shall be applied to the Token Box by the ring entrant.

- 3.4.3 Valid Authorized Lockout/Tagout training, and valid Electrical Safety Training and valid C-A Access Training on [BTMS Listing](#), are the minimum training requirement for workers entering the Booster or AGS enclosures under the following conditions:
  - 3.4.3.1 Some apparatus from the C-A-OPM Controlled Access LOTO checklist remains energized.

Under these conditions, a lock shall be applied to the Token Box by the ring entrant and the entrant shall carry an Energized Electrical Work Permit ([C-A-OPM-ATT 2.6.2.a](#)) issued by the MC. A CEE approved work plan is required to do work in the enclosure.

3.4.4 Valid Authorized Lockout/Tagout training, valid Electrical Safety training, and valid Electrical Safe Work Practice Training and valid C-A Access Training on [BTMS Listing](#), are the minimum training requirements for workers entering the Booster or AGS ring enclosures under the following conditions:

3.4.4.1 Only the Main Magnet Power Supply + high field back-leg windings + active filter has been LOTO.

Under these conditions, a lock shall be applied to the Token Box by the ring entrant and the entrant shall carry an Energized Electrical Work Permit ([C-A-OPM-ATT 2.6.2.a](#)) issued by the MC. A CEE approved work plan is required to do work in the enclosure.

3.4.5 Valid Authorized Lockout/Tagout training, valid Electrical Safety training , valid Electrical Safe Work Practice training and valid C-A Access Training on [BTMS Listing](#), as well as training in the tasks specified in the range D Energized Electrical Work Permit, are the minimum training requirements for workers entering the Booster or AGS ring enclosures under the following Controlled Access conditions:

3.4.5.1 The ring main magnets are energized.

Under these conditions, the entrants shall carry a work specific Range D Energized Electrical Work Permit. A CEE approved work plan is required to do work in the enclosure.

#### **4. Precautions**

4.1 Precautions for the Maintenance Coordinator:

4.1.1 The appropriate LOTO Checklist in [C-A-OPM 2.6.1](#) shall be used to ensure personnel safety against electrical hazards (minimum LOTO) even when some apparatus remains energized for testing.

4.1.2 For equipment **testing** in the Controlled Access state and with workers in the ring, apparatus on these checklists shall be unlocked by the CAS Technicians and energized by the System Specialist only with the approval of the CEE or his designee and under restrictions outlined in the table below.

Access Control State	Apparatus Permitted for Testing		Choose Apparatus From OPM LOTO Checklist
	Distributed Systems	Local Apparatus	
IF Controlled Access THEN	one string and rf + local apparatus	two maximum + distributed apparatus	Att 2.6.1 a,b,c,d (para 3.4.5 for high field BLW)
IF Restricted Access THEN	rf system + local apparatus	three maximum + distributed apparatus	difference between 2.6.1 a&c and 2.6.1 b&d + 2.6.4

4.1.3 No more than TWO Energized Electrical Work Permits may be issued at one time, per accelerator during Controlled Access. NO Energized Electrical Work Permits are needed during Restricted Access – Barriers are sufficient owing to the decreased hazard of the apparatus allowed to be energized.

4.1.3.1 Under Restricted Access conditions, the Maintenance Coordinator may approve work plans and barrier testing.

4.1.4 If an Energized Electrical work permit, for inspection purposes only, is issued to the individuals listed in Attachment 8.2, the permit does not count toward the 2 permits per accelerator limit defined in 5.2.3.4. A CEE approved work plan is required.

**Caution:**

To assure electrical safety for workers when apparatus is to be energized, barriers must be erected prior to removal of LOTO and prior to issuing Energized Electrical Permits.

4.1.5 When only the AGS main magnet power supply (MMPS+ high field back-leg windings + active filter) is locked and tagged during Controlled Access State, workers with an OC/MC approved low hazard work plan and an Energized Electrical Work Permit shall be permitted to enter only to:

4.1.5.1 To make a visual inspection of apparatus from the outside aisle, or

4.1.5.2 To reset an RF Power amplifier

4.1.5.3 To clear a water mat indication from a beam transport line eg. SEB C line, FEB U line. or BtA.

4.1.5.4 To reset the Bias Supply for the C15 Polarimeter.

**Note:**

Two persons, one a SWV, shall be the minimum number to enter the ring.

4.1.6 Entry into an accelerator with the MMPS not in LOTO and/or energized is permitted if a CEE approved work plan and valid Energized Electric Work Permit for a Range D Hazard is presented to the OC.

4.1.6.1 A minimum of two persons, listed on the Range D permit, one acting as a Safety Watch (SW), shall enter the ring and follow the specific provisions of the Range D procedure. The SW shall be qualified in CPR.

4.2 Access into the AGS, with all apparatus energized, is permitted if access is made via the north conjunction gate and entrants do not go beyond the buoys used for shielding or access is made via the south gate and entrants do not go beyond the sump at the bottom of the ramp.

4.2.1 An Energized Electric Work Permit ([C-A-OPM-ATT 2.6.2.a](#)) will be issued by the OC or MC for such an access. The OC or MC will create the low hazard work plan in this case.

4.2.2 A Range D Energized Electric Work Permit or a specific task procedure is not required for this case.

4.2.3 Two persons, one an MCR operator, shall enter the enclosure. The operator shall prevent any access beyond the shielding buoys.

4.2.4 The training requirements of paragraph 3.4.5 shall be invoked.

4.3 Caveats for Maintenance under Minimum LOTO conditions

4.3.1 No more than two jobs may be performed simultaneously in the enclosure.

4.3.2 Work plans will be created for specific tasks not generic tasks.

4.3.3 Work Plans will always use a Green Work Permit. This will ensure and document that the job controls and required LOTO have been reviewed and approved by the CEE, TS, MC, and a member of the ESSHQ Division for each task. (CK-01.1)

4.3.4 Work plans will specify the LOTO required to perform the task. The LOTO specification will include the equipment to be worked on and – if necessary -- adjacent equipment that could present an electrical hazard.

4.3.5 Approved Job Specific Procedures are encouraged to facilitate work planning. The procedure must include proper PPE, safety requirements, persons to be notified in case of a problem, and a LOTO specification.

4.3.6 Each work plan must be approved by the Chief Electrical Engineer (CEE) or

designee. Prior to use, the work plan must be reviewed/approved by the Technical Supervisor and Maintenance Coordinator.

- 4.3.7 A work plan must be reviewed prior to each use.
- 4.3.8 No high hazard jobs may be performed under minimum LOTO conditions. Also, no rigging jobs, no parallel jobs unrelated to the maintenance period, and no casual jobs (casual means not time critical for machine operation).
- 4.3.9 Electrically energizing and testing external equipment that appears on the Controlled Access LOTO checklist (e.g., power supplies) and connected to equipment inside the AGS Ring, shall be specifically prohibited during work in the AGS Ring using this protocol.
  - 4.3.9.1 The Chief Electrical Engineer may authorize testing of externally connected equipment if an equivalent level of safety is provided for workers in the Ring. The work plan for electrically energizing and testing external equipment shall be approved by the CEE, MC, each time it is performed.
  - 4.3.9.2 The Maintenance Coordinator may authorize testing of equipment that appears exclusively on the Restricted Access LOTO checklist.
  - 4.3.9.3 In all cases, if testing is authorized, workers in the ring must be informed by the MC prior to the start of testing.
- 4.3.10 Any deviations from the approved work plan after the start of maintenance will be documented by the Technical Supervisor on the Moderate Hazard Work Plan Form or “green sheet” and must be reviewed and approved.

**5. Procedure – IF access to AGS or Booster is planned for Maintenance under minimum LOTO conditions:**

5.1 Prior to Maintenance

- 5.1.1 The Maintenance Coordinator shall
  - 5.1.1.1 Determine the amount work to be done in the AGS/Booster on the Maintenance day and the complexity of the jobs.
  - 5.1.1.2 Determine if **all** the AGS or Booster work can performed under minimum LOTO conditions

<p><b><u>Caution:</u></b> IF YES, THEN CONTINUE, ELSE DO NOT USE THIS PROCEDURE, APPLY FULL LOTO</p>
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- 5.1.1.3 IF YES THEN CONTINUE, ELSE DO NOT USE THIS PROCEDURE -- APPLY FULL LOTO.
- 5.1.1.4 Instruct supervisors of jobs that will be permitted under minimum LOTO to create a moderate hazard work-plan if none exists.
  - 5.1.1.4.1 Supervisors must have Moderate Hazard work plans reviewed and approved by the CEE or his designee each time they are used.

- 5.1.1.4.2 Work plans will limit the number to THREE the number of workers who may work on a task in the ring under minimum LOTO (CK-01.2)
- 5.1.1.4.3 Work plans will always use a Green Work Permit. This will ensure and document that the job controls and required LOTO have been reviewed and approved by the CEE, TS, MC, and a member of the ESSHQ Division for each task. (CK-01.1)
- 5.1.1.4.4 Each work plan used during minimum LOTO must explicitly state that ring entrants stay three feet away from any equipment that is not LOTO'd or barriered. All non-LOTO'd equipment shall be considered energized (CK-01.4)
- 5.1.1.4.5 Worker feedback on problems and improvements for minimum LOTO shall be explicitly sought out, documented on the green work permit and quickly evaluated/implemented after each time it is used. (CK-01.5)
- 5.1.1.5 Plan for equipment testing at the end of maintenance by creating testing work plans and by getting them approved by the CEE.
- 5.1.1.6 Follow the caveats of paragraph 4.3 when planning for maintenance under minimum LOTO .

## 5.2 During Maintenance

- 5.2.1 IF minimum LOTO will be used then instruct CAS to apply minimum LOTO defined as the MMPS, all high field back-leg winding power supplies and the active filter power supply.
  - 5.2.1.1 IF some apparatus is to be tested THEN instruct the RAP to lock the keys to the safety locks for the apparatus that will be tested IN THE SUPPLEMENTARY LOCK BOX and lock the remaining keys into the LOCK BOX.
  - 5.2.1.2 IF an entry is to be made under minimal lockout conditions, THEN instruct the RAP to lock the keys to the safety locks for the LOTO elements in the Lock Box.
- 5.2.2 Instruct work groups (Technical Supervisor) to LOTO those elements listed on their work plan or procedure.
  - 5.2.2.1 Instruct CAS to LOTO adjacent accelerator elements that present a hazard to the worker and are maintained or "owned" by a different support group.
- 5.2.3 IF apparatus will be tested while workers are in the enclosure THEN:
  - 5.2.3.1 Review the Precautions given in Section 4.3.9 of this procedure.

- 5.2.3.2 Instruct the systems specialist to barrier the apparatus.
- 5.2.3.3 Instruct an Operator or CAS Technician to inspect the barrier.  
WHEN the barrier is acceptable, THEN
  - 5.2.3.3.1 instruct the RAP to unlock the SUPPLEMENTARY LOCK BOX,
  - 5.2.3.3.2 remove the keys to the safety locks for the apparatus to be tested,
  - 5.2.3.3.3 re-lock the SUPPLEMENTARY LOCK BOX
  - 5.2.3.3.4 remove LOTO from apparatus to be tested using the keys from the SUPPLEMENTARY LOCK BOX.
- 5.2.3.4 Issue Energized Electrical Work Permits ([C-A-OPM-ATT 2.6.2.a](#)) to every work team that enters the enclosure (limit 2 permits per accelerator).
  - 5.2.3.4.1 collect these permits (Attachment 8.1) when a worker/team has completed their task and inform the OC.
  - 5.2.3.4.2 forward the permits to the persons called for at the bottom of the permit

**Note 1:**  
IF powered back-leg windings (BLW) will be energized, THEN the table in paragraph 4.1.2 states that the training of all entrants shall comply with paragraph 3.4.5.

**Note 2:**  
If an Energized Electrical Work permit, for visual inspection purposes only, is issued to the individuals listed in Attachment 8.2, the permit does not count toward the 2 permits per accelerator limit defined in 5.2.3.4.

- 5.2.4 During Restricted Access NO Energized Electrical Work permits need be issued. Apparatus that appears only on the Restricted Access LOTO Checklist may be energized under these conditions. These power supplies present a decreased hazard compared to power supplies on the Controlled Access LOTO list. Barriers must be erected before any testing takes place with personnel in the enclosure. A MC approved work plan or procedure is required to energize elements in the enclosure under Restricted Access LOTO
  - 5.2.4.1 Follow the guidance given in the table in paragraph 4.1.2 when determining how many items may be energized simultaneously.

5.2.5 Changes to the work plan will be documented on the green sheet.

5.2.5.1 IF the scope of a repair, maintenance, or installation task changes **prior** to the start of the maintenance period, then the start of that task shall be delayed until the CEE, the Technical Supervisor and the Maintenance Coordinator have reviewed the work plan for changed LOTO requirements. The Technical Supervisor is responsible for informing his workers of any delays.

5.2.5.2 IF the scope of a repair, maintenance, or installation task changes **after** the start of the maintenance period, then the start of the additional task shall be delayed until the work plan has been reviewed by the CEE, the Technical Supervisor and the Maintenance Coordinator in order to determine how to communicate the additional hazard (if any) to workers in other work groups.

5.2.5.3 IF the scope of the job changes during maintenance such that a full Controlled Access LOTO must be applied, THEN stop the job, re-group the staff and assess the job, update the workplan, apply the LOTO, and inform the other workgroup in the ring enclosure (CK-01.3)

## 6. **Documentation**

- 6.1 Appropriate Checklist filled out from [C-A-OPM 2.6.1](#).
- 6.2 Issued Energized Electrical Work Permits.

## 7. **References**

- 7.1 [SBMS-Electrical Safety \(ESH1.5.0\)](#)
- 7.2 [C-A-OPM 2.6.1](#), "Operating Procedure for Lockout/Tagout for the AGS and Booster Rings, During Accelerator Operations".

## 8. **Attachments**

- 8.1 [C-A-OPM-ATT 2.6.2.a, "Energized Electrical Work Permit - AGS and Booster Enclosures"](#).
- 8.2 Special Case Energized Circuit Work Permit.

## ATTACHMENT 8.2

### SPECIAL CASE ENERGIZED ELECTRICAL WORK PERMIT.

When an Energized Electrical Work Permit is issued for inspection only to the individuals listed below, the permit shall not count towards the 2 permit limitation defined in Paragraph 4.1.4 and 5.2.3.4.

C-A Department Chair

C-A Associate Chair for Accelerators

C-A Associate Chair for ES&F

C-A Associate Chair for ESSHQ

C-A Division Head for ESSHQ

Chief Electrical Engineer or Designee

Chief Mechanical Engineer or Designee

ESH Coordinator

On-Duty Operations Coordinator or Designee

MCR Group Leader

Maintenance Support Group Leader

Maintenance Coordinators

CAS Group Leader or Designee

Water Systems Group Technical Supervisor or Designee

Booster/AGS Ring Power Supply Group Technical Supervisor or Designee