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C-A OPERATIONS PROCEDURES MANUAL

8.3.1 Warm Bore Vacuum Bakeout System Operation

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Hand Processed Changes

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

D. Weiss

8.3.1 Warm Bore Vacuum Bakeout System Operation

1. Purpose

This procedure covers the set-up, operation, and breakdown of the Warm Bore Vacuum Bakeout System. This OPM may be used for bakeout of any warm bore region of the RHIC Collider.

2. Responsibilities

Persons who set-up, operate or breakdown the Warm Bore Vacuum Bakeout System are responsible for following this procedure.

3. Prerequisites

3.1 All personnel involved in implementing this procedure shall have been trained on this procedure and the equipment by the cognizant engineer, or the cognizant technical supervisor. A list of personnel trained in this procedure shall be maintained by the cognizant technical supervisor and posted on or near the Bakeout System.

3.2 The system operator shall ensure only personnel required for the procedure enter the marked area while the system is enabled.

3.3 The system operator shall be trained to the level of “Knowledgeable Employee” as defined by [SBMS requirements for electrical safety](#).

3.4 Required Tools

- A. RHIC Vacuum Bakeout Station including 3 SCR Racks and associated cables
- B. RHIC Vacuum Bakeout Pumping Station
- C. Warm Bore Region Heater Elements and Thermal Insulation
- D. Tape, Caution (BNL #K-72110).
- E. Warning Placards (See [C-A-OPM-ATT 8.3.1.b](#))
Burn Hazard, Mild, Temperatures May Reach 60°C During Operation
- F. Cable Bridging

3.5 All personnel involved in working on any electrical system or equipment in the C-A shall be familiar with BNL SBMS [Electrical Safety Subject Area](#). C-A will provide on-site/work specific training to individuals in the electrical safety aspects of their job functions and assignments.

- 3.6 While work is underway and an abnormal condition arises, re-review the job against criteria in applicable SBMS Subject Areas, and/or work planning requirements. If unsure of further actions, discuss situation with supervisor.=-

4. **Precautions**

Warning:
Use extreme caution when working with any type of high voltage equipment.

Warning:
Use caution when working with any type of high temperature equipment.

Warning:
Failure to follow these operating procedures could result in serious injury or death.

- 4.1 All connections and switch settings must be made in the order specified herein.
- 4.2 When operational, all non-operator personnel must remain outside the marked area.
- 4.3 Ensure all indicated temperatures are below 50°C prior to shutting down the system.
- 4.4 Ensure all power is removed from the system prior to breaking down the system.
- 4.5 Identify the nearest exhaust fan and associated controls prior to set-up, in case of smoking during operation.
- 4.6 Identify the nearest fire alarm in case of fire during operation.
- 4.7 Identify the nearest exit in case of emergency.
- 4.8 Prior to enabling bakeout system, notify **Fire Department Duty Captain (x2350)** that a bakeout of a RHIC Warmbore region is about to begin, and state the expected bakeout duration.
- 4.9 Do not press the “Enable Bakeout” button until ready to begin, “Operation” per paragraph 5.4 of this procedure.

Circuit Breaker Panels, or Disconnect Switches (excluding 277 V wall light switches), operating more than 240 V, and rated less than or equal to 225 A, require the following NFPA 70E Cat. 2 (8 Cal/cm²) clothing:

- Cotton underwear and FR long-sleeve shirts and FR long pants,
- Hardhat with arc rated face shield: BNL #K64942,
- (protective storage bag for face shield and hat: BNL #K64793,
- Safety glasses,
- All leather gloves: BNL #K62902,
- Leather work shoes, and hearing protection,
- 8 Cal/cm² cotton underwear not required with 8 Cal/cm² FR long-sleeve shirts and FR long pants.

5. Procedure

5.1 Set-up

Note:
Refer to [C-A-OPM-ATT 8.3.1.c](#) and [C-A-OPM-ATT 8.3.1.d](#) for schematic and diagram of the Warm Bore Bakeout System.

- 5.1.1 Locate the Bakeout Station and SCR racks to maintain maximum aisle space and slack in all cables.
- 5.1.2 Install the ground connection between the Bakeout Station and a warm bore beamtube support.
- 5.1.3 Connect heater plugs into SCR output receptacles per configuration required for the specific warm bore region.
- 5.1.4 Connect thermocouple, SCR control, and SCR power connectors to Bakeout Station.

Note:
Insure that all cables are properly grouped. Groups are identified by the letters A, B and C. Each group consists of three (3) cables; one each of thermocouple, SCR control, and SCR power. Groups A, B and C typically cover the left, center and right side of the warm bore region respectively.

- 5.1.5 Insert contact leads of auxiliary equipment into BNC “Interlock” receptacles located on the Bakeout Station. Insure that shunt plugs are installed on all unused BNC “Interlock” receptacles. Examples of auxiliary equipment include vacuum pump station and Lambertson magnet water flow meter.

Warning:
Insure that circuit breakers and switches on the bakeout station are in the “OFF” position prior to connecting system to facility power.

- 5.1.6 Inspect all connections, switches and circuit breakers before proceeding to the next step. All cables should be properly grouped, and all switches and circuit breakers should be in the “OFF” position.

Warning 1:
If 480V extension cord is needed, the extension cord must be connected to the bakeout system cart BEFORE it is connected to the facility power receptacle.

Warning 2:
Be sure to wear the appropriate PPE per precaution 4.10 herein prior to performing the following step.

- 5.1.7 Connect 480V facility power extension cord to bakeout cart 480V power cable, only if extra main power cord length is needed.
- 5.1.8 Connect Bakeout Station to 480V facility power receptacle.

5.2 Powering the Bakeout System

- 5.2.1 Cordon off warm bore region with warning placards and caution tape.
- 5.2.2 Protect all cables that pass outside the cordoned region with cable bridges.
- 5.2.3 If not already underway, begin the pump down of the warm bore.
- 5.2.4 Switch 480V Facility Power Switch, located at the 480V facility power receptacle, to the “ON” position. This enables 480V to the input of the transformer primary and 110V 20 amp to the system controls receptacle, located inside the main control rack.
- 5.2.5 Switch the UPS AC power to the “ON” position.
- 5.2.6 Switch the computer to the “ON” position.
- 5.2.7 Switch the 3Ø 208V mains power to the “ON” position. This breaker enables the 3Ø 208V output of the transformer secondary. The bakeout system is now energized to the line side of the Bakeout Enabled contactor.

- 5.2.8 Switch the 3Ø 208V SCR rack circuit breakers (SCR Rack A, SCR Rack B, and SCR Rack C) to the “ON” position. If the Bakeout Enabled contactor were enabled, the system would be energized to the line side of the SCRs.
- 5.2.9 Verify that all circuit breakers are “ON.” The temperature controller “OK” and auxiliary contact “OK” indicators should be lit. The “Bakeout Disabled” indicator should be lit. The “Bakeout Enabled” indicator should NOT be lit. If not correct, press the “Bakeout Disable” switch. If this does not correct the problem, call the system engineer or supervisor.

5.3 Configure Controls

- 5.3.1 Double-click the SPECVIEW icon on the computer to START the control program.
- 5.3.2 SELECT the configuration for the warm bore region of the same name.
- 5.3.3 VERIFY the configuration shown on the screen matches the region of the bakeout.
- 5.3.4 DOWNLOAD the recipe.
- 5.3.5 Observe the LEDs on the zone controllers of the Bakeout Station. VERIFY that all zones required for the region are in AUTO (automatic) control and that all others are in MAN (manual) mode.
- 5.3.6 Verify proper sensor connection of zones. If the large LED display of an AUTO zone controller indicates “Sbr,” a sensor failure is indicated. Perform the following corrective action. First, verify that the correct software configuration has been downloaded. Reload if necessary. Check that all sensor connections and junctions are secure. Repair subject sensor connection and/or junction.

5.4 Operation

- 5.4.1 Press the Bakeout Power Enable button on the Bakeout Control Rack front panel. Verify that the Bakeout Power Enable indicator is lit. The system is now energized to the line side of the 8 SCR power controllers in each of the 3 SCR racks, and the system is “Ready to Bake.”
- 5.4.2 Verify all zones are working properly, by observing the main LED display of each controller. A failure is indicated, if the zone controller is in AUTO mode, and the temperature is not displayed continuously. If a failure is indicated, shutdown power to the bakeout station at the 3Ø 208V Mains power circuit breaker. Contact the System engineer or Vacuum Supervisor.

- 5.4.3 Press the virtual START button located in the upper left corner of the SPECVIEW display. The system bakeout is now underway. Verify that the program status indicator located next to the SPECVIEW START button indicates “RUN.” The system will bring the warm bore sector to the required dwell temperature (typically 250°C) at a rate not to exceed 50°C per hour.
- 5.4.4 Once the system is in the high temperature bakeout dwell segment, as indicated by the program display, conditioning of warm bore system pumps can proceed if specified.
- 5.4.5 Upon completion of the bakeout dwell segment, the system will ramp to a low temperature dwell (~70°C) at a rate not to exceed 50°C per hour.
- 5.4.6 Once the system is in the low temperature dwell segment, as indicated by the program display, the final conditioning of warm bore pumps can proceed.

Note:

The bakeout pumpstation isolation valve may be actuated closed upon completion of any final conditioning procedure, if specified.

- 5.4.7 Upon completion of the low temperature dwell segment at ~70°C, the system will ramp down to room temperature. Once the system has ramped down to room temperature, the bakeout is complete.
- 5.4.8 Verify that the “RUN” indicator of all zone controllers in “AUTO” mode are flashing. This indicates the program is complete.

5.5 System Shutdown

- 5.5.1 Press the Disable Bakeout Power button on the front of the Bakeout Station.
- 5.5.2 Verify the Bakeout Enabled indicator is extinguished.
- 5.5.3 Press the “DATA LOG OFF” button on the computer display.
- 5.5.4 Switch the 3Ø 208V SCR rack circuit breakers to the “OFF” position.
- 5.5.5 Switch the 208V main power to the “OFF” position. This disables the 3Ø 208V output of the transformer secondary.
- 5.5.6 Shutdown the computer.
- 5.5.7 Switch the UPS power to the “OFF” position.

5.5.8 Switch 480V Facility Power Switch, located at the 480V facility power receptacle to the “OFF” position. Disconnect the cable from the receptacle.

5.6 System Disassembly

5.6.1 Disconnect leads of auxiliary equipment plugged into BNC Interlock receptacles located on the Bakeout Station.

5.6.2 Remove heater blanket plugs from the receptacles in the SCR rack.

5.6.3 Disconnect thermocouple connectors located near each SCR rack.

5.6.4 Disconnect thermocouple, SCR control, and SCR power connectors at Bakeout Station.

5.6.5 Remove ground connection between Bakeout Station and warm bore beam tube support.

5.6.6 Remove caution tape and warning placards.

5.6.7 Remove Bakeout Station and SCR racks from Warm Bore region.

5.6.8 Complete entries in the RHIC Warm Space Bakeout Log (see example in [C-A-OPM-ATT 8.3.1.a](#)), maintained by the Vacuum Systems Group Leader, for the just completed bakeout.

6. Documentation

6.1 RHIC Warm Space Bakeout Log

7. References

7.1 [SBMS Electrical Safety](#).

8. Attachments

8.1 [C-A-OPM-ATT 8.3.1.a “RHIC Warm Space Bakeout Log \(Sample\)”](#)

8.2 [C-A-OPM-ATT 8.3.1.b “Warning Placard”](#)

8.3 [C-A-OPM-ATT 8.3.1.c “Bakeout System Schematic”](#)

8.4 [C-A-OPM-ATT 8.3.1.d “Bakeout System Diagrams”](#):