

*If you are using a printed copy of this procedure, and not the on-screen version, then you **MUST** make sure the dates at the bottom of the printed copy and the on-screen version match. The on-screen version of the Collider-Accelerator Department Procedure is the Official Version. Hard copies of all signed, official, C-A Operating Procedures are kept on file in the C-A ESHQ Training Office, Bldg. 911A*

C-A OPERATIONS PROCEDURES MANUAL

2.5.2 RHIC Accelerator Safety Envelope Parameters

Text Pages 2 through 13

Hand Processed Changes

<u>HPC No.</u>	<u>Date</u>	<u>Page Nos.</u>	<u>Initials</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

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

E. Lessard, R. Karol

2.5.2 RHIC Accelerator Safety Envelope Parameters

1. Purpose

- 1.1 This procedure assigns responsibility for the Accelerator Safety Envelope Parameters for the RHIC Collider, STAR experiment, and PHENIX experiment, based on the [Accelerator Safety Envelope](#), and any subsequent USIs documented using [C-A OPM 1.10.1](#), Unreviewed Safety Issues.
 - 1.1.1 Additionally, the Collider, STAR, PHENIX and BRAHMS, and other experiments, are limited by ESH requirements established by the C-A Radiation Safety Committee (RSC), the C-A Accelerator Systems Safety Review Committee (ASSRC), and the C-A Experimental Safety Review Committee (ESRC). C-A safety-committee requirements are documented in RSC, ASSRC, and ESRC Checkoff Lists in the Main Control Room (MCR). These Checkoff Lists must be completed before allowing reviewed systems to become operational, allowing beam in the Collider, or allowing beam collisions for experiments.
- 1.2 Implicit in the notion of an Accelerator Safety Envelope Parameter is that variations in operating conditions are permitted if and only if they do not exceed the defined boundaries. A variation beyond the boundaries described in this procedure shall be evaluated as a reportable occurrence by C-A management, as defined by [SBMS](#) Subject Area on Occurrence Reporting. Notifications of occurrences shall be made according to [C-A OPM 10.1](#).
 - 1.2.1 If a Requirement is not satisfied and it has a specific Authorized Alternative associated with it, then implement the Authorized Alternative, or safely stop the activity associated with the Requirement within one hour.
 - 1.2.2 If a Requirement is not satisfied and it does not have a specific Authorized Alternative, then stop that activity that uses the affected equipment within one hour.
 - 1.2.3 If an Authorized Alternative is implemented, then this is not a reportable occurrence; however, a C-AD Critique shall be conducted (as required by the BNL ESH Committee) to document the reasons and any recommendations made to reduce the need for implementing the Authorized Alternative in the future to the C-AD Chair.
- 1.3 Emergency actions may be taken that depart from these approved ASE Requirements when no actions consistent with the Requirements are immediately apparent and when these actions are needed to protect the public, workers or environment.

- 1.3.1 These actions shall be approved by the person in charge of facility safety, as defined in the operating procedures, when the emergency occurs and shall be reported to C-AD management within 2-hours.

2. Responsibilities

- 2.1. The C-A Department Chairman shall approve all changes to the Accelerator Safety Envelope Parameters (ASEPs).
- 2.2. The following individuals have responsibilities for each of the ASEPs as specified in the beginning of the ASEP:
 - 2.1.1 Associate Chair for ESHQ
 - 2.1.2 Chair of ESRC
 - 2.1.3 Chair of RSC and RSC
 - 2.1.4 Head of MCR
 - 2.1.5 Collider and Collider Experiments Liaison Physicists
 - 2.1.6 Liaison Engineers
 - 2.1.7 On-duty Operations Coordinator
 - 2.1.8 Cryogenic Shift Supervisor
 - 2.1.9 Facility Support Representative (RCD)
 - 2.1.10 Access Controls Group Leader
 - 2.1.11 Maintenance Coordinator
 - 2.1.12 ESH Coordinator
 - 2.1.13 CAS Group Leader
 - 2.1.14 Cryogenic Systems Group Leader
 - 2.1.15 Facilities and Experimental Support Group Head
- 2.3. The person in charge that approves Emergency Actions that depart from the requirements of this procedure (see step 1.3.1) shall inform the Department Chair within 2-hours of this decision.

3. Prerequisites

None

4. Precautions

None

5. Procedure

Accelerator Safety Envelope Parameters are established for:

- Collider Particle Limit and Limiting Particle Loss
- Radiological Area Classification
- RSC, ASSRC and ESRC Checkoff Lists
- Particle Accelerator Safety System (PASS)

- Oxygen Deficiency Hazard Control
- Fire Protection
- Staffing
- STAR Experiment
- PHENIX Experiment
- Shutdown Periods
- Groundwater Protection, Radiological Barriers and Dose Limits

5.1 Collider Particle Limit and Limiting Particle Loss

5.1.1 The on-duty Operations Coordinator shall maintain the maximum number of heavy ions in each ring to be equal to or less than the equivalent of 2.4×10^{11} Au ions at 100 GeV/u. Examples of equivalence are as follows:

5.1.1.1 Deuterium – 1.2×10^{13} ions per ring at 125 GeV/u

5.1.1.2 Oxygen – 2×10^{12} ions per ring at 125 GeV/u

5.1.1.3 Silicon – 1.34×10^{12} ions per ring at 125 GeV/u

5.1.1.4 Copper – 6.48×10^{11} ions per ring at 115 GeV/u

5.1.1.5 Iodine – 3.6×10^{11} ions per ring at 104 GeV/u

5.1.2 Prior to injection in RHIC, the C-AD Radiation Safety Committee shall consider each new species.

5.1.3 The on-duty Operations Coordinator shall maintain the maximum number of protons in each ring to be equal to or less than the equivalent of 2.4×10^{13} at 250 GeV.

5.1.4 The on-duty Operations Coordinator shall routinely interpret loss monitoring results and RCT radiation survey results in order to maintain beam loss, “As Low As Reasonably Achievable”, as defined in the [BNL Radiological Control Manual](#).

5.1.5 When applicable, the appropriate Liaison Physicists for the Collider, or the Collider experiments, shall provide the Operations Coordinator with OPM Procedures that will allow the on-duty Operations Coordinator to control radiation levels.

5.1.5.1 In no case shall beam-loss induced radiation within uncontrolled Collider areas be greater than 0.5 mrem in an hour, or for repeated losses be greater than 25 mrem in a year.

5.1.5.2 In no case shall beam-loss induced radiation within Collider Controlled-Areas be greater than 5 mrem in an hour and for repeated losses greater than 100 mrem in a year.

Note:

Controlled Areas at RHIC also include any posted Controlled Area portions of the AtR.

5.2 Radiological Area Classification

5.2.1 The appropriate Liaison Physicists for the Collider, or the Collider experiments, shall not allow changes to radiological area classifications before consultation with the Facility Support Representative, the RSC Chair, and the Associate Chair for ESHQ, or their designates. Changes shall be in accord with the requirements in the [BNL Radiological Control Manual](#).

5.3 Completion of RSC, ASSRC and ESRC Checkoff Lists

5.3.1 The Head of the Main Control Room, or designee, shall ensure all relevant RSC, ASSRC and ESRC Checkoff Lists are completed and signed by appropriate personnel before allowing beam into the associated accelerator, transfer line, or experimental program; e.g., AtR operations, Collider operations, STAR operations with Collider beam, etc.

5.4 Particle Accelerator Safety System (PASS)

5.4.1 The Access Controls Group Leader shall ensure that safety-system configuration control and maintenance is in accordance with [C-A OPM 4.91](#).

5.4.2 The Access Controls Group Leader shall ensure the radiological portions of the Access Controls System are functionally tested according to the requirements in [BNL RadCon Manual, Chapter 3, Appendix 3A](#).

5.4.3 The Access Controls Group Leader shall ensure that ODH ventilation fans that are signaled by the PASS are functionally tested annually or before the running period. Accessible fans and air inlet louvers shall be manually tested semiannually (not to exceed 8 months) during operations, or within one month of accessibility.

5.4.4 The Access Controls Group Leader shall ensure that area radiation monitors that are interfaced with the Access Controls System are within their calibration date. Calibration shall be completed annually (not to exceed 15 months).

- 5.4.5 The Access Controls Group Leader shall ensure high intensity proton beam is prevented from the W line, either by the Access Controls System or by RSLOTO of appropriate critical devices.
- 5.4.6 The Access Controls Group Leader shall ensure that the locations of area radiation monitors are maintained as defined by the C-A Radiation Safety Committee.

5.5 Oxygen Deficiency Hazard Control

Note 1:
Personnel may be escorted into ODH areas without completion of training (ODH 0 or 1 areas) or medical exam (ODH 1 areas). Untrained personnel shall not perform work in ODH areas.

Note 2:
The following apply when the MCR is staffed and/or the Cryo Shift is staffed for operations.

- 5.5.1 IF EITHER an oxygen sensor is not working, OR less than three ventilation fans in a Sextant of the Collider tunnel are available for operation, AND the temperature of helium in the Collider Tunnel is below 50 degrees Kelvin, THEN the MCR Operations Coordinator shall only allow work in the affected Sextant of the Collider Tunnel if:
 - 5.5.1.1 an Enhanced Work Planning Form has been completed for moderate hazard, AND
 - 5.5.1.2 personnel performing the work are ODH 1 trained.
- 5.5.2 IF EITHER an oxygen sensor is not working, OR less than one ventilation fan in a Collider support building is available for operation, AND the temperature of helium in the Collider support building is below 50 degrees Kelvin, THEN the Cryogenic Shift Supervisor shall only allow work in that Collider support building if:
 - 5.5.2.1 an Enhanced Work Planning Form has been completed for moderate hazard, AND
 - 5.5.2.2 personnel performing the work are ODH 1 trained.
- 5.5.3 IF EITHER an oxygen sensor is not working, OR less than three ventilation fans in the compressor building are available for operation, THEN the Cryogenic Shift Supervisor shall only allow work in the compressor building if

5.5.3.1 an Enhanced Work Planning Form has been completed for moderate hazard, AND

5.5.3.2 personnel performing the work are ODH 1 trained.

5.5.4 IF EITHER an oxygen sensor is not working, OR less than two ventilation fans in the 80K Cooler portion of Building 1005E are available for operation, THEN the Cryogenic Shift Supervisor shall only allow work in the compressor building if

5.5.4.1 an Enhanced Work Planning Form has been completed for moderate hazard, AND

5.5.4.2 personnel performing the work are ODH 1 trained.

Note:

Tunnel sextant 1 is from 12 o'clock to 2 o'clock; tunnel sextant 3 is from 2 o'clock to 4 o'clock, etc. Sextants 5 and 7 do not include the STAR IR and sextants 7 and 9 do not include the PHENIX IR.

5.6 Fire Protection

5.6.1 During periods of beam operation, when access to the Collider primary beam areas is prohibited, the on-duty Operations Coordinator shall insure that installed fire detection and suppression systems are operable.

5.6.1.1 Both smoke detector strings in an area shall be fully operational.

Note: The collider has two 'strings' of smoke detection in a cross-zoned arrangement for redundancy. An area is covered by an 'A' string detector, then a 'B' string detector as you walk along the tunnel.

Authorized Alternatives (Note: [C-A-OPM 3.24](#) specifies implementation of these alternatives):

- 1) Up to two smoke detectors per string in an area may be inoperable with approval of the BNL Fire Protection (FP) Engineer. Required compensatory actions shall be specified by the FP Engineer to ensure equipment protection. These compensatory actions shall be implemented by the MCR Operations Coordinator.
- 2) One smoke detector string in an area may be inoperable if the heat detector string in the affected area is operable. The inoperable smoke detector string shall be made operable on the next maintenance day, not to exceed 10 days from discovery.
- 3) Both smoke detector strings in an area may be inoperable if the heat detector string in the affected area is operable. Both smoke detector strings shall be made operable on the next maintenance day, not to exceed 4 days from discovery.

- 4) If both smoke detector strings and the heat detector string in an area are out of service, shutdown the facility within 8 hours and restore the fire detection systems.

- 5.6.2 During periods of shutdown, and if the facility is to be occupied, the ESH Coordinator or the Maintenance Coordinator, shall insure that at least one of the smoke detector strings in the occupied area, or the heat detector string, AND the fire alarm bells, are operable.

Authorized Alternative: The Operations Coordinator, ESH Coordinator or Maintenance Coordinator, may allow partial or full inoperability of any fire detection system or fire alarm bell in occupied areas, as long as a Fire Watch is posted who can verbally communicate to evacuate occupants and to contact the BNL Fire/Rescue Group by radio or phone. [C-A OPM 3.24](#) specifies notifications following implementation of this alternative.

- 5.6.3 Personnel may occupy the Collider tunnel if the exhaust fans in the occupied area, required for personnel protection during an emergency, can be activated manually or automatically.

Authorized Alternative: If exhaust fan operability in the affected area cannot be restored within four hours, the on-duty Operations Coordinator, ESH Coordinator or Maintenance Coordinator shall empty the affected area of occupants and prevent occupancy until operability is restored.

- 5.6.4 The ESH Coordinator shall ensure the Plant Engineering Division has tested the Collider Fire Protection system annually (not to exceed 15 months between tests).

5.7 Staffing

- 5.7.1 The Head of the Main Control Room shall ensure an adequate number of qualified personnel in the C-A Main Control Room. As a minimum, one Operations Coordinator and one Operator shall be on duty when beam is in operation. During normal operations, one shall remain in the Main Control Room at all times.

Authorized Alternative: If one of the two on-duty operators is incapacitated, the remaining operator may continue Collider operations as long as manning requirements are restored within two hours.

- 5.7.2 The Collider-Accelerator Support Group Leader shall ensure shall ensure a qualified Collider Accelerator Support (CAS) watch person is on duty for experimental operations with beam.

- 5.7.3 The Cryogenic Systems Group Leader shall ensure the following requirements for the Cryogenic Control Room: one Cryogenic Shift

Supervisor or designee and one qualified Cryogenic Operator shall be on watch when the main refrigerator is in operation. One of the two must remain in the Cryogenic Control Room at all times unless controls in the Cryogenic Control Room are relocated to the Main Control Room or unless emergency conditions require actions to be taken by all cryogenic watch standers.

Authorized Alternative: If one of the two on-duty operators is incapacitated, the remaining operator may continue main refrigerator operations as long as manning requirements are restored within two hours.

5.8 STAR Experiment

5.8.1 The C-A Facilities and Experimental Support Group Head shall ensure the following whenever flammable gas is in the integrated detector positioned in the IR:

5.8.1.1 Both STAR and PASS flammable gas detection systems are operational.

Authorized Alternative: Within 2 hours of discovery and if requested by the Experimental Shift Leader, the Operations Coordinator may request that the Department Chair or designee allow partial or full inoperability of any one of the two flammable gas detection systems for up to 8 hours with flammable gas present if the benefit of continuing STAR detector operations is judged to outweigh the potential risk of STAR experiment damage. Operating procedures (OPM 3.24) specify the compensatory actions to be taken during inoperability.

5.8.1.1.1 The PASS functions of the flammable gas detection system are to be tested in accord with requirements in [BNL RadCon Manual, Chapter 3, Appendix 3A](#).

5.8.1.1.2 The STAR functions of the flammable gas detection system are to be tested annually (not to exceed 15 months).

5.8.1.2 If the Silicon Vertex Tracker (SVT), or the Silicon Strip Detector (SSD), are operational, then the Inner Field Cage (IFC) detector ventilation system shall be delivering air flow.

Authorized Alternative: Within 2 hours of discovery and if requested by the Experiment Shift Leader, the Operations Coordinator may request that the Department Chair or designee allow detector ventilation system failure for up to 8 hours with flammable gas present if the benefit of continuing STAR detector operations is judged to outweigh the potential risk of STAR experiment damage. Operating procedures (OPM 3.24) specify the

compensatory actions to be taken during inoperability.

5.8.1.3 At least one of the two emergency exhaust fans connected to PASS is operational and functionally tested annually (not to exceed 15 months).

5.8.1.4 Purge gas operational requirements are specifically defined in the approved STAR Operating Procedures for the detector.

5.8.1.5 The TPC gas used in the detector shall be P-10 or equivalent hazard. Equivalent gasses shall be approved by the Facilities and Experimental Support Group Head or ESRC Chair.

5.8.2 The C-A Facilities and Experimental Support Group Head shall ensure the following whenever electronics are powered in the integrated detector in or out of the IR:

5.8.2.1 The Highly Sensitive Smoke Detection (HSSD) system on the detector or the ceiling-level HSSD system is operational and functionally tested annually (not to exceed 15 months).

5.8.3 The STAR Liaison Physicist shall ensure, via the ESRC Checkoff List, that whenever flammable gas is in the integrated detector:

5.8.3.1 A sufficient quantity of purge gas is maintained to dilute the detector flammable gas volumes below 25% of the LEL.

5.8.3.2 When the TPC is in operation, no more than 80 cubic meters of methane gas at STP is attached to the gas mixing system.

5.8.3.3 A qualified local watch is provided.

5.8.4 The STAR Liaison Physicist shall ensure that a STAR Experiment Shift Leader is present at the STAR Experiment when experimental beam is delivered to STAR.

5.9 PHENIX Experiment

5.9.1 C-A Facilities and Experimental Support Group Head shall ensure the following whenever flammable gas is in the integrated detector positioned in the IR:

5.9.1.1 Both PHENIX and PASS flammable gas detection systems are operational.

Authorized Alternative: Within 2 hours of discovery and if requested by the Experiment Shift Leader, the Operations Coordinator may request that the Department Chair or designee allow partial or full inoperability of any one of the two flammable gas detection systems for up to 8 hours with flammable

gas present if the benefit of continuing PHENIX detector operations is judged to outweigh the potential risk of PHENIX experiment damage. Operating procedures (OPM 3.24) specify the compensatory actions to be taken during inoperability.

5.9.1.1.1 The PASS functions of the flammable gas detection system are to be functionally tested in accordance with requirements in the [BNL RadCon Manual, Chapter 3, Appendix 3A](#),

5.9.1.1.2 The PHENIX functions of the flammable gas detection system are to be tested annually (not to exceed 15 months).

5.9.1.2 Both emergency fans, EF1 (exhaust), and EF2 (supply), that are connected to PASS are operable.

5.9.1.2.1 The emergency fans are to be functionally tested annually (not to exceed 15 months).

5.9.1.3 Purge gas operational requirements are specifically defined in the approved PHENIX Operating Procedures for the detector.

5.9.1.4 The detector or ceiling level HSSD system is operational and functionally tested annually (not to exceed 15 months).

5.9.1.5 The High Capacity Ventilation System is operational and functionally tested before the introduction of flammable gas into the Ring Imaging Cherenkov (RICH) Detector.

5.9.1.6 The interstitial space between the RICH and the Pad Chamber Front End Electronics (FEE) shall be inerted when flammable gas is in the RICH.

5.9.2 The Liaison Physicist for the PHENIX experiment shall ensure the following whenever electronics are powered in the integrated detector in or out of the IR:

5.9.2.1 The electronics racks interlocks in the IR are operational and functionally tested annually (not to exceed 15 months).

Authorized Alternative: Within one hour of discovery, de-energize the integrated detector electronics.

5.9.2.2 Either the Highly Sensitive Smoke Detection (HSSD) system on the detector or the ceiling-level HSSD system, is operational and is functionally tested annually (not to exceed 15 months).

- 5.9.3 The Liaison Physicist for the PHENIX experiment shall ensure the following, via the ESRC Checkoff List, whenever flammable gas is in the integrated detector:
 - 5.9.3.1 A qualified local watch is provided.
 - 5.9.3.2 A sufficient quantity of purge gas is available to dilute the detector flammable gas volumes below 25% of the LEL.
- 5.9.4 The PHENIX Liaison Physicist shall ensure that a PHENIX Experiment Shift Leader is present at the PHENIX Experiment when experimental beam is delivered to PHENIX.
- 5.10 If personnel occupy an IR after flammable gas is present, then the Liaison Physicist for the PHENIX or the STAR experiment shall ensure that the personnel plug door and the emergency escape labyrinth are available for egress.
- 5.11 Shutdown Periods
 - 5.11.1 During shutdown periods, specific safety requirements for the experiments shall be reviewed on a case-by-case basis by the ESRC and approved by the Chair of the ESRC.
- 5.12 Groundwater Protection, Radiological Barriers and Dose Limits
 - 5.12.1 The C-A Facilities and Experimental Support Group Head shall ensure the Collider water-impermeable rainwater barriers are inspected annually (not to exceed 15 months).
 - 5.12.2 The C-A Facilities and Experimental Support Group Head shall ensure that radiological barriers are inspected annually (not to exceed 15 months).
 - 5.12.3 The C-AD Associate Chair for ESHQ shall ensure that:
 - 5.12.3.1 No individuals in other BNL Departments or Divisions, located adjacent to C-AD facilities receives more than 25 mrem in a year.
 - 5.12.3.2 The maximum dose equivalent to a member of the public at the BNL site boundary is less than 5 mrem in a year from C-AD operations.
 - 5.12.3.3 Offsite drinking water concentration and on-site potable well water concentration must not result in 4 mrem or greater to an individual in one year from C-AD operations.
 - 5.12.3.4 No C-AD staff member receives more than 1250 mrem in a calendar year.

5.12.3.5 C-AD operations do not cause tritium concentrations in the BNL sanitary system effluent to exceed 10,000 pCi/liter averaged over a 30-day interval.

5.12.3.6 All airborne radioactive emissions from Collider facilities are managed in accordance with the Radioactive Air Emissions subject area. If emissions are anticipated to exceed 0.1 mrem per year to the Maximally Exposed Individual, actions will be taken to ensure operations comply with NESHAP requirements including continuous emissions monitoring and permitting.

5.12.3.7 In order to protect groundwater, if the annual activity concentration of sodium-22 or tritium in leachate is calculated to exceed the limits given in the Accelerator Safety Subject Area, then a cap shall be used unless BNL Management is convinced otherwise.

6. Documentation

None

7. References

7.1 [RHIC SAD](#)

7.2 [Accelerator Safety Envelope for RHIC](#)

7.3 [BNL RadCon Manual, Chapter 3, Appendix 3A](#)

7.4 [C-A-OPM 1.10.1, "Procedure for Documenting Unreviewed Safety Issues"](#)

7.5 [C-A-OPM 4.91, "Configuration Management Plan for the C-A Access Controls System"](#)

7.6 [C-A-OPM 10.1, "Occurrence Reporting and Processing of Operations Information"](#)

8. Attachments

None