

**Collider-Accelerator Department  
(C-AD)**

# **COLLIDER USER TRAINING**

**Radiation Safety  
Conventional Safety  
Access Control**

## **INFORMATION GUIDE**

Includes Equivalency for training courses:

- General Employee Radiation Training (GERT)
- Oxygen Deficiency Hazard (ODH) - Class 0

**NOTE !** If after completing this training you are unsure of how to properly enter AND exit the Primary Area through the PASS gates, then please get assistance since improper operation can cause programmatic delays.



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# COLLIDER USER TRAINING

## Learning Objectives Or Why Take This Course?

This course is required if you want unescorted access to the Relativistic Heavy Ion Collider (RHIC) complex. This includes RHIC experimental areas such as at STAR and PHENIX. Unescorted access requires that you have facility-specific knowledge. This training alone, however, does not qualify you to perform work at your experimental area. As a minimum to perform work, you are also required to read & sign a work plan document specific to your experiment. At this time, for the STAR and PHENIX experiments, these documents are provided as web-based training items. To access these documents, go to <https://www.bnl.gov/training/courses/web/> and click on: PHENIX Awareness (RC-PAT); or STAR Low Hazard Worker-Planned Work for Users (RC-SOCSTAR). Further information about the work plan document may be obtained from your Experiment Spokesperson or from the Collider-Accelerator Department (C-AD) Liaison Physicist for your experiment.

Other additional training may be required depending on your work activities. For example, the following may require additional training:

- operating electrical circuit breakers or disconnect switches,
- performing work on electrical circuits or equipment,
- working at heights (work plan may allow within limits),
- climbing portable ladders,
- climbing vertical fixed type ladders,
- handling compressed gas cylinders,
- entering confined spaces,
- performing LOTO (lockout/tagout),
- entering magnetic field areas,
- operating a crane,
- use of a man-lift or aerial lift,
- use of a scaffold,
- entering noise hazard areas,
- entering Radiation Areas,
- entering areas that require a TLD (for example, much of the Collider Tunnel),
- using machine shop equipment,
- use of portable power tools.

These are examples and not intended to be an all-inclusive list. You should consult with your Spokesperson, Liaison Physicist or experiment Work Control Coordinator regarding additional training. A job-specific BNL Work Permit may be required as well.

If you are a Shift Leader or Run Coordinator at your experiment, you are also required to complete additional training, which includes Read & Acknowledgement (R&A) of certain C-AD procedures. The R&A training will include Emergency Procedures for your experimental area.

The training requirements for these positions are specified via these web sites:

For STAR: <http://www.bnl.gov/guv/training/RHIC/STAR/default.asp>

For PHENIX: <http://www.bnl.gov/guv/training/RHIC/PHENIX/default.asp>

Information about this training may also be obtained from the Experiment Spokesperson or C-AD Liaison Physicist for your experiment. Another contact for questions regarding training requirements is the C-AD Training Office: x7007.

This course provides you with basic information about the access control system at the Collider, the physical and administrative controls that prevent accidental exposures to radiation in Primary Areas, Work Planning, and certain conventional safety hazards.

This course includes an approved equivalency for BNL training courses:

- General Employee Radiation Training (TQ-GERT)
- Oxygen Deficiency Hazard for Class 0 Areas (TQ-ODH)

A Controlled Area is a posted area established to protect individuals from exposure to radiation and/or radioactive materials. At C-AD, GERT does not generally allow you entry into Controlled Areas that require personal dosimetry. The typical dosimeter used at C-AD and BNL is the Thermo luminescent Dosimeter (TLD). The practice at C-AD is that you complete BNL's Radiation Worker-1 training for access to TLD areas.

In addition to ionizing radiation hazards, experimental areas may contain hazards posed by:

- heavy objects
- mechanical equipment
- overhead cranes
- working at heights
- climbing ladders
- magnetic fields
- electricity/electrical energy (high-voltage and high-current electrical systems)
- lasers
- hot and cold surfaces
- high noise
- oxygen deficiency from release of helium or nitrogen
- radio-frequency (RF) radiation
- contamination and oxygen deficiency from smoke and fire
- slips, trips and falls
- compressed gas
- startle hazards; e.g.: from equipment auto starts, pressure reliefs

We strive to maintain an excellent safety record in such a complex environment without undue inconvenience to the User. With your help, over the past several years we have significantly reduced or avoided fire losses, personnel radiation dose, reportable occurrences, environmental releases and injuries. We can assure the continuity of this safety record only by having the active cooperation of each individual who has access to the experimental areas.

## Liaison Physicists

Your Liaison Physicist (LP) is your primary contact for Environmental, Safety and Health issues concerning the experiment. A list of Liaison Physicists can be found at:

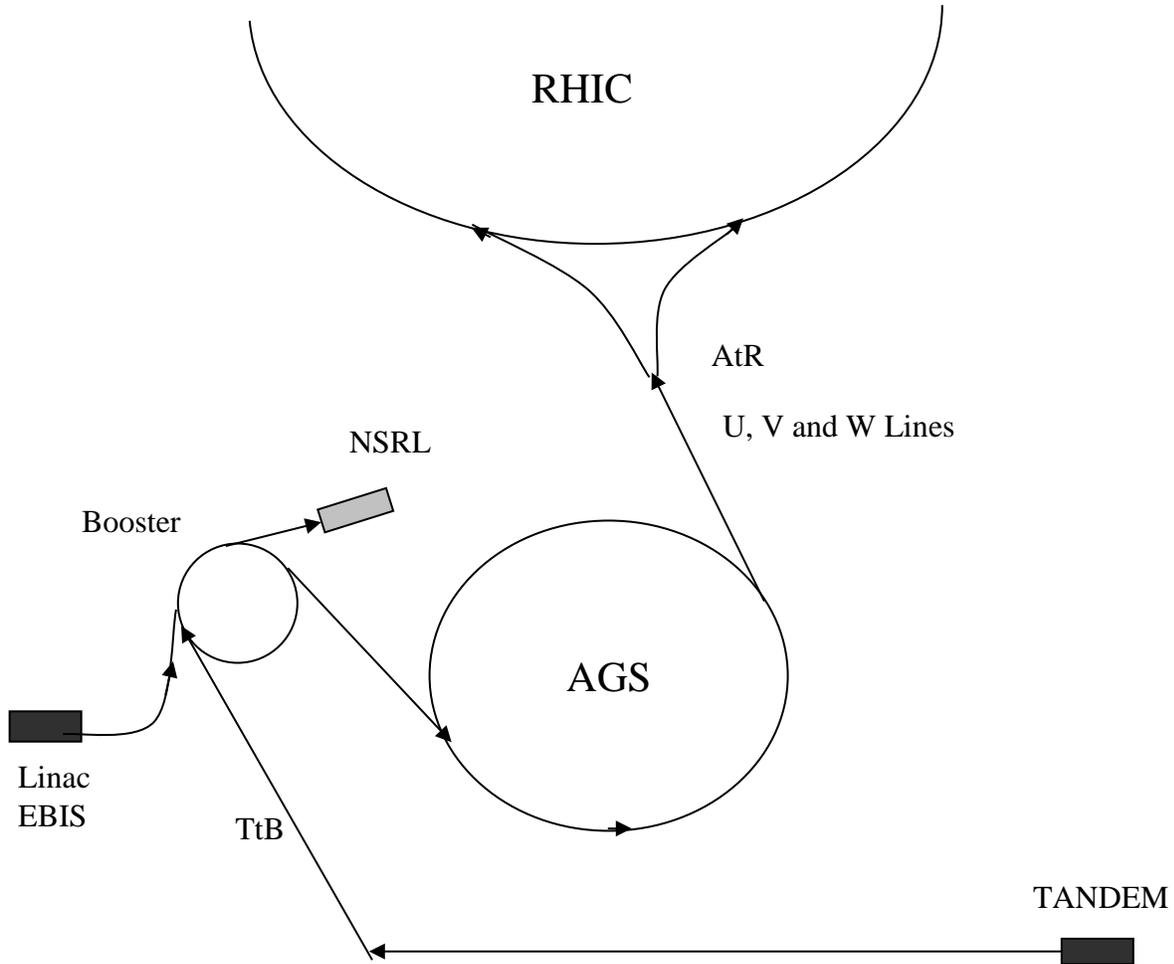
<http://www.c-ad.bnl.gov/esfd/liaisons.htm>. For RHIC experimental areas:

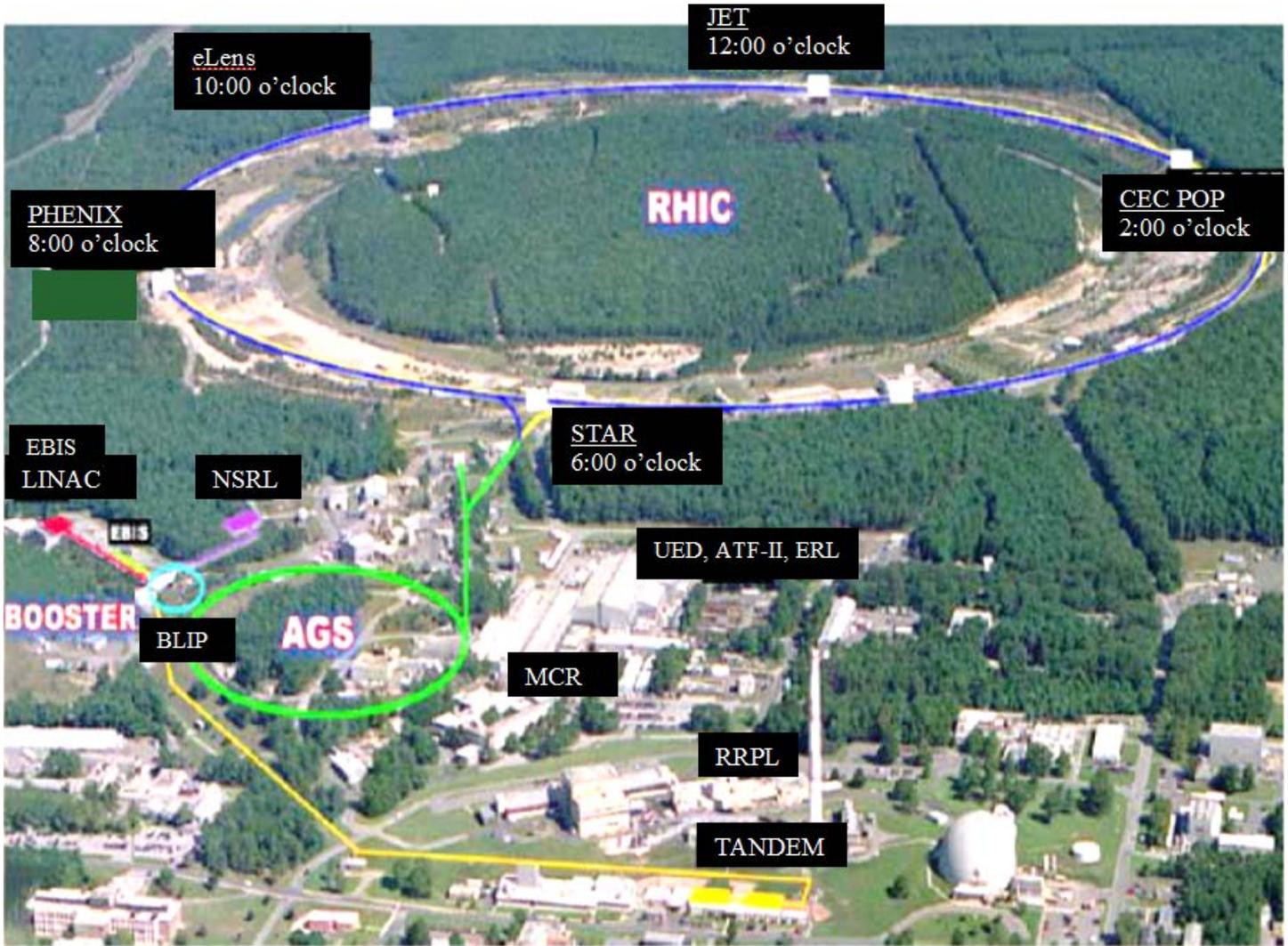
<u>Experimental Area</u>	<u>Liaison Physicist</u>	<u>Telephone</u>
STAR	Robert Pak	4380
PHENIX	Andrei Poblaguev	7508
PP2PP	Kin Yip	4116
eLens	Xiaofeng Gu	4724
CeC	Vladimir Litvinenko	2570

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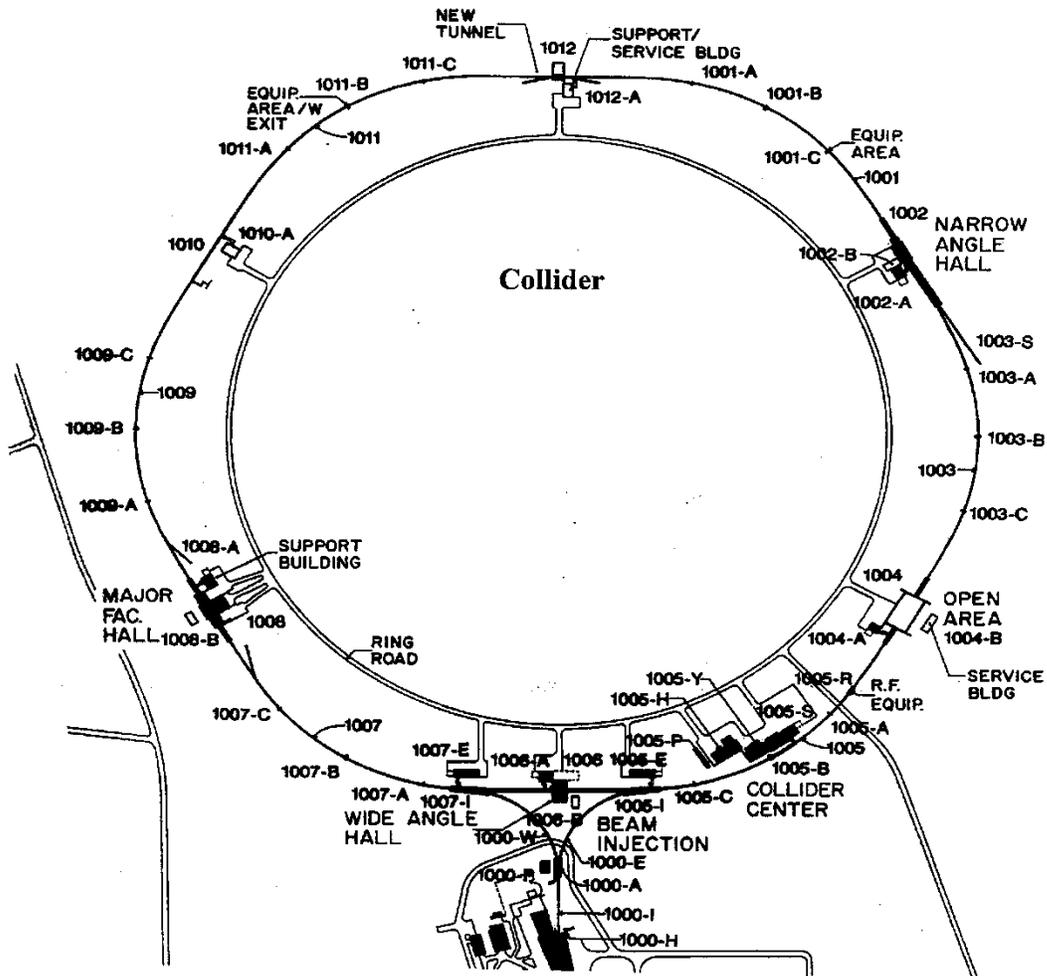
# General Facility Description

The Collider-Accelerator complex includes the Linear Accelerator (LINAC), Electron Beam Ion Source (EBIS), Tandem Van De Graaff, Booster and Alternating Gradient Synchrotron (AGS) accelerators, which deliver particles to the Relativistic Heavy Ion Collider (RHIC).





# COLLIDER RING



Two main experimental areas that RHIC Users access are:

**STAR:** Located at building 1006, at the 6 O'clock position along the collider.

**PHENIX:** Located at building 1008, at the 8 O'clock position along the collider.

Other experimental areas or upgrades, planned or ongoing:

**CeC PoP:** 2 O'clock position

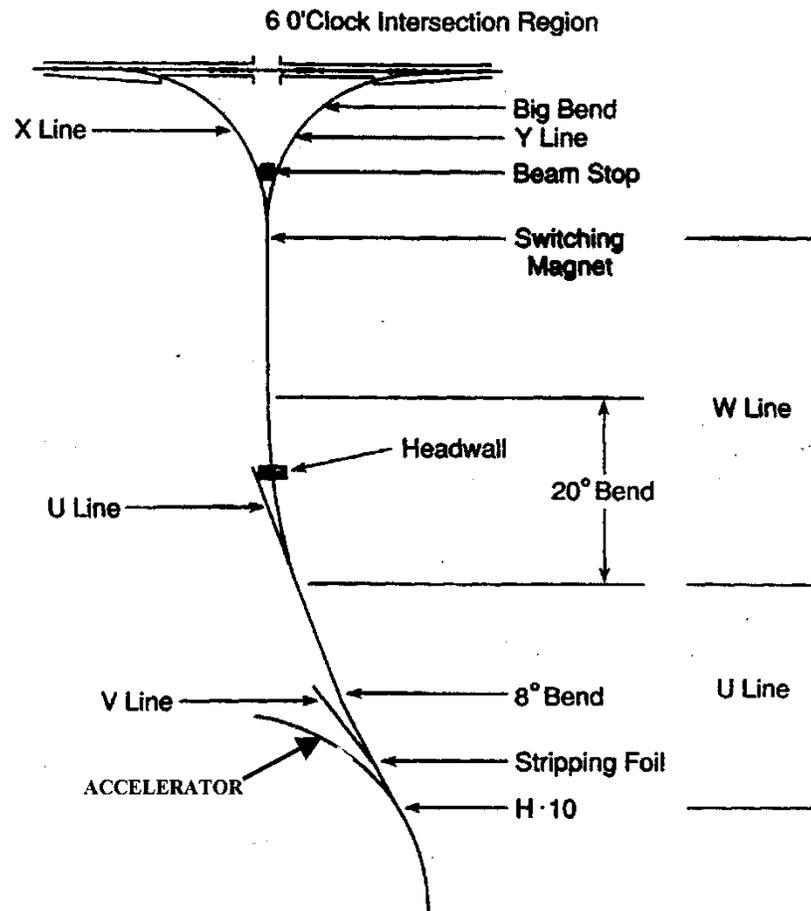
**eLens:** 10 O'clock position

**Jet Target/Polarization Measurement:** 12 O'clock location

**PP2PP:** part of STAR

**Energy Recovery LINAC (ERL)**

# ACCELERATOR TO COLLIDER TRANSFER LINE



# C-AD Conduct of Operations

The Collider-Accelerator Department (C-AD) is managed and operated under a "Conduct of Operations" written agreement with the U.S. Department of Energy (DOE). This requires:

- Definitive lines of authority
- Written procedures for most operations
- Use of trained & qualified personnel where required
- Appropriate authorizations and work permits before beginning a job

The Conduct of Operations agreement requires that you be familiar with the above requirements.

During operating periods, responsibility for the safe and reliable operation of the C-AD complex resides with the on-duty Operations Coordinator (OC). The OC is the focal point for all questions or problems related to operations and can be reached at phone extension 4662 during operating periods. The OC is located in the C-AD Main Control Room (MCR) in Bldg 911. In an emergency, during operating periods, the OC can make the necessary notifications and arrange for assistance. To call MCR from a cell phone: (631) 344-4662.

You can determine if the accelerators or Collider (RHIC) are in an operating or shutdown status by reading this information on TV monitors located throughout the C-AD complex. Also, control panels at access control gates to each experiment's Intersection Region (IR) will display a RED, YELLOW or GREEN light indicating an access control mode for that gate. The access control system is discussed in more detail later. The system is known as PASS: Particle Accelerator Safety System.

During maintenance or shutdown periods, operational-related maintenance must be coordinated through the C-AD Maintenance Coordinator and must have the required authorization. Required authorizations are listed in the C-AD Operations Procedure Manual. Lead personnel are to be appropriately trained. If requested, you must satisfy C-AD requirements for authorization (e.g., to work on a system declared as a "critical" system).

Contacts for RHIC Users include:

Experiment Work Control Coordinator  
Experiment Spokesperson  
C-AD Liaison Physicist for the experiment  
C-AD Liaison Engineer for the experiment  
C-AD Environment Safety & Health Coordinator

# Restrictions for Medical Reasons

## What is your Responsibility?

If you have a permanent or temporary medical condition that you believe should restrict or limit your expected activities here at BNL, please understand it is your responsibility to inform your Experiment Spokesperson of this situation. Our intent is to protect your health and safety as well as the health and safety of the people around you without undue infringement on your privacy. A few examples of restrictions that might be required due to some medical condition are (depending on your expected work activities):

- no work at heights above 5 feet
- no climbing vertical fixed ladders
- no work requiring color discrimination
- no entry into magnetic field areas

Note: Entry into posted magnetic field areas by medical device wearers is generally not allowed. Medical devices are defined as: electronic medical devices, cardiac pacemakers, ferromagnetic medical devices and other implants affected by magnetic fields. In some cases, approval by the BNL Clinic may be given to enter, depending on the medical device or implant and field strength.

The BNL Occupational Medicine Clinic (OMC) performs periodic routine Physical exams that identify restrictions **for employees**. However, **for guests/Users**, please understand it is your responsibility to notify your Experiment Spokesperson if you believe you have some medical condition that should restrict or limit your expected activities here at BNL.

## Radiation Hazards

PROMPT RADIATION - The most significant source of radiation at the Collider is prompt radiation. Prompt radiation occurs while the Collider is in operation (when beam is on). Prompt radiation is found in the primary beam line and at the intersection region of each experiment. It is radiation occurring during beam-to-beam collisions or during collision of the beam with other matter; e.g.: beam pipe, beam stop, targets. Primary beam areas have interlocked enclosures designed to prevent personnel access when beam is on. These areas include, but are not limited to, AGS to RHIC (AtR) Transfer line, U and W lines, the Collider Tunnel and the experiment intersection regions. A fatal dose of radiation may occur as a result of exposure to prompt radiation in an area of primary beam, or in an area of operating RF (radio frequency) systems. RF Storage and Acceleration Cavities located in the beam line at the 4 o'clock region are an x-ray hazard. **No occupancy is permitted in primary areas where beam or RF cavities are enabled or on.**

RESIDUAL RADIATION - Residual radiation exists as a result of material being activated from the accelerated beam, and exists even after the beam is turned off. Activation occurs from the beam colliding with material directly, or from secondary particles colliding with material or being absorbed into the material. This activation process can occur in the beam stop locations as well as other high interaction or beam loss areas. These areas are posted with radiological signs.

# Experiment and Equipment Reviews

All experiments and experimental support equipment must be reviewed by the C-AD Experimental Safety Review Committee (ESRC). Once approved, an experiment may not be changed or added-to without re-review and approval by the C-AD ESRC. For example, any material placed in or near the primary beam needs to be reviewed by the ESRC and the ALARA Committee for potential gaseous or particulate releases that could contaminate the area, equipment or personnel, and must be reviewed for potential overheating.

Procurement of new equipment (Electrical or non-Electrical): Procured items or products for use at BNL may be required to be NRTL-listed (Nationally Recognized Test Laboratory). This applies to more than just electrical equipment. If an NRTL listed item or product is not available for what is needed, BNL subject matter experts may be allowed to review and examine the unlisted equipment and permit its use. In the case of electrical equipment, if an NRTL listed item cannot be found, the equipment must be reviewed by a C-AD qualified Electrical Equipment Inspector (EEI). If you have any questions regarding NRTL requirements, please contact the C-AD ESRC.

Procurement of Pressure Vessels: (NOTE: the discussion here is intended to be awareness level training only. The BNL Subject Area on Pressure Safety should be referred-to regarding pressure vessels, pressure piping and piping system components.)

When purchasing a new pressure vessel, or a vacuum vessel that could possibly be unintentionally backfilled with >15 psig, the vessel may be required to be ASME-certified and U-stamped in order to be used at BNL. ASME-certified vessels are fabricated and stamped by an ASME-certified manufacturer and registered with the National Board of Boiler and Pressure Vessel Inspectors (NBBI).

When ASME codes are not applicable (because of pressure range, vessel geometry, use of special materials, etc.), we must still implement measures to provide equivalent protection and ensure a level of safety greater than or equal to the level of protection afforded by the ASME or applicable state or local code.

*Repairs and alterations:* Only staff trained to perform repairs and alterations on pressure vessels or pressure systems are allowed to make such repairs or alterations. ASME-certified pressure vessels must be repaired or altered by an ASME-certified "R" stamp holder to maintain ASME certification.

If you have questions regarding requirements for pressure vessels or pressure piping systems/components, contacts available to you are:

- C-AD Chief Mechanical Engineer
- BNL Pressure and Cryogenic Safety Subcommittee (a subcommittee of the Lab Environment, Safety & Health Committee (LESHC))

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# General Employee Radiological Training (GERT)

This Collider User Training includes an approved equivalency for BNL's General Employee Radiological Training.

GERT allows you unescorted access into **Controlled Areas**. This includes Radioactive Material Areas within Controlled Areas. At C-AD, this training does not generally allow you to enter any area that requires a TLD (thermo luminescent dosimeter). Such areas include Controlled Areas that indicate a TLD is required for entry on the posting (check postings). Most of the Collider tunnel is posted as a Controlled Area with TLD required. The intersection regions at STAR and PHENIX (common areas that many RHIC Users need access to) do not require a TLD at this time.

Other areas that require a TLD, even if not stated on the posting, include: Radiation Areas, High Radiation Areas, Airborne Radioactivity Areas, Contamination Areas, and Radiological Buffer Areas. Additional training is required for entry into these areas. Visiting RHIC Users typically do not need access to these type areas.

The C-AD practice of not generally allowing entry into a TLD area with just GERT may differ elsewhere at BNL. That is, some BNL departments may issue TLDs, and allow entry into Controlled Areas requiring a TLD, with just GERT. At C-AD however, in order to be issued a TLD and enter a TLD area unescorted, the practice is that you successfully complete BNL's Radworker-1 Training, which is a higher-level training than GERT. A reason for this C-AD practice is that there are many posted "Radiation Areas" within the C-AD complex. For entry into posted Radiation Areas, a TLD *and* Radworker-1 training are required. Logging into a Radiological Work Permit (RWP) is also required. With many Radiation Areas as well as Controlled Areas throughout the C-A complex, the C-A Department must avoid individuals mistakenly thinking that they may enter Radiation Areas simply because they have been issued and are wearing a TLD. Therefore, we do not generally issue TLDs without Radworker-1 training.

## Tiered Dose Limits and Administrative Control Levels (ACL):

- The Federal Government has established, as law, a maximum radiation dose limit of 5,000 mrem/year for radiological workers.
- DOE has established an Administrative Control Level of 2,000 mrem/year to assure we do not exceed the Federal Limit.
- BNL has established an Administrative Control Level of 1,250 mrem/year to assure we do not exceed the DOE level.
- C-AD has established an Administrative Control Level of 1,000 mrem/year to assure we do not exceed the BNL level. Note: The ALARA Committee reviews the necessity for allowing an individual to exceed 500 mrem in a year at C-AD, and allowance must be approved by the C-AD Chairman. (Other BNL department facilities may set their own ACL; below 1,250 mrem/year.)

Maximum Expected Exposure: Individuals trained to the GERT level who are not issued personal dosimetry (e.g.: TLD) are not expected to receive in excess of 100 mrem/year. GERT trained individuals utilizing personal dosimetry (not the common practice at C-AD) may encounter radiation dose rates resulting in a small potential for cumulative doses to exceed 100 mrem in a year, although this is not expected since access is restricted to posted Controlled Areas and Radioactive Material Areas.

## RISK ASSOCIATED WITH RECEIVING IONIZING RADIATION DOSE

We know that receiving very large doses of ionizing radiation somewhere between 50,000 and 100,000 millirem in a short period of time may cause some people to experience nausea, vomiting, and diarrhea, which are all primary symptoms of radiation sickness. People receiving doses exceeding 100,000 millirem will experience more severe sickness and some people may even die from the exposure.

Through scientific research, ionizing radiation dose has been identified as a potential cause of cancer in humans. The National Academy of Sciences, National Council on Radiation Protection and Measurement, and the International Commission on Radiation Protection estimate the average risk (to an adult) of fatal cancer from radiation in his/her lifetime is 4 in 10,000 per 1,000 millirem of radiation dose.

To put the risk of radiation-induced cancer into perspective, let's compare it with the risk we face of dying from cancer in everyday life. As a member of the general population in the United States you have roughly a 20% chance of dying from cancer from all causes combined. In other words, each of us has a one in five chance of dying from a cancer-related illness. By receiving an additional 1,000-millirem radiation dose from an occupational source, an individual's risk of developing a fatal cancer would increase from 20 % to 20.04%. This increased risk is well below the risk of dying from an accidental death, such as a car accident. Although the risk is very low, we continuously strive to reduce the potential for any radiation induced injury.

## **RADIOLOGICAL POSTINGS**

Read all radiological postings carefully. They are used to alert personnel to radiation and radioactive materials. They indicate requirements for entry and exit of the area.

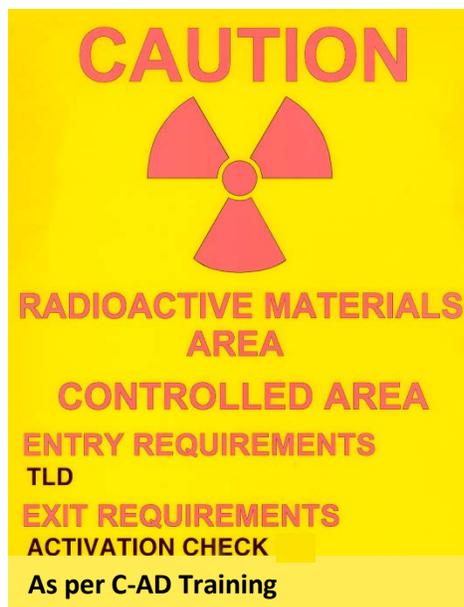
The following are examples of typical postings encountered at the Collider complex.

### **Approach to RHIC Inner Ring Road: CONTROLLED AREA**



During operation, the above posting is displayed at the entrance to RHIC Inner Ring Road, on northbound Renaissance Rd before the berm. At the successful completion of this course, which includes GERT, you would be permitted past this posting. It indicates Controlled Area. It does not indicate that a TLD is required. During extended shutdown periods, this posting might be removed for convenience. (Note: The Collider Tunnel usually remains posted as a Controlled Area even during an extended shutdown period and does require a TLD. The experiment intersection regions (IRs), however, typically do not require a TLD. Please observe postings.)

- RHIC Tunnel:** - CONTROLLED AREA,  
- TLD Required\*,  
- Activation Check Required\*



Most of the RHIC tunnel is posted as shown above. The posting indicates a Controlled Area with a TLD required for entry. Without a TLD, you are not permitted into areas posted this way. To be issued a TLD and to enter TLD areas at C-AD, the practice is that you complete BNL's Radiation Worker-1 Training.

Activation Check Requirements: The above posting also indicates "Activation Check" under Exit Requirements. This is typical for the RHIC Tunnel (see \* below). Objects that are exposed to primary beam may become radioactive and are to be handled with special care to avoid excessive and unnecessary exposure. Items may not generally be removed from areas posted "Activation Check" without a Radiological Control Technician (RCT) checking the item for radioactivity. However, items or material that you bring into an area posted "Activation Check" may be removed without an activation check if the item was never left in the area during beam operation and was in your purview while in the area. Check the postings for the area to see if activation checks are required. If you are unsure if an item you are removing needs to be checked, then ask for assistance (C-AD Health Physics x4660).

\* **STAR and PHENIX Intersection Regions:**

The STAR and PHENIX experimental intersection regions (IRs) typically do not require a TLD, and do not require activation checks. **However**, please observe current postings. As of the writing of this training guide revision, plans are to disassemble the PHENIX detector in preparation for sPHENIX, and area postings and work controls may change significantly.

**Ground to Sky:** A note about radiological postings and boundaries: Radiological areas are identified by postings at an entrance to an area and/or on surrounding fencing, rope or tape barriers. Where rope, tape or fencing is in use, it is to be considered a boundary that extends from ground to sky. “Entering the area” is defined as any part of the body crossing the boundary. For example if you simply reach over a rope boundary, you have entered that posted area.

## PREGNANCY

Because the embryo/fetus is more susceptible to injury from radiation (compared to mature, developed cells), DOE and BNL have a policy which permits the worker to declare that she is pregnant and have the dose received by she and her developing fetus restricted. Any woman working in areas where she could be exposed to radiation or radioactive materials has the option of voluntarily notifying her supervisor in writing that she desires to reduce her radiation dose to protect the embryo/fetus. For a declared pregnant worker, Brookhaven National Laboratory has established an administrative control level of **350** mrem throughout the gestation period to be received at a maximum rate of 40 millirem/month.

## RADIATION LEVELS, AREA NAMES, AND TRAINING REQUIRED

<b>Radiation Level</b>	<b>Area Name</b>	<b>Training Required</b> (for unescorted access)
< 5 mrem per hour  < 100 mrem per year (for area not requiring personal dosimetry)	Controlled Area	GERT  And  For RHIC areas: Collider User Training (includes GERT)
≥ 5 mrem per hour  < 100 mrem per hour	Radiation Area	Radworker-1 Training  And  For RHIC areas: Collider User Training
≥ 100 mrem/hr at 30cm  < 500,000 mrem/hr at 1m	High Radiation Area	Radworker-1 Training  And  For C-AD areas: Other designated C-A Facility-Specific Training

## PERSONAL DOSIMETRY (Thermo luminescent Dosimeter badge - TLD)

Although at C-AD you are not typically issued a TLD with Collider User Training/GERT, personal dosimetry is discussed here as part of the GERT qualification. The practice at C-AD is that you successfully complete Radworker-1 training to be issued a TLD.

The TLD **monitors** your exposure to beta, gamma, and neutron radiation. It offers **no protection** from radiation. TLDs are exchanged on a monthly basis. The TLD is the basis for the legal record of your occupational dose. Requirements for TLD use include:

- TLDs are worn when required by signs or postings, Radiological Work Permits, and when directed by Facility Support personnel.
- TLDs must be worn on the front of the torso, between the waist and the neck unless directed otherwise by Facility Support personnel.
- Either immediately following a job or at the end of the work shift, return the TLD to the badge board. Be careful to place it in the correct slot. Temporary ("TEMP") badges should not be placed in slots designated for permanent badges. Permanent badge slots have assigned numbers.
- If you leave BNL (employment is terminated or your guest appointment has expired), be sure to leave your TLD on a badge board, or return your TLD to Facility Support personnel (x4660 at C-AD) or to the individual who issued you the TLD.
- TLDs issued at BNL should not be worn at another facility and dosimetry issued from another facility should not be worn at BNL. The concern is that your dose should be recorded only once for any time period monitored, and that it be associated with the proper facility.
- You must never use someone else's TLD and never lend your TLD for someone else to use. Violation of this policy can result in serious disciplinary actions.
- Persons successfully completing GERT may be issued a TLD at BNL, although the C-AD practice is that you have Radworker-1 training to be issued a TLD. Trained personnel receive a TLD with a blue or yellow stripe on the front of the badge. The color alternates monthly. A red stripe on the front of the badge identifies an untrained visitor TLD. Individuals wearing an untrained visitor TLD require escort in an area requiring dosimetry. If you encounter an unescorted untrained (RED-striped TLD) visitor within a TLD area, immediately escort them out of the area. **DO NOT REMAIN IN THE AREA AS THEIR ESCORT UNLESS YOU HAVE BEEN PROPERLY APPROVED TO DO SO.** (Note: entry into a 'Controlled Area', even if a non-TLD area, still requires an escort and a signed/approved escort form for an untrained person).
- Never open or tamper with the TLD. If you suspect the TLD has been misused or damaged in any way, (such as having been put through the laundry cycle or been worn during a medical x-ray), you should notify Facility Support personnel (x4660 at C-AD) or the C-AD A&R Division Head (x5636).
- If while in a TLD area your TLD is lost, damaged, or contaminated, place your work activities in a safe condition, immediately exit the area and notify Facility Support personnel (x4660 at C-AD) or the C-AD A&R Division Head (x5636).
- Report any lost TLD badge immediately.

Regarding the seriousness of proper use of personnel monitoring devices, the following is an excerpt from an article published in *BNL Radiological News*, May 2004:

Recently there have been several noncompliances concerning the use of thermo luminescent dosimeters (TLDs) at Brookhaven National Laboratory. For example: worker wears another person's TLD; worker does not exchange TLD at month's end but wears it for many months. One of these issues resulted in BNL having to report the noncompliance in the Department of Energy's (DOE) Noncompliance Tracking System (NTS), which is the DOE system for reporting nuclear and worker safety noncompliances. It is important that trained radiological workers and escorts follow the requirements for use of personnel monitoring devices.

## MEDICAL TESTS THAT MAY IMPACT DOSIMETRY

A common test for evaluating the condition of the human heart is the Thallium (or Technetium) Stress Test, which injects a radioactive dye into the bloodstream. For several days following the test, there remains enough radioactive material in the body to affect the radiation dose being recorded on your TLD. This could also occur if you have had radioactive “seeds” implanted for radiotherapy. It is important that you notify your Facility Support Representative of any medical treatment or diagnostic procedures that you received which involved the use of radioactive materials being placed in your body. The FS Rep may ask that you not wear your TLD for a specific period of time (and not enter TLD areas). Otherwise, your TLD report could incorrectly indicate that you received an occupational dose.

## PERSONAL DOSIMETRY RECORDS AND REPORTS

The BNL Personnel Monitoring Group maintains the data collected from TLDs. The Personnel Monitoring Group compiles and distributes personalized dose reports annually to all affected BNL employees. If you as a User require a record of your exposure, you must provide the Personnel Monitoring Group with a written request. A report will be sent to you within 90 days.

## BNL's RADIOLOGICAL STOP WORK POLICY

Each individual who has received radiological safety training (GERT or Radworker-1) has the authority and responsibility to stop non-compliant or unsafe radiological work immediately. This policy is commonly known as the Radiological Stop Work Policy. If you believe that a serious deviation from BNL radiological requirements is occurring, inform the workers that you are issuing a Stop-Work order and tell them to stop work. A serious deviation is something that could create the threat of unplanned radiological exposures or releases. In most situations, a formal Stop-Work Order is not needed. Supervisors do not need to invoke a Stop-Work Order in exercising their normal responsibilities to monitor work in progress and to ensure proper adherence to BNL practices.

If someone refuses to Stop Work, you should immediately bring this to the attention of your supervisor, or to the C-AD Environment, Safety & Health (ES&H) Coordinator (x4006), or to the C-AD A&R Division Head (x5636).

If a Radiological Stop Work Order is issued to you, you **MUST**:

- Stop working on the affected activity as soon as possible and as safely as possible.
- Place the workspace in a safe condition.
- Report to your supervisor and explain why the Radiological Stop Work Order was issued at your job.

Work is not to resume until safety reviews are performed and the responsible Department Chairperson or equivalent line manager authorizes work to restart.

## BNL's RADIOLOGICAL AWARENESS REPORTING (RAR) PROGRAM

The RAR program provides an avenue of communication between daily work activities and management concerning deficiencies in the administration of the Radiological Controls Program. If you have a concern regarding radiological practices or a radiological deficiency, you may initiate a Radiological Awareness Report (RAR) as follows:

- Obtain an RAR Form from the C-AD Facility Support Representative (the form is also available on-line via SBMS)
- Submit the completed RAR Form to your Supervisor

Your supervisor will submit the RAR to the BNL RAR Coordinator.

If you have any questions regarding the RAR Program you may contact the RAR Coordinator at extension 4408.

## RADIATION EXPOSURE CONTROL

People have always been exposed to radiation from natural sources. We are exposed to this radiation from our environment, from materials inside our bodies, and from certain man made sources such as medical x-rays and other medical procedures. The average radiation dose to a member of the general population in the United States is about 620 mrem/year. This amount is a combination of both natural background and man made sources of radiation, with natural background contributing about 300 mrem/year.

### C-AD EXPOSURE PHILOSOPHY

Radiation Exposure at C-AD Must:

- Have a Net Benefit
- Be *As Low As Reasonably Achievable (ALARA)*

Once an experiment is configured and enabled, valuable scientific information is obtained. It is difficult to estimate the economic or other worth of this information. It is assumed that this research has a net benefit. Eating, drinking, or smoking in a radiological area increases the time spent in the area, and correspondingly the dose, without increasing the net benefit. Therefore, eating, drinking, and smoking are prohibited in all Radiation and High Radiation Areas.

## ALARA STRATEGIES

The basic ALARA strategy on the part of the User revolves around reducing dose by the efficient use of time, distance, and shielding. Reduce the time spent in radiological areas, increase the distance from sources of radiation, and use shielding whenever possible. ALARA is also incorporated into design and operations. For example, the access control system at C-AD prevents inadvertent entry into Primary Areas with beam on. Obey all signs and postings. **Do not enter** any area restricted for radiological purposes unless qualified or properly escorted.

Our greatest dose reduction at the C-AD complex has come by the way of improvement projects. We have improved the reliability of the vacuum system, injection system, and extraction system. Improvements, redesign and the use of radiation tolerant materials have resulted in fewer repairs of activated equipment, thereby reducing personnel dose incurred for maintenance.

## PRICE-ANDERSON AMENDMENTS ACT (PAAA)

It is important to make you aware of the absolute requirement to follow all safety requirements (both radiological and non-radiological) at C-AD and BNL facilities. The Price-Anderson Amendments Act (PAAA) is a Congressional Act which provides the Federal Government the ability to impose enforcement penalties if you do not follow the requirements fully. If safety requirements are violated, enforcement penalties may be imposed against Brookhaven Science Associates (BSA), or even against individuals. Personnel have been the subject of criminal investigations when found to willfully violate safety requirements, such as removing a radiation barrier.

When signing documents related to radiological or non-radiological safety, an employee or User is essentially confirming that he or she will do his or her assigned work according to the rules. The signature does not mean that the individual is guaranteeing that the work will be carried out perfectly or that there is no potential for a violation. It does mean that the individual is performing his or her duties to the best of their ability and has made a good faith effort to comply with the safety requirements. A "good faith effort to comply" means that the employee or User has familiarized him or her-self with the requirements that fall within his or her area of responsibility.

DOE has put nuclear and radiological safety requirements into the Code of Federal Regulations (CFR), Title 10 (Energy), Part 835 Occupational Radiation Protection. This is referred to as: 10 CFR 835.

DOE has also more recently put safety requirements (non-radiological) into the Code of Federal Regulations (CFR), Title 10 (Energy), Part 851 Worker Safety and Health Program. This is referred to as: 10 CFR 851.

### WARNING

It should be understood that any User or employee who intentionally violates any safety requirement, regardless of whether the User or employee signs any document related to compliance, might be subject to criminal prosecution or other disciplinary action.

The intent of the Price-Anderson Amendments Act is to protect the health and safety of workers and the general public.

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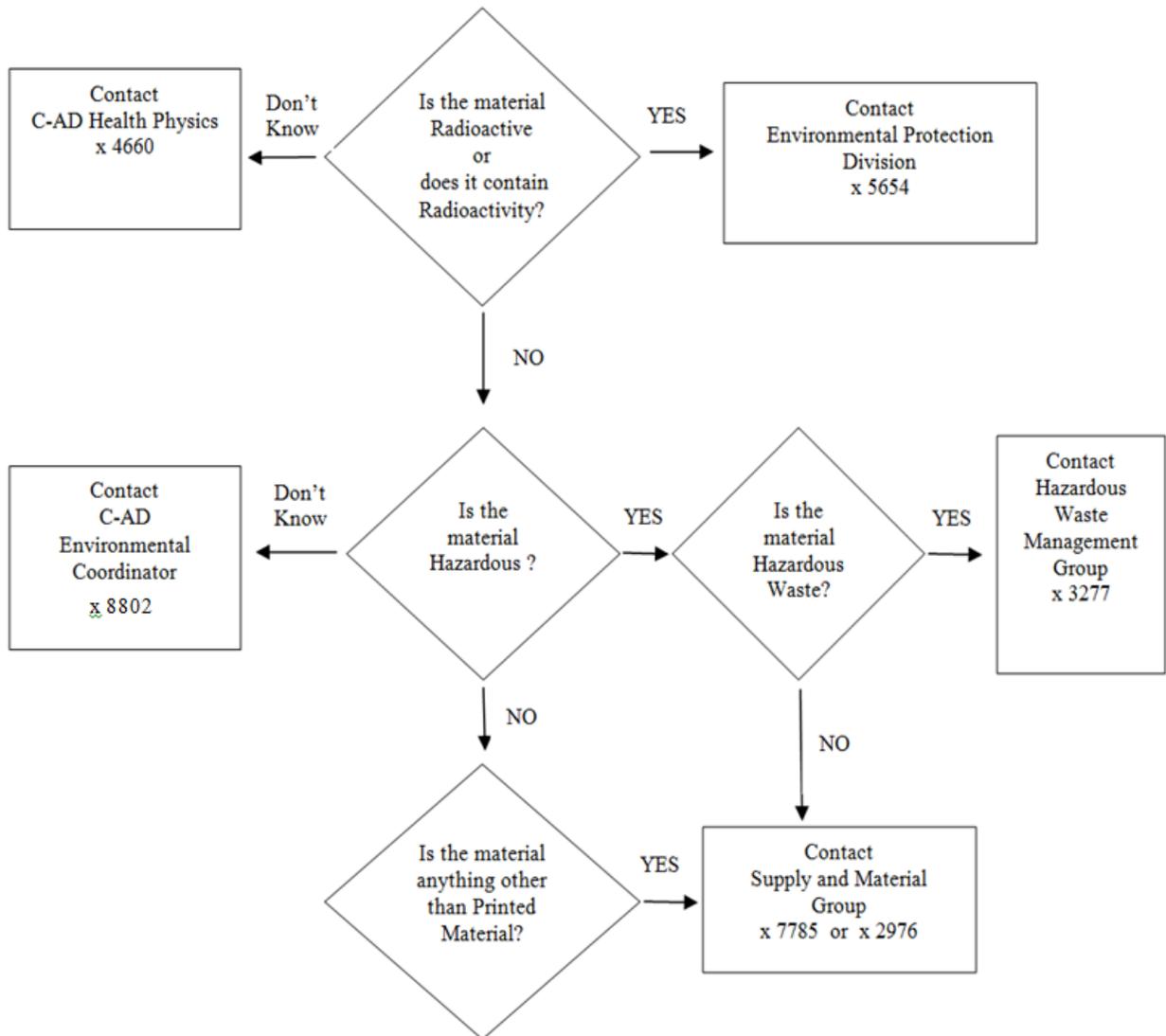
## Deliveries to C-AD Facilities

BNL and C-AD must prevent outside delivery personnel from inadvertently entering areas that they are not qualified to enter while attempting to find the recipient of a package. For example, an untrained Fed Ex or UPS delivery person entering an area controlled for radiation protection could receive unnecessary exposure and the occurrence could be a PAAA violation. To prevent this type of incident, the C-A Department requires that, during normal working hours, deliveries for the C-A complex be made to Shipping & Receiving, Building 98. Arrangements can be made with the C-AD Main Control Room (MCR) (x4662) for off-hour deliveries. You must make such arrangements in advance. When the delivery is made to Bldg 98 or to the MCR, personnel there will then contact you, the addressee. Under no circumstances are deliveries to be made to other buildings in the C-A complex without approval of the C-A A&R Division Head (x5636).

When placing an order or having any delivery made, inform the vendor or addresser to address the package to Bldg 98 (or MCR under rare circumstances and if advance arrangements are made with MCR). In addition, it is important that you inform the vendor or addresser to also put your name and contact information on the package so that Bldg 98 or MCR personnel have a way to contact you. Packages arriving without a name may be sent back.

# Shipping Off Site

If you are shipping material from the C-AD complex to off-site, then ask yourself these questions:



Note: If the material may be Mixed Waste, there are specific labeling and processing requirements. Please see BNL Subject Area “Mixed Waste Management” for details. Mixed Waste is waste that is both Hazardous and Radioactive.

# Particle Accelerator Safety System (PASS)

**NOTE!** If after completing this training you are unsure of how to properly enter AND exit the Primary Area through the PASS gates, then please get assistance since improper operation can cause programmatic delays.

**The main purpose and design of PASS is to protect personnel from radiation.**

The Particle Accelerator Safety System located within the Collider portion of the C-AD complex is designed to control access to primary beam areas, and it provides for a beam-imminent warning alarm. The system also detects excessive radiation levels outside shielded areas using area radiation monitors. These monitors are sometimes called 'chipmunks'. Additionally, the system detects Oxygen Deficiency Hazard (ODH) conditions with in-place oxygen monitors, it activates ODH alarms and activates ventilation equipment if low oxygen is detected.

The system includes the many locked gates that lead to primary beam areas. The gates control or limit access to the primary beam areas. Entry through the gates is with the use of a plastic card-key (which is typically a pink color for RHIC Users) OR by use of an RFID tag pulled from a key-tree (using iris recognition).

PASS gate entries require **one key for one person only!** Each person must enter with his or her own key (unless special escort procedures are followed). More than one person entering under one key is considered a serious violation of procedure, and is subject to disciplinary action. If there is a need to escort an untrained individual (who doesn't have their own key) into a gated area, contact the C-AD A&R Division.

## **Entry Modes and Status Indicators**

There are 3 basic entry modes that the Particle Accelerator Safety System (PASS), or a particular gate, may be in:

(RED) **PROHIBITED ACCESS** Mode

(YELLOW) **CONTROLLED ACCESS** Mode

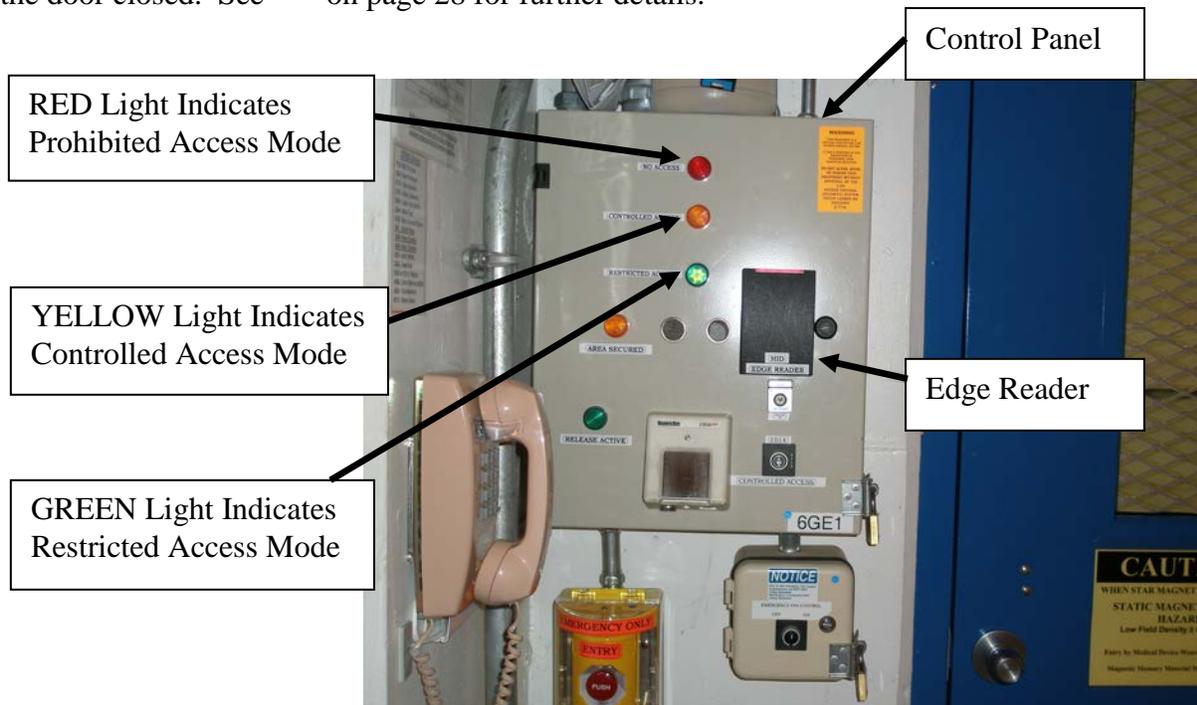
(GREEN) **RESTRICTED ACCESS** Mode (*least restrictive*)

## ENTRY and EXIT

### CONTROL PANELS

Control panels are located at entrances and exits of PASS gates. A system of lights on the panels indicates the machine's operational access status, or the access control mode of that particular gate. Users typically enter and exit gates that lead to the Intersection Region (IR) of their experiment. Some Users enter the tunnel (TLD area) beyond the IR.

Note: Several gates have been replaced with a 'newer' type door. The older gates are chain link type. The newer type is a solid door with a window. The entry and exit procedures are essentially the same, except there is no mechanical latch assembly with the door knob holding the newer door closed. Instead, there is a magnet installed at the top of the door frame that holds the door closed. See "\*" on page 28 for further details.



**RED LIGHT - - PROHIBITED ACCESS**

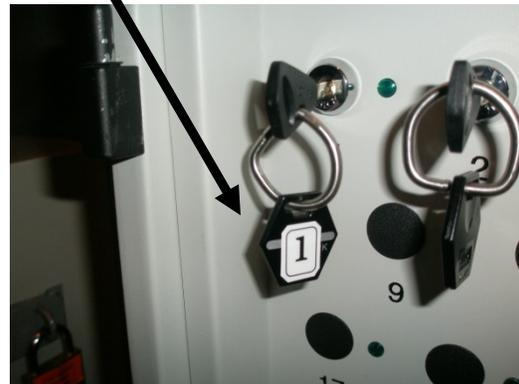
No access is allowed. Beam is on, or beam may be imminent.

**YELLOW LIGHT - - CONTROLLED ACCESS**

During Controlled Access Mode, each individual entering the area is being accounted-for (unlike during Restricted Access). During Controlled Access mode, we must positively verify that every person who enters the area, also exits the area. You must enter and exit the same gate. For entry into the intersection region at STAR or PHENIX, or into the 12 O'clock RHIC location, you will obtain a key & RFID tag from a key tree. Key trees are located at each experimental area.



Iris Scanner



Key-tree key, with RFID Tag

In order to obtain a key & RFID tag from the key tree, you must first have your irises enrolled. If you are unsure if you need to have your irises enrolled for access during Controlled Access Mode, contact your Experiment Spokesperson, Liaison Physicist or supervisor. The C-A Department A&R Division performs iris enrollment in Bldg 911, Room A128 (telephone x7007).

Note: If you need to enter the Intersection region (IR) during Controlled Access Mode, please confirm accessibility to the area with the experiment Shift Leader.

## IR Entry & Exit procedure during Controlled Access Mode

Note: For initial iris enrollment, new Users go to Bldg 911, Room A128 (telephone x7007)

1) Go to the experimental access area. From a distance of about 10 inches look into the iris scanner and center the bridge of your nose with the green dot seen in mirror.

Note: There are two up/down buttons on either side of the scanner to adjust the scanner alignment to suit your height.

2) Follow the instructions of the iris scanner automated voice command. The iris scanner will speak instruction back to you if you are too far or too close.

3) Choose key #1 or the next sequentially available key from the Key-Tree. You have four seconds to retrieve a key.

Note: Once a key is removed, you cannot access the Key-Tree again until a second iris scan. The same individual cannot retrieve two keys at the same time without a violation.

Note: Each key has an RFID tag attached. Each tag has a unique ID based on its slot position in the Key-Tree. Each key is labeled with the number of its corresponding key slot.

4) Take the key with RFID tag to the control panel at the access gate. Observe that the YELLOW Controlled Access light is on (2nd light from top).

5) Request access from MCR Operations via the telephone:

Identify yourself to the MCR operator by giving your name, and ask for a release (opening) of that particular gate, identifying the gate by number.

➡ ***For example: "This is John Doe. Please release Gate 6GE1".***

Note: The MCR Operator is observing you and the gate area remotely by camera.

6) Present the RFID tag within approximately 1 1/2 inches of the Edge Reader until the indicator light at the top of the Edge Reader illuminates Green.

Note: The Edge Reader is the black box labeled "HID Edge Reader" located on the control panel.

Note: **Do not open the gate until you receive the green light on the Edge Reader.**

7) Open the gate and enter.

For the 'newer' type gate (solid door with window):

Pull on the door knob and pull the door open. The door knob does not turn. There is no mechanical latch assembly with the door knob.

For the 'older' type gate:

Turn the door knob and pull the gate open.

**Important:** Take the key with RFID tag with you into the IR.

**Caution:** Beam cannot be 'turned on' unless all keys are properly returned to the key tree. Therefore, taking the key with you into the IR is important for your safety.

**Caution:** Each person entering must obtain a key from the key tree. More than one person entering under one key is a serious violation of procedure, and is subject to disciplinary action.

Note: You are not using the key itself to open the door. You are using the RFID tag. The key serves as a placeholder in the key tree.

8) To leave the IR, use the telephone on the IR side of the gate and ask the MCR Operator for a release (opening) of the gate.

➡ ***For example: "This is John Doe. Please release Gate 6GE1".***

Note: **Wait for the indicator light on the control panel located on the IR side of the gate to illuminate BEFORE opening the door.** Failure to do so will require the MCR to re-sweep the area which will result in delay.

9) Open the gate and exit.

For the 'newer' type gate (solid door with window):

Push on the black bar (channel) with your hand and push the door open.

For the 'older' type gate:

Turn the door knob and push the gate open.

Note: You will not use your key/RFID tag to exit

**In an emergency, open the gate and exit without waiting for a release from MCR.**

10) Proceed to the iris scanner for iris system logout and key replacement.

11) From a distance of about 10 inches look into the iris scanner and center the bridge of your nose with the green dot seen in mirror.

12). Upon recognition by iris scanner, put the key back in the slot of origin within 4 seconds.

Note: You can only return the key to the same slot that you took it from. The system will not allow you to put the key in another slot. Each key is labeled with the slot number on the Key-Tree.

**GREEN LIGHT - - RESTRICTED ACCESS** (least restrictive mode)

For the 'newer' type gate (solid door with window):

To enter during Restricted Access Mode, place your access card-key on the card reader. A small green light on the reader will come on. Open gate by pulling on the door knob. The door knob does not turn. There is no mechanical latch assembly with the door knob.

To exit, push on the black bar (channel) with your hand, and push the door open (you do not need to use your card-key to exit).

For the 'older' type gate:

To enter during Restricted Access Mode, place your access card-key on the card reader and get a small green light on reader to come on. Turn the door knob and pull the gate open.

To exit, turn the door knob and push open the gate (you do not need to use your card-key to exit).

During Restricted Access Mode, personnel are not being accounted for. The card reader stores information for later use if needed, however you are not being tracked or accounted-for during this mode.

Access Card-Key



Card Reader



## If multiple people want to enter with one opening of the gate

Essentially the same rules apply as before. However, here are important notes:

### For entry during Controlled Access Mode:

Each individual still scans their own irises and pulls their own key from the key tree.

Using the phone at the access gate one person contacts the C-AD Main Control Room (MCR) to request access.

The person communicating with MCR informs the MCR Operator of how many people would like to enter with one opening of the gate.

The MCR Operator decides whether or not he or she will allow multiple people to enter. (It is usually allowed, however it is at the discretion of the on-duty Operations Coordinator).

Assuming MCR is allowing multiple people to enter, identify each individual to MCR by giving the name of each individual to the MCR Operator. This may take a couple of moments so please be patient. Also give the gate number to the MCR Operator.

One individual presents their RFID tag (attached to the key) to the edge reader to open the access gate.

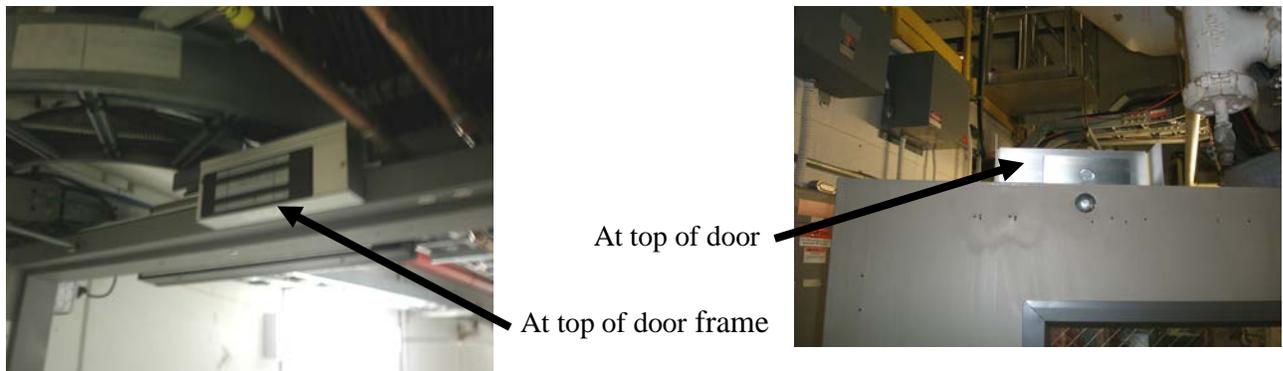
All individuals may enter while the gate is open.

**IMPORTANT:** Each individual **MUST** still bring in their own individual key with RFID tag that they took from the Key-Tree by scanning their own irises. As a courtesy to the MCR Operator watching by video camera, each person entering should hold up and show their key to the camera while entering.

### For entry during Restricted Access Mode:

During Restricted Access Mode, more than one person may enter through the door with one opening of the door provided each individual still scans their own access card-key on the card reader key pad and the small green light on the card reader comes on. The required training of each individual must be current.

\* Example of newer type access gate (solid door with window):

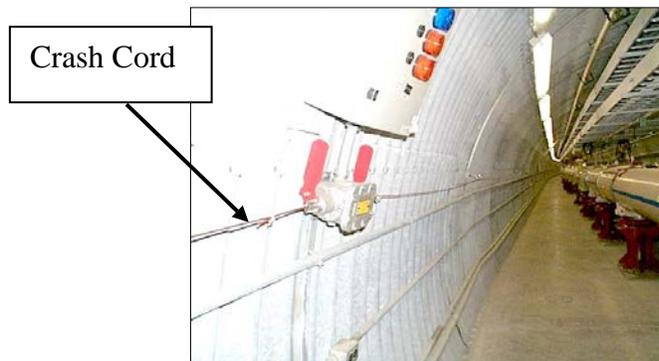


With this 'newer' type door, there is no mechanical door knob latch mechanism. The door is held closed by a magnet installed at the top of the door frame. To exit, simply push on the black bar (channel) with your hand, and push the door open. (REMEMBER: During CONTROLLED ACCESS Mode, contact MCR BEFORE opening door). Within the bar (channel) is housed a capacitive sensor. The act of a person touching it will release the magnet, allowing the door to be easily pushed open.

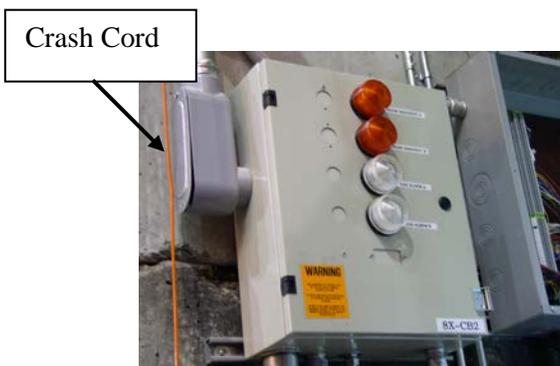
With these newer type access doors, there is a RED button located on the inside as well as the outside of the gated area. These buttons are for EMERGENCY USE ONLY. In the event of an emergency, lift the plastic cover and push the Red Button. This will release the magnet and allow the door to be easily pushed open from the inside, or pulled open from the outside.



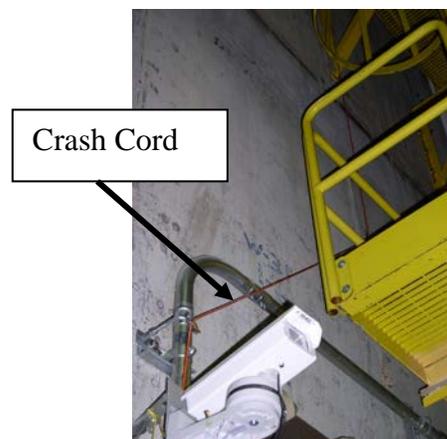
# Beam Imminent Alarm & Crash Cords



Crash Cord and Orange Lights in the Collider Tunnel



Example of Crash Cord in IR



Example of Crash Cord in IR

In the Intersection Regions (IRs) of the Collider experiments, in Experimental Halls, and in the Collider Tunnel, there are Orange Crash Cords and Orange Strobe Lights. If you are in any of these areas and an orange strobe light goes on and an audible alarm is heard, this is a signal that beam is imminent. If you observe the warning signal, then pull a crash cord; or if you are already at an exit then open the gate from the inside and exit (“crash” out). Pulling a crash cord or opening a gate will do the same thing: interrupt normal operations and prevent beam from entering the area. **Do not panic**, you have time, 60 seconds minimum before beam is on. After exiting the area, call the MCR (x4662) and inform them of the incident.

**Do not tamper with crash cords.** Do not hang tools or clothing on the crash cords. This may stretch them causing reset errors. Do not block access gates open. Any modifications to the PASS system (such as an access gate) must be pre-approved by the C-AD Access Controls Group.

# Barriers, Signs, Labels, Warning Tags, Alarms

Throughout the C-AD complex, there are radiation barriers, electrical barriers (and other type barriers), signs, labels, warning tags, and detectors that activate visual and audible alarms to warn of hazards.

- Do not climb over or defeat barriers, regardless of machine status.
- Do not ignore signs, labels, warning tags or alarms, regardless of machine status.

## Barricade Tape

Barricade Tape used at BNL for the purpose of limiting or preventing entry into an area with a hazard must be either YELLOW Caution or RED Danger tape. It must have the specific wording shown here:

**CAUTION ENTRY REQUIRES PERMISSION**

or

**DANGER DO NOT ENTER**

You must complete BNL training TQ-BARRICADES to be allowed to install barricade tape.

Violating barricade tape may result in disciplinary action.

A tag or sign is required to accompany the tape. The tag or sign must include description of the hazard, contact name of group or individual who installed the barrier and installation date.

Tags may be ordered through the BNL Production Services Group.

The tape may be ordered through BNL stock.

If you have questions regarding:

- When should this barricade tape be used,
- Who is allowed to put up barricade tape,
- How to order BNL-acceptable barricade tape or tags,
- How to install barricade tape or tags, or
- How to acquire permission to enter an area that is barricaded\*,

then contact your experiment Work Control Coordinator or Liaison Physicist..

\* Summary of entry rules:

- Entry to areas with DANGER DO NOT ENTER is limited to individuals:  
Indicated in the work planning process, or  
Authorized by a method established by the installing organization, or  
Escorted and always in the presence of the person who installed the barrier.  
Entrants must be wearing the PPE required for the area and hazard.
- For areas with CAUTION ENTRY REQUIRES PERMISSION:  
Entrants must meet all entry requirements, and  
Must obtain permission of the person who installed the barrier.  
Entrants must be wearing the PPE required for the area and hazard.

## Sealed Radiation Sources



Beta, gamma and neutron sources produce radiation levels that may travel many feet in air. The radiation level drops rapidly as the inverse square of distance from the source. This is because most sources are point-like objects. Federal rules define sealed sources as any radioactive item manufactured for the sole purpose of using the emitted radiation. A common example of a sealed source is an instrument calibration source. If you are not sure about the definition of a sealed source, then contact the C-AD Health Physics Office (x4660) in order to make a determination regarding the rules.

If you are using a radioactive source in your work, you are required to complete BNL training course: Sealed Radioactive Source Control (web-based). You may also need department-specific training or a briefing.

When not in use, sources should be stored in shielded containers. Many experimental areas have source boxes like the one shown above.

If you are using a source in your work, then the following rules apply, even if you obtained the source from another BNL Department or Division:

- Contact the C-AD Source Custodian if you are a new sealed source user at C-AD or if you are bringing a source to a C-AD area.
- Contact the C-AD Source Custodian if you plan to procure any new source. Sources are required to be inventoried.
- Have sources inventoried and leak-checked every six months by the C-AD Health Physics Office.
- Complete the “Sealed Radioactive Source Data Form” and the “Sealed Radioactive Source Inventory-Leak Test Form” found in the SBMS Subject Area. Forward a copy of the completed forms to the C-AD Source Custodian. Keep a copy with the source.
- Notify the BNL Nuclear Materials Management (NMM) Group prior to shipping a source to or from BNL. Also contact the BNL Environmental Protection Division if shipping off site.
- Contact the C-AD Source Custodian if you are going to remove a source from the C-AD facility.

If you are responsible for a sealed source, then DOE Orders require than you keep track of it in a way that can be audited by the Federal government.

# Electrical Safety

This Collider User Training does not qualify you to work on electrical equipment or circuits that are physically connected to a power source, or that have stored electric charge (capacitors) or magnetic fields (inductors). Connection may be through circuit breakers, disconnect switches and/or fuses. Additional training and authorization is required to perform electrical work. However, certain *low hazard* electrical work is permitted for STAR and PHENIX Users within certain limits and if rules are followed. This is discussed further in the work plan document written for your specific experiment. These documents for STAR and PHENIX are currently in the form of web-based training items. Go to <https://www.bnl.gov/training/courses/web/> and click on:

PHENIX Awareness (RC-PAT); or  
STAR Low Hazard Worker-Planned Work for Users (RC-SOCSTAR).

(You are required to complete this web-based training for your experiment to perform *any work* at the experimental areas.)

This Collider User Training does not qualify you to work on-or-near energized equipment or conductors. Additional training, personal protective equipment (PPE) and a special work permit (Energized Electrical Work Permit) and authorization are required to work on-or-near energized electrical equipment or conductors.

## Operation of circuit breakers or disconnect switches

During operation of circuit breakers or disconnect switches there is a potential for arc flash. Additional training and authorization is required, as well as PPE, for operation of such devices; even for relatively low voltage such as a 120-Volt breaker. For certain low current and low voltage circuit breakers and disconnect switches, the Laboratory offers a convenient web-based training course for non-electrical workers: Electrical Circuit Breaker and Switch Operation Safety. Please understand that this provides only limited qualification. You may refer to the course itself for further details.

If you have questions regarding the electrical safety requirements for your specific situation, then stop and please refer to contacts available to you. Available contacts include:

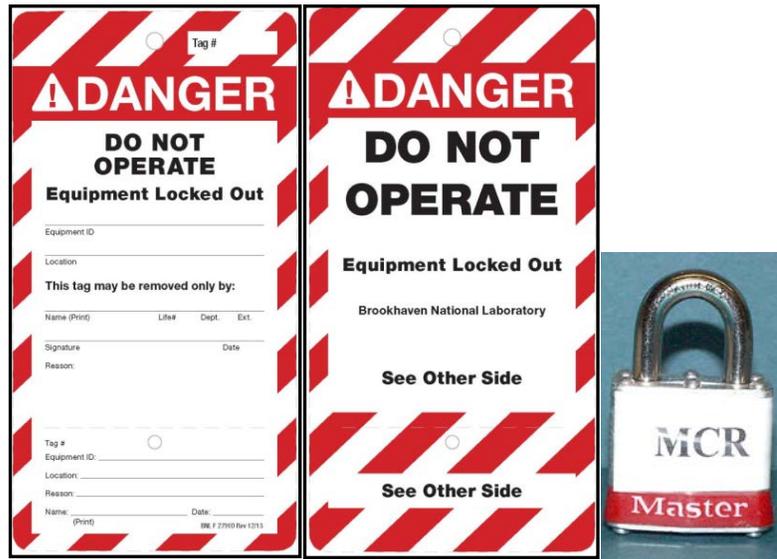
Work Control Coordinator for your experiment,  
C-AD Liaison Physicist for your experiment,  
C-AD ESH Coordinator,  
C-AD Work Control Manager,  
C-AD Training Manager,  
C-AD A&R Division Head,  
C-AD Electrical Systems Head/Chief Electrical Engineer.

# Flash Hazard

A flash hazard is present when the potential exists for electrical equipment to arc, producing a shock hazard as well as possible sparks and molten metal spray. For example, this can occur during operation of a circuit breaker or switch, or in situations where electronic components and connections are exposed during testing. If a conductive tool is dropped into these areas a flash event may occur. Care is required in these areas to prevent any inadvertent electrical contact. The potential for electrocution is well known, but arc flash hazard may not be as well known.

## LockOut/TagOut (LOTO)

Beginning Jan 5, 2015, the LOTO tag used by BNL staff was changed to a BNL-produced two sided red-&-white striped tag — Stock Number S81043. The older red tags (below) that were in place on January 5, 2015 were allowed to remain until January 5, 2016. Contractors can use an OSHA-compliant tag that is similar in appearance (striped red borders). Contractor tags may be printed on one side.

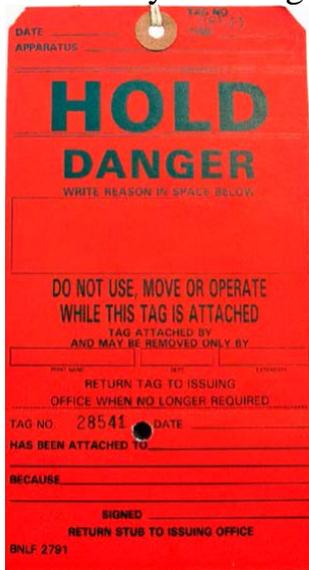


Personnel performing LOTO must complete BNL training (classroom initially, web-based annually, and Job Performance Measure (JPM) annually) and also must have C-A Department-specific authorization. This Collider User Training does not allow you to place or remove locks or tags. An Authorized employee is trained to recognize hazardous energy sources and methods and means to isolate and control these energy sources.

LOTO refers to the specific practices and procedures to protect workers from injury due to the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during servicing, maintenance, installation, and demolition.

It is recognized by the presence of a red-&-white striped tag and a lock, and it requires that you obey specific OSHA requirements. In some cases equipment cannot be easily locked with the typical padlock, and LOTO boots or other commercially available locking devices may be used to establish LOTO.

## Older style red tag



This older style red LOTO tag may still be used for isolation of hazardous energy sources when *not* performing servicing, maintenance, installation or demolition. It may also be used to isolate materials, the release of which could impact the environment.

All personnel who must work on electrical circuits that are connected through circuit breakers, disconnect switches and/or fuses, must LOTO the circuits. OSHA, BNL and C-AD require that all workers performing these tasks be trained in LOTO and be authorized. If you or your co-workers fall into this category of needing to perform LOTO, then assure you are properly trained and authorized.

To prevent accidental electrical shock or other injury from other sources of hazardous energy, the LOTO is only to be removed by the individual who attached it. Under rare circumstances, however, if the individual who attached the LOTO is not available, a committee of three employees may be formed to authorize removal. The membership of the committee must be as designated in the C-AD Operations Procedures Manual (OPM). These persons will be familiar with the area or equipment under the LOTO and they shall determine if it is safe to remove the red tag and lock. If you need to have someone else's LOTO removed, contact the Work Control Coordinator for your experiment, MCR (x4662) or the C-AD ES&H Coordinator (x4006). A similar procedure is used for Radiation Safety (RS) LOTO.

If you have questions regarding the LOTO safety requirements for your specific situation, then stop and please refer to contacts available to you. Available contacts include:

- Work Coordinator for your experiment,
- C-AD Liaison Physicist for your experiment,
- C-AD ESH Coordinator,
- C-AD Work Control Manager,
- C-AD Training Manager,
- C-AD A&R Division Head,
- C-AD Electrical Systems Head/Chief Electrical Engineer.

# Radiation Safety LockOut/TagOut (RS LOTO)

BROOKHAVEN NATIONAL LABORATORY  
COLLIDER ACCELERATOR DEPARTMENT

**RADIATION LOCKOUT**  
USERS MUST BE TRAINED IN  
COLLIDER ACCELERATOR DEPARTMENT  
OPM 9.1.16

**HOLD**

**DANGER**  
DO NOT OPERATE

RADIATION LOCKOUT  
SEE OTHER SIDE

DATE \_\_\_\_\_ TIME \_\_\_\_\_  
RAD. AREA \_\_\_\_\_

**HOLD**

**DANGER**  
WRITE REASON IN SPACE BELOW

DO NOT USE MOVE OR OPERATE  
WHILE THIS TAG IS ATTACHED

TAG ATTACHED BY  
AND MAY BE REMOVED ONLY BY

PRINT NAME \_\_\_\_\_ EXTENSION \_\_\_\_\_  
COLLIDER ACCELERATOR DEPARTMENT DIVISION

Tag NO. 3550 RETURN TAG TO MCR WHEN NO LONGER NEEDED

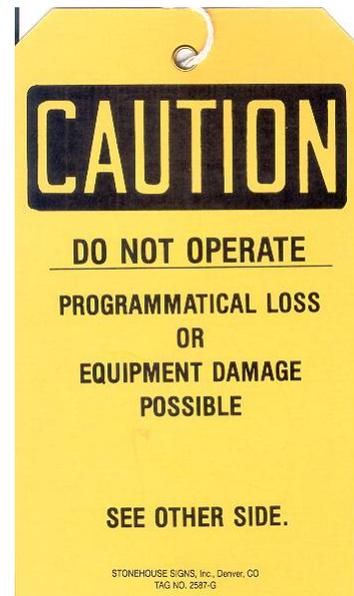
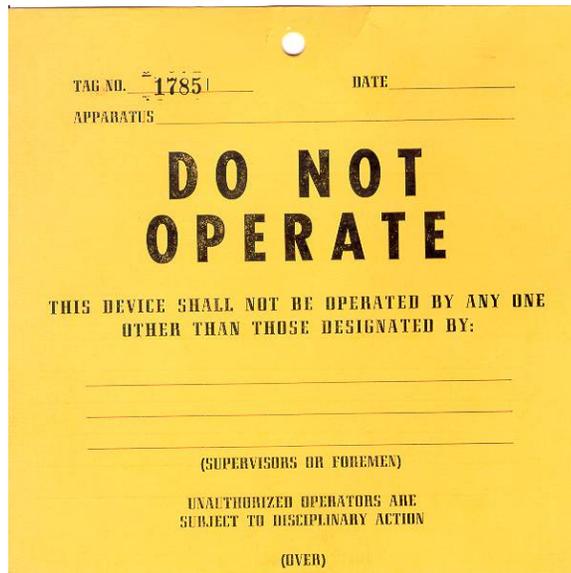
Tag NO. 3550 Date: \_\_\_\_\_

Attached to: \_\_\_\_\_

Signed: \_\_\_\_\_

Liaison Physicists, Liaison Engineers, Access Controls Group staff, Operations Coordinators (OC), members of the Radiation Safety Committee, and certain other personnel perform RS LOTO. They must follow a specific procedure in order to lock out and tag out equipment or beam lines for radiation protection. Equipment or beam lines are generally locked out during barrier modifications or barrier removals, or whenever the PASS system alone does not provide the required protection. This lockout is required in order to limit beam parameters such as polarity and intensity, or whenever a beam line is not authorized to operate. **DO NOT** alter or otherwise tamper with equipment that bears the RS LOTO tag.

## Yellow "DO NOT OPERATE" Tags



Yellow "Do Not Operate" Tags are used to inform and warn personnel that altering the equipment may cause damage to the equipment or system, or can have adverse programmatic impact. They may also be used to remind staff of required equipment configuration. For example, the tag on the right could instruct an operator to open a throttle valve 2 turns during system operation. The equipment should not be altered without consulting the owner of the tag or the system specialist. Only personnel listed as authorized operators may operate the equipment, or may authorize others to temporarily operate the equipment. Note: These tags may never be used for personnel protection. If personnel protection is involved, then LOTO shall be used.

Ref: C-AD OPM Procedure 2.13, Use of "Do Not Operate" and "Caution" Tags for equipment and Systems

# Ground Fault Circuit Interrupter (GFCI) Electrical Outlets

Personnel may notice warning stickers on GFCI electric outlets in bathrooms or kitchen areas, or elsewhere. These GFCI receptacles are designed to constantly monitor the flow of current through the protected circuit and sense any loss of current to an outside path. If the current flowing into the protected device differs by a very small amount from what flows out of the device, the GFCI instantly interrupts the current flow, protecting the user of the device from a potentially fatal electric shock.

Underwriters Laboratory (UL) recommended that all GFCI outlets be tested regularly.

C-AD procedure states:

- GFCIs subject to continuous use are to be tested monthly by the Building Manager or Designee.
- GFCIs subject to infrequent use are to be tested prior to use by the user.

The BNL Laboratory Electrical Safety Committee has stated that testing the GFCI device prior to each use will meet the intent of the UL recommendation and protect the user of the device.

Testing the GFCI is easy. Testing is with the self-test button and a routine load. A portably light or radio, for example, may be used as a load. Simply press the test button on the front of the outlet. You should hear a click and the reset button should pop out. The load should go off. Push the reset button back in and you are ready to use the outlet. If you push the test button and nothing happens, please do not use the outlet and report the problem to the Building Manager or ESH Coordinator as soon as possible.



There are also commercially available inexpensive GFCI receptacle testers:



## Chipmunks and Radiation Surveys



Do not move or tamper  
with Chipmunks

Radiation monitor – Chipmunk

During a running period, radiation surveys are performed and updated periodically by the Health Physics Group, and continuous area monitoring is performed by instruments called Chipmunks. There are approximately 100 chipmunks located throughout the C-AD complex at this time. Most of these instruments alarm in the Main Control Room, as well as locally, when a pre-set alarm level is reached. Many also have interlock set-points that will shut down the beam. Set points are established by the Radiation Safety Committee.

Main Control Room Operators are trained to respond to alarms and interlocks, and investigate the cause, even if it means interrupting the physics program. Do not move or tamper with chipmunks.

Chipmunk readings are recorded continuously and maintained in a database for later retrieval and review if desired. They are stationed at fixed locations in order to monitor high occupancy areas and other areas of interest. Retrospective exposure rates for an area of interest can be determined by the C-AD Health Physics Group.

The Chipmunk is set up like a street light with red, yellow and green indicators. A Chipmunk will display a red blinking light for radiation levels greater than 20 mrem/h, and a yellow blinking light for levels approximately 2.5 to 20 mrem/hr. Normally, Chipmunks operate in the green range indicating nominal radiation levels. If you observe a Chipmunk indicating in the yellow or red range, leave the immediate area, alert your collaborators to leave the immediate area, and then contact the Main Control Room (x4662) for instructions. Inform them of the Chipmunk location as best you can; most Chipmunks have an “NM” number listed on an attached tag. Note: In some cases, it may be expected that a Chipmunk will be indicating slightly into the yellow range; for example, near a target room if running high-energy proton beam.

During shutdowns, radiation surveys are done initially, and whenever a job specific Radiological Work Permit (RWP) is used, or when deemed necessary or appropriate by the C-AD Health Physics Group. Records of surveys are maintained by the C-AD Health Physics Group. Survey data is normally attached to the permits and copies are maintained at the job site.

## Security System Orange Tags

Devices that are part of the security system (PASS) must remain correctly connected and located. (The term “Security System” here is synonymous with Particle Accelerator Safety System, PASS). In order to help ensure that personnel do not disconnect or alter these devices without following approved procedure, the Access Controls Group will identify devices with an **orange warning tag**. In the experimental areas, these tags alert personnel that the device is critical to safety and the operation of the PASS system. **Do not move** these devices since relocation will compromise their effectiveness. Contact the Main Control Room if these devices are inhibiting your work.

- Program disruption and/or electrical shock may occur by overlooking an orange warning tag.
- Tags and signs are often placed only on the front of equipment. Look at the front of equipment



## Radiation Safety Services

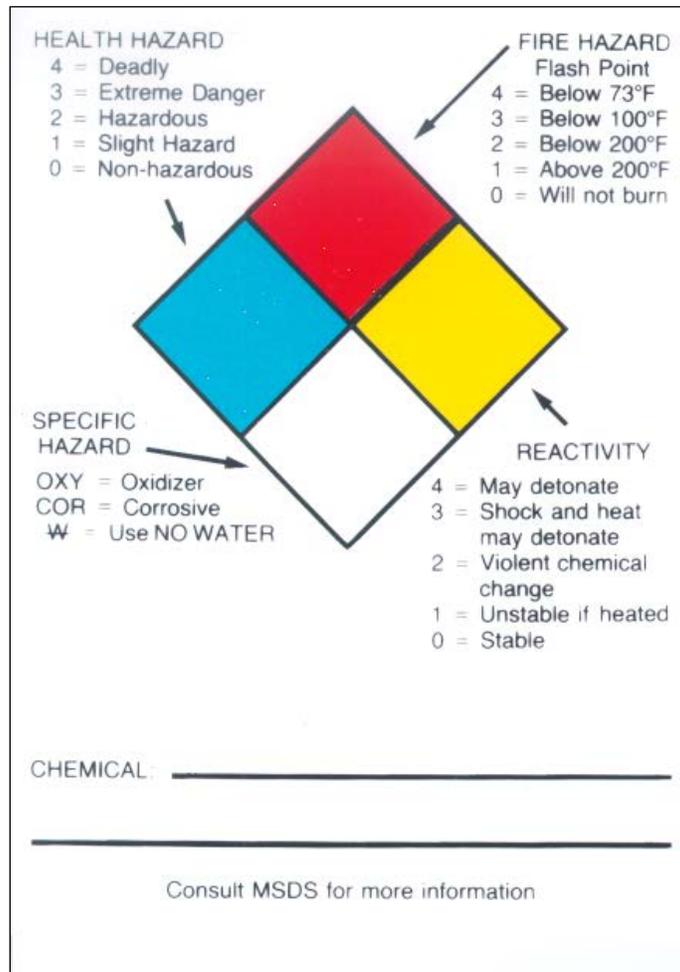
- C-AD Health Physics Office: Telephone x4660

The BNL Radiological Control Division provides the C-A Department with radiation safety services. They provide dose records, radiation surveys, Radiological Control Technician (RCT) coverage for high-dose jobs, and review of RWPs for ALARA. They also assist in interpreting abnormal radiation levels.

During running periods, RCT coverage is provided on all shifts. During shutdown, services are provided from 8:30 a.m. to 4:30 p.m., Monday through Friday. Assistance is obtained by contacting the Health Physics Office (x4660), or by contacting the C-A Main control Room (MCR) at x4662. The MCR can then contact an RCT by radio.

Special shifts for RCTs may be pre-assigned allowing for specific round-the-clock coverage when needed during a shutdown.

## Information on Hazards - - - Your right to know



You have the right to know about potential health and safety hazards in your workplace, and whenever the potential for exposure to hazardous materials exists. You will be provided with specific safety and health information by the ES&H Coordinator. Contact the ES&H Coordinator at x4006. The ES&H Coordinator can provide you with information on the Laboratory's policy on hazardous material, how to obtain Material Safety Data Sheets (MSDS) and how to interpret them. MSDSs may also be obtained from the BNL Chemical Management System web site (<http://intranet.bnl.gov/esh/cms/>). Examples of information found on an MSDS are: name of the chemical, manufacturer, hazardous ingredients, physical characteristics, fire and explosion hazard data, reactivity data, health hazard data, precautions for safe handling and safety control measures.

National Fire Protection Association (NFPA) diamonds appear on containers and on various structures that contain hazardous materials indicating the degree of hazard for the materials.

The ES&H Coordinator can also provide information on how to select and use protective equipment, and explain the labeling system used on chemical containers.

## Noise Hazard Areas



Personnel who enter posted Noise Hazard Areas at C-AD are required to complete BNL's Noise & Hearing Conservation Training: web-based course TQ-NOISE.

If entering a posted noise hazard area, as a minimum you are required to:

- wear hearing protection\*

**AND**

- complete the BNL web-based training course before entry; the course informs you of how to correctly wear the hearing protection

Medical surveillance (periodic hearing test) may also be required depending on your occupational exposure: decibel levels you are exposed to, and length of time you spend in posted areas. Contact the C-AD ES&H Coordinator if you have questions regarding noise exposure.

\* Some postings will say hearing protection required *with equipment on*

## Chemical Safety

For your safety, purchased chemicals are inventoried by the Laboratory prior to delivery for end use. If you bring un-inventoried chemicals on site you must contact the ES&H Coordinator to have these chemicals inventoried and bar-coded prior to use. Purchased chemicals must be ordered through the BNL Purchase Order System. Credit cards may not be used to order chemicals.

# Confined Space Recognition

General Definition: A confined space is a space that (even if not posted “Confined Space”):

1. Is large enough and so configured that personnel can bodily enter and perform assigned work,
2. Has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, and pits), and
3. Is not designed for continuous personnel occupancy.

If you are entering a space with these characteristics, even if the area is not posted, and:

- you are not sure of the regulatory or safety requirements for entry, or
- you are not sure of the requirements for working within the space, or
- you are introducing any hazard

THEN contact the ES&H Coordinator prior to entry.

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# Magnetic Field Safety

NOTE: BNL procedure states that for guests/Users (who do not receive an annual Physical exam from the BNL Clinic) to be exposed to fields greater-than-or-equal-to 0.5 mT (5 Gauss), they are to print out and complete the [Non-Employee Static Magnetic Field Questionnaire](#) and mail it to BNL Occupational Medicine Clinic (OMC) Bldg 490 for approval.

Where magnetic fields may be present, the area is posted. Be aware that areas may be temporarily posted for magnet testing. Shown below is an example of the lowest level BNL posting for magnetic fields. It indicates: greater-than-or-equal-to 0.5 milli Tesla (5 Gauss).

The next higher level postings could be:

60 mT (600 G)  
600 mT (6,000 G)  
2,000 mT (20,000 G) ... etc

Be aware that postings may be customized, and they may not all have the same appearance. For example, signs may have different wording, may have a pictogram, or may state the maximum time allowed in an area. Please read postings carefully.

0.5 mT (5 Gauss) is posted on doors of assembly buildings, experimental areas, the Collider tunnel and other areas throughout the C-AD complex. Even for this lowest level posted area, if you wear a medical device or have a medical implant, entry is not allowed unless evaluated and approved for entry by the BNL Clinic. Medical devices are defined as: cardiac pacemakers; electronic medicals devices; ferromagnetic medical devices; and implants affected by magnetic fields. In some cases, if entry is needed, approval by the BNL Clinic might be given to enter depending on the medical device or implant. The BNL Clinic and your personal physician can determine the magnetic field strength that can adversely affect your device or implant. If in doubt about the requirements or about your specific situation, contacts available to you include the C-AD ESH Coordinator and the BNL Clinic.



For entry into higher level posted areas additional training is required and work planning must assure limits set by the BNL Subject Area on Static Magnetic Fields are not exceeded. The subject area has exposure limits for:

- 8-hour Time-Weighted Average, and
- Ceiling (max)

Potential hazards include: (depending on field strength)

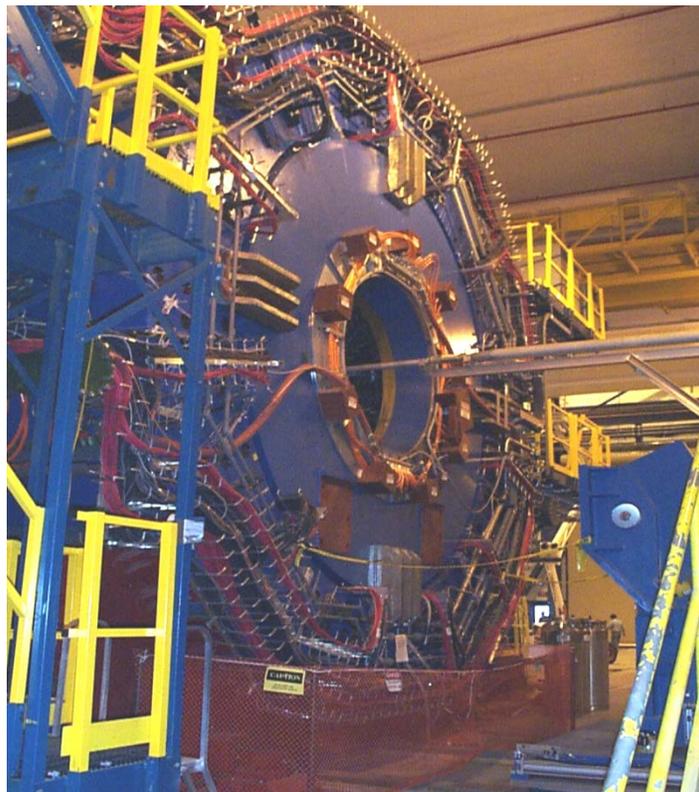
- Uncontrolled movement of ferromagnetic objects in high magnetic fields that cause injuries such as pinched fingers or being struck by metallic objects rapidly pulled towards the source
- Interference with the functioning of cardiac pacemakers, insulin pumps and similar devices
- Internal bodily injuries from the movement of ferromagnetic implants and prostheses

Another potential concern:

- Deletion of information on magnetic memory materials, such as credit cards, identification badges, computer disks and video tapes.

Working around magnets with large gaps

Use extreme caution with iron and steel objects when working around magnets with large gaps such as spectrometer magnets. The magnetic field can cause these objects to become dangerous projectiles. Be sure that magnets are not energized or that a magnet safety plan is followed before free access is allowed to the area. Remember that the field may be effective at a surprisingly long distance.



Example: East Face of the STAR Magnet.  
Posting on fence indicates high magnetic field.

When conducting tours:

When conducting tours with visitors in magnetic fields areas, plan routes to not exceed exposure limits. Inform tour groups of the restriction that anyone with a cardiac pacemaker, insulin pump or other medical device or implant, may not enter areas equal to or greater than 0.5 mT (5 Gauss). The C-AD escort form prompts the escort (tour guide) to inform the visitors of this.

# Laser Safety

Lasers must be registered with the BNL Laser Safety Officer. This includes higher hazard class lasers (Classes IIIb and IV) as well as lower hazard class lasers (Classes II and IIIa). Examples of Class II or IIIa lasers include alignment lasers, and devices incorporating pointing lasers.

Use of higher class lasers, Classes IIIb and IV, requires additional Laboratory training as well as completion of a Laboratory Standard Operating Procedure (SOP).

Class II and IIIa lasers require a permit.

Make sure you are aware of the safety requirements established for lasers in your area.

If you have questions regarding lasers, you may contact the C-AD Laser Coordinator on x4006.

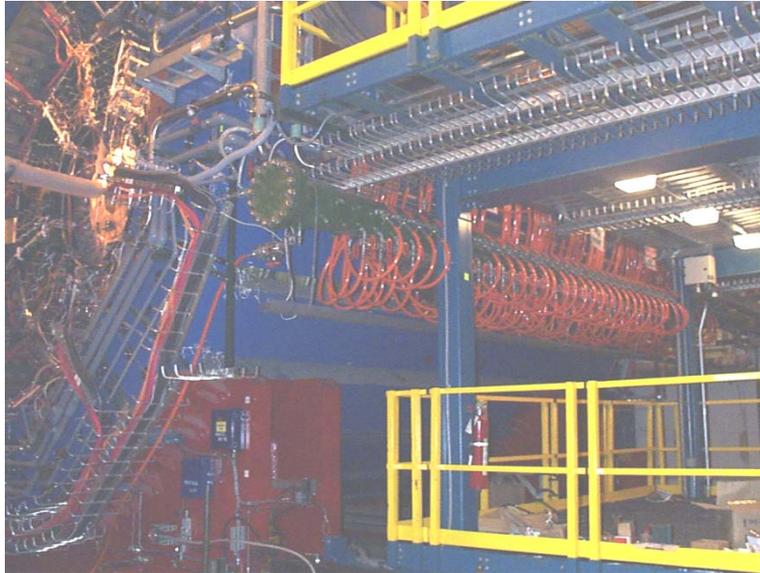


Lasers located at STAR



# Magnet Cooling Water

Magnet cooling water systems may incorporate electrical buses. The water systems operate under pressure and special training is required to work on them. Depending upon the location in the C-A complex, some magnet cooling water systems may have a radiation field associated with them. These are clearly labeled and should not be handled without proper training and authorization.



STAR Magnet Cooling System

## Personal Protective Equipment (PPE)

Department safety policy states that each workplace should be created and maintained in a manner that minimizes safety and health problems. For some jobs or for some areas it may not be practical to eliminate the hazards completely, and protective clothing and/or equipment may be required for safety. Plan your work in advance. Consider whether PPE may be needed. Contact the C-AD ES&H Coordinator (x4006) for reviews and approvals whenever PPE is to be used, or if you have questions on PPE requirements.

## Hardhat Policy

You are required to wear a hardhat:

- When people are working overhead
- When overhead cranes are operating above you
- At all times at a construction site

## Safe Footwear

You must wear footwear that is appropriate for the area and activities in which you are involved. The footwear should fully enclose the foot and provide stable footing for walking on uneven surfaces. Safety shoes are required where there is a potential hazard from falling, rolling or piercing objects or when heavy objects are handled.

Safety shoes are also required for some electrical work activities, such as working on-or-near energized conductors.

It is especially important to remember this during warm weather when people might otherwise choose footwear more for comfort than for safety.

## Working at Heights

Work at heights (above 4 ft) is performed in experimental areas from scaffolds, aerial lifts, ladders or other elevated surfaces. Working at heights must be performed in a safe manner, with proper work planning, fall protection, training and PPE as applicable. If you are not sure of the requirements for your work, contact your Work Control Coordinator before starting.

### Issue “Stop Work” Order if Dangerous Activity is Observed

Example: If you observe a coworker working at heights in a dangerous manner, for example standing on a scaffold railing without proper fall protection, what should you do?

*Answer:* Issue a Stop Work Order

## Vehicle Safety

You must have a valid driver’s license to use a motor vehicle, including a government motor vehicle. Lock government vehicles when not in use. Cannot leave government vehicles running unattended, including Kubotas during warm-up.

# Vertical Fixed Ladders

Note: This is not applicable to stairs or ship's stairs (also known as ship's ladders) including the alternating-step type of ship's stairs.

If you climb any ladder (vertical fixed; or portable over 4 ft) at C-AD, you must complete web-based training TQ-LADDER. Go to <https://www.bnl.gov/training/courses/web/> and click on "Ladder Safety (TQ-LADDER)".

BNL has issued SBMS Subject Area "Fixed Ladders, Design, Inspection, and Use" (Aug 5, 2015, Rev. 0) to assure vertical fixed ladders are inspected for compliance to industry standards, and to assure work controls are in place for safe use. To comply with BNL requirements, existing vertical fixed ladders at C-AD have been inspected to determine if they meet industry standards. These type inspections can only be done by trained engineers and safety staff. The training for this is given by the BNL Central ESH Division.

Inspected ladders are indicated by a color marked (e.g. painted) on the side rail, visible at the point of use. Ladders are classified by the following:

## Green

Ladder was inspected and found in compliance with standards. The ladder may be used by physically fit and trained personnel.

## Yellow

Ladder was inspected and some non-compliances with standards were noted. However, with the use of additional provisions, the ladder can be used safely. These ladders are posted with a caution tag listing the problems found during the inspection, and are marked (e.g. painted) yellow at the top and bottom entry points. The information on the posting helps the user understand the nature of the non-compliances for that particular ladder. The ladder cannot be used if the caution posting is not attached.

## Red

Ladder was inspected and one or more non-compliances with standards were noted and the ladder has been taken out of service. An "Out of Service" Warning posting is attached to the ladder. **Do not use the ladder** until the ladder has been corrected, re-inspected and approved for use; or in some cases a red-marked ladder may be used with proper work planning and any required fall protection.

If there is no indication that an inspection was performed, then you may not use the ladder. Contact the Work Control Coordinator for your experiment to have the ladder inspected.

**Requirements for use of Vertical Fixed Ladders at C-AD:**

- Complete BNL's Ladder Safety web-based training TQ-LADDER
- Be physically fit to climb. (Employees must be cleared by the BNL Occupational Medicine Clinic\*).
- Before use of a yellow-marked ladder, review the yellow caution posting to assess and identify the non-complaint issues with that specific ladder.

Supervisors: For your employees: Assure that "90 degree Vertical Fixed Ladders > 4 ft high" is marked on the Job Assessment Form (JAF) of staff who might climb a vertical fixed ladder, and that the Clinic has not indicated any restrictions for climbing ladders or for working at heights.

Remember:

- Use 3 points of contact when ascending or descending the ladder
- Don't carry heavy or bulky tools or materials up a ladder
- Make sure you feel physically fit to use the ladder that day and that your ladder training is current
- On a vertical ladder in particular, there is always a force (your weight) that will cause you to fall off the ladder if you lose your grip or footing
- For yellow-marked ladders, review the caution posting each time you use the ladder

If any unexpected or unidentified issues are discovered while climbing, notify your experiment Work Control Coordinator promptly.

# Fragile Equipment

Many experiments at the C-AD complex employ devices and equipment that are fragile such as vacuum windows, scintillation detectors, prototype detectors, electronic cards, connectors and cables. All of these devices require proper training and authorization prior to performing work on them. All Collider experiments have beryllium beam pipes installed. This material is fragile, and toxic. Protection is provided to prevent physical damage.

Care is always required in experimental areas to prevent damage to fragile components of the experiment.

## Work Planning & Hazard Screening at C-AD and the Green Work Permit

<b>BROOKHAVEN</b> NATIONAL LABORATORY		Work Permit # _____
		Work Order # _____
		Job# _____ Activity# _____
<i>See "Instructions for Filling out the Work Permit" contained in the Work Planning and Control for Experiments and Operations Subject Area.</i>		
1. Work request WCC fills out this section. <input type="checkbox"/> Standing Work Permit		
Requester:	Date:	Ext.:
Other Contact person (if different from requester):		Ext.:
Work Control Coordinator:	Start Date:	Est. End Date:
Brief Description of Work:		
Building:	Room:	Equipment:
		Service Provider:
2. WCC, Requester/Designee, Service Provider, and ESSH (as necessary) fill out this section or attach analysis		
<b>ESSH ANALYSIS</b>		
<b>Radiation Concerns</b>	<input type="checkbox"/> None	<input type="checkbox"/> Activation
	<input type="checkbox"/> Airborne	<input type="checkbox"/> Contamination
	<input type="checkbox"/> Radiation	<input type="checkbox"/> NORM
	<input type="checkbox"/> Other	
<input type="checkbox"/> Special nuclear materials involved, notify Isotope Special Materials Group		
<input type="checkbox"/> Fissionable/Radiological materials involved, notify Laboratory Nuclear Safety Officer		
<b>Radiation Generating Devices:</b>	<input type="checkbox"/> Radiography	<input type="checkbox"/> Moisture Density Gauges
	<input type="checkbox"/> Soil Density Gauges	<input type="checkbox"/> X-ray Equipment
<b>Safety and Security Concerns</b>		
<input type="checkbox"/> None	<input type="checkbox"/> Explosives	<input type="checkbox"/> Transport of Haz/Rad Material
<input type="checkbox"/> Pressurized Systems		
<input type="checkbox"/> Adding/Removing Walls or Roofs	<input type="checkbox"/> Critical Lift	<input type="checkbox"/> Fumes/Mist/Dust*
<input type="checkbox"/> Magnetic Fields*	<input type="checkbox"/> Railroad Work	
<input type="checkbox"/> Asbestos*	<input type="checkbox"/> Cryogenic	<input type="checkbox"/> Heat/Cold Stress
<input type="checkbox"/> Nanomaterials/particles*	<input type="checkbox"/> Rigging	
<input type="checkbox"/> Beryllium*	<input type="checkbox"/> Electrical	<input type="checkbox"/> Hydraulic
<input type="checkbox"/> Noise*		
<input type="checkbox"/> Biohazard*	<input type="checkbox"/> Elevated Work	<input type="checkbox"/> Lasers*
<input type="checkbox"/> Non-ionizing*		
<input type="checkbox"/> Chemicals/Corrosives*	<input type="checkbox"/> Excavation	<input type="checkbox"/> Lead*
<input type="checkbox"/> Oxidizing*		
<input type="checkbox"/> Confined Space*	<input type="checkbox"/> Ergonomics*	<input type="checkbox"/> Material Handling
Ladder Access Required: <input type="checkbox"/> Portable Ladder <input type="checkbox"/> Fixed Ladder - Status/Restrictions:		
* Safety Health Rep. Review Required <input type="checkbox"/> Haz, Rad, Bio Material Exceed DOE 151.1-C Level*		
<b>Environmental Concerns</b>		
<input type="checkbox"/> None		
<input type="checkbox"/> Atmospheric Discharges (rad/non-rad/GHG)	<input type="checkbox"/> Land Use Institutional Controls	
<input type="checkbox"/> Chemical or Rad Material Storage or Use	<input type="checkbox"/> Liquid Discharges	
<input type="checkbox"/> Cesspools (UIC)	<input type="checkbox"/> PCB Management	
<input type="checkbox"/> High water/power consumption	<input type="checkbox"/> Spill potential	
Waste disposition by:		
Pollution Prevention (P2)/Waste Minimization Opportunity: <input type="checkbox"/> **		

All work at the Collider-Accelerator Department must be screened by a qualified Work Control Coordinator (WCC) for each of the following attributes:

- ESSH (environment, safety, security and health),
- Work Complexity, and
- Work Coordination.

All work must be done by trained/qualified personnel and with appropriate work permits and authorizations.

The qualified Work Control Coordinator (WCC) determines the method by which the work is to be planned:

- (1) worker planned,
- (2) prescribed, or
- (3) permit planned.

(1) The "worker planned work" concept recognizes the skill levels and technical capabilities of the workers. Worker planned job activities do not require the level of rigor detailed in permit planned work. Worker planned work can only be performed when there are adequate barriers in place to reduce the hazards to acceptable levels in the areas of ESSH, work complexity, and work coordination as determined by the Screening Tool for Worker Planned Work.

(2) The "prescribed work" practice relies on instructional work documents (e.g., written and approved internal procedures, contractor health and safety plan, contractor procedure, and vendor operating or maintenance manuals).

(3) The "permit planned work" practice requires use of a site-wide Work Permit Form (green form) when the ESSH, work complexity, or coordination do not have sufficient barriers to reduce the hazards to acceptable levels and the work is not covered by prescribed work documents.

Additional details and specific requirements for work planning at C-AD are found in C-AD Operations Procedures Manual (OPM) Procedure 2.28, "C-A Procedure for Work Planning and Control for Operations". Your Work Control Coordinator will help assure work is planned in accordance with the intent of C-AD procedures.

STAR and PHENIX Users:

You are required to read a work plan document written for your specific experiment. These documents for STAR and PHENIX are currently in the form of web-based training items. Go to <https://www.bnl.gov/training/courses/web/> and click on:

PHENIX Awareness (RC-PAT); or  
STAR Low Hazard Worker-Planned Work for Users (RC-SOCSTAR).

You are required to complete this web-based training for your experiment prior to perform *any work* at the experimental areas. Further information about the work plan document may be obtained from your Experiment Spokesperson or from the Collider-Accelerator Department Liaison Physicist for your experiment. These work plan documents describe the type of "low hazard" work, and associated hazards, that Users may perform at an experiment. Other additional training may be required depending on your work activities. It is the Experiment Spokesperson's responsibility to ensure that all work is planned in accordance with the intent of the C-AD work planning policy.

## Removing Damaged Equipment From Service

If any equipment presents an immediate hazard that could reasonably be expected to cause serious injury or environmental harm, then you must remove it from service (e.g., broken ladders, frayed slings, defective power cords, leaking tanks). If you have questions on how to remove an item from service, please contact the C-AD ES&H Coordinator for assistance.

## Accountability for Following the Rules

You are responsible for following C-AD rules and procedures for which you have been trained. If you cannot follow the rules and procedures in order to perform your work, you must seek to have the rule or procedure officially changed to suit what is needed. Rules and procedures shall be followed even if staffing levels are low. Do not violate safety requirements to get the job done.

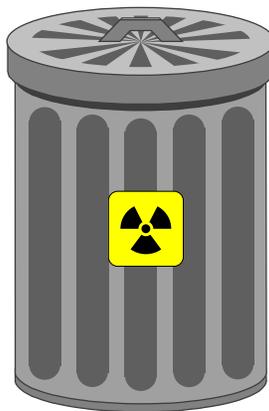
This policy applies to C-AD staff as well as Users and will be enforced everywhere.

# Waste Disposal

## CAUTION:

Improper disposal of radioactive or hazardous waste may result in fines, criminal prosecution, and facility shutdown. Contact the C-AD Environmental Coordinator (x8802) for information on any waste. The C-AD Environmental Coordinator is familiar with rules, permits, authorizations and analysis requirements necessary for proper disposal.

Contact the Environmental Compliance Representative (ECR - x2905) prior to establishing any new airborne, liquid or solid radioactive or hazardous waste stream.



Removing waste from the Laboratory is complex and costly. Your cooperation is necessary in order to control waste according to Federal, State, and Suffolk County regulations. Additionally, the regulations of the States receiving waste from C-AD must also be followed.

Information on proper disposal of waste is contained in BNL's Standards Based Management System and in C-AD's Operations Procedures Manual, Chapter 8.

All chemical containers must be marked as to contents, even water containers. All bags or packages of waste must be marked indicating the contents and where the waste came from.

Each person is responsible to ensure that they handle, accumulate or dispose of waste using proper controls and documentation. Waste generators at C-AD must be trained. Generators must know whether or not the waste they are generating is radioactive waste and/or hazardous waste. If unsure, then the waste must be checked by personnel qualified to perform such checks.

Generators of hazardous or radioactive waste at C-AD should minimize the amount of waste they generate by substituting re-usable materials where possible, using minimum quantities of materials, and segregating different wastes to allow for reclamation.

Hazardous waste is subject to time limits and volume limits that must be strictly adhered to. Generally, accumulation of more than 55 gallons at a satellite accumulation area is not allowed. Once the waste is moved to the C-AD Hazardous Waste Trailer, a 90-day clock starts. The waste must leave the C-AD complex within this 90-day period. Containers must be appropriate for the type of waste being collected and be dated and labeled. Your cooperation in this area is important in order to maintain C-AD's good reputation in the surrounding community.

Mixed Waste: Activated lead is an example of mixed waste. It is both hazardous and radioactive. Do not put mixed waste in radioactive waste cans.

Clean metals: Do not throw clean metals into waste cans used for ordinary clean waste. Non-radioactive metals should be re-cycled. Metals in our clean waste stream are a problem since the Brookhaven Town Landfill will refuse BNL's clean waste if they find metal in it.

*Question: You need to throw out empty cans of a liquid chemical that you used to clean equipment. You realize the liquid itself required special handling, but the containers are now empty and dry. What do you do?*

*Answer: Initially treat the container as hazardous waste and contact the C-AD Environmental Coordinator (x8802) to determine how to properly dispose of the waste.*

Some general rules:

- Do not place clean materials in radioactive waste bins
- Do not place radioactive materials in the green 3-yard bins used for clean waste
- Substitute reusable materials where possible in order to reduce waste
- Use minimum quantities of materials
- Segregate wastes
- Do not leave unnecessary items in primary areas since they may become radioactive waste
- Do not throw clean metals into waste cans used for ordinary clean waste

# Spills

The C-A Department is required to report spills; internally, externally, or both. C-AD must report to outside (external) agencies on spills that impact the environment. Reporting must be made within certain time constraints so it is important that you notify appropriate people of a spill promptly. Even minor events, such as spilling any amount of oil in an outdoor area, require reporting. The rules are such that we must *consider* reporting spills of any type or size. For any spill, notify your Experimental Spokesperson and/or the Liaison Physicist.

If you spill any hazardous or industrial material outdoors on the ground, or anywhere inside and the spill is beyond your control, call x2222 or 911 to report the spill. Then call the C-AD Main Control Room (x4662), the C-AD A&R Division Head (x5636) or the C-AD Environmental Coordinator (x8802) as soon as possible. Do not leave a message on an answering machine as notification.

When reporting a spill, give your name and information on the spill location, type of material and approximate amount as best you can.

For further information on spills, see BNL's SBMS Subject Area "Spill Response".

## Compressed Gas Safety

**Note:** If you will be working with compressed gas cylinders, you must complete BNL web-based course Compressed Gas Safety (TQ-COMPGAS1). The short discussion in this training manual does not replace the requirement to complete TQ-COMPGAS1.

All compressed gases are hazardous due to high pressure. Because of the different hazards associated with different gases, it's important that cylinders be properly labeled. When a cylinder is delivered to the BNL gas warehouse, an experimental area or a job site, it should have:

- content identification,
- DOT label, and
- a valve protection cap.

**UNDER NO CIRCUMSTANCE** should the means of identification be removed from a cylinder. The valve protection cap should remain in place until the user has secured the cylinder to a fixed support at the point of use and is ready to attach a pressure regulator to withdraw the contents.

Personnel at the BNL gas warehouse will attach a Cylinder Status Tag on the cylinder when it is received. The gas cylinder user will tear off the bottom of the Cylinder Status Tag and write the name of the assigned user on the tag indicating that the cylinder is in use.

**Regulators:** The regulator must be compatible with the gas used and no Teflon tape may be used to connect the cylinder to the regulator/supply piping. Never use an adaptor to allow a cylinder valve to match up with another component (e.g. regulator).

Some general rules for cylinder handling:

- Do not drop cylinders or permit them to violently strike each other.
- Do not roll cylinders in a horizontal position.
- Do not drag cylinders.
- Do not handle cylinders with oily hands or oily gloves. This is especially important when handling oxygen and other oxidizers.
- If hoisting is necessary, use a suitable cradle or platform.
- Do not lift a cylinder by its cap.
- Do not attempt to pry off caps that are stuck. You may use a strap wrench as designed, but no cheater bar.
- Keep cylinder caps on the cylinder whenever they are not in use.
- Transport cylinders using a cart or hand truck designed for that purpose.
- Cylinders may not be re-filled if past the hydrostatic test date (typically 5-year retest).

Compressed gas cylinder safe storage:



- Storage areas should be dry, cool, and well ventilated, and where practical, fire resistant.
- Gases of different types are to be grouped by type and non-compatible types should be separated. Flammable gases shall not be stored within 20 ft of oxidizing gases, unless a proper fire wall is installed.
- Cylinder storage areas are to be prominently posted with the types of gases stored.
- Charged and empty cylinders should be stored separately.
- Cylinders should be arranged so that old stock can be removed first with a minimum handling of other cylinders.
- Cylinders should not be stored at temperatures above 125 °F, (51° C) or near sources of heat.
- Cylinders should not be stored near highly flammable or combustible materials.
- When cylinders are being moved on a cylinder cart, they must be secured to the cart.
- Cylinders are not to be stored on carts unless specifically designed for storage. They may not be on a cart without the cylinder valve protective cap in place unless attended; or unless approved safeguards are in place.

## Fire or Other Emergency

BNL on-site Fire/Rescue Group: { From an on-site BNL phone: **2222 or 911**  
From a cell phone: **(631) 344-2222**

Fire Alarm Box



In any emergency, you may (and are encouraged to) pull/activate a fire alarm, even if there is no fire. Also call 2222 or 911\* and inform the Fire/Rescue Group of the emergency. Fire alarm boxes are located throughout the complex; at the experimental halls, and in the Collider tunnel. This is the best way to simultaneously alert the C-AD Main Control Room (MCR) and the BNL Fire/Rescue Group. Pulling/activating a fire alarm and telephoning 2222 or 911\* brings the Fire/Rescue Group to your specific alarm box location within about two minutes, and appropriate additional personnel can be summoned quickly.

**Medical Emergency:** If there is a medical emergency involving an injury or illness for which immediate medical attention is wanted, then pull/activate a fire alarm (if an alarm box is in the area) and call 2222 or 911\*. Let the Fire/Rescue Group know it is an injury or illness (as opposed to a fire) so that the ambulance & Emergency Medical Technician (EMT) are dispatched to the scene. They usually do not send the ambulance for a fire only.

Unless an injury is very minor: **Never** transport the injured person to the BNL Occupational Medicine Clinic yourself. The Clinic is not intended for emergency care. Wait for the Fire/Rescue Group to arrive with the ambulance and Emergency Medical Technician. If you transport the person yourself to the Clinic, time may be wasted in having the ambulance track you down. In addition, you may be stuck with an injured person who passes out or stops breathing, etc., on the way to the Clinic, or you could be nervous and have an accident on the way to the Clinic.

**Medical non-Emergency:** If you are injured but do not require emergency attention, then report as soon as possible to the BNL Occupational Medicine Clinic, which is located in Building 490. Your supervisor or Liaison Physicist should accompany you. If your supervisor or Liaison Physicist are not available, you should call upon another member of supervision or management in your Department, Division or experimental area to go with you. In most circumstances, it is expected that you report to the Clinic immediately after the injury. If this is not possible, you are required to *notify* the Clinic immediately, and then report to the Clinic with your supervisor or alternate member of management before the end of the work shift in which the injury occurred or at the start of your next work-shift. If *employees* fail to notify and report to the Clinic as required, any resulting missed work may be considered unauthorized leave and will be ineligible for sick leave.

**Fire Alarm:** If you hear a Fire Alarm Bell, evacuate the area after placing equipment in a safe condition and go to the Outdoor Assembly Area. Indoor and Outdoor Assembly Areas are posted at building entrances. A fire alarm bell has a metal "clanging" sound.

In the Collider (RHIC) tunnel, vertical and horizontal emergency exits alternate and are located throughout the tunnel. Exits from the experimental intersection regions lead to the assembly halls and you may then exit the assembly halls to inner ring road.

Once outside a smoky area, report to the Local Emergency Coordinator (LEC) or the Department Emergency Coordinator (DEC) if they are present. They will be wearing hats (like baseball caps) marked DEC or LEC. Do not chat with the Fire Captain or other emergency response personnel in the area. Obey the directions of the Fire Captain, DEC or LEC.

The accelerator and Collider tunnels are restricted spaces. If fire should break out, then smoke could quickly impair visibility, and asphyxiation from contained gases can occur.

**Fire Safety:** The fire safety program at BNL emphasizes prevention and mitigation through the design of buildings, automatic fire protection systems, building inspections, use of cutting and welding permits & controls, fire safety training, and an on-site Fire/Rescue Group.

**If you suspect a fire:** If you suspect a fire, pull/activate a fire alarm and call 2222 or 911\*, Fire/Rescue Group. Alert everyone in the area and evacuate as required. If you think you can combat the fire without putting yourself in danger, a fire extinguisher may be effective. **Never let the fire get between you and your escape route.** Use a fire extinguisher only if you are trained and it can be done safely. Only use a fire extinguisher if you're confident in your ability to put out the fire safely. Determine what is burning and select the appropriate fire extinguisher. Fire extinguishers are classified according to their ability to handle specific types and size fires. If you have any doubts, let firefighters handle the situation.

\* **IMPORTANT:** From an on-site BNL phone, 911 is the same as 2222. From a cell phone, use (631) 344-2222. If you use 911 from a cell phone you will get the off-site county police, which is not the type of help you need for your situation here on site.

## BNL Site-Wide Sirens

- If you hear a continuous site-wide siren for five minutes, go to the Indoor Assembly Area. Indoor and Outdoor Assembly Areas are posted at building entrances.
- If you hear a pulsating site-wide siren, then evacuate the BNL site.

The site evacuation plan covers C-AD as well as other facilities on-site.

C-AD Main Control Room (MCR) personnel will remain on station if they have emergency duties, but will evacuate during imminent danger situations

Siren testing: The site-wide sirens are tested each Monday at noon. You will hear the sirens being tested.

Inside the RHIC tunnel: It has been noted that the BNL site-wide sirens can not be heard within the RHIC tunnel.

If the site-wide *continuous* siren is activated:

This indicates that all should report to an Indoor Assembly Area. Individuals within the tunnel are likely safe. However, C-AD Management would evaluate the situation and make an educated decision on whether or not to evacuate individuals who may be within the tunnel, and would decide on how best to do this at that time.

If the site-wide *pulsating* siren is activated:

This indicates a site-wide evacuation. If there could be people inside the tunnel, any individual (User or employee) outside the tunnel at RHIC should pull/activate a fire alarm from a fire alarm box. This will cause the alarm bells to ring inside the portion of the tunnel associated with that box location.

There is one fire alarm box that will ring the bells throughout the tunnel. It is located in the lobby of Bldg 1005S. See photo below. Any individual (User or employee) in the area of this box should pull/activate the alarm from this box.

Upon evacuating the RHIC tunnel and then hearing the site-wide pulsating siren, individuals should then evacuate the site.

Bldg 1005S Lobby: Pulling this fire alarm will ring the alarm bells throughout the RHIC Tunnel:



# Electrical Power Failure - Be Prepared

In the event of an electrical power failure, the accelerator tunnels and experimental areas could become pitch black if emergency back-up power also fails to turn on. It is strongly recommended that you bring a flashlight with you if you enter any of these areas.

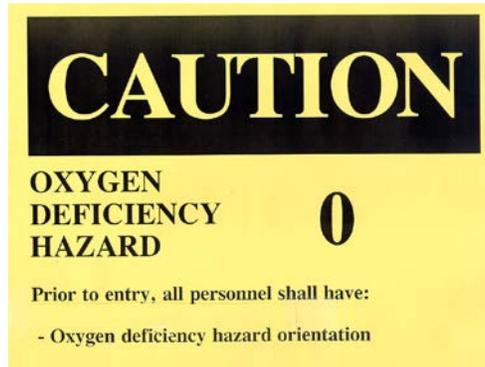
## Make a Mental Note

In your work area, make a mental note of the following:

- Exits
- Fire Alarm Pull Boxes
- Crash buttons
- Crash cords
- Postings
- Emergency exhaust, if any
- Telephones

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# Oxygen Deficiency Hazards



The RHIC Tunnel is posted as ODH Class “0” during RHIC running months. This Collider User Training includes an equivalency for BNL's ODH Class 0 training (TQ-ODH). It is included as a convenience to RHIC Users who may need to enter the RHIC tunnel (with beam off) and provides facility-specific as well as general ODH information. If you will be entering Class 0 areas at another BNL facility, please consult with the ESH Coordinator or Training Coordinator for that facility.

Note: It is possible that the ODH classification for the RHIC tunnel may be increased to Class “1”. This could be the case if newly installed safety systems do not function as planned and tested. This is not very likely but is possible. If increased to Class 1, then postings at the entrances to the tunnel would be changed to Class 1. Please pay attention to postings and understand that **this Collider User Training does not qualify you to enter ODH Class 1 areas.** Entering a Class 1 area requires additional training, medical approval, and use of a breathing air escape pack and personal oxygen monitor.

In an ODH event, it is important to remember that you are not to enter or re-enter an oxygen deficient or alarming area in an attempt to rescue others. Let the Fire/Rescue Group handle it. ODH deaths usually come in pairs. More than 50% of ODH deaths are of people entering or re-entering an area trying to save another person. One or two breaths could cause loss of consciousness under certain conditions, and lung damage is possible if the gas cloud temperature is -50 to -70 °C. You may not enter or re-enter even if you have a breathing air escape pack and are qualified to use it. The escape pack is for **escape only**. This ODH training (Class 0) **does not include** use of a breathing air escape pack or personal oxygen monitor.

## What is oxygen deficiency?

Normal atmospheric content is 20.9% oxygen, 78% nitrogen, and 1% argon. Oxygen deficiency is defined as less than 19.5 % oxygen. This happens when air in an enclosed space is displaced by another gas.

## What causes oxygen deficiency?

Cryogenic systems at RHIC use large amounts of helium and nitrogen. Both liquids expand about 700-800 times when released into air. This could happen quickly, such as with a major release as a result of catastrophic failure. In a major release, one might see a rapidly expanding white cloud and hear a "whooshing " sound. However, the leak could also be slow, invisible and silent. Both helium and nitrogen are colorless and odorless. Other causes of oxygen deficiency are use of compressed gasses, chemical reactions, fire/combustion, welding, and use of fire suppressants. All of these in a confined space or area of low ventilation are significant concerns.

## Effects of Oxygen Deficiency

The following table summarizes the physical health effects of oxygen deficiency. These are general guidelines. Different people may feel effects at different oxygen levels.

EFFECT THRESHOLDS FOR EXPOSURE TO REDUCED OXYGEN	
(Normal Individuals at Rest at Sea Level)	
Volume Oxygen %	Oxygen Effect
17	Night vision reduced Increased breathing volume Accelerated heartbeat
16	Dizziness Increased time (doubled) for novel tasks
15	Impaired attention Impaired judgment Impaired coordination Intermittent breathing Rapid fatigue Loss of muscle control
12	Very faulty judgment Very poor muscular coordination Loss of consciousness Permanent brain damage
10	Inability to move Nausea Vomiting
6	Spasmodic breathing Convulsive movements Death in 5 - 8 minutes

Effects may occur rapidly. Effects can become permanent if exposure is not terminated quickly. The major effects hindering escape are disorientation and unconsciousness. With prolonged oxygen deprivation, permanent central nervous system damage or death will result.

## Classification Levels of ODH

There are five ODH classes: 0 through 4, with 0 being the least hazardous. Each class requires controls and posting commensurate with the hazard. Classification is based on the likelihood of fatality and the probability of occurrence. This training allows you to enter Class 0 ODH areas only.

The RHIC tunnel is Class 0 (unless posted otherwise). Some but not all Users access the tunnel. The Intersection Regions at STAR and PHENIX are not posted for ODH (neither 0 nor 1).

In addition to the RHIC tunnel, the following are a few other areas at the RHIC complex posted ODH Class 0. They are mentioned here although Users typically do not need to enter these buildings.

- Building 1005E (west end, Helium Reliquifier section)
- Compressor Building 1005H
- Service and support buildings with helium valve boxes: 1002B, 1004B, 1006B, 1008B, 1010A, 1012A
- CeC support building 1002A
- In future: Bldg 1010A mezzanine

The RHIC Refrigerator Building 1005R is posted a Class 1 area at the RHIC complex during operating months. It is mentioned here although Users typically do not need to enter this building.

Remember, additional training, medical approval, and use of a breathing air escape pack and personal oxygen monitor are required for entry into a Class 1 ODH area.

When is evacuation of an area required?

Any one or combination of the following requires an **immediate** evacuation of an ODH area:

- The in-place oxygen monitors activate an alarm. At the RHIC complex, the alarm is a BLUE strobe light accompanied by an audible alarm.
- A vapor cloud is observed inside the ODH area or a loud "whooshing" sound is heard (even if no alarm is seen or heard).

You should also evacuate if you feel the early physical signs of oxygen deficiency. Different people may feel effects at different oxygen levels, but the early signs are generally:

- Increased breathing volume
- Accelerated heartbeat
- Dizziness

The evacuation procedure is as follows:

- Immediately leave the area, moving away from any vapor cloud, loud “wooshing” sound or other potential problem. The release could be a lethal freezing hazard as well as an oxygen deficiency hazard if you are close to the release point.
- Stay Low. Do not use vertical escape exits, such as the vertical ladders at RHIC. Use only ‘horizontal’ exits.
- If someone is in danger, hurt or feeling ill, call 2222 or 911 (from a cell phone: (631) 344-2222) . Otherwise, call the C-AD Main Control Room (x4662) and inform them of the incident.
- Notify your supervisor and the ESH Coordinator.

Note: If you are qualified and are in a Class 1 ODH area, you would don your breathing air escape pack hood and evacuate immediately if your personal oxygen monitor alarmed. Additional training and medical approval are required for entry into Class 1 areas.

Cryogenic gases may be lighter or heavier than air. This is important in knowing where the released cryogen will accumulate and therefore in deciding on your best escape path. Both helium and nitrogen are used at RHIC.

Regarding helium: Helium is lighter than air so it will rise and accumulate (displacing air & oxygen) at higher elevations, and continue accumulating downward as the helium release continues. This is why we instruct not to use the vertical exits (escape ladders) at RHIC to evacuate in an ODH event.

Regarding nitrogen: The evacuation instruction is generally the same as above: Stay Low; Do not use vertical escape exits; Use ‘horizontal’ exits. Nitrogen, however, can be slightly heavier than air when ‘cold’ (when first released) and may accumulate in low lying areas at first, such as in trenches or pits. Therefore, for nitrogen, evacuate low lying areas immediately. As it ‘warms’ soon after the release, it will rise.

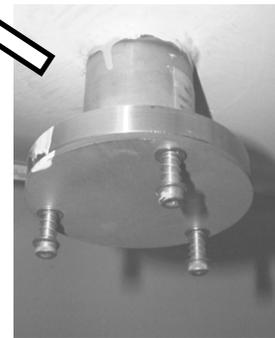
During RHIC run months, which is when most Users are here, helium is generally the hazard. During summer shutdowns, when fewer, if any, Users are here, we routinely circulate N2. However, the temperature of the N2 would not be low enough to expand to cause an ODH event during that process. This N2 process is not going on during the RHIC run periods. If we were to use N2 in some other way that could cause an ODH event, procedures would require that areas be posted and clearly marked for ODH. We may also require a Personal Oxygen Monitor (POM) to be worn by individuals entering a specific posted area.

## RHIC Tunnel change from ODH-1 back to ODH-0

The Collider-Accelerator Department recently completed a major modification that allowed the RHIC tunnel to go back to an ODH-0 Area posting. It had been Class 1 for several years. Newly installed pressure switches on the RHIC magnet cryostats throughout the tunnel will detect a magnet cooling line failure and helium leak much sooner than the in-place oxygen monitors installed in the tunnel. The new system works by detecting pressure within the vacuum space of the magnet cryostat if there is a helium leak, which is early indication of a helium leak. This will activate ODH alarms and start ventilation systems sooner than the oxygen monitors installed in the tunnel. The new system will also automatically close cryogen isolation lines, thereby minimizing the inventory of Helium available to leak into the tunnel. The original in-place oxygen monitors installed in the tunnel are also still maintained operable.



**Typical Pressure Switch**



**Typical Cryostat relief.  
Opens at ~ 1.2 atm.**

# Summary of C-AD Alarm Signals

**Orange Strobe and Audible Alarm:**

*Beam is Imminent*

Pull crash cord or exit through ("crash" through) the Primary Area access gate, exit the area, contact MCR.

**Blue Strobe and Audible Alarm:**

*Oxygen Deficiency Event*

NOTE: If you are qualified and are in a Class 1 ODH area, you would don your breathing air escape pack hood. Additional training and medical approval are required for entry into Class 1 areas.

Exit the area through horizontal exit at RHIC, stay low. Move away from any vapor cloud or "wooshing" noise.

**Yellow Strobe and Audible Alarm** (two-tone horn):

*Combustible/explosive  
or Flammable Gas Leak*

Exit the area, report to outdoor assembly area.

For example, the STAR and PHENIX experiments use flammable/explosive gas

**Fire Alarm Bell** (the typical metal "clanging" bell sound):

*Fire*

Exit the area, report to outdoor assembly area

DO NOT RE-ENTER buildings/areas. Wait for further instructions from the Fire Captain, Local Emergency Coordinator (LEC), Department Emergency Coordinator (DEC) or the C-AD ESH Coordinator.

Indoor and Outdoor Assembly Areas are posted at building entrances.

# Laboratory Computers

Any User who has access to the BNL Network and its computing resources must complete a BNL Course titled "Cyber Security". Essentially all Users will be required to complete this training.

# Safety Attitude

In the recent past in New Jersey, an Exxon worker did not turn off an ignition source, which was the truck he drove to a gas storage site, he did not wear his protective clothing to perform the job, and he did not follow a procedure that minimized gas leakage when he opened valves. These individual failures added up to a tragedy. A film describing this incident is available for viewing (~1 hour long) from the BNL Safety and Health Services Division. See the C-AD Training Coordinator if you want to view this film. Likewise, simple failures have added up to major disruptions at BNL, such as not installing groundwater wells south of the HFBR or not installing an interlock on the C-line diffuser at AGS. The risk of losing 500 jobs due to a forced shutdown is very real at BNL since our work is radiological in nature. We do not have to ignite a few million gallons of gasoline in order to have upheaval and misfortune.

Many “errors” in series must usually occur to cause an accident. For a single accident there may be many causes and sub-causes, and certain combinations of these give rise to accidents. From a simple viewpoint, the causes can be grouped into the following two categories:

a) Behavioral - This category includes factors pertaining to the worker, such as improper attitude like the Exxon worker, or lack of knowledge, lack of skills and inadequate physical and mental condition. In the case of the Exxon worker, his attitude was based on years of experience in which nothing ever went wrong for him whenever he took a short cut.

b) Environmental - This category includes improper protection from hazardous work elements and degradation of equipment through use and unsafe procedures and inadequate maintenance.

Major accidents are rarely, if ever, the result of a single cause or act. You can view an accident as toppling dominoes. The accident will occur if the sequence of events lets all the dominoes topple to the last. If one or more of the dominoes is removed, then the last domino toppling, which is the accident, probably won't occur.

After an accident, most people tend to look for "things" to blame, because it's easier than looking for "root causes," such as those listed below. Consider the underlying accident causes described below. Have you been guilty of any of these attitudes or behaviors? If so, you may not have been injured, but next time you may not be so lucky.

- **Taking Shortcuts:** Every day we make decisions we hope will make the job faster and more efficient. But do these time savers ever risk your own safety, or that of coworkers?
- **Being Over Confident:** Confidence is a good thing. Overconfidence is *too much* of a good thing. "It'll never happen to me" is an attitude that can lead to improper use of procedures, tools, or methods in your work.
- **Starting a Task with Incomplete Instructions:** To do the job safely and correctly the first time you need complete information. Have you ever been sent to do a job, having been given only a part of the job's instructions? Don't be shy about asking for explanations about work procedures and safety precautions. It isn't dumb to ask questions; it's dumb not to.

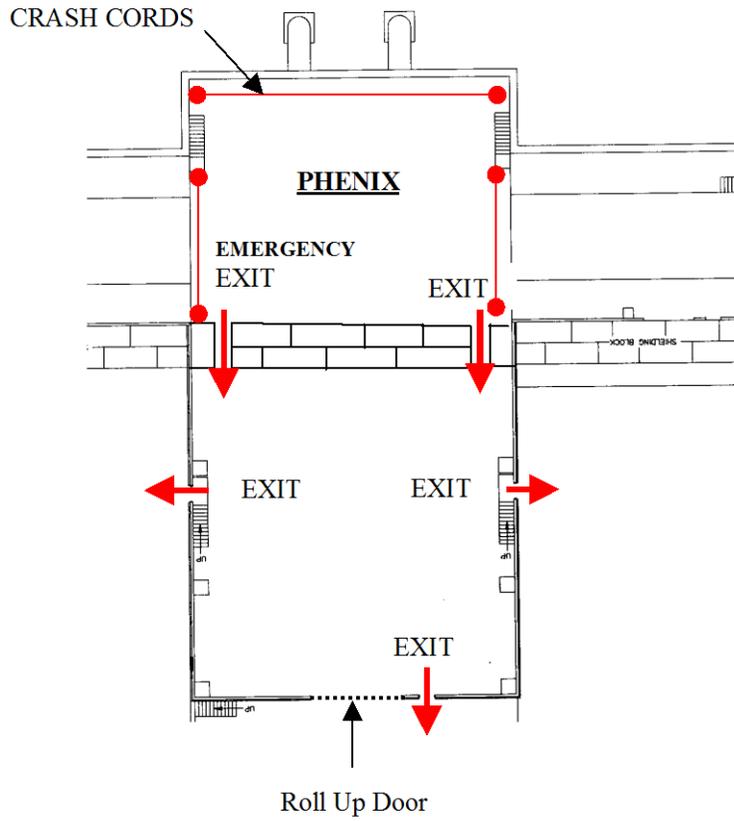
- **Poor Housekeeping:** When managers, supervisors or safety professionals walk through your work site, housekeeping is almost always an accurate indicator of your attitude about safety. Poor housekeeping creates hazards of all types.
- **Ignoring Safety Procedures:** Purposely failing to observe safety procedures can endanger you and your coworkers and cost you your job.
- **Mental Distractions from Work:** Having a bad day at home and worrying about it at work is a hazardous combination, and visa versa. Dropping your 'mental' guard can pull your focus away from performing any task safely including changing the gas bottle on your barbecue. You can also be distracted when you're busy at work and a friend comes by to talk while you are trying to do a hazardous job. Don't become a statistic because you took your eyes off the job at hand "just for a minute."
- **Failure to Pre-Plan the Work:** Job Hazard Analysis and Enhanced Work Permits are an effective way to figure out the smartest ways to work safely and effectively. Being hasty in starting a task or not thinking through the process can put you in harms way. Instead, Plan Your Work and then Work Your Plan.

#### Alcohol/substance Abuse:

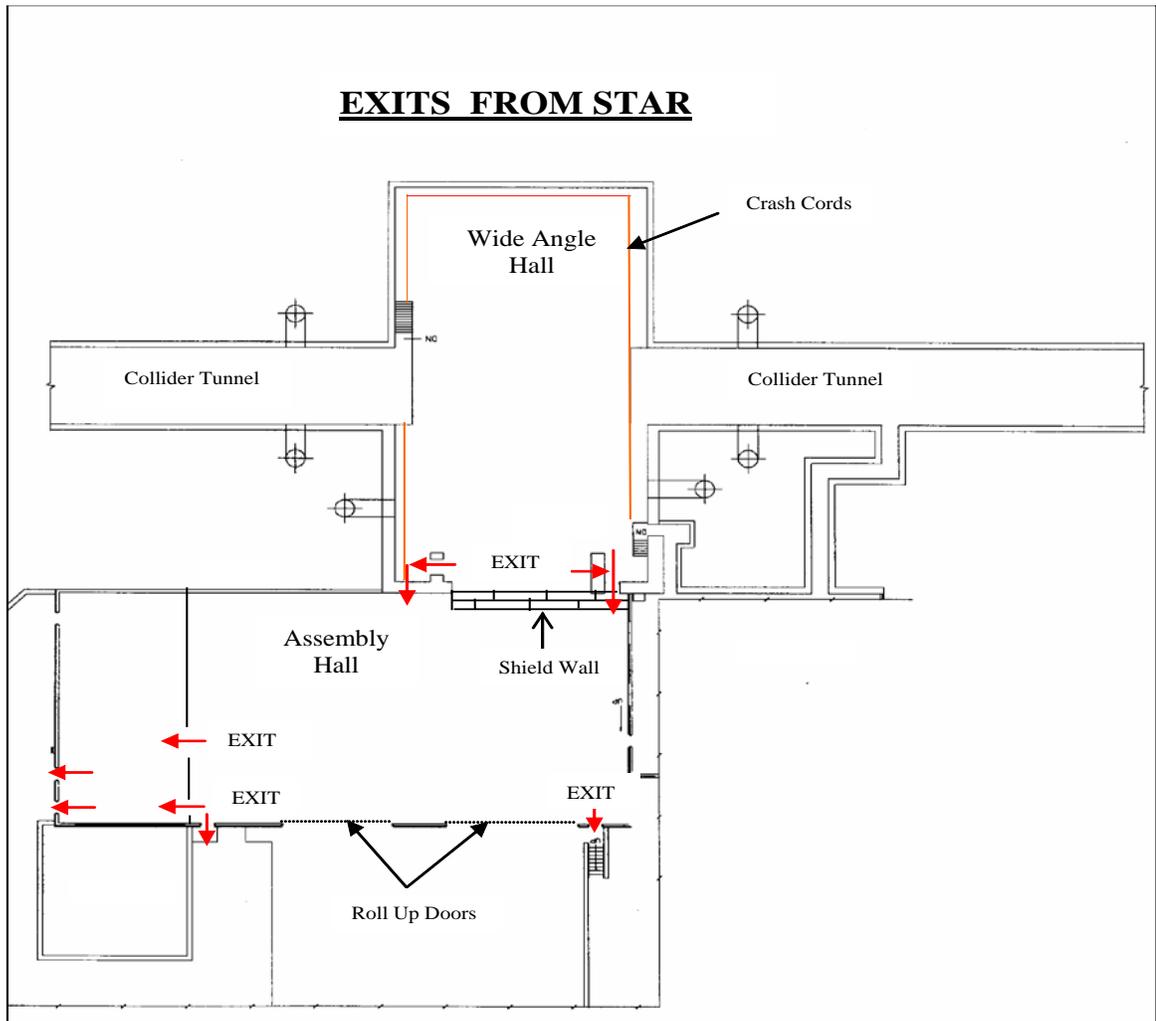
Employees or Guests of the Laboratory who abuse alcohol and/or controlled substances pose unacceptable risks to the safe and efficient operation of the Laboratory. In addition to jeopardizing employee safety and/or impacting on performance, conduct and reliability, substance abuse is illegal.



# EXITS FROM PHENIX



# EXITS FROM STAR



# Acronyms

A&R Div	-	C-AD Analysis & Requirements Division
AGS	-	Alternating Gradient Synchrotron
ALARA	-	As Low As Reasonably Achievable
BNL	-	Brookhaven National Laboratory
BSA	-	Brookhaven Science Associates
C-AD	-	Collider-Accelerator Department
CeC PoP	-	Coherent Electron Cooling, Proof of Principle
DEC	-	Department Emergency Coordinator
DOE	-	United States Department of Energy
ESH	-	Environment, Safety & Health (e.g.: ESH Coordinator)
ESRC	-	Experiment Safety Review Committee
HP	-	Health Physics
IR	-	Intersection Region
LEC	-	Local Emergency Coordinator
LOTO	-	Lock Out / Tag Out
LE	-	Liaison Engineer
LP	-	Liaison Physicist
MCR	-	Main Control Room
NRTL	-	Nationally Recognized Test Laboratory
OC	-	Operations Coordinator
ODH	-	Oxygen Deficiency Hazard
OSHA	-	Occupational Safety and Health Administration
PAAA	-	Price-Anderson Amendments Act
PPE	-	Personal Protective Equipment
RAR	-	Radiological Awareness Report
RCT	-	Radiological Control Technician
RWP	-	Radiological Work Permit
SBMS	-	Standards Based Management System
SOP	-	Standard Operating Procedure
SRD	-	Self-Reading Dosimeter
TLD	-	Thermo-Luminescent Dosimeter