Brookhaven National Laboratory

Collider-Accelerator Department (C-AD)

COLLIDER USER TRAINING

Radiation Safety
Conventional Safety
Access Control

INFORMATION GUIDE

NOTE ! After completing this training, if you are unsure of how to properly enter and exit the Primary Area through the Access Control System (ACS) gates, then seek and receive assistance prior to, or in conjunction with, your first entry since improper operation can cause programmatic delay. If you need assistance, you may consult with your experiment Shift Leader, with another trained co-worker or User, or contact the C-AD training office at x7007, C-ADTrainingGroup@bnl.gov.

Table of Contents

COLLIDER USER TRAINING

Why Take This Course? (Learning Objectives)

This course is required if you want unescorted access to the Relativistic Heavy Ion Collider (RHIC) complex. This includes the STAR and sPHENIX experimental areas. 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 at STAR, you are required to read a low-hazard work plan document specific to your experiment. The STAR work plan document is provided as a web-course. Contact your host and/or Training Coordinator to add Job Training Assessment (JTA) **RC-82C | STAR Training to** your training profile, you will then need to complete STAR Low Hazard Worker-Planned Work for Users (RC-SOCSTAR web-course. After taking the web-course, your BNL training record will be updated to indicate you have completed the course. 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. The sPHENIX work plan document will be available when sPHENIX is established at the RHIC experimental area.

In addition to this Collider User Training, Users are required to complete the following online training:

Cyber Security (GE-CYBERSEC)
Guest Site Orientation (TQ-GSO)
General Employee Radiation Training (TQ-GERT)
Oxygen Deficiency Hazard (TQ-ODH)

The above on-line training is available at https://www.bnl.gov/training/courses/web/.

Other additional training may be required depending on your work activities. Here are examples of work activities that may require additional training:

- operating electrical circuit breakers or disconnect switches,
- performing work on electrical circuits or equipment,
- performing work on electrical circuits or equipment while energized,
- 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)
- performing Operations Lockout,
- 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.

This is 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 at STAR or sPHENIX you are required to complete additional training which includes Read & Acknowledgement (R&A) of certain C-AD procedures, including Emergency Procedures for your experimental area.

Information about Shift Leader training may be obtained from your Experiment Spokesperson, the C-AD Liaison Physicist for your experiment or the C-AD training office x7007, C-ADTrainingGroup@bnl.gov.

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.

During run periods, the RHIC complex is posted as a Controlled Area. A Controlled Area is established to protect individuals from exposure to radiation and/or radioactive materials. RHIC Users are required to complete BNL's General Employee Radiological Training (GERT), which allows access to Controlled Areas. At C-AD, however, GERT does not allow you entry into Controlled Areas that require personal dosimetry. The practice at C-AD is that you complete BNL's higher level Radiation Worker-1 training for access to TLD areas. Most Users at RHIC require only the lower level GERT training. The typical dosimeter used at C-AD and BNL is the thermo luminescent dosimeter (TLD).

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 and pressure reliefs

We strive to maintain an excellent safety record in such a complex environment without undue inconvenience to the User. With your help, we can avoid injuries, environmental releases, personnel radiation dose, fire losses and reportable occurrences. We can assure the continuity of our 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:

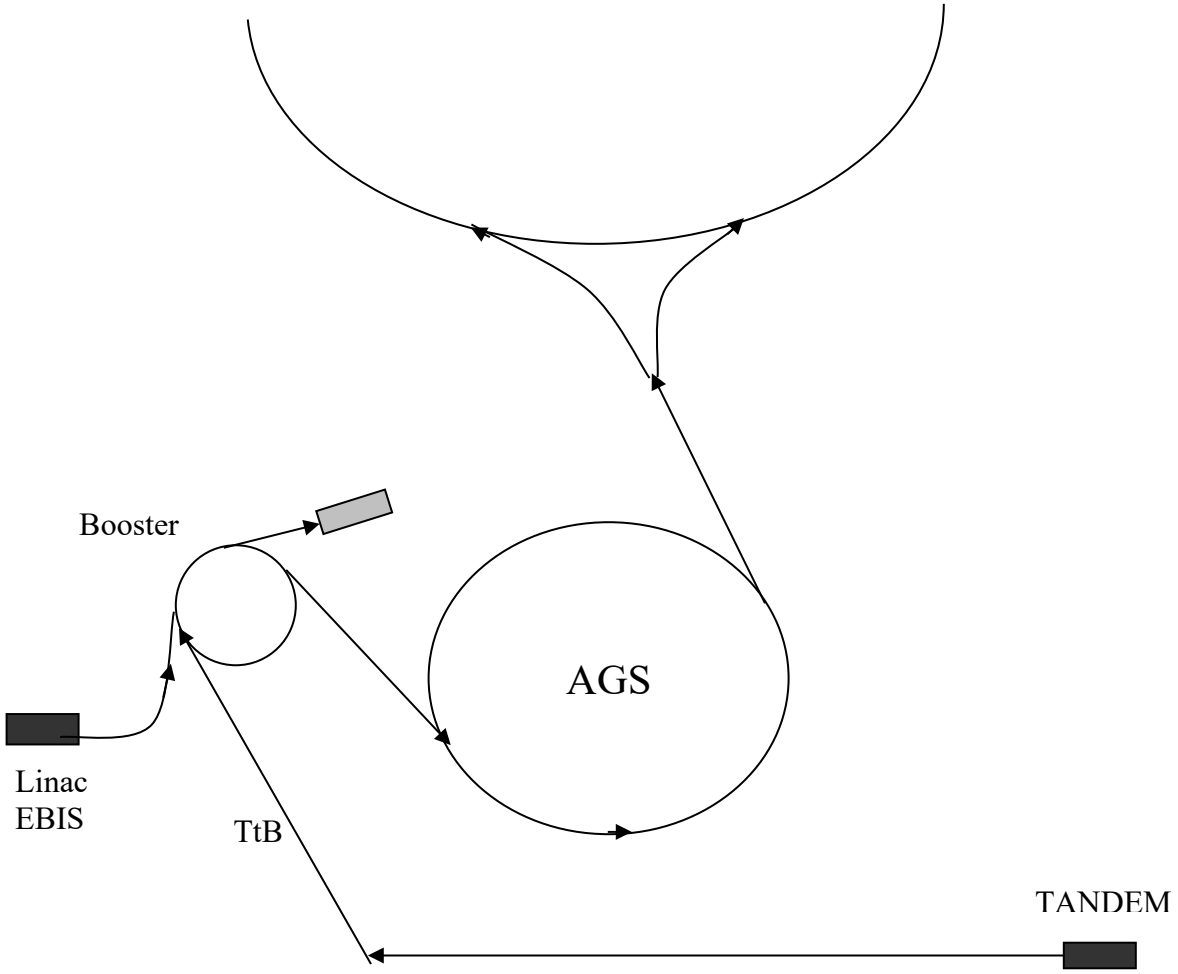
https://www.c-ad.bnl.gov/esfd/liaisons/LP_LE.html.

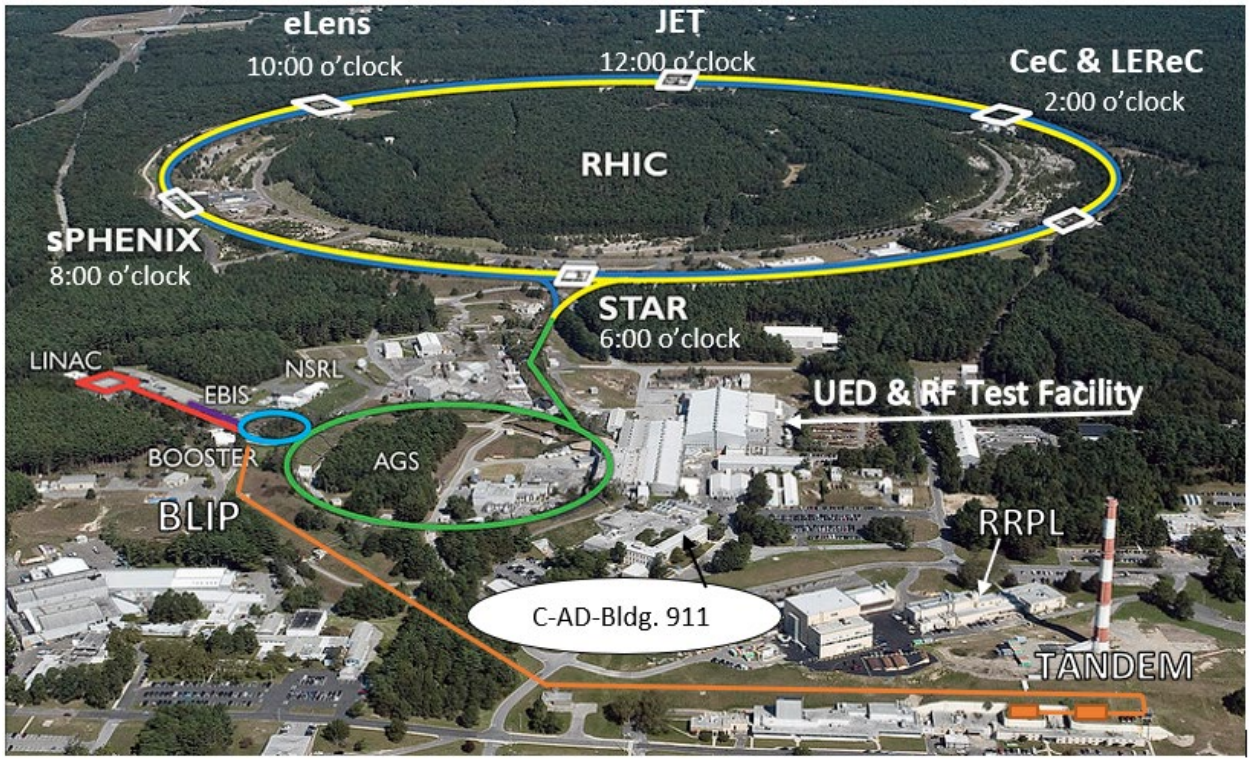
For RHIC experimental areas:

Experimental Area	Liaison Physicist	Telephone
STAR		
sPHENIX	Andrei Poblaguev	7508
eLens	Xiaofeng Gu	4724
CeC	Angelia Drees	2348

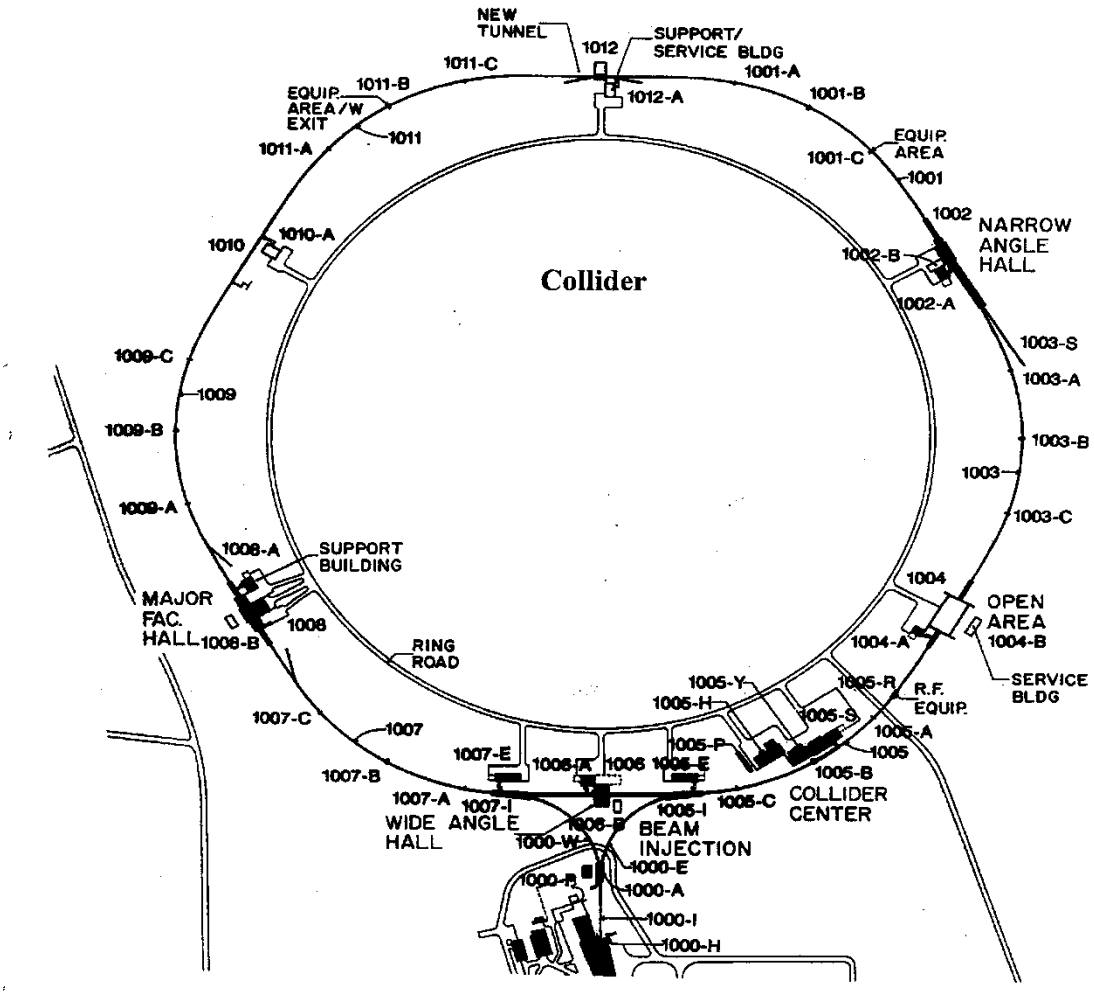
General Facility Description

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).




eLens
10:00 o'clock
JET
12:00 o'clock
CeC & LEReC
2:00 o'clock
RHIC
sPHENIX
8:00 o'clock
STAR
6:00 o'clock
LINAC
NSRL
EBIS
UED & RF Test Facility
BOOSTER
AGS
BLIP
RRPL
C-AD-Bldg. 911
TANDEM

COLLIDER RING



Experimental areas at RHIC include:

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

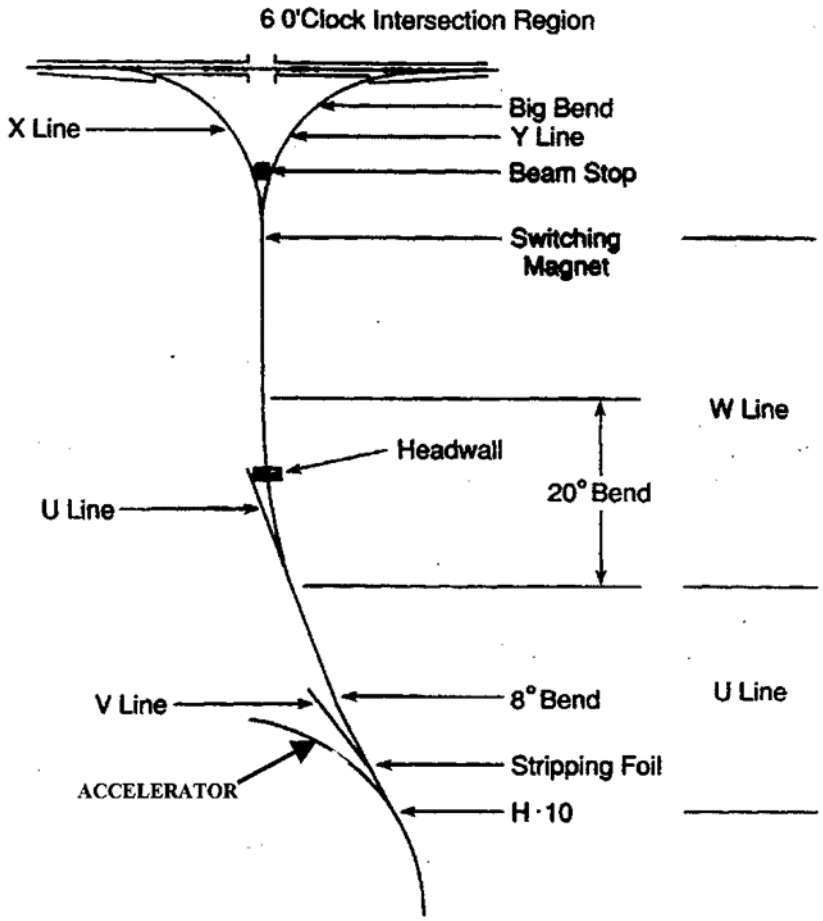
sPHENIX: To be located at building 1008 (replaces PHENIX), at the 8 O'clock position along the collider.

CeC: 2 O'clock position

eLens: 10 O'clock position

Jet Target/Polarization Measurement: 12 O'clock location

ACCELERATOR TO COLLIDER TRANSFER LINE



C-AD Conduct of Operations

The Collider-Accelerator Department (C-AD) has made a written commitment to the U.S. Department of Energy (DOE) that it will manage and operate its accelerator facilities under a "Conduct of Operations" program. This requires that C-AD follow certain rules and regulations. As part of this program, visiting Users/experimenters and employee staff members must be aware that we must:

- Have definitive lines of authority
- Use written procedures for most operations
- Use trained & qualified personnel where required
- Have appropriate authorizations and work permits before beginning a job

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 located in the C-AD Main Control Room (MCR) in Bldg 911. 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.
For urgent matters during operating periods, the OC can make the necessary notifications and arrange for assistance. To call MCR from a cell phone: 1 (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) (your primary beam area) 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 ACS: Access Control 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 Procedures Manual. Lead personnel are to be appropriately trained. If requested, you must satisfy C-AD requirements for authorization to work on certain systems; for example, to work on a system declared as a “critical” system.

Contacts for RHIC Users include:

- Experiment Work Control Coordinator (WCC)
- Experiment Spokesperson
- C-AD Liaison Physicist for the experiment[1]
- C-AD Liaison Engineer for the experiment
- C-AD Environment Safety & Health Representative (ESHR)
- C-AD Environment Safety, Security, Health & Quality (ESSHQ) Division

[1] C-A Department Physicists & Engineer Contact List

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 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 Occupational Medicine Clinic (OMC) may be given to enter, depending on the medical device or implant and the magnetic field strength.

The BNL OMC performs routine periodic medical exams (annual Physicals) 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 primary beam lines and at the intersection region of each experiment when beam is on. 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, the Collider tunnel and experiment intersection regions, AGS to RHIC (AtR) Transfer line, U and W lines. 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 location of RHIC 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. (ALARA: As Low as Reasonably Achievable).

Procurement of new equipment (Electrical or non-Electrical): Procured items or products for use at BNL may be required to be listed by a Nationally Recognized Test Laboratory (NRTL). The primary focus in the past had been on electrical equipment, however this applies to non-electrical equipment as well. 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 an LESC-approved Electrical Equipment Inspector (EEI). If you have any questions regarding NRTL requirements, contact the C-AD ESRC.

Procurement of Pressure Vessels: (NOTE: the discussion here is for awareness. The BNL Subject Area on Pressure Safety should be consulted 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). ASME: American Society of Mechanical Engineers.

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: Repairs and alterations of pressure vessels, pressure piping and piping system components must be pre-evaluated. Repairs and alterations of ASME-certified pressure vessels, pressure piping and piping system components must be approved by an ASME-certified "R" stamp holder to maintain ASME certification. Trained staff must perform the repair or alteration.

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

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

Radiological Training

RHIC Users are required to complete BNL's General Employee Radiological Training (GERT). It is available on line here: https://www.bnl.gov/training/courses/web/; course # TQ-GERT. GERT, this training, as well as Oxygen Deficiency Hazard (ODH) training allows access to Controlled Areas, and Radioactive Material Areas (RMAs) within Controlled Areas. It does not allow access to higher level areas such as Radiation Area, High Radiation Area or Contamination Area, for example. A large portion of the RHIC complex is posted as a Controlled Area during operating periods.

At C-AD, GERT does not allow you entry into a Controlled Areas that also requires that you be wearing a personal dosimeter. The typical dosimeter used at C-AD and BNL is the thermo luminescent dosimeter (TLD). Most of the RHIC tunnel, for example, is posted as a Controlled Area requiring a TLD. Your experiment intersection region (IR) currently does not require a TLD. Pay attention to postings. The practice at C-AD is that you complete BNL's Radiation Worker-1 training for unescorted access to TLD areas. Most Users at RHIC require only GERT. The intersection regions at STAR and sPHENIX (common areas that RHIC Users access) do not require a TLD at this time.

The C-AD practice of not 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. One reason for the 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 ***and*** you must sign/log onto a Radiological Work Permit (RWP) prior to entry. 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 issue TLDs without the higher level 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. In addition, 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.

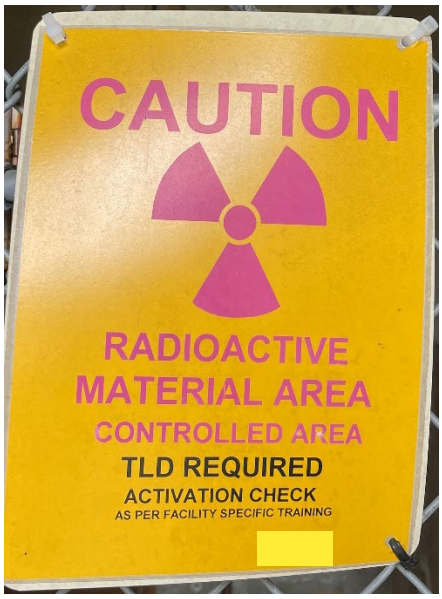
Maximum Expected Exposure: Individuals trained to the GERT level who are not issued personal dosimetry (e.g.: TLD) are not expected to receive in excess of 100 mrem/year. GERT trained individuals utilizing personal dosimetry (not the common practice at C-AD) may encounter radiation dose rates resulting 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.

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 is an example of a typical posting encountered at the Collider complex.

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). Always read the posting prior to entering the area. 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 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 at x4660).

* **STAR and sPHENIX Intersection Regions**:
The STAR and sPHENIX experimental intersection regions (IRs) typically do not require a TLD or activation check. **However**, please observe current postings. As of the writing of this training guide update, the sPHENIX detector experimental area is under new development and area postings and work controls may change significantly at any time.

Radiation Levels, Area Names and Training Required

Radiation Level	**Area Name**	**Training Required** (for unescorted access)
< 5 mrem/hour < 100 mrem/year (for area not requiring personal dosimetry)	Controlled Area	GERT And For RHIC areas: Collider User Training ODH
≥ 5 mrem/hour < 100 mrem/hour	Radiation Area	Radworker-1 Training And For RHIC areas: Collider User Training ODH
≥ 100 mrem/hr at 30cm < 500,000 mrad/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)

The practice at C-AD is that you complete BNL's Radiation Worker-1 training to be issued a TLD and to enter TLD areas unescorted. The typical dosimeter used at C-AD and BNL is the thermo luminescent dosimeter (TLD). Most of the RHIC tunnel, for example, is posted as a Controlled Area requiring a TLD. Pay attention to postings.

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 ESSHQ 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 ESSHQ Division Head (x5636).
- Report any lost TLD badge immediately.

Regarding the seriousness of proper use of personnel monitoring devices:

In past years there have been 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.

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.

C-AD EXPOSURE PHILOSOPHY

Radiation Exposure at C-AD Must:

- Have a Net Benefit
- Be ***A***s ***L***ow ***A***s ***R***easonably ***A***chievable (***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.

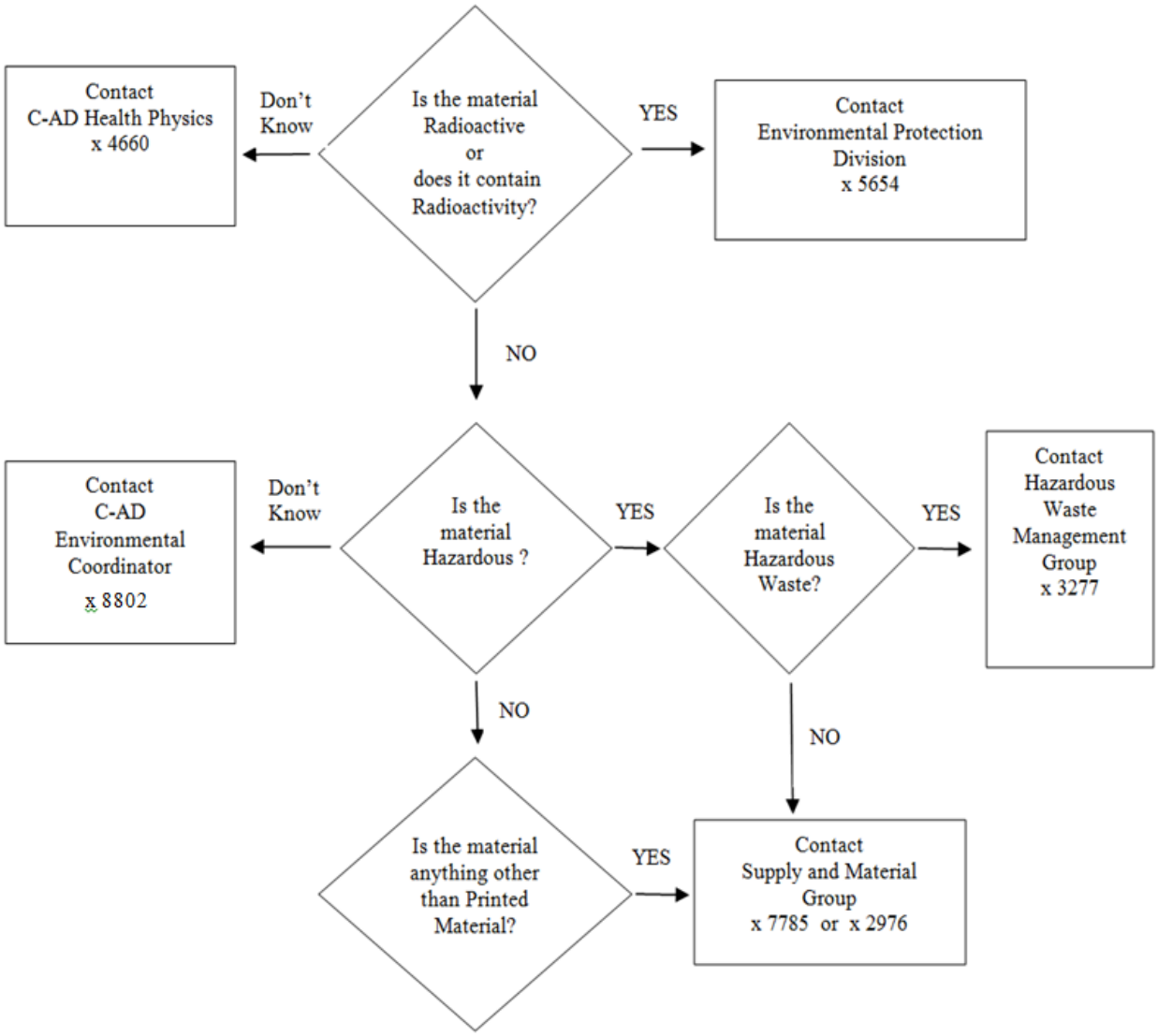
Deliveries to C-AD Facilities

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 ESSHQ Division Head (x2356).

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. See BNL Subject Area "Waste" (Mixed Waste section) for details. Mixed Waste is waste that is both Hazardous and Radioactive.

Access Control System

(ACS)

NOTE ! After completing this training, if you are unsure of how to properly enter and exit the Primary Area through the ACS gates, then seek and receive assistance prior to, or in conjunction with, your first entry since improper operation can cause programmatic delay. If you need assistance, you may consult with your experiment Shift Leader, with another trained co-worker or User, or contact the C-AD training office at x7007.

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

The Access Controls 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, 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).

Unescorted ACS 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 ESSHQ Division.

Entry Modes and Status Indicators

There are 3 basic entry modes that the Access Control System (ACS), 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 ACS 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.

Example: STAR gate

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 sPHENIX, 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

Iris Scanner

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, Shift Leader or supervisor. The C-A Department Training Group performs iris enrollment in Bldg 911A, Room A-128 (telephone x7007).

Note: If you need to enter the Intersection region (IR) during Controlled Access Mode, 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 or C-ADTrainingGroup@bnl.gov).

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

3) Choose key #1 or the next sequentially available key from the Key-Tree. You have four seconds to retrieve a key after iris recognition. Turn the key 180 degrees counterclockwise and pull to remove it.

Note: Once a key is removed, the Key-Tree cannot be accessed 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: An 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. Failure to do so will require the MCR to re-Sweep the area which will cause programmatic delay.

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. 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):
Place your hands on the black bar (channel) 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 the iris scanner, insert the key back into the slot of origin within 4 seconds. Turn the key 180 degrees clockwise to lock it in.

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

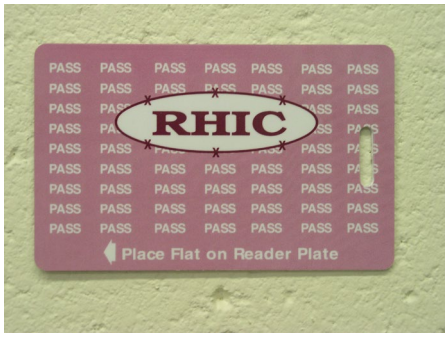
For the 'older' type gate:

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

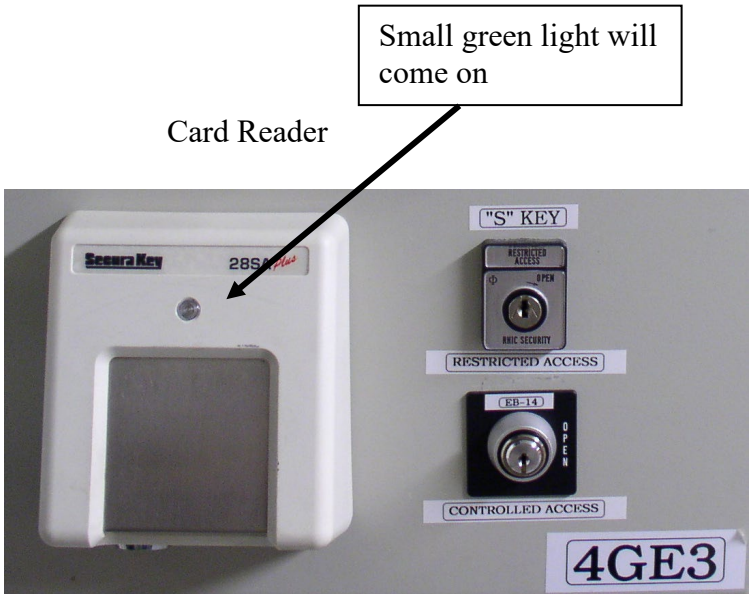
To exit, turn the door knob and push open the gate (you do not need to use your card-key to exit).

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.

RHIC Access Card-Key



Card Reader



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

The same rules apply as before, however, here are some 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 and a release of the gate.

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 and provide the gate #. This may take a couple of moments so please be patient.

The individual communicating with MCR presents their RFID tag (attached to the key) to the edge reader to open the access gate.

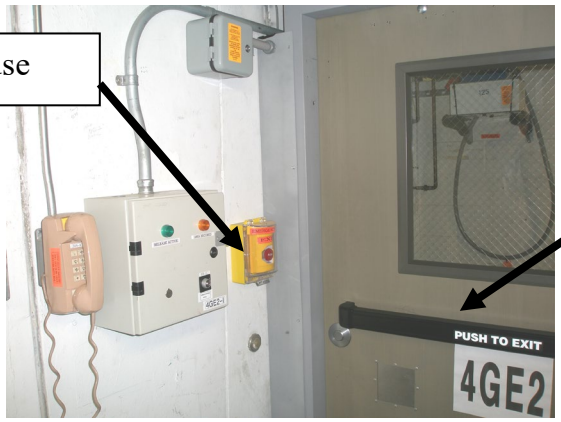
All individuals may enter while the gate is open.

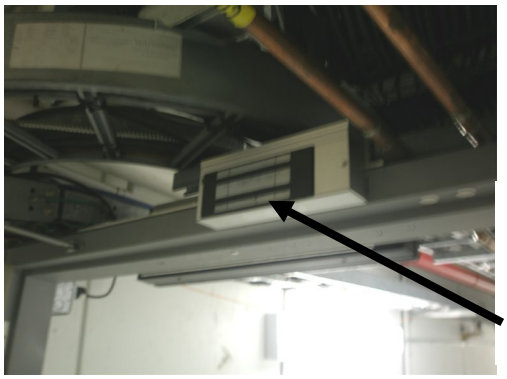
> **IMPORTANT**: Each individual MUST still bring in their own individual key with RFID tag that they took from the Key-Tree by scanning their own irises. This is important for your safety. As a courtesy to the MCR Operator watching remotely by video camera, each person entering should hold up and show 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 one individual scans their own access card-key on the card reader key pad, the small green light on the card reader comes on and all individuals entering have all required training completed and current.

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

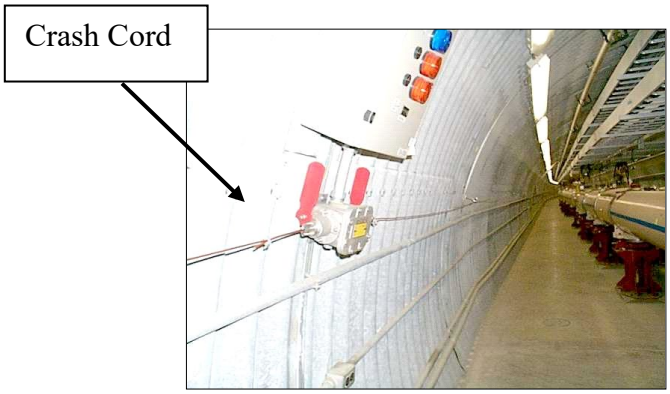




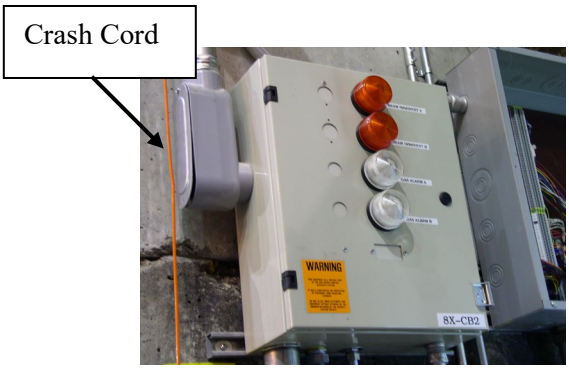
With this 'newer' type door, there is no mechanical door knob latch mechanism. The door is held closed by a magnet installed at the top of the door frame. To exit, simply push on the black bar (channel) with your hand, and push the door open. (REMEMBER: During CONTROLLED ACCESS Mode, contact MCR BEFORE 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 pushed open from the inside, or pulled open from the outside.

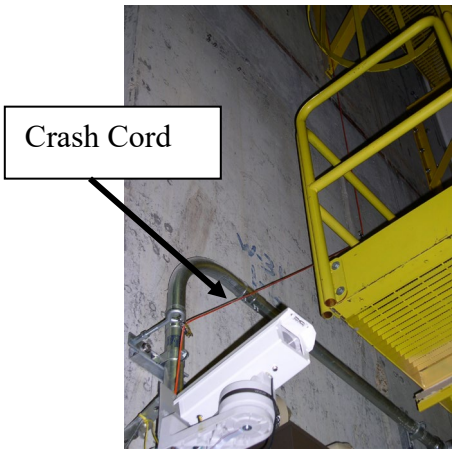
Beam Imminent Alarm & Crash Cords



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 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 warning 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. Also, do not block access gates open. Any modifications to the ACS 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

Specific barricade tape is used at BNL for the purpose of limiting or preventing entry into an area with a hazard. It must be either the 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 the 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
  Individuals authorized by a method established by the installing organization, or
  Individuals escorted and always in the presence of the person who installed the barrier.
  Entrants must be wearing the PPE required for the area and for the hazards.

- For areas with CAUTION ENTRY REQUIRES PERMISSION:
  Entrants must meet all entry requirements for the area (e.g.: training, medical clearances … etc. as required), and
  Must obtain permission of the person who installed the barrier.
  Entrants must be wearing the PPE required for the area and for the hazards.

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 need to use a sealed source and are not sure about the definition or rules for use, then contact the C-AD Health Physics Office (x4660) or the C-AD ESSHQ Division in order to make a determination regarding the rules.

If you are using a sealed radioactive source (SRS) in your work, you are required to complete the following BNL training courses: Sealed Radioactive Source Control (**HP-RWT-700**) and Radiological Worker I (**HP-RWT002**). This training is required for all work with Accountable and non-Accountable SRS. You may also need C-A department-specific training or a briefing.

For all work with exempt sources, Sealed Radioactive Source User training (**HP-RWT-700**) and General Employee Radiological Training (**TQ-GERT**) are required. Consult with the Radiological Control Division (RCD) to verify if a particular source may be considered exempt.

Contact the Source Custodian for any Department/Division training.

When not in use, sources should be stored in shielded containers. Many experimental areas have containers (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 alone 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.

This Collider User Training does not qualify you to work on or near exposed energized conductors above 50 V. Additional training, personal protective equipment (PPE) and authorization are required.

In general, additional training and authorization is required to perform electrical work, including operating electrical breakers or switches, where there is an electrical hazard: either a shock hazard or an arc flash hazard.

> Certain *low hazard* electrical work, however, is permitted for STAR Users within certain limits and if rules are followed. This is discussed in the STAR low-hazard work plan document, which Users are required to read:
>
> The STAR work plan document is provided as a web-course. Contact your host and/or Training Coordinator to add Job Training Assessment (JTA) **RC-82C | STAR Training to** your training profile, you will then need to complete STAR Low Hazard Worker-Planned Work for Users (RC-SOCSTAR web-course.
>
> The sPHENIX work plan document will be available when sPHENIX is established at the RHIC experimental area.

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 a common 120-Volt circuit breaker.

Use of electric power tools also requires separate additional safety training. The minimum training is called Advanced Electrical Safety Awareness CBT (TQ-ESA-W) available on line here https://www.bnl.gov/training/courses/web/.

If you have questions regarding the electrical safety or training requirements for your specific situation, then stop and consult with your Liaison Physicist or the Work Control Coordinator for your experiment.

Additional available contacts are:

- C-AD ESSHQ Division
- C-AD Work Control Manager
- C-AD Training Manager
- C-AD 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)

Personnel performing LOTO must complete BNL training (classroom initially, web-based annually, and Job Performance Measure (JPM) initially & 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. However, all personnel who must work on electrical circuits that are connected through circuit breakers, disconnect switches and/or fuses, must LOTO the circuits using an OSHA-compliant LOTO tag.

OSHA, BNL and C-AD require that all workers performing LOTO tasks be trained and 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 LOTO 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 ESSHQ Division (x5636). A similar procedure is used for Radiation Safety (RS) LOTO.

If you have questions regarding LOTO safety or training requirements for your specific situation, then stop and refer to your Liaison Physicist or the Work Control Coordinator for your experiment.

Additional available contacts are:

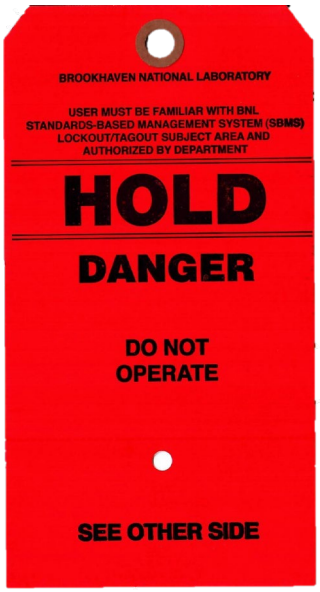
- C-AD ESSHQ Division
- C-AD Work Control Manager
- C-AD Training Manager
- C-AD Chief Electrical Engineer

Radiation Safety Lockout/Tagout (RS-LOTO) at the Medical Isotope Research and Production (MIRP) Facilities and the Accelerator Test Facility (ATF)

C-AD also uses Radiation Safety Lockout/Tagout at the Medical Isotope Research and Production facilities (BLIP, RRPL, MIRP Cyclotron) and the ATF. RS-LOTO tags are used to inform and warn personnel at MIRP of equipment that is isolated or configured to provide radiation protection to personnel and to satisfy Accelerator Safety Envelope (ASE) requirements. RS-LOTO is to prevent unauthorized changes to this equipment and has specific application requirements at MIRP facilities and the ATF.

Staff personnel must be specifically authorized to implement RS-LOTO for Radiological Protection at MIRP facilities. Liaison Physicists, Liaison Engineers, Access Controls Group, Operations Coordinators (OC), members of the Radiation Safety Committee, and certain other personnel are typically authorized to perform or direct RS-LOTO for radiological protection at MIRP. They must follow a specific procedure to lock and tag equipment for radiation protection. Equipment is locked to prevent exposure to hazardous radiation. Do not alter equipment that bears the RS-LOTO tag.

Operations Lockout

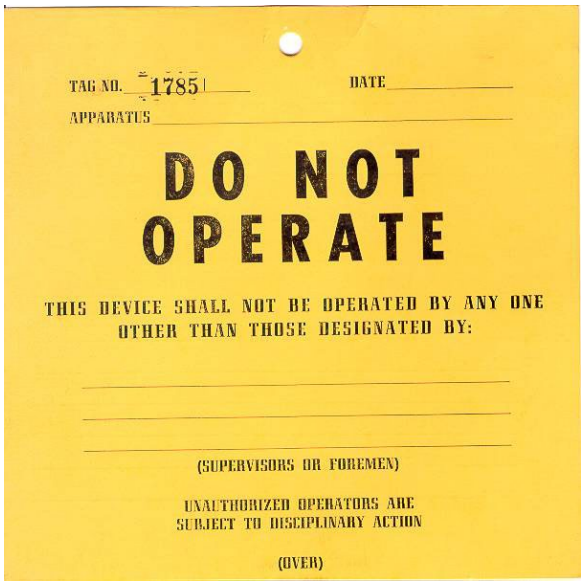


C-AD uses Operations Lockout to protect personnel during operations that are not service and maintenance activities. Operations Lockout tags may be used to inform and warn personnel of equipment that is isolated or configured to provide and protect personnel from hazards including, but not limited to, electrical, mechanical, and radiological hazards. The Operations Lockout is to prevent unauthorized changes to this equipment.

Staff personnel must be specifically authorized to implement Operations Lockout for Radiological Protection. Liaison Physicists, Liaison Engineers, Access Controls Group, Operations Coordinators (OC), members of the Radiation Safety Committee, and certain other personnel are typically authorized to perform or direct Operations Lockout. Equipment or beam lines are locked out during barrier or shielding modifications or removals, or whenever a beam line is not authorized to operate, or whenever the Access Control System (ACS) alone does not provide the required protection.

NOTE:
If you are operating an electrical circuit breaker or disconnect switch to perform Operations Lockout, then the electrical safety training, PPE and required authorization for that electrical task also apply.

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.

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

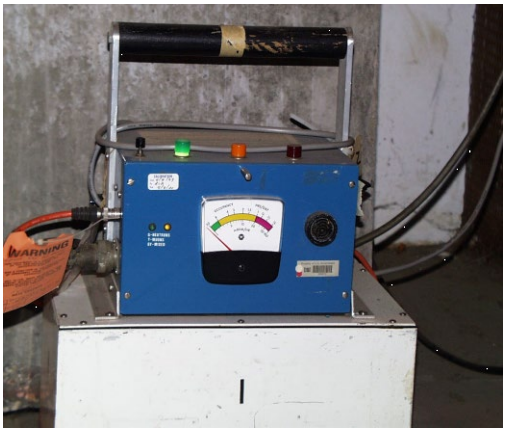
- GFCIs subject to infrequent use are to be tested prior to use by the user.

- Extension cords must be protected by a ground fault circuit interrupter (GFCI). The GFCI can consist of a special circuit breaker, a GFCI outlet, or an extension cord with a built-in GFCI.

Testing the GFCI is easy. Testing is with the self-test button and a routine load. A portable 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, do not use the outlet and report the problem to the Building Manager or ESH Representative as soon as possible.

There are also commercially available inexpensive GFCI receptacle testers:

Chipmunks and Radiation Surveys



Radiation monitor – Chipmunk

Do not move or tamper with Chipmunks

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.

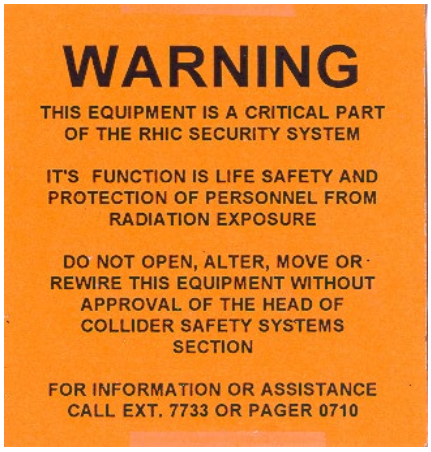
The Chipmunk is set up like a street light with red, yellow and green indicators. A Chipmunk will display a red blinking light for radiation levels greater than 20 mrem/h, and a yellow blinking light for levels approximately 2.5 to 20 mrem/hr. Normally, Chipmunks operate in the green range indicating 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 at C-AD, it may be expected that a Chipmunk will be indicating in the yellow range. This is not typically expected for areas at RHIC however.

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 (ACS) must remain correctly connected and correctly located. (The term "Security System" here is synonymous with Access Controls System, ACS). In order to help ensure that personnel do not disconnect or alter these devices without following approved procedure, the Access Controls Group will identify such devices with an **orange warning tag**. In the experimental areas, these tags alert personnel that the device is critical to safety and to the operation of the ACS 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

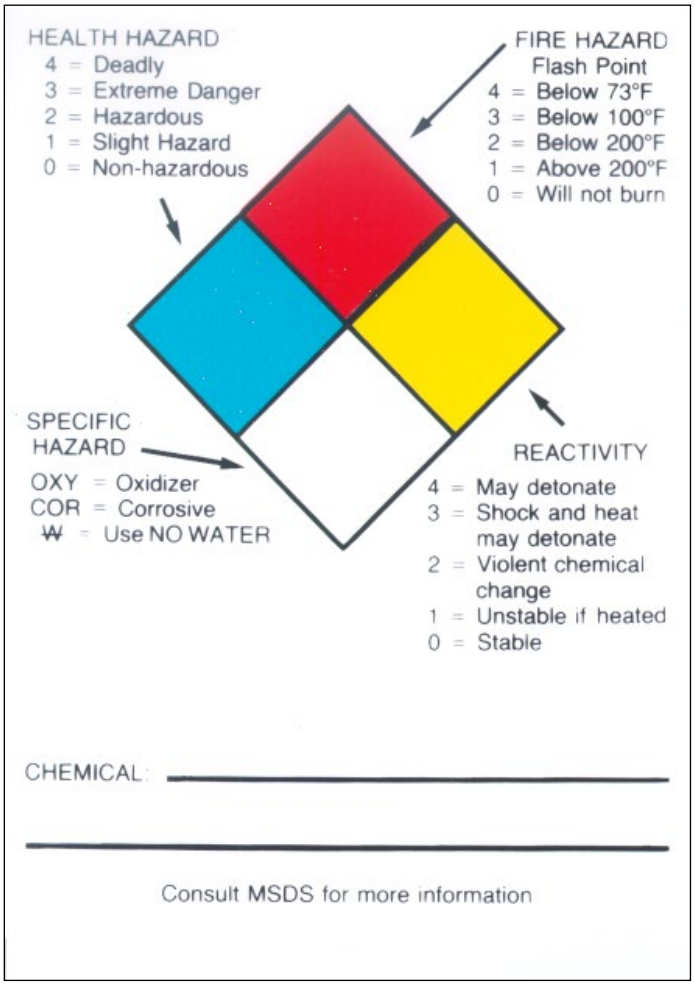
- C-AD Health Physics Office: Telephone x4660

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. Please make arrangements in advance.

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. The C-AD ESSHQ Division can provide you with information on the Laboratory's policy on hazardous material, how to obtain Safety Data Sheets (SDS) and how to interpret them. SDSs may also be obtained from the BNL Chemical Management System web site (http://intranet.bnl.gov/esh/cms/). Examples of information found on an SDS 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 C-AD ESSHQ Division 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

- Have documented training for wearing hearing protection

If you work often in noise areas, you may need to complete the BNL web course TQ-NOISE. 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. The typical RHIC User does not typically reach exposure levels that requires medical surveillance. Specific or unusual tasks or jobs may, however. Contact the C-AD ESSHQ Division 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 C-AD ESSHQ Division 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

This Collider User Training does not qualify you to enter a Confined Space. The information here is for awareness.

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 C-AD ESSHQ Division prior to entry.

Explosive Gas

Yellow strobe and audible alarm indicates gas leak ⟶ leave the building

The STAR detector uses combustible gas. The area will be posted to indicate use of the gas and to warn personnel to not bring ignition sources into the area. A yellow strobe light and audible alarm is an indication of a flammable or combustible gas leak. If an alarm occurs, leave the building immediately, wait at least 50 feet away from the building and do not reenter the building until the Fire Captain indicates it is safe to do so.

Magnetic Field Safety

NOTE: If you will be exposed to magnetic fields 0.5 milli-Tesla (5 Gauss) or greater, medical clearance is required. Contact the BNL Occupational Medicine Clinic (OMC) in Bldg 490 for instruction and clearance, or contact the C-AD training office x7007. OMC will ask you questions to help determine if it is safe for you to enter the magnetic field area.

Where magnetic fields may be present, the area is posted. Some areas remain posted long-term, and some may be temporarily posted for magnet testing.

Following is an example of a lower 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 lower level posted area, if you wear a medical device or have a medical implant, entry is not allowed unless evaluated and approved by the BNL Clinic. Medical devices & implants include cardiac pacemakers, electronic medicals devices, ferromagnetic medical devices, and implants affected by magnetic fields. 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 ESSHQ Division and the BNL Clinic.

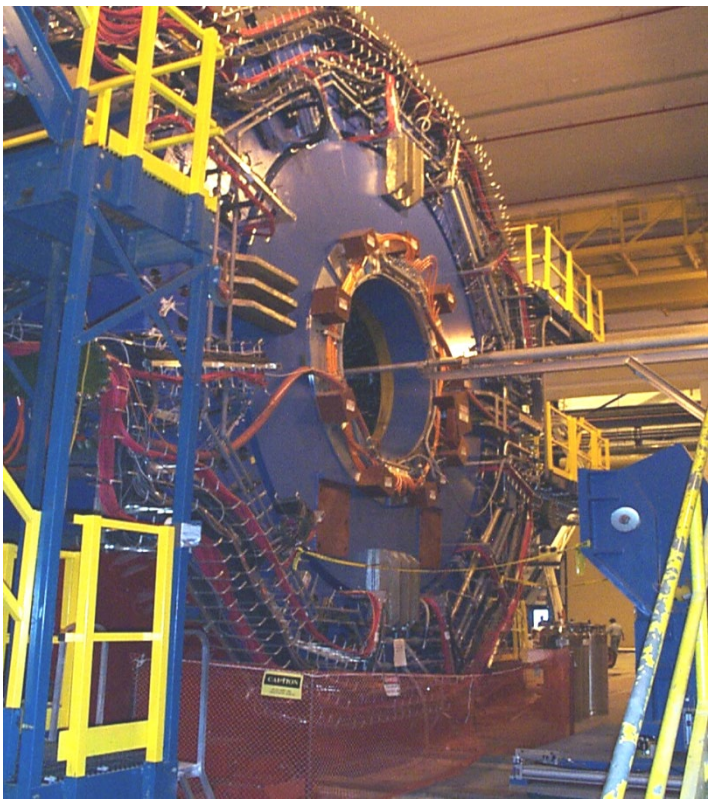
For entry into higher level posted areas additional training is required and work planning must assure limits set by the BNL Subject Area on Static Magnetic Fields are not exceeded. The subject area has exposure limits for:

- 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.

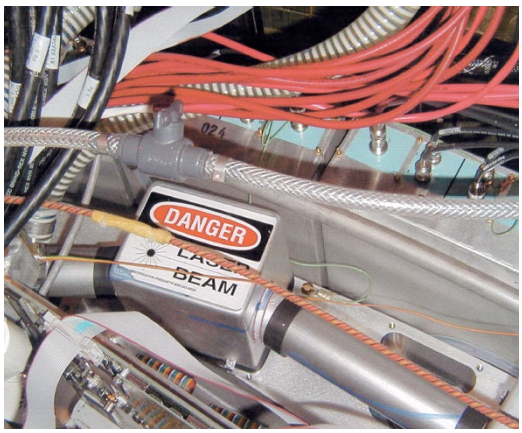
Use of higher class lasers, Classes IIIb and IV, requires additional Laboratory training as well as completion of a Laboratory Standard Operating Procedure (SOP). You must be given permission by the laser owner before use.

Class II and IIIa lasers require a permit.

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

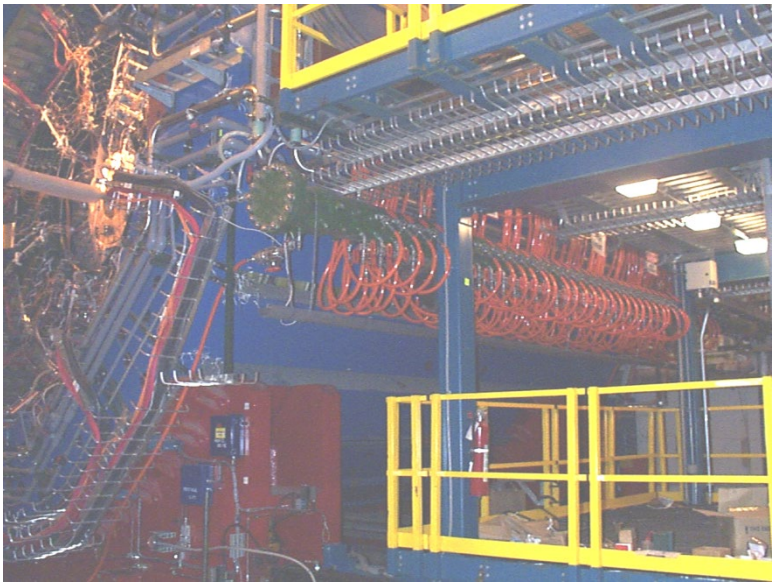
If you have questions regarding lasers, you may contact the C-AD ESSHQ Division.

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 protective equipment may be required for safety. Plan your work in advance. Consider whether PPE may be needed. Contact the C-AD ESSHQ Division 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 (on scaffolding for example)
- When overhead cranes are operating above you
- At all times at a construction site

Safe Footwear & Long Pants

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**.** These shoes will have a safety toe that is non-metallic.

Short pants must not be worn in industrial work areas, such as at RHIC. Long pants are required.

It is especially important to remember this during warm weather when we might prefer footwear and clothing for warm-weather comfort.

Inclement Weather

The winters in this part of the U.S. are cold, rainy, snowy and icy. This is a hazard. Be aware of this especially when walking in such conditions, since there is a significant increased potential for a slip & fall, and possibly significant injury to yourself.

Working at Heights

Work at heights (above 4 ft) is performed in experimental areas using 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

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 course 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" (April 9, 2019 Rev 1.4 as of this writing) to assure vertical fixed ladders are inspected for compliance with 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 by physically fit and trained personnel. 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 and it is red-marked. **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. (Requires clearance 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 before you use the ladder

If any unexpected or unidentified issues are discovered while using the ladder, 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.

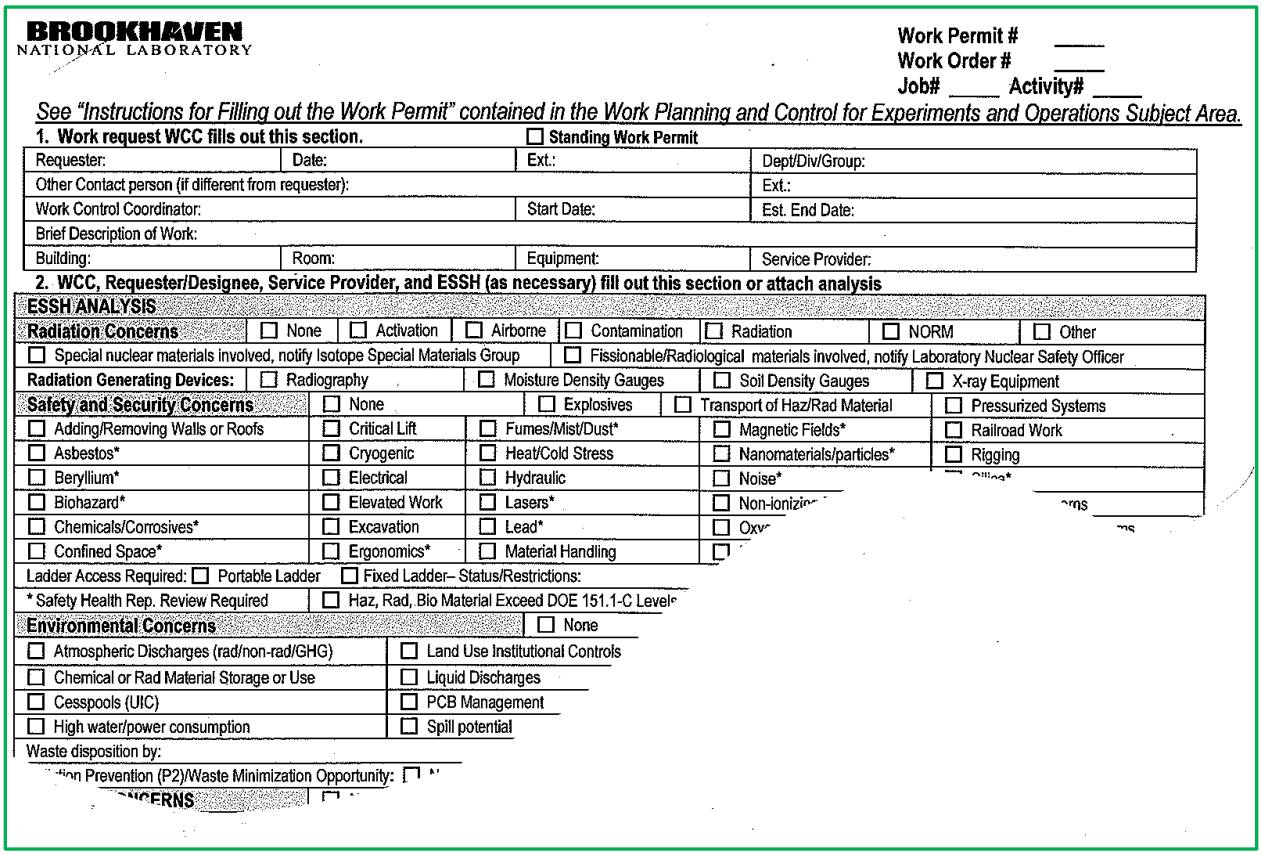
Collider experiments have beryllium beam pipes installed. This material is fragile, and toxic. Protection is provided to prevent physical damage.

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 "Green Sheet"



BROOKHAVEN NATIONAL LABORATORY

Work Permit # _____
Work Order # _____
Job# _____ Activity# _____

See "Instructions for Filling out the Work Permit" contained in the Work Planning and Control for Experiments and Operations Subject Area.

1. Work request WCC fills out this section. ☐ Standing Work Permit

Requester:	Date:	Ext.:	Dept/Div/Group:
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

ESSH ANALYSIS						
Radiation Concerns	☐ None	☐ Activation	☐ Airborne	☐ Contamination	☐ Radiation	☐ NORM	☐ Other
☐ Special nuclear materials involved, notify Isotope Special Materials Group				☐ Fissionable/Radiological materials involved, notify Laboratory Nuclear Safety Officer		
Radiation Generating Devices:	☐ Radiography	☐ Moisture Density Gauges	☐ Soil Density Gauges	☐ X-ray Equipment		
Safety and Security Concerns	☐ None	☐ Explosives	☐ Transport of Haz/Rad Material	☐ Pressurized Systems		
☐ Adding/Removing Walls or Roofs	☐ Critical Lift	☐ Fumes/Mist/Dust*	☐ Magnetic Fields*	☐ Railroad Work		
☐ Asbestos*	☐ Cryogenic	☐ Heat/Cold Stress	☐ Nanomaterials/particles*	☐ Rigging		
☐ Beryllium*	☐ Electrical	☐ Hydraulic	☐ Noise*			
☐ Biohazard*	☐ Elevated Work	☐ Lasers*	☐ Non-ionizing			
☐ Chemicals/Corrosives*	☐ Excavation	☐ Lead*	☐ Oxy			
☐ Confined Space*	☐ Ergonomics*	☐ Material Handling	☐			
Ladder Access Required: ☐ Portable Ladder	☐ Fixed Ladder– Status/Restrictions:					
* Safety Health Rep. Review Required	☐ Haz, Rad, Bio Material Exceed DOE 151.1-C Level					
Environmental Concerns	☐ None					
☐ Atmospheric Discharges (rad/non-rad/GHG)	☐ Land Use Institutional Controls					
☐ Chemical or Rad Material Storage or Use	☐ Liquid Discharges					
☐ Cesspools (UIC)	☐ PCB Management					
☐ High water/power consumption	☐ Spill potential					
Waste disposition by:						
Prevention (P2)/Waste Minimization Opportunity: ☐						
CERNS	☐					

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, or vendor or manufacturer operating or maintenance manuals).

(3) The "permit planned work" practice requires use of a BNL 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 sPHENIX Users: You are required to read a low-hazard work plan document written for your experiment. For STAR, the document is available on line for you to read: Go to https://www.bnl.gov/training/courses/web/ and click "STAR Low Hazard Worker-Planned Work for Users (RC-SOCSTAR)". You are required to complete this read of the work plan document prior to performing *any work* at the experimental area. The work plan document describes 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.

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.

The low-hazard work plan document for sPHENIX will be available when sPHENIX is established at the RHIC experimental area.

Removing Damaged Equipment From Service

If any equipment presents an immediate hazard that could reasonably be expected to cause injury or environmental harm, then 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, contact the C-AD ESSHQ Division or your experiment's Work Control Coordinator for assistance.

Accountability for Following the Rules

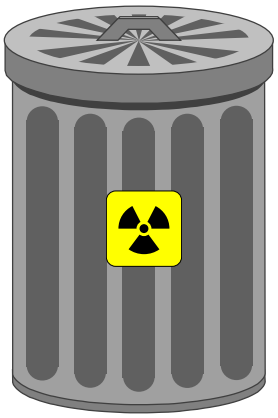
You are responsible for following C-AD rules and procedures for which you have been trained. If you cannot follow the rules and procedures in order to perform your work, you must seek to have the rule or procedure officially changed to suit what is needed prior to performing the work. Rules and procedures 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.

Storage of hazardous waste is subject to time limits and volume limits that must be strictly adhered to. 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 within BNL, or to external/outside agencies, or both. C-AD & BNL must report to external/outside agencies on spills that impact the environment. Reporting must be made within certain time constraints therefore 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, Liaison Physicist or your Work Control Coordinator.

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 ESSHQ Division Head (x2356) 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 ^{0}F, (51^{0} 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 a few 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*. Inform the Fire/Rescue Group it is an injury or illness (as opposed to a fire) so that the ambulance & Emergency Medical Technician (EMT) are dispatched to the scene.

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 your 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 the outdoor area and 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 as opposed to the on-site BNL Fire/Rescue Group directly. This might result in some delay getting you the 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:
The BNL site-wide sirens may not be heard within the RHIC tunnel.

If the site-wide continuous siren is activated:
This indicates personnel should report to an Indoor Assembly Area. Individuals within the tunnel are likely safe. However, C-AD Management would evaluate the situation and make a 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. To alert staff who may be in the RHIC tunnel, or at the STAR or sPHENIX intersection regions, C-AD procedure instructs MCR and Collider Accelerator Support (CAS) personnel to make an announcement over the Public Address system. (Ref: C-AD OPM Procedure 3.22[1])

[1] 3.22 Procedure to Evacuate RHIC Tunnel During a BNL Site-Wide Emergency

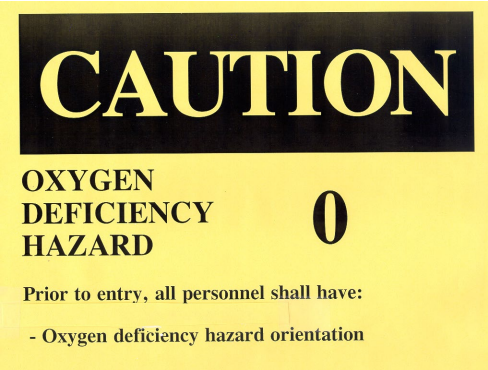
Electrical Power Failure - Be Prepared

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.

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

Oxygen Deficiency Hazards



All RHIC Users are required to complete BNL's on line Oxygen Deficiency Hazard (ODH) Training, available here https://www.bnl.gov/training/courses/web/ as course number TQ-ODH. The RHIC tunnel during operating periods and other areas at RHIC are posted as ODH Class 0 Areas. This Collider User Training alone does not qualify you to enter such areas.

It is possible that the ODH classification for the RHIC tunnel may be increased to Class "1". This could be the case if certain safety systems are not operable such as oxygen monitors, ventilation fans or pressure switches that would detect a helium leak into the cryostat vacuum space. This is unlikely but possible. If increased to Class 1, then postings at the entrances to the tunnel would be changed accordingly to Class 1. Entering a Class 1 area requires additional training, medical clearance, and a breathing-air escape pack and personal oxygen monitor. **Pay attention to postings.**

The RHIC tunnel is Class 0 (unless posted otherwise). Some but not all Users access the tunnel. The Intersection Regions at STAR and sPHENIX are not typically posted for ODH (neither Class 0 nor Class 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
- 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. 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 early symptoms of exposure to low oxygen (16% or 17% for example):

- increased breathing volume
- accelerated heartbeat
- dizziness
- increased time to perform tasks

The evacuation procedure is as follows:

- **Immediately leave the area**. Once you have escaped, pull a fire alarm or dial X2222.

- **After you have escaped**, call the C-AD Main Control Room (x4662) and inform them of the incident. Notify your supervisor and the C-AD ESSHQ Division.

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 (the vertical escape ladders) at RHIC to evacuate in an ODH event.

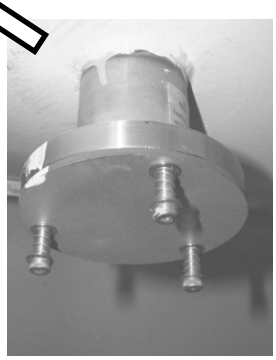
Regarding nitrogen: The evacuation instruction is similar to that outlined above: Stay Low; Do not use vertical escape exits; Use 'horizontal' exits. Nitrogen, however, can be slightly heavier than air when 'cold' (when first released) and may accumulate in low lying areas at first, such as in trenches 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 the primary hazard. During summer shutdowns 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 or other cryogen in some other way that could cause an ODH concern, procedures would require that areas be posted and clearly marked for ODH. We may also require that a Personal Oxygen Monitor (POM) 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 valves, 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 and exit through a Primary Area access gate. Contact MCR.

Blue Strobe and Audible Alarm: *Oxygen Deficiency Event*
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 detector uses a flammable/explosive gas mixture.

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 Representative.

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

Several years ago 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 monitoring wells south of an on-site research reactor, 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 harm's way. Instead, Plan Your Work and then Work Your Plan.

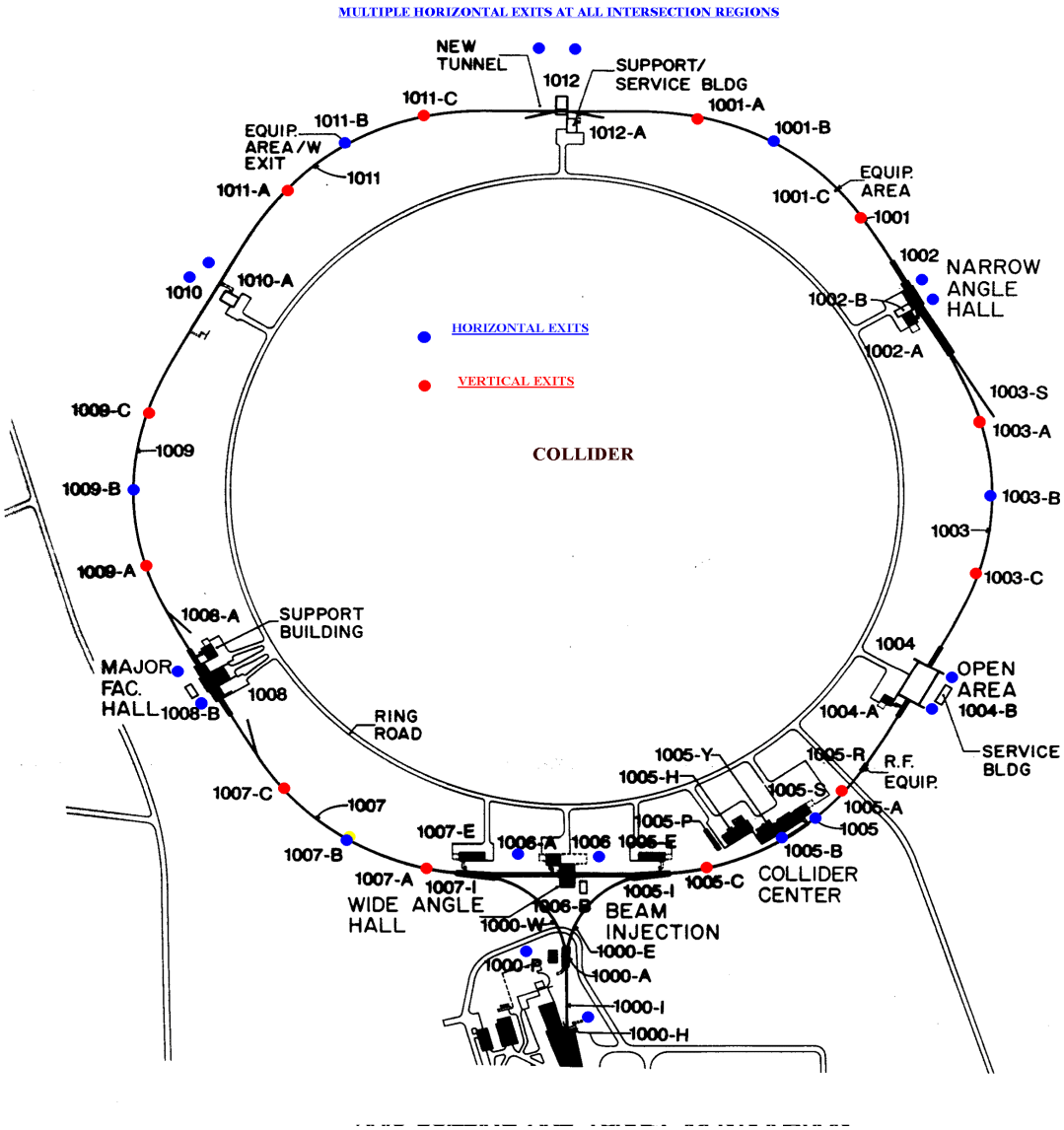
Alcohol/substance Abuse:

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 performance, conduct and reliability, substance abuse is illegal.

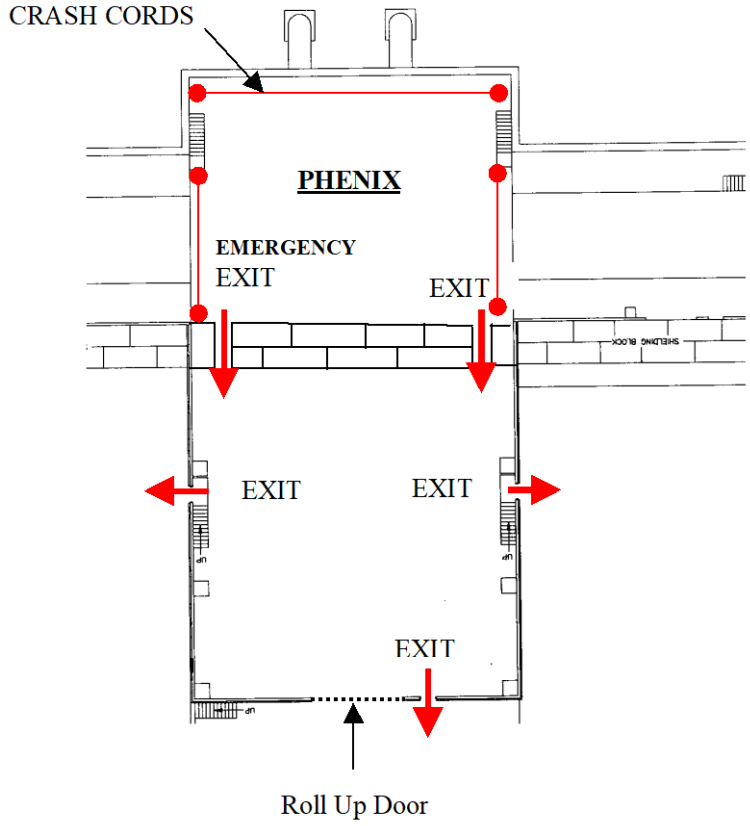
Emergency Egress Diagrams

Upon entering any building or experimental area/hall at the C-A complex one should note the locations of emergency equipment as well as the exit points.

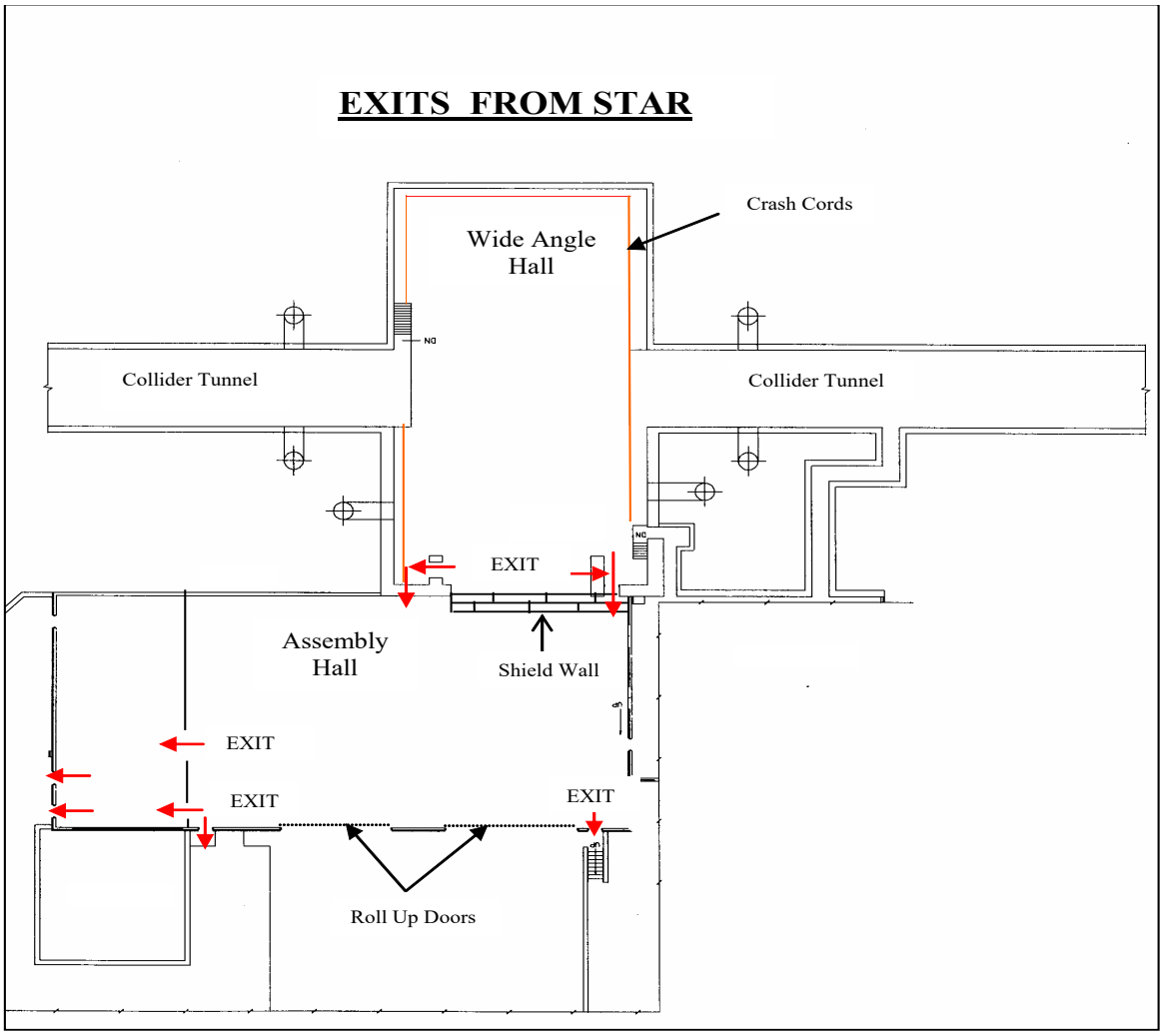
EXITS FROM COLLIDER TUNNEL



EXITS FROM PHENIX



EXITS FROM STAR



List of Acronyms

ACL	-	Administrative Control Level (radiation dose)
AGS	-	Alternating Gradient Synchrotron
ALARA	-	As Low As Reasonably Achievable
ASME	-	American Society of Mechanical Engineers
BNL	-	Brookhaven National Laboratory
BSA	-	Brookhaven Science Associates
C-AD	-	Collider-Accelerator Department
CAS	-	Collider Accelerator Support Group
CeC	-	Coherent Electron Cooling
CFR	-	Code of Federal Regulations
DEC	-	Department Emergency Coordinator
DOE	-	United States Department of Energy
ESH	-	Environment, Safety & Health
ESHR	-	Environment, Safety & Health Representative
ESSH	-	Environment, Safety, Security & Health
ESRC	-	Experiment Safety Review Committee
ESSHQ	-	Environment, Safety, Security, Health & Quality
GERT	-	General Employee Radiological Training
HP	-	Health Physics
IR	-	Intersection Region
LE	-	Liaison Engineer
LEC	-	Local Emergency Coordinator
LESC	-	Lab Electrical Safety Committee
LOTO	-	Lock Out / Tag Out
LP	-	Liaison Physicist
MCR	-	Main Control Room
NBBI	-	National Board of Boiler and Pressure Vessel Inspectors
NRTL	-	Nationally Recognized Test Laboratory
OC	-	Operations Coordinator
ODH	-	Oxygen Deficiency Hazard
OSHA	-	Occupational Safety and Health Administration
PAAA	-	Price-Anderson Amendments Act
PASS	-	Particle Accelerator Safety System
PPE	-	Personal Protective Equipment
RCT	-	Radiological Control Technician
RHIC	-	Relativistic Heavy Ion Collider
RWP	-	Radiological Work Permit
SBMS	-	Standards Based Management System
SOP	-	Standard Operating Procedure
SRD	-	Self-Reading Dosimeter
TLD	-	Thermo-Luminescent Dosimeter