Brookhaven National Laboratory

Collider-Accelerator Department (C-AD)

Access Training

Radiation Safety
Conventional Safety
Access Control

INFORMATION GUIDE

October 2023

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C-A D Access Training

Description & Purpose:

This course is required for unescorted access to Collider-Accelerator Department (C-AD) Primary Areas.* This course is also required for unescorted access to other non-Primary areas of the C-AD complex such as assembly buildings, service and support buildings, areas of the LINAC, EBIS, Tandem or NSRL facilities, AGS Bldg. 912, or other areas of the complex, both indoors and outdoors. This training is NOT required to enter the office areas of Bldg. 911, Bldg. 901A, Bldg. 930, and Bldg. 1005S although it is important to maintain awareness of all signs and postings in these buildings since some areas in these facilities have special access and training requirements.

This course may be required if you are conducting work anywhere at the C-AD complex. Be aware that work policies and practices at C-AD may be more restrictive than elsewhere at the Lab so you must always follow proper C-AD work planning procedures. Work control requirements at C-AD are discussed in this course.

This course provides you with basic information about the Access Control System (ACS) at C-AD. The course covers physical design features and administrative controls that are used to prevent accidental radiation exposure.

In addition to this course, BNL's Oxygen Deficiency Hazard web-based training course #TQ- ODH is required and BNL's Radiological Worker-1 Training is generally required for unescorted access to the C-AD complex.

Successful completion of this Access Training, ODH Training and Radiological Worker-1 Training does not allow you to work in Contamination Areas or Radiological Buffer Areas. Additional training is required for these areas. Class 1 ODH areas require additional training and medical clearance as well.

Successful completion of this Access Training does not allow you to remove activated materials from posted areas without the assistance of a Radiological Control Technician (RCT).

* Primary Areas are areas where beam travels and are fully surrounded by radiation shielding and/or have barriers. They are generally arranged as shielded areas with interlocked gates. Primary Areas are to be considered lethal with beam on. With beam on, access is prohibited. The beam may be intense enough to deliver a lethal dose in a single pulse. You are never permitted to climb over or defeat barriers. Primary Areas include (but are not limited to): W, X, and Y lines, the Collider Tunnel, the AGS Tunnel, the Booster Tunnel, LINAC to Booster (LtB) Line, HEBT Line, Tandem to Booster (TtB) Line, U Line, AGS to RHIC (AtR) Transfer Line, Booster to NSRL primary beam line, R Line and target rooms (such as at NSRL). The inner space of the tube-like vacuum enclosures (beam pipe) that directly surround the beam are also considered primary areas.

General Hazards

In addition to ionizing radiation hazards, C-AD areas may contain hazards posed by:

- heavy objects
- mechanical equipment
- remotely operated equipment (personnel entanglement in mechanism)
- overhead cranes
- working at heights
- magnetic fields
- hot and cold surfaces
- cryogens
- steam
- high-voltage and high-current electrical systems
- noise hazards
- startle hazards, e.g.: from equipment auto starts, pressure reliefs
- hazardous materials
- ozone (used in treating cooling water)
- oxygen deficiency from release of helium, nitrogen, sulfur hexafluoride
- radio-frequency (RF) radiation
- contamination and oxygen deficiency from smoke and fire
- slips, trips & falls
- lead
- lasers
- machine shops
- fixed vertical ladders

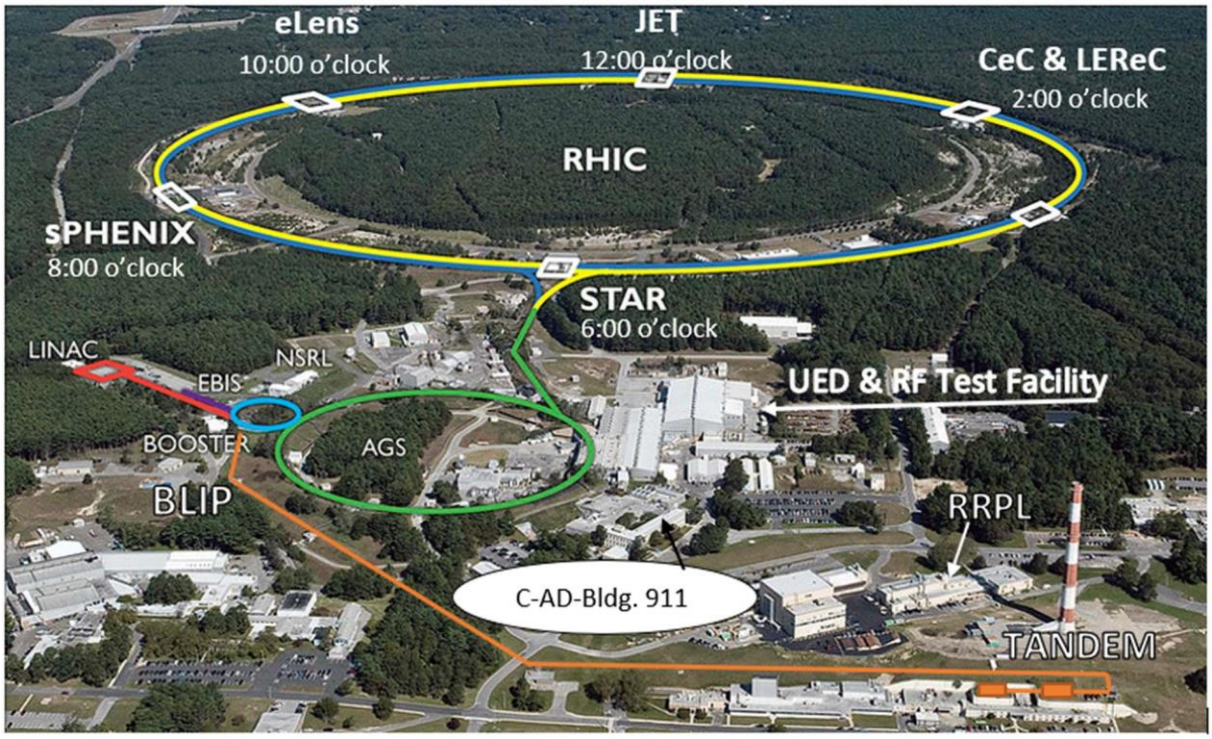
We strive to maintain an excellent safety record in such a complex environment without undue inconvenience to the C-AD staff or others. We can assure the continuity of a good safety record only by having the active cooperation of everyone who has access to the C-AD complex. Each of you should familiarize yourselves with C-AD safety requirements, procedures, and the Local Emergency Plan, found in the C-AD Operations Procedures Manual (OPM), Chapter 3.

As a worker at the C-AD complex you will most likely require additional job specific training. This may include web-based training, classroom training given by the BNL Training Office or by C-AD. Your supervisor should consult with the C-AD Training Manager to determine your training requirements.

Appendix A is a sample list of training applicable to various work activities at C-AD. This is not intended to be an all-inclusive list. It is intended as an aid in determining what training might be required for you.

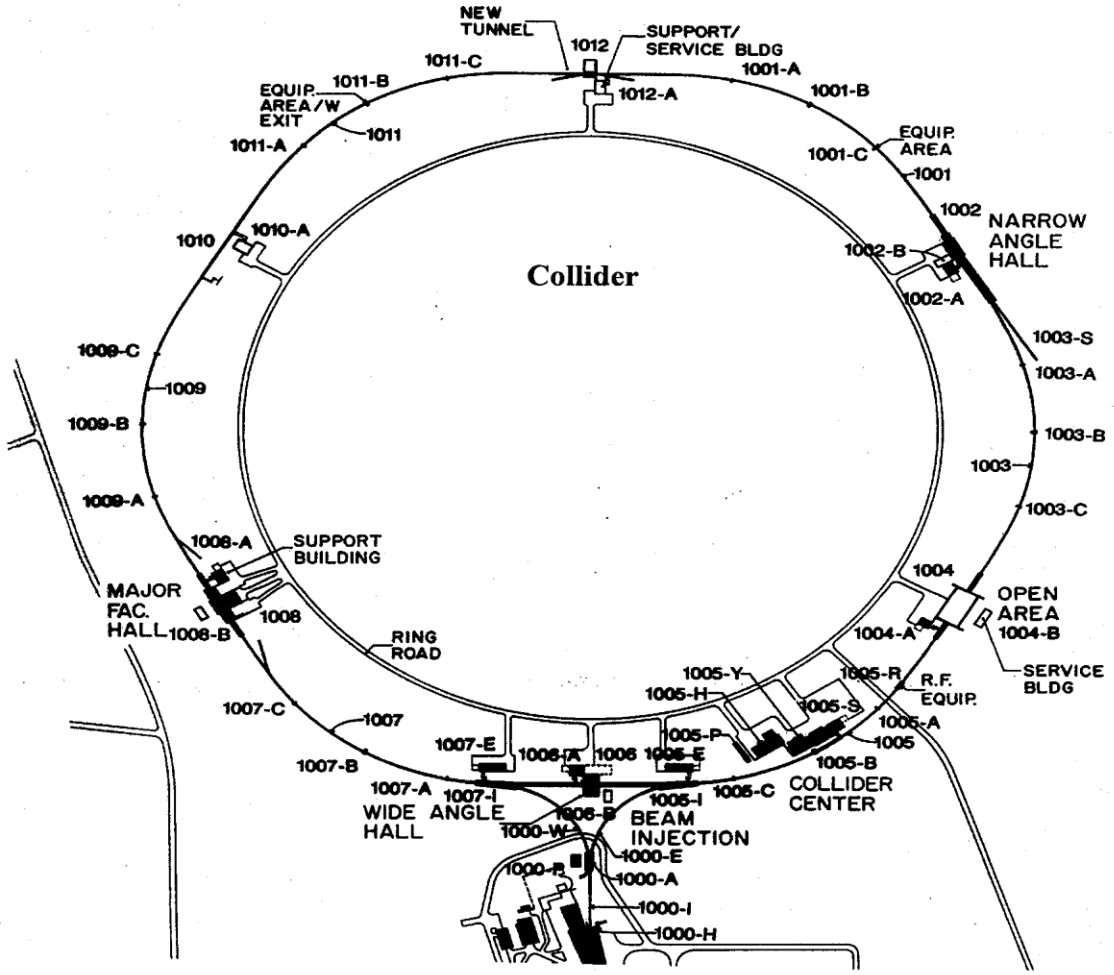
It is your responsibility to maintain your training current. The BNL Training Management System (BTMS) can help you and your supervisor easily check your training status. You are not allowed to perform work or enter areas for which you are either untrained or for which your training has expired.

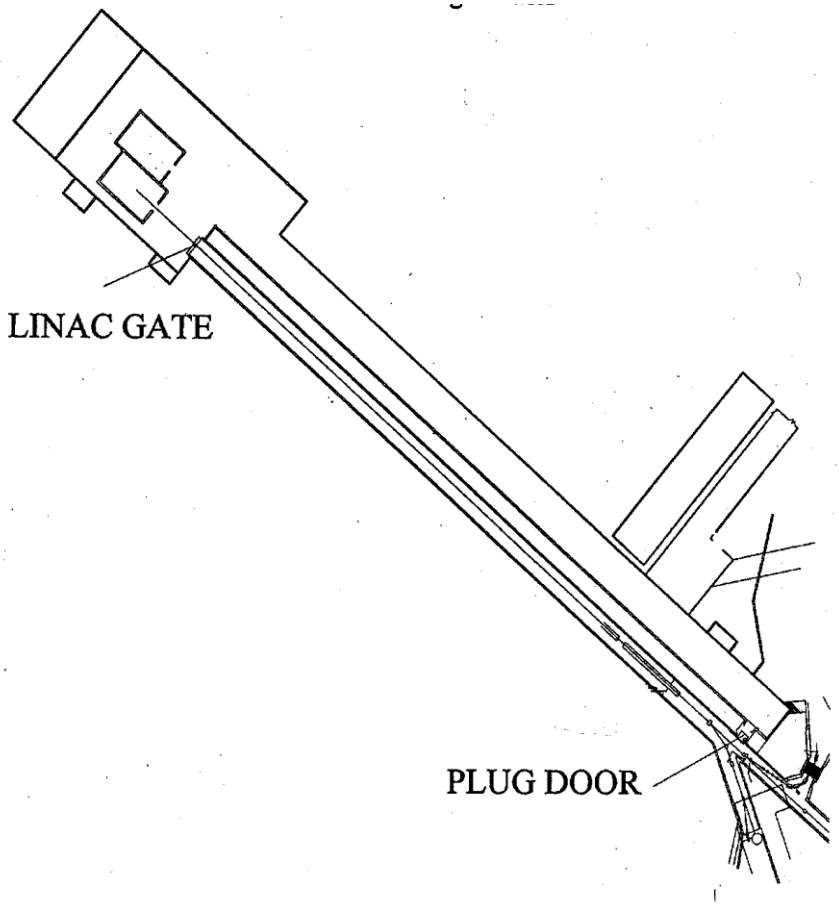
Basic Layout of Collider-Accelerator Department (C-AD) Complex



Relativistic Heavy Ion Collider (RHIC)

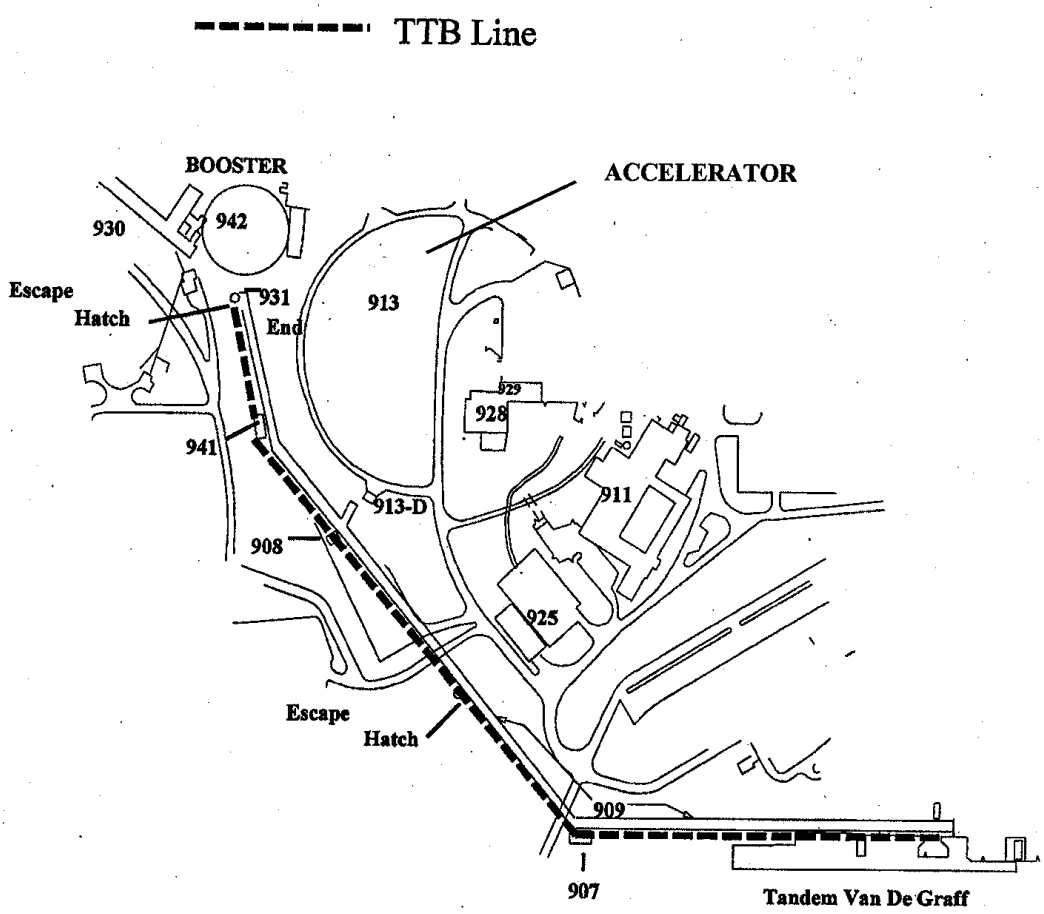
COLLIDER RING





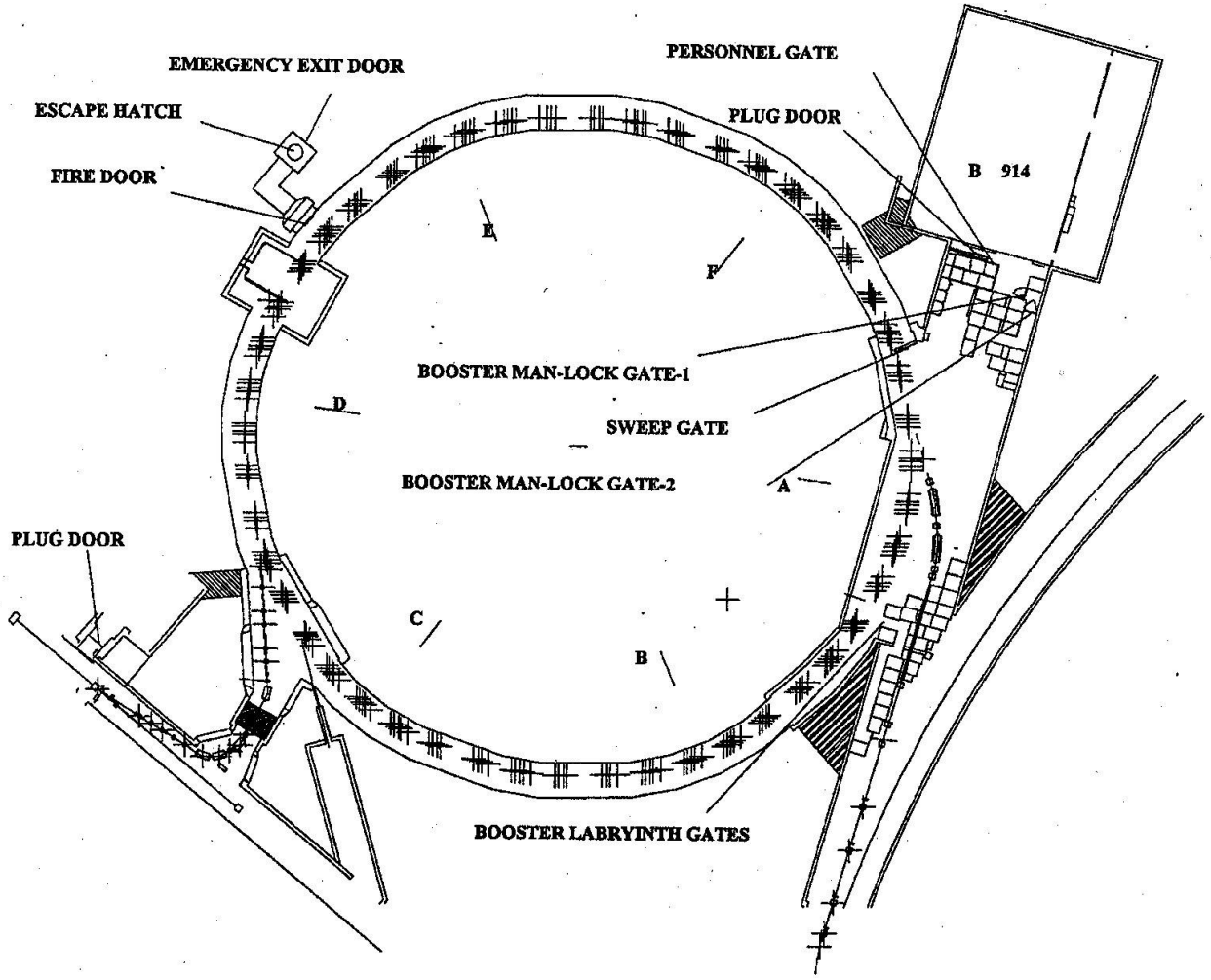
LINAC Tunnel Building 930 Basement

Gate entrance at north end
Plug door at south end
Exits are through Entries



TANDEM TO BOOSTER (TTB) Tunnel

Entrance gates at Buildings 907, 908, 941
Obtain Key from Tandem Operator
Exit through gates
Emergency exits through the escape hatch at Boosted end of tunnel and between buildings 907 and 908



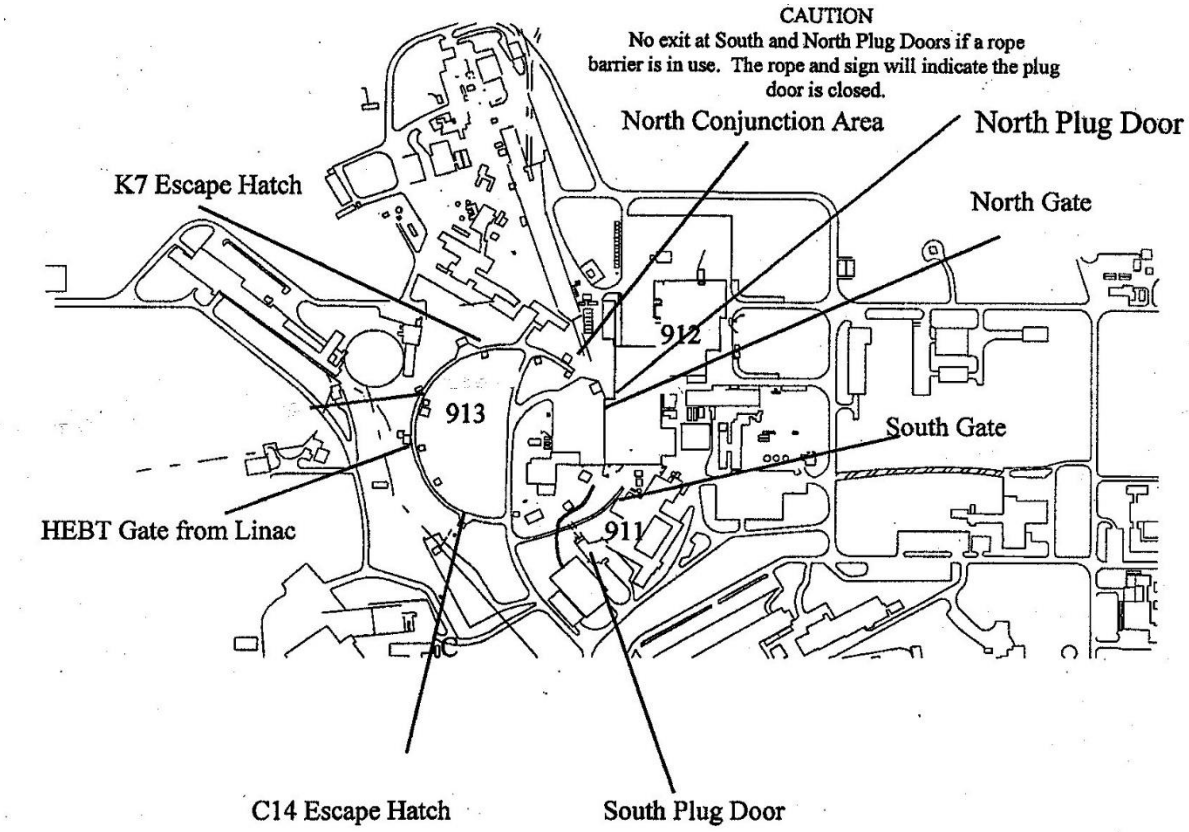
BOOSTER RING BUILDING 942

Gate Entrance from Building 914 (Also Emergency Exit)
Plug Door from Building 914 (Equipment Entrance)
Labyrinth from Accelerator Ring with Booster Off

Exits are through 914 Gate and Plug Door (When Plug is Open)
Escape Hatch for Emergencies ONLY, labyrinth is NOT an emergency exit.

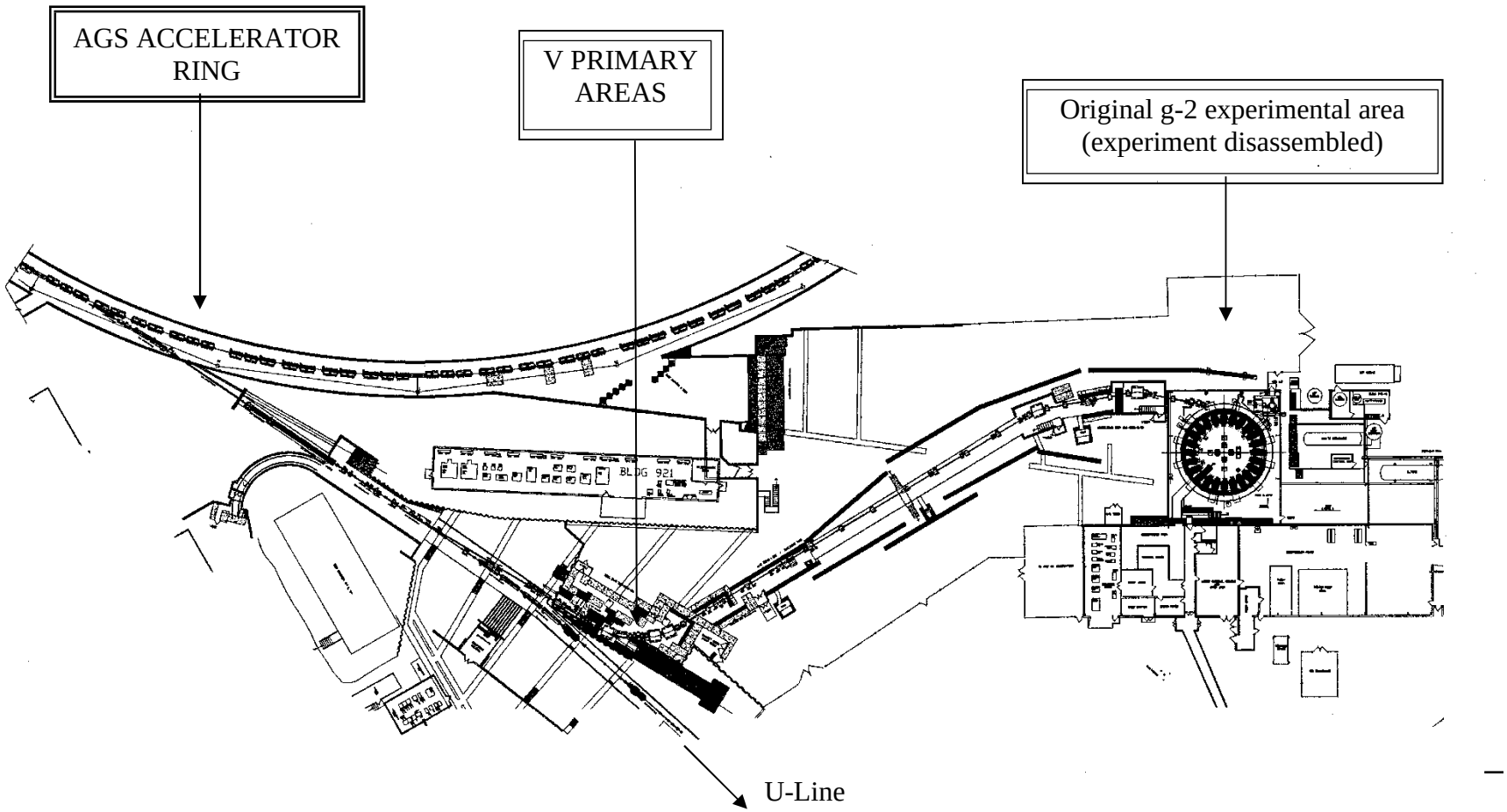
AGS BUILDING 913

Entrances at:
South Gate from Building 911A
North Gate from building 912
North Conjunction Area near Building 919
South Plug Door near Building 911
HEBT Gate from LINAC Tunnel
Booster Accelerator Labyrinth



Booster Acce

Exits at:
Any gate during Restricted Access
The Gate you enter during Controlled Access; or
may exit North Gate with South Gate key
(return key to South Gate key tree)
Emergency Exit at Escape Hatches C14 and K7
DO NOT use HEBT Gate or Booster Accelerator Labyrinth



- Fast extraction beam areas
- Original g-2 experimental area; experiment disassembled

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Handling Lead (Pb)

You may encounter lead shielding in primary areas and elsewhere at C-AD. Be aware that handling lead may be hazardous if it is not enclosed or painted since lead oxide is easily airborne to produce a potential inhalation hazard or is easily absorbed through bare skin during handling. You are required to go through the C-AD work planning process to handle lead. You are required to use personal protective equipment (PPE) such as gloves, and possibly additional PPE, when handling lead. Additional training and medical surveillance may also be required. This should be determined during work planning. Lead may be found in brick, sheet, or cast forms, or as wool which is used in lead blankets. In most applications, the bare metal should be covered or painted if practicable. You need to wear safety shoes in addition to gloves when handling lead bricks or sheets of lead. You are not allowed to shape, drill, or otherwise work with lead in any way that causes it to become dispersed. If you need to work with lead in any way, contact the C- AD ESSHQ Division Head or the C-AD ESH Manager for proper work planning, personal monitoring and PPE.

Magnetic Fields

There are many posted magnetic field areas throughout the C-AD complex. C-AD beam lines incorporate large magnets, and they may be energized. Magnet testing may also in progress in some areas. Where magnetic fields may be present, the areas are posted.

Personnel who enter posted areas at C-AD are required to complete BNL's Static Magnetic Fields Training (web-based course TQ-SMF).

Personnel are also required to be cleared by the BNL Occupational Medicine Clinic for entry into posted magnetic field areas. This is the case even for the lowest level posted area of 5 Gauss (0.5 milli Tesla). A sample posting is shown above. It indicates greater-than-or-equal-to 5 Gauss.

Especially if you wear a medical device or have a medical implant, entry is not allowed unless evaluated and cleared for entry by the BNL Clinic. If in doubt about the requirements or about your specific situation, contacts available to you are the C-AD ESH Manager and the BNL Clinic. If entry is needed, the BNL Clinic and your personal physician can determine the magnetic field strength that can adversely affect your device or implant.

The next higher-level postings could be:

600 G
6,000 G
20,000 G … etc

However, 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. Read postings carefully.

At C-AD, 5 Gauss is posted on doors of assembly buildings, experimental areas, the Collider tunnel, areas of Building 912 and possibly other areas throughout the C-AD complex.

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.

For entry into areas at higher level postings, work planning must assure that 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)

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.

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.

Note:

Current BNL procedure states that for all guests/users (who do not typically receive a routine physical examination by the BNL Clinic) with the potential to be exposed to a field greater-than-or-equal-to 0.5 mT (5 Gauss), print and complete BNL's Non-Employee Static Magnetic Field Questionnaire and submit it to the BNL Occupational Medicine Clinic (OMC), Bldg. 490.

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

Gas Alarms

Flammable and combustible gases are used throughout the C-AD facility. Equipment that contains these gases will be labeled. Entranceways to enclosed areas that contain these gases will also be posted to indicate the possible use of the gas and to warn personnel to not bring ignition sources into the area. Gases are used in particle detectors and targets. Large detectors may have electronic warning signs to indicate that the gas is currently in use. The STAR detector at RHIC, for example, uses an explosive gas. 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.

Example of one type of posting that you may encounter:

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***

- **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. In general, all C-AD and BNL employees who routinely enter posted noise hazard areas at C-AD are on the medical surveillance.

Disposable ear plugs are located at entrances to noise hazard areas. For certain areas at C-AD, double hearing protection is required. Examples of this are the RHIC Helium Compressor Building (Bldg. 1005H), the Siemens Motor-Generator Room (Bldg. 928) and the RF Testing Cryo Pumping Facility (near the North end of Bldg. 912). Hearing protection, or double hearing protection, may also be assigned for specific jobs during the work planning process. Disposable ear plugs along with ear muffs are typically used as double protection.

* Some postings ay say hearing protection required with equiptment on,

Confined Space Recognition

The intent here is only to provide a general definition of a Confined Space. This is so you may recognize when you are about to enter a Confined Space, even if the space is not posted as such. This training does not qualify you to enter a Confined Space. Additional training is required.

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 three characteristics, even if it is not posted, and:

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

then contact the Environment, Safety & Health (ESH) Manager prior to entry.

Even if not posted, if you need to enter a space with the above characteristics contact the ESH Manager prior to entry.

Electrical Safety

Please note that this training does not qualify you to work on electrical equipment that is physically connected to a power supply (through circuit breakers, disconnect switches and/or fuses), or that has stored energy. This training does not qualify you to work on electrically energized equipment.

If you work on electrical equipment or circuits that are powered through circuit breakers, disconnect switches and/or fuses, then you must de-energize and LOTO (Lockout/Tagout) the circuits. You must use your own LOTO lock.

All workers performing LOTO or electrical tasks must have the appropriate training and C-AD authorization. OSHA, NFPA, BNL and C-AD require that all workers performing these tasks be trained. Even operating a 120 V circuit breaker at BNL requires training and PPE: non-melting fabric long-sleeve shirt, long pants, leather-palm gloves, safety glasses with side shields and hearing protection.

You are not permitted to be potentially exposed to an electrical hazard (shock or arc flash hazard) without the required training and authorization. Depending on tasks performed, required training may include:

- BNL Qualified Electrical Worker (QEW-1, QEW-2 and/or QEW-3 as applicable)
- Advanced Electrical Safety Awareness
- BNL Lockout/Tagout (LOTO) Authorized Worker
- LOTO Job Performance Measure (JPM)

It is always preferred that circuits or equipment be de-energized and LOTO'd before working on them, if not completely disconnected. Under rare circumstances however, it may be necessary to work or conduct testing on electrical circuits or equipment while energized. Under these circumstances, you must be a Qualified Electrical Worker and work under an energized Electrical Work Permit.

BNL SBMS Subject Area "Electrical Safety" defines "working on" energized electrical conductors or circuit parts as follows:

> Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment (PPE) a person is wearing. There are two categories of "working on":
>
> 1. Diagnostic (testing) is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment;

2. Repair is any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.).

In general, the rules for “working on” apply above 50 volts.

Keep in mind that Personal Protective Equipment (PPE) is required for most electrical tasks. For example:

Operating circuit breakers or switchgear operation requires PPE;

Performing zero-energy verification on electrical circuits to complete a LOTO is considered working on energized electrical equipment and requires PPE.

PPE is required for **shock hazard** and **arc flash hazard**. Working on live equipment or operating switchgear is not permitted without the correct PPE and the required training. We must comply with the BNL Electrical Safety Subject Area and NFPA 70E.

NFPA 70E
NFPA: National Fire Protection Association
70E: Electrical Safety in the Work Place

Some specific electrical hazards at C-AD:

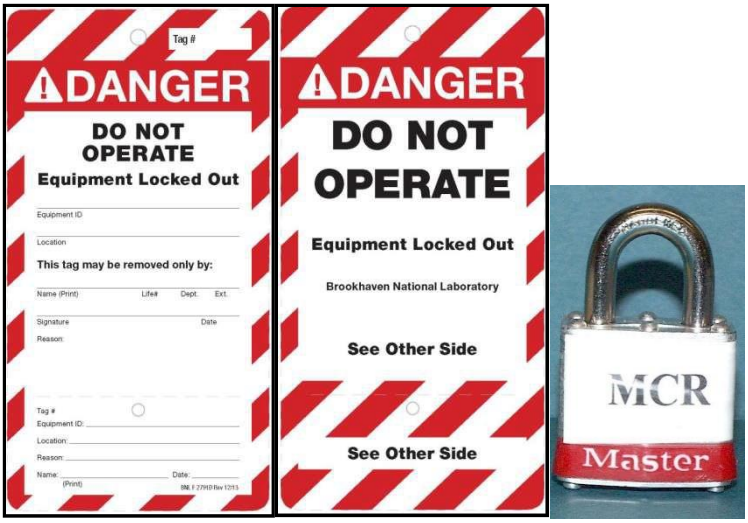
Vacuum ion pumps may remain powered and represent high-voltage electrical hazards (5000 Volts) if conductors become exposed. If you are working on a vacuum pump inside an accelerator enclosure, be sure that LOTO is properly implemented and that you are at the correct pump location since areas look similar.

The Wood's metal system (110 V) is always powered as is the Access Control System (some at 24 V and some at 110 V). Always assume the wiring in the Access Control System is capable of delivering a serious electrical shock.

If you or your coworkers have questions regarding electrical safety or PPE requirements for your specific situation, contacts available to you include:

C-AD ESH Manager
C-AD Work Control Manager
C-AD ESSHQ Division Head
C-AD Chief Electrical Engineer

Lockout/Tagout



Personnel performing LOTO must complete BNL training (classroom initially, web-based annually, and Job Performance Measure [JPM] annually) and also must have C-A Department-specific authorization. This C-AD Access Training alone 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.

Operations Lockout Red Tag

This older style red Operations Lockout 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.

To prevent accidental exposure to hazards from different sources of energy, an Authorized individual may only remove their own personal LOTO locks and tags. However, under rare circumstances, when the individual who attached the LOTO is not available, a committee of three employees can be formed to authorize removal of the LOTO. Membership requirements for the committee are specified in the C-AD Operations Procedures Manual (OPM). These members will be familiar with the area or equipment under the LOTO and they shall determine if it is safe to remove the LOTO. Contact the C-AD Main Control Room (MCR), the C-AD ESH Manager or the C-AD Work Control Manager if you need to remove someone else's LOTO. A similar procedure is used for Operations Lockout.

Personnel trained to the "Affected" level of LOTO are trained to recognize when LOTO is in effect and can identify locks and tags used in the LOTO program. However, they are not authorized to place or remove any LOTO tag or lock. BNL's LOTO Affected training (HP- OSH-151A-W) is required for personnel who work in the vicinity of locked/tagged equipment. This training is required for those individuals who are not LOTO Authorized needing unescorted access to the C-AD complex.

C-AD also uses Group LOTOs. A responsible employee known as the Primary Authorized Employee has additional departmental authorization to control a Group LOTO. This employee's lock will be the first-on, and then last-off before the equipment or system is returned to service. Each Authorized worker applies their own lock to the group LOTO; which could mean applying their lock to a lock box or token box for example.

If you or your coworkers have general questions regarding LOTO at C-AD, or questions for a specific situation, contacts available to you include:

C-AD ESH Manager
C-AD Work Control Manager
C-AD ESSHQ Division Head
C-AD Chief Electrical Engineer
C-AD Maintenance Coordinator

Electrical Safety in Primary Areas

AGS / Booster

Token box located at AGS South Gate

The electrical equipment in primary areas covers a wide spectrum of voltage and current. In order to meet OSHA requirements and BNL rules, a special lockout/tagout procedure is in place for the AGS and Booster tunnels (rings).

Before workers enter the AGS or Booster tunnel, Main Control Room (MCR) Operators lock out about one hundred electrical devices. This procedure is called an Operations Lockout. Operators will capture all the appropriate keys under this procedure and lock them in a box in the MCR. The key for this box is called the TOKEN. The token is placed in a box at the AGS South Gate and/or at the Booster plug door as appropriate. This box is called the TOKEN BOX.

A single senior individual at C-AD is responsible for the token box and will be the first to place an Operations Lockout Lock and tag on the token box, and the last to remove them. After their Operations Lockout is placed on the token box, each worker entering a ring may be required to place their own lock and tag on the box as well. The need for each entrant to apply their own lock and tag depends on the work they are to perform. For example, walk-through of the areas where beam line equipment is not handled might not require a Radiation Worker to add their own lock to the token box. If you plan to work on top of the magnets or behind them, however, then you must place your own lock on the token box.

In addition, if you plan to work on a piece of equipment that is connected to a power supply, then you must place your lock on the token box AND you must also LOTO the power supply for that specific piece of equipment. Placing your lock on the token box does not satisfy the requirement to LOTO the power supply for the specific piece of equipment you plan to work on. The execution of an Operations Lockout for a ring will secure much equipment that C-AD believes represents potential electrical hazards to personnel entering the ring. However, always assume equipment in the rings is energized unless you have placed your own LOTO on the equipment's energy source and have verified that the equipment is de-energized.

The C-AD Operations Procedure Manual (OPM) defines the LOTO program in detail and contains several group LOTO procedures.

Note:
Be aware that increased electrical hazards may exist during Controlled Access (CA) Mode, as opposed to Restricted Access (RA) Mode. During CA Mode, more electrically powered equipment is typically energized or not LOTO'd versus during RA Mode.

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Operations Lockout

Front side Backside

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 generally 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.

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

C-A D 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.

Ground Fault Circuit Interrupters (GFCIs)

Electrical Outlets and portable GFCIs

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

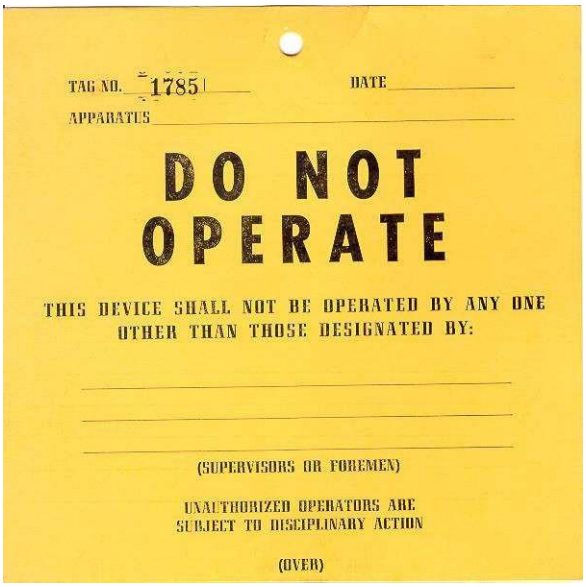
Underwriters Laboratory (UL) recommends that GFCI devices be tested regularly. BNL requires that GFCI outlets and portable GFCIs be tested prior to use to meet the intent of the UL recommendation and protect the user.

Testing the GFCI is easy. Testing is with the self-test button and a routine load. A portable light or radio 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 Manager as soon as possible.

Inexpensive GFCI receptacle testers are also commercially available:

Access Control System (ACS)

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 two 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 authorize others to temporarily operate the equipment.

Note: These tags may never be used for personnel protection. If personnel protection is involved, then Operations Lockout shall be used.

Ref: C-AD OPM Procedure 2.13, “Use of “Do Not Operate” and “Caution“ Tags for Equipment and Systems”.

Orange Tags

Orange Tags are used to identify devices that are part of the Access Control System (ACS). These devices must remain correctly connected and located. To help assure personnel do not disconnect or alter these devices without following approved procedure, the C-AD Access Controls Group identifies such devices with an ORANGE WARNING TAG. The equipment is used for radiation protection, and in some cases oxygen deficiency warning and protection. In addition, much of the system wiring is maintained at 110 Volts AC so it also represents an electric-shock hazard if tampered with. 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 before starting work.

Only the owner (the C-AD Access Controls Group) of the tag may remove the tag and adjust or move the equipment.

Orange Warning Tag:

In addition to an orange warning tag, equipment specialists document allowable work, such as routine maintenance, that may be performed on ACS equipment. Equipment specialists provide this information for each piece of equipment they connect to ACS. The Access Controls Group makes these informational documents available to all personnel who work on the equipment. C-

AD staff who work on equipment with an orange warning tag must proceed by the guidelines in these informational documents.

Examples of tagged equipment are scintillation detectors called NMCs (Nuclear Measurements Corporation) in experimental areas, Chipmunks (area radiation monitors), certain breakers and disconnect switches, and ODH panels. Do not move these devices since relocation will compromise their effectiveness and accuracy.

Barricade Tape

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

CAUTION ENTRY REQUIRES PERMISSION

or

DANGER DO NOT ENTER

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

Violating barricade tape may result in disciplinary action.

A tag or sign is required to accompany the tape. The tag or sign must include description of the hazard, contact name of 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 Supervisor or the C-AD ESSHQ Division.

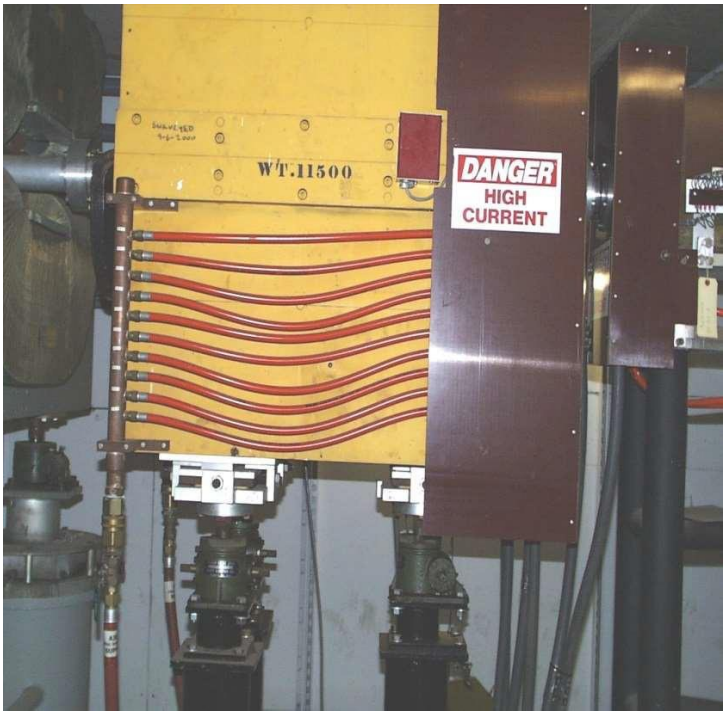
* Summary of entry rules:

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

Magnet Cooling Water

Magnet cooling water systems may incorporate electrical buses. The water systems are operated under pressure and require special training to work on them. Depending upon the location in the C-AD complex, some magnet cooling water systems may have a radiation field associated with them. These are labeled and should not be handled without proper training and authorization. The water may be activated and contain tritium or Na-22.

Orange tubing typical for magnet cooling water:



Laser Safety

Lasers must be registered with the BNL Laser Safety Office. This includes higher hazard class lasers (Classes IIIb and IV) as well as lower hazard class lasers (Classes II and IIIa).

Classes IIIb and IV also require:

- Additional Laboratory training (web-based course TQ-LASER), and
- A baseline eye exam (completed by BNL's OMC or by an off-site ophthalmologist), and
- Completion of a Laboratory Standard Operating Procedure (SOP).

Classes II and IIIa require a permit.

For all lasers being newly installed at C-AD, or if modifying a previously reviewed laser at C- AD, contact the C-AD ESH Manager. All lasers need to be reviewed by BNL Laser Safety Office personnel prior to initial use or following modification to a previously reviewed laser. Make sure you are aware of the safety requirements established for lasers in your area.

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 to perform work on.

Experiments at the Relativistic Heavy Ion Collider (RHIC) have beryllium beam pipes installed at the intersection regions. This material is fragile and toxic. Protection is provided to prevent physical damage to the beam pipe. Special work planning is required to protect workers from inhalation and/or absorption of beryllium through the skin, and in most cases personal monitoring is performed to ensure exposure control is effective.

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

Personal Protective Equipment (PPE)

Department safety policy states that each workplace be created and maintained in a manner that minimizes safety and health problems. For some tasks, it is not always practical to completely eliminate the hazards, and protective clothing and protective equipment may be required for safety. Plan your work in advance. Consider whether PPE may be needed or required. Contact the C-AD ESH Manager for review and approval whenever PPE is to be used. Contact the ESH Manager if you are unsure of PPE requirements. Employees may only use PPE supplied by C- AD or BNL. PPE brought and used by contractors should be addressed during work planning and contract preparation and must meet industry standards.

Hardhat Policy

You are required to wear a hardhat:

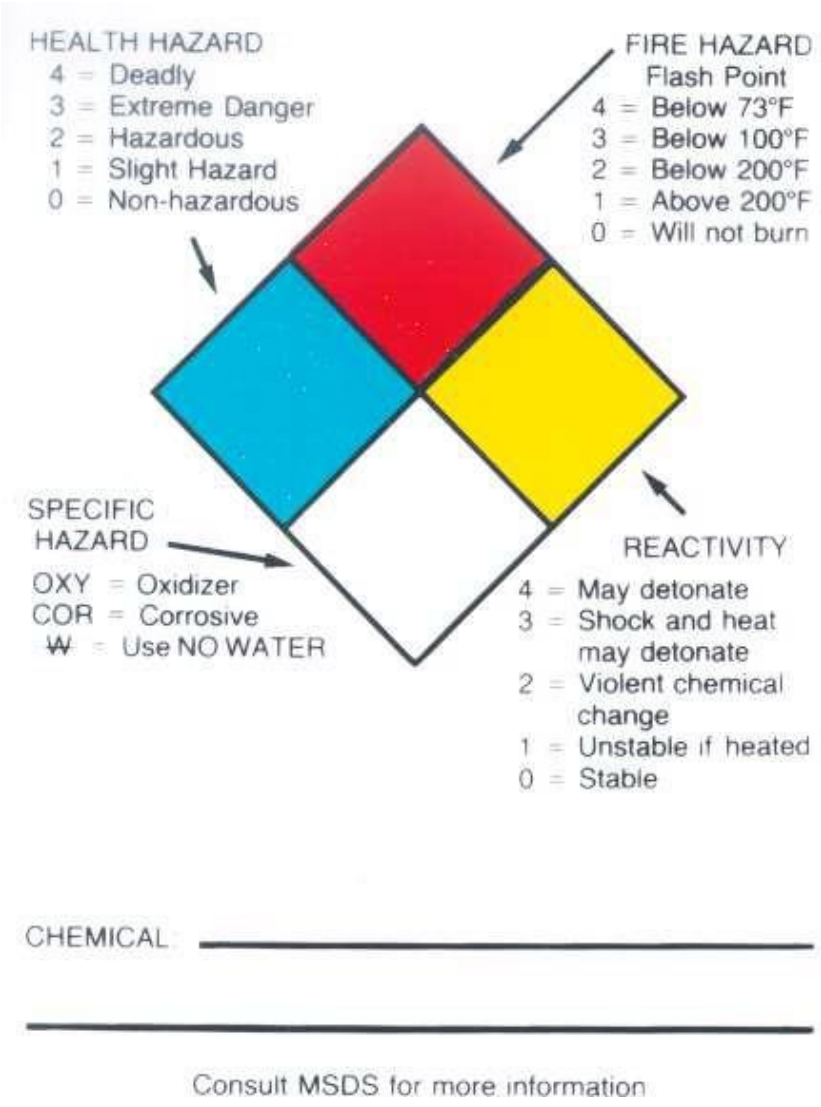
- When people are working overhead
- When an overhead crane is in use (do not stand under objects being handled by the crane)
- At all times in a posted Construction Area

Information on Hazards and Your Right to Know

You have the right to know of any potential health and safety hazards in your workplace whenever the potential for exposure to hazardous materials exists. Contact the C-AD ESH Manager if you would like specific safety and health information about your workplace. The ESH Manager can provide you with information on the Laboratory's policy on hazardous material, and on 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 that may be 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 various containers or structures that contain hazardous materials:



The C-AD ESH Manager or C-AD ESSHQ safety staff can explain the labeling system and can provide information on how to select and use protective equipment.

Chemical Safety

It is the goal at Brookhaven National Laboratory to have all chemicals accounted for in the BNL Chemical Management System (CMS). For your safety, purchased chemicals are inventoried and bar coded by the Laboratory prior to delivery for end use.

All chemicals must be ordered through an approved BNL chemical acquisition process:

- Place a web requisition order
- Use an open purchase order if approved for the department in cooperation with CMS group
- In general, credit cards may not be used to purchase chemicals, except they may be used to purchase chemicals only from CMS-approved vendors (contact the CMS group)
- Place an order with Procurement and Property Management (PPM) Stock

Request a Safety Data Sheet (SDS) from the vendor when ordering your chemical.

Purchased chemicals arrive on-site through Materials Handling Building 98. Containers will be inventoried and bar-coded by the Safety and Health Services Division's CMS Team.

If you bring un-inventoried chemicals on site, you must contact the C-AD ESH Manager to have these chemicals inventoried and bar coded by the CMS Team prior to use.

If ever in doubt, contact the BNL Chemical Management System Team (cmsteam@bnl.gov) or the C-AD ESH Manager. You may also consult the BNL CMS web site http://intranet.bnl.gov/esh/cms/.

Procurement of New Equipment

(Electrical and Non-electrical)

NRTL Requirements

(NRTL: Nationally Recognized Test Laboratory)

Procured items or products for use at BNL may be required to be NRTL listed. This applies to more than just electrical equipment. If a 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 approved BNL Electrical Equipment Inspector (EEI). The Laboratory Electrical Safety Committee (LESC) approves BNL EEIs. If you have questions regarding NRTL requirements, contact the C-AD Chief Electrical Engineer.

Pressure Vessels

Procurement, Repair or Alteration

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 to be used at BNL. ASME-certified vessels are fabricated and stamped by an ASME- certified manufacturer and registered with the National Board of Boiler and Pressure Vessel Inspectors (NBBI).

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

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

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

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

The BNL Subject Area on Pressure Safety and the BNL SME should be referred to regarding pressure vessels, pressure piping and piping system components.

Environmentally Preferable Purchasing

Definition: Acquisition of products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose.

Why BNL?

- The Federal government is country's largest purchaser of goods and services: $370 billion per year
- Government can create markets for more environmentally friendly products, leading to greater product availability

Resources for Product Information

- EPA Environmentally Preferable Purchasing
  https://www.epa.gov/greenerproducts/about-environmentally-preferable-purchasing-program
- Alternative Fuels/Vehicles
  http://energy.gov/eere/vehicles/vehicle-technologies-office
- Electronic Equipment
  http://www.epeat.net/
- Energy/Water Efficient Product
  https://www.energy.gov/eere/femp/energy-and-water-efficient-product-efficiency-programs
- Ozone Depleting Substances
  https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances
- Significant New Alternatives Policy (SNAP) Program
  https://www.epa.gov/snap
- Sustainable Buildings
  http://www.wbdg.org/

Or, go to BNL SBMS Subject Area "Pollution Prevention and Waste Minimization".

Price-Anderson Amendments Act (PAAA)

It is important to make you aware of the absolute requirement to follow all safety rules at C-AD facilities. Federal law (PAAA) provides for enforcement penalties if you do not follow the rules fully. For example, personnel have been the subject of criminal investigations when found to *willfully* remove a radiation barrier. Thus, we request that you pay particular attention to safety rules. In the past, PAAA applied only to radiological safety rules. Now, however, it applies to conventional safety rules as well.

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

Is staff at C-AD accepting additional legal liabilities when signing documents related to compliance with safety rules under the Price-Anderson Amendments Act? The short answer is that the employee incurs no personal liability under the provisions of the Act unless he/she intentionally acts to violate radiological or conventional safety rules.

The Price-Anderson Amendments Act (PAAA) sets up a regulatory program for enforcement of safety rules. Rules are set forth by:

10 CFR 835: Title 10, Code of Federal Regulations, Part 835 "Occupational Radiation Protection", and by

10 CFR 851: Title 10, Code of Federal Regulations, Part 851 “Worker Safety and Health Program”.

Failure to comply with these rules, or to identify and report non-compliance to DOE, subjects the Laboratory to enforcement action.

WARNING

Any employee who intentionally violates a safety procedure, regardless of whether the employee signs any document related to compliance, may be subject to criminal prosecution or other disciplinary action.

Deliveries to C-AD Facilities

To help assure outside non-BNL delivery personnel do not inadvertently enter areas controlled for radiation protection or for other hazards without the appropriate training and authorization, deliveries for the C-AD complex (and to the BNL site in general) should be made to shipping & receiving Building 98; during normal business hours. For deliveries expected during off-hours, it might be possible to make arrangements with the C-AD Main Control Room (MCR) to receive a package if we are in an operating mode and if MCR is being manned during those off-hours. You must make off-hour arrangements in advance.

When placing an order for normal business hours delivery, inform the sender to address the package to Building 98. Also inform them to include your name and contact information on the package so that personnel receiving the package at BNL have a way to contact you or deliver the package to you. Packages arriving without a name may be sent back.

Deliveries are not to be made to other buildings in the C-AD complex without pre-review and pre-approval of the C-AD ESSHQ Division Head or designee (an appropriate supervisor).

Caution: Any deliveries to any C-AD facility or area that could introduce any hazard **must be pre-reviewed and pre-approved**. Please contact the ESSHQ Division Head as soon as possible before delivery so that proper reviews and approvals may be initiated. Examples (not intended to be an all-inclusive list) of what could introduce a new hazard are lasers, Radiation Generating Devices (examples include analytical or industrial X-ray devices (e.g. fluoroscopes), neutron generators, sealed source irradiators), chemicals ... etc. If you are not sure if what you plan to bring to the facility needs to be pre-reviewed & pre-approved, then consult with the ESSHQ Division Head beforehand.

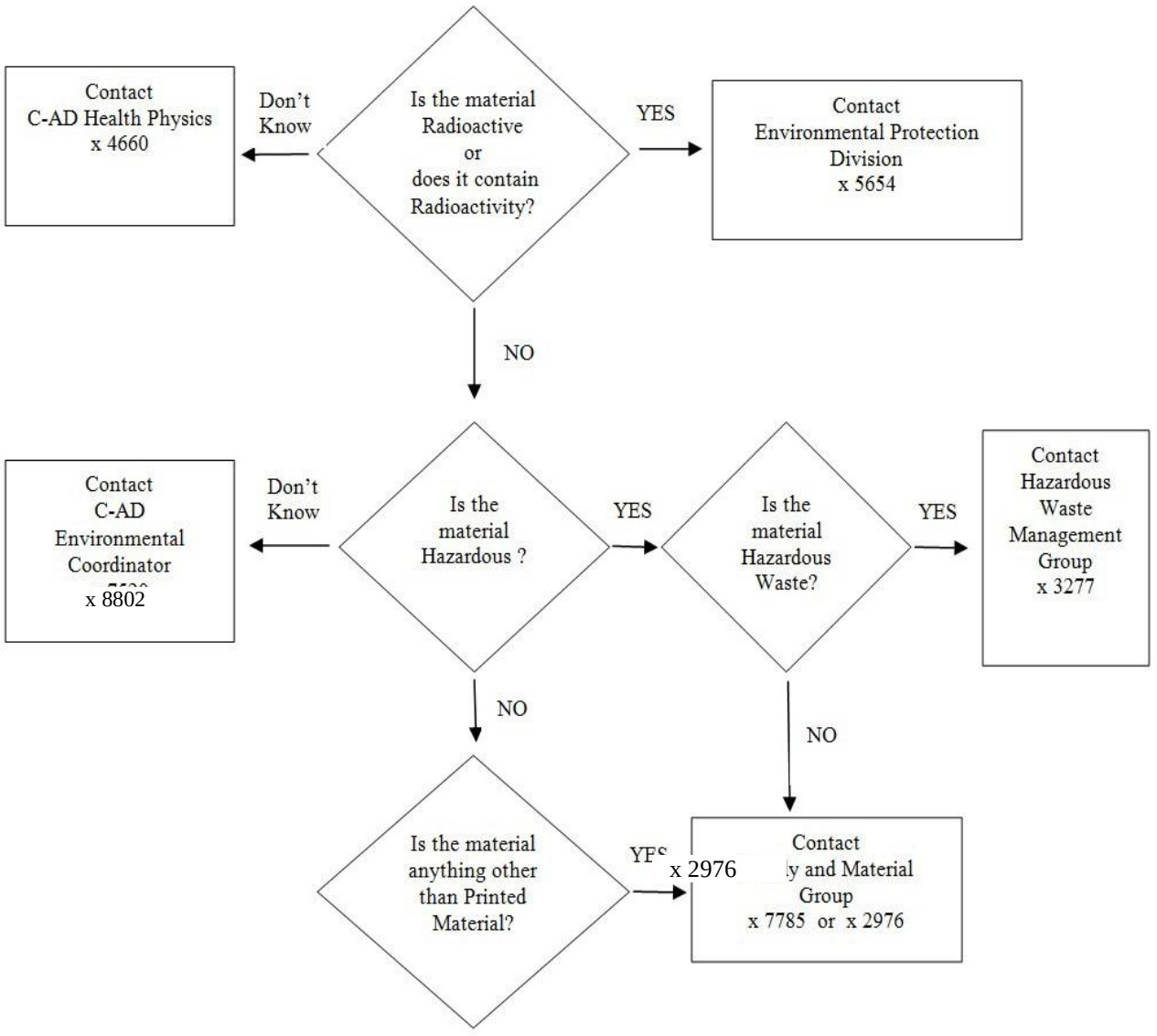
Under the Price-Anderson Amendments Act (PAAA), we are required by Federal law to obey all safety rules (radiological and non-radiological) or face stiff penalties if we do not. All persons, including delivery people, who enter areas controlled for radiation protection or for other hazards must be properly trained, or they must be formally escorted by a trained worker. Untrained and unescorted delivery personnel entering such controlled areas could result in a PAAA violation, even if the delivery person did not knowingly violate the area's entry requirements.

Remember: All persons, including delivery people, who enter Radiological/Controlled Areas must be trained or be escorted by a trained individual, and must wear any dosimetry (e.g.: red-striped Visitor TLD) required for the area. A Radiological Work Permit (RWP) may also be required for entry. Escorting requires paperwork and approvals. An example is routine escorting of helium or nitrogen delivery trucks for the C-AD Cryogenic Group while RHIC is posted as a CONTROLED AREA.

If there are rigging needs: In order to facilitate deliveries that require rigging upon arrival, please inform the C-AD Facilities & Experimental Support Section riggers well in advance of anticipated rigging needs for your package.

Shipping from C-AD or BNL to Off-Site

If you are shipping from C-AD or BNL to off-site, then ask yourself the following questions and follow instructions prior to shipping



Radiation Safety

Many areas throughout the C-AD complex are posted for radiation protection. BNL's Radiological Worker-1 (RW-1) qualification is required for entry into most of these areas. In some cases, BNL's General Employee Radiological Training (GERT) qualification may be sufficient. It is the practice at C-AD, however, that any area requiring a TLD for entry also requires that you have the full RW-1 qualification. This may be stricter than elsewhere at BNL. Elsewhere it may be the practice to allow a TLD with only GERT.

Common Type Postings Encountered at C-AD, and Entry Requirements

CONTROLLED AREA:	- General Employee Radiological Training
CONTROLLED AREA with TLD indicated for entry on the posting:	- Radiological Worker-1 Training, TLD
RADIATION AREA:	- Radiological Worker-1 Training, TLD, RWP
HIGH RADIATION AREA:	- Radiological Worker-1 Training, TLD, RWP, SRD
BUFFER AREA:	- Radiological Worker-1 Training, TLD, RWP (if required for the particular area; for example, Bldg 801 Buffer Area requires that you sign onto an RWP) - Radiological Buffer Area Training, or Contamination Worker Training, or Benchtop Dispersibles Training
CONTAMINATION AREA	- Radiological Worker-1 Training, TLD, RWP - Contamination Worker Training
RAD MATERIAL AREA with Dispersibles-In-Use	- Radiological Worker-1 Training, TLD, RWP - Benchtop Dispersibles Training

VERY HIGH RADIATION AREA is any accessible area where an individual could receive a whole-body absorbed-dose of greater than 500 Rad in one hour at 1 meter. Areas of such high potential dose are not posted at C-AD since they are access-controlled.

To enter any area posted for radiation protection, you must be trained and qualified or you must be escorted by a qualified individual. Escorting requires written approvals as per C-AD OPM 2.16by C-AD and has limitations on areas you may enter and on activities allowed to be performed while under escort.

Radiological Work Permits (RWP)

A Radiological Work Permit (RWP) is required for entry into any "radiological area" at the Collider-Accelerator Department complex. The term "radiological area" in this context includes, but is not limited to: Radiation Area, High Radiation Area and Contamination Area. All personnel entering or working in any radiological area at C-AD must sign-onto and follow the requirements of the C-AD RWP for the area.

C-AD's General RWP for Radiation Areas

At C-AD there is a General RWP for entry into Radiation Areas. This RWP covers Radiation Areas (not High Radiation Areas) in the C- AD complex. It is valid for 1 year, which means you only need to sign-on once for the 1-year period. The 1-year period is defined on the RWP by the "Work Begins" and the "Work Ends" dates. A copy of this RWP for you to sign is located at the C-AD Training Office (Bldg 911, Room A128) and the lobby area of 911 or you may contact and the C-AD Health Physics Group. This RWP has dose limits:

20 mrem to an individual, and 200 person-mrem to a work crew

This General RWP is for routine work activities, tours, data collection, and inspections in posted Radiation Areas only. Job-Specific RWP's are required for non-routine or non-repetitive work in High Radiation or Contamination Areas. There are separate C-AD RWPs for entry into High Radiation Areas, as well as for Contamination Areas.

Entering High Radiation Areas and Contamination Areas

The C-AD RWPs for High Radiation Areas and Contamination Areas are located at the area entrances or at the C-AD Health Physics Office. For these type areas, you must sign in and sign out each day that you enter. NO EXCEPTIONS. If you are making multiple entries throughout your day, you may choose to sign in once at the time of your initial entry, and then wait to sign out upon your final exit for the day. Do not forget to sign out for the day. As a minimum, each entrant must sign in and sign out at least once per day, including for multi-day jobs. There must be NO BLANKS across the row after signing out; all information must be entered. Remember that a Self-Reading Dosimeter (SRD) is required for entry into High Rad Areas; in addition to your TLD.

Note: The RWP log is not the same as the Main Control Room (MCR) "gate watch" log that keeps track of people going in and out of a Primary Area during Controlled Access Mode. The RWP log is NOT used to keep track of people inside Primary Areas.

A corresponding WP (Work Permit) is also with the RWP log. When signing-in on the log, you are signing-in for both the RWP and the WP.

Please only use only blue or black ink when entering your information on the RWP log.

The logs are collected periodically and reviewed. The SRD data is reviewed. Make sure you enter ALL your exposure for the day onto the log. The C-AD ESSHQ Division will notify your supervisor if you are approaching a C-AD Administrative Control Level (ACL), **although it is also your own responsibility to be aware of your own dose and the ACLs**.

If the Self Reading Dosimeter (SRD) calibration due date has passed, do not enter the posted area. Obtain a new dosimeter that is within the calibration due date. The C-AD Training Office and C-AD Health Physics Office can issue SRDs.

The RWP sign-in log provides Radiation Workers or Contamination Workers with an opportunity before entering the area to review requirements for entering or working in the area. See the example sheet below.

RWP ACCESS SHEET RWP # _____

PRINT NAME	SIGNATURE	Individual Under Escort Y/N	LIFE #	DATE	EPD#	EPD CAL Due Date	TIME IN	SRD READING PRE	TIME OUT	SRD READING POST	NET-SRD READING
	Please Do Not write in this section ----------							PAGE TOTAL			

NOTE*: *Signing this access sheet indicates you have had any required pre-job briefing, and have read, understand and meet the requirements of this RWP unless properly escorted*. *ALL ENTRIES SHALL BE IN BLUE OR BLACK INK ONLY!

CAUTION*: *Changes in Job Scope or in Radiological Conditions will void this RWP. Consult the Radiological Control Division Facility Support Representative for direction.

Job-Specific RWPs

A Job-Specific RWP is required for jobs predicted to cause greater than:

20 mrem to an individual
or
200 person-mrem to a work crew

A Job-Specific RWP is also required for jobs that may alter radiological conditions or involve unpredictable or changing radiological conditions.

Individuals signing onto an RWP must read the RWP and are signing that they are aware of, and will comply with, the requirements of the RWP.

Primary Areas

Do NOT enter Primary Areas improperly! Primary Areas are areas where uncollided beam travels, such as the accelerator rings, transfer lines and target rooms. Primary Areas are areas where:

- radiation hazards are the most extreme with beam on (these areas are to be considered lethal with beam on)
- with beam off, a key is required for access through posted interlocked gates
- shielding, walls, fences, interlocked gates and/or other barriers are in place around the beam path

Direct exposure to the beam is not possible if Primary Areas are entered properly.

PRIMARY BEAM: in-beam dose rates up to 10^{14} mrem/hr from hadrons.

SECONDARY BEAM: in-beam dose rates up to 10^{11} mrem/hr from hadrons, and leptons.

Entering Berm Areas

Berms throughout the C-AD complex cover accelerator rings, transfer lines, target rooms and the Relativistic Heavy Ion Collider (RHIC) ring. Much of the berm areas are enclosed by fence with gates that may be locked closed during beam operating periods. Contact the MCR if entry is required. Typically, access is not granted, or needed, when beam is on.

Even for berm areas that are not fenced or locked closed, you must contact MCR before entering to determine beam status. Even during summer months when beam is typically off, you must verify beam status with MCR, or CAS, prior to entering onto berms. Testing with beam on may be in progress.

At RHIC, it is required that you read and sign onto a C-AD Work Permit to enter the berm when beam is on. One stipulation of that permit is that you stay at least 10 feet away from any ventilation or survey penetration when beam is on.

FAULTS: Radiation penetrating through shielding from unplanned beam losses may lead to doses from several tens of mrem/h to hundreds of mrem from neutron and gamma radiation near

shielding or fences. Faults may last for as long as one second, such as during a beam crash due to loss of a steering magnet power supply, before machines are interlocked off.

NORMAL OPERATIONS: During normal operations, area dose rates in continuously occupied areas range from natural background levels to < 1 mrem/hr from neutron and gamma radiation that penetrates the shielding at the accelerators and RHIC.

Note: Entering berms may also be a tick and chigger hazard when in-season. PPE may be required to walk onto the berms. Contact your supervisor or C-AD Safety Engineering for guidance.

Residual Radiation and Primary Areas

The principal personnel radiation exposure associated with C-AD primary areas is from residual radiation. Exposure to this radiation results from working on or near activated machine components, beam stops, shield blocks and cooling water.

Residual radiation is more a concern in accelerator primary areas such as the LINAC tunnel and the AGS & Booster rings, versus the RHIC primary areas. RHIC has residual radiation levels generally well below 1 mrem/hr, except near beam dumps and kickers which are at higher levels (for example, the beam dumps at the 10 o'clock area of the RHIC tunnel may be up to 10's of mrem/hr right after shutdown).

The first entry into a primary area after beam has been turned off is typically made by a Radiological Control Technician (RCT) to perform a radiation survey. This is to assure that appropriate decay time has elapsed before other personnel are allowed access. Contact MCR to request a survey before first entry. Note: Some areas, however, where experience has shown no significant residual radiation, do not require a survey prior to first entry. The C-AD OPM specifies areas that do not require a survey. If you are in doubt about any area, contact MCR before entry.

Radioactive Material Areas

Activation Check Required

At C-AD you will encounter areas posted as Radioactive Material Area (RMA). These areas contain activated materials. Primary Areas are essentially always posted as RMA. RMAs could also be non-primary areas however. Examples include Buildings 912, 922, and 923, the steel yard and the block yard. Pay attention to postings. Not all radioactive material in a posted Radioactive Material Area is tagged while it is within the area. An activation check is required to remove such material from the area.

Example RMA postings: **"ACTIVATION CHECK"** required

This posting means you must not release items from the area without having the items checked (surveyed) for activation and tagged, if activated. Always read the posting prior to entering the area.

This training does not qualify you to perform this activation check. A Radiological Control Technician (RCT) must perform the check. Contact the C-AD Health Physics Office (X4660) to have these checks performed. Activated items leaving the area must be properly tagged.

Note: Activation check has nothing to do with the requirement of checking yourself for contamination upon exiting a posted "Contamination Area".

Some locations may have background radiation levels that preclude performing the activation check in accordance with Facility Support Procedures (FS-SOP-1000) at the area's exit location. In these cases, if coordinated with the C-AD Health Physics Office (X4660), it is permissible to transport the material to an area of suitable background in order to perform the activation check. The movement of these materials applies ONLY to "activation check" areas. Such materials MUST remain in a posted Controlled area. Any material leaving a Contamination, Airborne Radioactivity or Dispersibles-In-Use area requires an RCT survey at the area's exit location.

Only you can prevent untagged radioactive materials from leaving C-AD Radioactive Material Areas and Primary Areas. Ordinary items inside Primary Areas may not bear labels indicating that they are activated and must receive an activation check before removal from the area. If found to be activated, they must be tagged with a Radioactive Materials. They could find their way into general office areas or waste streams unless you follow the rules. This violates federal law under 10 CFR 835 and results in an investigation to find the reason for the violation.

Note: The intent of the "Activation Check" requirement is that any item that is possibly activated material must be checked. Generally, no item may be released from areas posted "Activation Check" without a Radiological Control Technician (RCT) first checking the item for radioactivity. However, non-activated items that you bring into an area posted "Activation Check" may be removed without an activation check only if you have accurate process knowledge of their exposure, i.e., only if you know the items could not have been exposed to beam or have become activated in any other way, and the items were in your purview while in the area. If you did not bring the item into the area, however, and you want to bring it out, then you must have it checked for activation; e.g., a tool you may find. Objects exposed to beam, or that were in a Primary Area with beam on, may be activated material. If you are unsure if an item you are removing needs to be checked, then ask for assistance. (C-AD Health Physics x4660).

Many small radioactive parts that came from a larger assembled item may be inside a Radioactive Material Area and these small parts might not be tagged, even though the original assembled item may have been tagged. These smaller parts should be set aside to be surveyed and tagged if radioactive by an RCT.

Any shipments of radioactive material off-site must be checked to ensure proper packaging and labeling. Off-site shipping of radioactive materials must be coordinated with the BNL Environmental Protection Division and C-AD Facility Support.

SUMMARY OF “ACTIVATION CHECK” RULES

Items MUST remain within a posted Controlled Area until an RCT has surveyed them.

Items that REQUIRE an RCT survey before removal from an area posted "activation check" are:

- ✓ Floor sweepings
- ✓ Fixed structures
- ✓ Installed components
- ✓ Shielding
- ✓ Items of unknown origin

Items that DO NOT REQUIRE an RCT survey before removal from the area posted "activation check" are:

- ✓ Items where process knowledge has been maintained and can establish that the item has zero potential for activation
- ✓ Items under your control at all times after removal from the posted area that are being moved with coordination HP support to a low-background area for radiation monitoring
- ✓ Items that are labeled, under your control at all times and that are moving from the posted area to a Radiation Area, High Radiation Area, RMA, or Controlled Area
- ✓ Items that you carried into the area that you know not to be activated

C-AD Administrative Control Levels & DOE Limits

Administrative Control Levels (ACLs) are an integral part of the dose reduction scheme at BNL and the C-A Department. These administrative levels are less than the dose limits set by DOE and Federal Regulations. The administrative levels help assure that we do not violate DOE limits.

C-AD Administrative Control Levels for Radiation Workers (RW-1 Trained individuals)

Period	Maximum Individual Dose ACL (mrem)	Control levels with line authority approvals (mrem)
Calendar Year	700*	500 to 1250 (ALARA Committee review and C-AD Chair Approval)
		1250 to 2000 (Lab Director Approval)
Daily	100	100 to 200 (Approval will be on RWP)

* Note: The ALARA Committee reviews the necessity for allowing an individual to exceed 400 mrem in a year at C-AD, and allowance must be approved by the C-AD Chairman.

(ALARA: As Low as Reasonably Achievable)

Administrative Control Levels for Visitors, Untrained Individuals and Minors

Visitors, Untrained Individuals
25 mrem per year

Minors
25 mrem per year
Minor (< 18 years) dose limit is 25 mrem per year and parental consent is required. Minors are not allowed to ***work*** in radiological areas but are allowed to visit or tour radiological areas, ***with parental consent***.

Pregnancy
ACL of 350 mrem for the gestation period.
After a female Radiation Worker voluntarily notifies C-AD management in writing that she is pregnant, she is considered a "declared pregnant worker" for the purpose of fetal and embryo radiation protection.

She may choose from two options:
- No Dose Option
- Limited Dose Option

After a person voluntarily notifies C-AD management that she is pregnant, she must follow-up and notify management in writing when she is no longer pregnant.

C-AD Exposure Philosophy

Radiation exposure at C-AD must:

- Have A Net Benefit
- Be As Low As Reasonably Achievable (ALARA)
- Be Within Limits

Annually, over $100,000,000 will be expended to operate accelerators for experiments at the C- AD complex. Once an experiment is configured, valuable scientific information is obtained. It is difficult to estimate the economic worth of this information, but there is considered to be a net benefit to the dose received from conducting the research. Dose received from eating, drinking or smoking in a Radiation Area or a High Radiation Area obviously has no net benefit and is not permitted. Doing so would increase the time spent in the area and correspondingly the dose. In addition, taking a shortcut through a radiological area in order to save time or to avoid inconvenience is not an appropriate practice.

The collective dose, which is the sum of dose to all radiation workers at C-AD, has declined in recent years. The dose has remained low from 2003 to present.

The ALARA Committee consensus is that the majority of this collective dose comes from working on small short-duration jobs. The Committee wishes to capture all Self Reading Dosimeter (SRD) dose for all jobs in High Radiation Areas and Contamination Areas. The Committee would like to determine which dose goes with which job. Your cooperation in entering self-reading dosimeter (SRD) data each day on the correct RWP log is required and will help define jobs where further dose reduction may be achieved.

ALARA Strategies

Basic ALARA strategy on the part of the worker revolves around effective use of time, distance and shielding. Time tends to have a linear impact on dose reduction, distance a quadratic impact (dose reduction proportional to inverse square of distance), and shielding an exponential impact. ALARA may also be incorporated into design and operations. The following are examples of ALARA strategies at C-AD:

- Track and reduce unnecessary beam loss by MCR to reduce soil activation
- Design and add temporary shielding
- Hold discussions in areas where the radiation level is the lowest
- Use remote handling equipment to increase distance from source
- Use portable power tools
- Plan work and practice outside radiological areas to reduce time spent in a radiation field
- Install quick disconnect and alignment features on beam-line components
- Install radiation resistant devices
- Assemble parts out of the area
- Identify lower dose rate areas
- Use mirrors and video cameras

ALARA is applied most effectively at the design stage of a facility or of a piece of equipment.

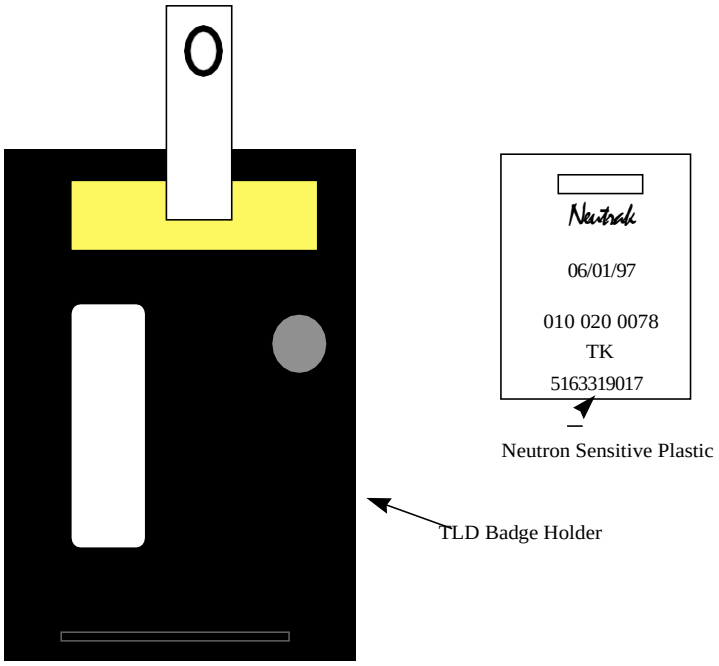
In the past, the most dose reduction has come by way of Accelerator Improvement Projects (AIP). We have improved the reliability of the vacuum system, the beam injection system, and the beam extraction system. Additionally, the Experimental Support & Facilities Division has designed radiation-hardened magnets that can operate properly after very high doses. This has resulted in fewer repairs, which in turn reduces the dose burden because we are working less frequently on broken, activated equipment. Additionally, new accelerator systems have been installed to achieve better control of beams, which results in less activation of equipment.

Information on collective dose associated with specific jobs is available from the C-AD ALARA Committee and C-AD Management. The C-A Department learns which jobs or experimental areas are associated with the highest dose. This in turn may lead to a future AIPs.

Personal Dosimetry

Thermo-Luminescent Dosimeter – TLD

N<u>ote:</u> To be issued a permanent or temporary TLD at the C-A Department, the general practice is that you have Radiation Worker-1 Training and C-AD facility-specific training. (Elsewhere at BNL a TLD may be issued with just GERT, versus the full Radiation Worker-1 Training.)



The TLD **monitors** your exposure to beta, gamma, and neutron radiation. It offers **no protection** from radiation.

- The TLD is the basis for the legal record of your occupational dose.
- Permanent and Temporary TLDs are exchanged on a monthly basis. Currently, TLD exchange day is the first Friday of each month. For Permanent TLDs, you may find your new badge each month at its assigned badge board location. If it arrives on a portable badge board, you should exchange the badge yourself: take your new badge off the portable board and put your old badge in its place. Check your name on the badge carefully to avoid mistakenly using someone else's TLD.
- Trained personnel receive a "regular" (Permanent or Temporary) TLD. A regular TLD has a blue or yellow stripe on the front. The color alternates monthly and the correct

monthly color is posted at the exchange boards. A red stripe on the front of the badge identifies a “visitor” (untrained person) TLD. See "TLD's for VISITORS" below.

- TLDs must be worn on the front of the torso, between the waist and the neck unless directed otherwise by Facility Support personnel.

- TLDs are worn when required by signs or postings, Radiological Work Permits, and when directed by Facility Support personnel. A TLD is always required for Radiation Areas, High Radiation Areas and Contamination Areas, even if not stated on the posting. A TLD is also required for Controlled Areas when indicated on the posting. There are several Controlled Areas at C-AD that require a TLD - - pay attention to postings.

- Either 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") or Visitor (red-striped) 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 turn your TLD in to Facility Support personnel or to the office who issued you the TLD.

- TLDs issued at BNL should not be worn at another non-BNL facility and dosimetry issued from another non-BNL facility should not be worn at BNL. At issue is that your dose should be recorded only once for any time period monitored, and it should be recorded by the facility at which the dose was received.

- 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. Avoid error by always checking your name on the TLD when you get it from the badge board.

- 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 or the C-AD ESSHQ Division Head.

- Report any lost badge immediately to Facility Support personnel or to the C-AD ESSHQ Division Head.

- Individuals wearing a visitor TLD (red-striped) require an escort in the area. If you encounter an unescorted 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:
"Facility Support" personnel is synonymous with "Health Physics" personnel at C-AD.

Regarding the seriousness of proper use of personnel monitoring devices, following is an excerpt from an article published in *BNL Radiological News***,** May 2004. These noncompliances occurred several years ago but are still noteworthy:

> Recently there have been several noncompliances concerning the use of thermo-luminescent dosimeters (TLDs) at Brookhaven National Laboratory (BNL) (i.e., 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 safety noncompliance. It is important that trained radiological workers follow the requirements for use of personnel monitoring devices.

If you are going to have a medical procedure that will inject or implant radioactive material into your body (such as technetium, thallium or radioactive seeds) please notify the Facility Support Representative, ESH Manager or ESSHQ Division Head. They will set up restrictions on your use of your TLD so that the medical dose is not recorded on your TLD. Your TLD is intended to record occupational dose and not medical dose.

The TLD monitors exposure and verifies the effectiveness of the C-AD radiation protection program. TLDs are read by the BNL Radiological Control Division (or are sent to an off-site lab) and monthly results are back after a few weeks. Emergency TLD read-out can be done in a day.

Two neutron sensitive plastics may be added to the C-AD TLD badge during high intensity proton running periods. These plastics are used to record neutron dose. The plastics more accurately interact with a broader spectrum of neutron energies, which is different from the TLDs.

TLDs "see" greater than 5 mrem per month. The plastics "see" greater than 30 mrem per month. The accuracy is ± 20% for gamma and less accurate for neutrons. Do not expose the TLD or plastics to heat, get it wet, take it home, wear it under your clothes or tamper with the TLD or plastics. The accuracy of the exposure data is dependent on proper care and use.

Visitor TLD (for untrained individuals)
Red-striped TLD

(25 mrem/year MAX allowed for visitor/untrained person)

The term "visitor" here means an "untrained" person.

- Visitors are not expected to work
- A Red-striped TLD is issued to Visitors for a limited period
- Red-striped TLDs are to be returned to their assigned badge board each day
- An Escort is required at all times for a Red-striped Visitor TLD wearer

A visitor red-striped TLD may be issued to untrained people with the approval of the C-AD ESSHQ Division Head or designee. TLDs may be issued by the C-AD Training Office during normal business hours, and by the on-duty Radiological Control Technician (RCT) during off hours. For off-hours, prior arrangements should be made with the Health Physics Office or Training Office.

The expected estimated dose to the visitor (untrained individual) must be understood by the escort based on the areas the individual will enter and is LIMITED to 25 mrem. The escort must by qualified to at least the level required for the area (for example, Radiological Worker-1 Training is required to escort a visitor into a posted Radiation Area).

Proper escort paperwork must be completed and approved. See the C-AD Training Manager or the ESSHQ Division Head for guidance and approvals.

Self Reading Dosimeters (SRD)

A digital alarming Self Reading Dosimeter (SRD) is required for entry into High Radiation Areas and Contamination Areas at C-AD. You are required to wear both a TLD and an SRD when entering these areas. The SRDs alarm at pre-set set points. Examples of posted High Radiation Areas at C-AD are the AGS and Booster tunnels. Some areas are posted "High Radiation Area with Beam On". If you are unsure of the beam status, or you are unsure of any requirements for entering or working in any radiological area, contact the MCR Operations Coordinator (x4662) or the C-AD Maintenance Coordinator for assistance.

The purpose of the self-reading dosimeter is to allow personnel to monitor their own exposure and compare it to the daily C-AD administrative control level (ACL) of 100 mrem. Self-reading dosimeters have ± 20% accuracy for gamma. They only respond to gamma. They are not calibrated to measure neutrons.

Always:
- Log all measured dose on the High Radiation Area or Contamination Area RWP log
- Wear your SRD on your torso outside of clothing

Digital dosimeters:
- Easy to read
- Chirping function warns of increasing radiation field
- Alarming function warns of high accumulated dose and high dose rate
- Required in order to enter or work in High Radiation Areas and Contamination Areas

The C-AD Training Office can issue SRDs and can provide you with instructions on how to operate the SRD (e.g.: turn on, turn off, re-zero). SRDs are set to alarm at certain set points. Typically, these set points are: 18 mrem total accumulated dose, and 90 mrem/hour dose rate. These set points may be changed by the C-AD Health Physics Group as appropriate.

You should always check the SRD before using it:

- check the calibration due date
- read the SRD
- re-zero the SRD if you wish

Abnormal Radiation Levels

If you encounter either of the following conditions:

- self-reading dosimeter (SRD) is alarming or the chirp rate increases unexpectedly
- radiation levels are not what were anticipated based on the RWP or work planning,

Then:

- stop work and place work area in a safe condition
- notify others in the work area
- immediately exit the area
- notify a C-AD Radiological Control Technician and your supervisor - your TLD badge may need to be read-out immediately

Contamination

BNL Contamination Worker Training is required to work in any C-AD Contamination Area. This is in addition to BNL Radiation Worker-1 Training and facility-specific training.

Radioactive contamination at C-AD is an issue of consideration mostly in areas of high activation such as target areas and beam extraction areas, and also at the BLIP and TPL facilities. Also, the BLIP spur in the LINAC is a posted Contamination Area.

Activated material that becomes dispersed or dispersible is a contamination concern. The following materials or activities are examples of what could be a contamination concern at C- AD:

- Leaking water from magnet cooling systems
- Drilling or grinding of materials in radiological areas
- Leaking oil from vacuum systems in primary areas
- Activated pump oil
- Accidental spill of liquid target material after irradiation
- A failed target
- Opening a beam pipe during repair
- The contents of fire extinguishers or gas cylinders that reside in primary areas during beam operations
- Moving vermiculite bags used as fire stops in cable trays in primary areas

C-AD controls the handling and processing of radioactive material through facility and equipment design, training, procedures and proper work practices and work controls.

Some work requirements for Contamination Areas at C-AD:

- C-AD Radiological Control Technician (RCT) job coverage is required
- You must be a trained Contamination Worker
- C-AD RWP required
- SRD required
- You can be escorted by a trained Contamination Worker into a Contamination Area, but not to do work; escorting requires prior approval
- You cannot be escorted into a High Contamination Area
- Check (frisk) all removed items, and yourself, for contamination

Skin or personal clothing contamination is a reportable DOE Occurrence. The total number of reportable occurrences is a performance indicator that C-AD must track as required by contract with DOE. We are obligated by contract to try to reduce the annual number of occurrences. Contamination incidents involving ingestion, inhalation, skin or street clothes are avoidable if you follow the rules that are posted in these areas and follow the RCT's direction.

It is C-AD's practice to not leave areas as posted Contamination Areas. The preference is to remove dispersible radioactive material in order to allow an area to be released as a non-contamination area.

If you are going to produce or work with dispersible radioactive material, you must consult with the C-AD Radiological Control Division (RCD) Representative prior to the start of work. Work involving dispersible radioactivity must be performed under a job-specific Radiological Work Permit.

Some contamination is not easily detected. Allow the RCTs to make an accurate determination of the beta- and gamma-emitters that might be present prior to beginning a job in a Contamination Area. They have detection capability that can be optimized to find the types of radioactive materials that might be present at C-AD.

Radioactive Sealed Sources

Federal rules define sealed sources as any radioactive item manufactured for the sole purpose of using the emitted radiation. Sealed sources are commonly used at C-AD for instrument checks and instrument calibration. The following are not sealed sources: smoke detectors, tritium exit signs, activated beam-line components, activated shielding and radioactive materials in-process such as targets or cooling water.

C-AD sealed source users are required to complete the following training:

- C-AD Sealed Source Inventory Procedure (AD-OPM20.1)
- Sealed Radioactive Source Control (HP-RWT-600)
- Radiological Worker I (HP-RWT002)

Sealed source Custodians also complete:

- Rad Buffer Area Access Training (HP-RWT002A)

Sources may be stored in shielded containers:

Sealed source users are responsible to follow the rules for source procurement, transport by vehicle, safe use and storage.

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

Following are rules that apply to sealed sources: (even if you obtain a source from another on-site BNL Department)

- Contact the C-AD Source Custodian if you are a new sealed source user at C-AD.
- Contact the C-AD Source Custodian if you plan to procure a new source. Sources are required to be inventoried.
- Have all accountable sources inventoried and leak-checked every six months by the C-AD Health Physics Office.
- For exempt sources that are ≥ 10% of accountable activity level, consult with the C-AD Source Custodian for leak testing and inventory requirements.
- 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.
- 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.

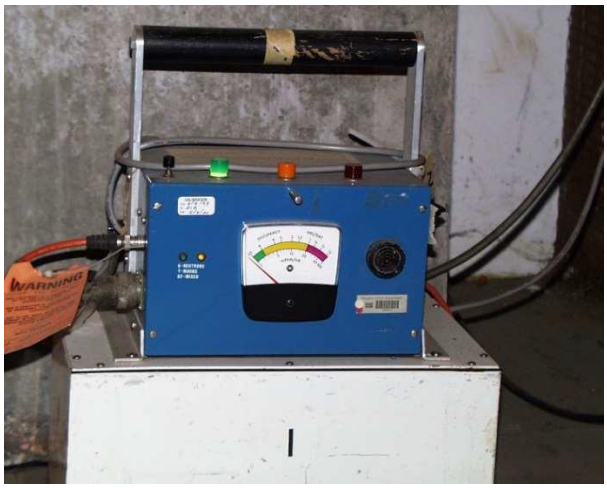
Beta, gamma and neutron sources produce radiation levels that may travel many feet in air. The radiation level drops rapidly as the inverse square of distance. This is because most sources are point-like objects.

If you are not sure about the rules or definition of a sealed source, then contact the C-AD Source Custodian.

Radiation Generating Devices

If you plan to bring a Radiation Generating Device (RGD) to a C-AD area, you must contact the C-AD ESSHQ Division Head beforehand to initiate proper reviews and documentation. Refer to BNL's SBMS Subject Area on Radiation Generating Devices. RGDs include X-ray devices (analytical and industrial) – e.g. fluoroscopes, neutron generators, and sealed source irradiators.

Chipmunks (Area Radiation Monitors) & Radiation Surveys



During running periods, radiation surveys are updated periodically, and continuous area monitoring is performed by instruments called Chipmunks. Most of these instruments alarm in the Main Control Room. During shutdowns, surveys are done initially, and whenever a job-specific RWP (Radiological Work Permit) is used, or when deemed necessary or appropriate by the C-AD Health Physics Group. Records of the 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.

Chipmunk readings are also recorded continuously and maintained in a database for later retrieval and review. Retrospective exposure rates for an area of interest can be determined by the staff at the C-AD Health Physics Office. In addition to alarming in the Main Control Room, Chipmunks are capable of alarming locally and are stationed at fixed locations in order to monitor high occupancy areas and other areas of interest.

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. In some cases, it may be expected that a chipmunk will be indicating slightly into the yellow at some locations or during certain activities. If you observe a chipmunk indicating in the red range, or unexpected yellow range, leave the immediate area, notify your collaborators or co-workers to leave the immediate area, and then contact the Main Control Room (x4662) for instructions. Notify them of your Chipmunk location if you know it. Chipmunk locations are numbered locally.

There are over 100 chipmunk monitoring devices in use at this time. They have pre-designated alarm levels established by the Radiation Safety Committee, and some have a beam interlock. Main Control Room Operators are trained to respond to alarms and interlocks to investigate the cause, even if it means interrupting the physics program. Do not move or tamper with chipmunks.

Radiation Safety Services

C-AD Health Physics Office: x4660 in Bldg. 923 or x4482 in Bldg. 801

The Radiological Control Division provides the C-AD with services that encompass several operational aspects of safety including radiation safety. They provide dose records, radiation surveys, Radiological Control Technician (RCT) coverage for high-dose jobs and experiment runs, and review of RWPs for ALARA. They assist in re-setting secondary beam lines, and assist in interpreting abnormal radiation levels. They also deliver training to C-AD staff and Users for certain radiological training needs.

During accelerator 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 C-AD Health Physics Office (x4660). If HP personnel are not available at x4660 and you need immediate assistance, you may contact the C-AD Main Control Room (x4662) if they are staffed. During running periods, the MCR is staffed around-the-clock. MCR can then contact an RCT for you by radio.

Special shifts for RCTs may be pre-assigned allowing for specific round-the-clock coverage when needed during a shutdown. A few weeks advance notice should be given to the Radiological Control Division Representative for special RCT coverage.

Primary Areas

Entry & Exit

Access Control System (ACS)

The intent of this training is to provide a general overview of ACS, and of the general procedure for entering and exiting Primary Areas. If you are ever unsure of how to properly enter & exit any Primary Area, through any particular access gate in any particular access control mode, stop and ask for assistance.

Primary Areas are areas where beam travels. Access to Primary Areas is controlled by either the Access Control System (ACS), depending on the area of the C-AD complex. ACS is the major design feature used for ***personnel radiation protection***.

ACS incorporates interlocked gates throughout the C-AD complex to control or limit access to Primary Areas. Primary Areas ***are to be considered lethal with beam on***. Access to Primary Areas is through interlocked ACS gates that require a key for entry. The "key" may be a plastic card-key, your BNL ID badge, and may include iris recognition as well. Proper procedure for entry and exit must be followed, and may vary depending on the particular gate, and does vary depending on the access mode the gate is in.

Unless special escort procedures are followed:
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 a serious violation 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 Training Manager or a member of the C-AD ESSHQ Division.

The Access Control System (ACS) also perform two other important functions:

- The ACS detects radiation levels outside shielded areas using radiation monitors (called "chipmunks") and will shut off the beam if chipmunk set points are reached.

- The ACS provides warning and mitigation for oxygen deficiency (low oxygen) in certain areas; at RHIC for example. Upon indication from sensors of oxygen deficient conditions, ACS activates visual and audible alarms, turns on ventilation equipment and secures some electrical equipment.

Bring a flashlight: Based on experience, when power failures occur Primary Areas can become dark or poorly lighted even with emergency lighting. It has become standard practice to take a flashlight with you when you work in Primary Areas, particularly when working in the AGS, Booster or RHIC tunnels. Bring a flashlight.

ACS, or any particular gate, can be in any one of three (3) basic access modes:

(RED) **PROHIBITED ACCESS** Mode
(or No Access Mode)

(YELLOW) **CONTROLLED ACCESS** Mode

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

Description of each mode:

During **RESTRICTED ACCESS** mode you may enter and exit the Primary Area essentially at will using your access key. During this mode, beam is off and the Main Control Room is not set to turn beam on. You are not being tracked during this mode. That is, no one is making sure that who goes in, comes out. You may enter through one gate and exit a different gate. During this mode, most electrical systems in the primary area are turned off, and many are locked-out and tagged-out (LOTO'd).

During **CONTROLLED ACCESS** mode, a "Sweep" (see below) is in place and personnel are being tracked (accounted for) entering and exiting the Primary Area. Entry AND exit from the Primary Area must be coordinated with the C-AD Main Control Room (MCR). A MCR "gate watch" verifies that each person who enters also exits the Primary Area. The gate watch can take different forms. The gate watch could be a MCR Operator located at the gate logging in and out each person - - you may be required to sign in and out on a gate watch log, and you may be asked to leave your BNL ID badge upon entry, which will be returned upon exit.

At some gates, access during Controlled Access Mode is controlled by MCR remotely. Depending on the gate, this procedure uses a combination of: BNL ID badge, key-tree, RFID tag, iris recognition, camera system and/or telephone communication. Again, entry AND exit from the Primary Area must be coordinated with MCR. Gates where an established procedure is in place for controlling access remotely include:

- gates to Intersection Regions of RHIC experiments (e.g.: STAR, PHENIX)
- gates to the AGS tunnel (South Gate, North Gate, North Conjunction Area Gate)

The ACS gate to the NSRL target room uses a local User-controlled procedure for entry & exit.

During Controlled Access Mode, most electrical systems are turned on and beam is more ready (not "enabled" however) to be turned on than in Restricted Access mode.

During **PROHIBITED ACCESS** (NO ACCESS) mode, access is not allowed. This mode means that either beam is on or may be set to be turned on ("enabled"). With beam on, the radiation hazard in Primary Areas ***is to be considered lethal***. Access is prohibited. During this mode, a locking mechanism similar to a deadbolt is kept in place and your key will not work. If you force an ACS gate open, sensors will detect the door's open position. This will cause at least two critical devices (such as beam stops, steering magnets) to intercept the beam before a person can penetrate the area to any significant degree.

Certain areas of the primary enclosure have RF accelerator cavities that could generate hundreds of Rad/hr if the cavities "spark". These areas are placed in the NO Access Mode during RF cavity conditioning; such as at the RHIC ring 4 o'clock region.

"Sweep" of Primary Areas

How is it assured that no persons are left inside a primary area before beam is enabled?

NOTE: Radiation dose inside primary areas ***is to be considered lethal*** with beam on.

Part of the answer is that an audible announcement is broadcast stating that all personnel are to exit the Primary Areas. However, the **essential** and **most reliable** action taken to assure the areas are cleared of personnel is that a "Sweep" is performed. Trained personnel physically walk-down the Primary Areas where beam will be set to travel and verify that no one remains in the areas. This visual inspection can take several trained personnel several hours, depending on the areas to be swept. Approved procedures and detailed checklists and check-stations are used to assure that all required areas have been carefully checked and cleared.

When the Sweep is complete, and it is assured that all individuals have exited, the Primary Area gates are set to Controlled or Prohibited Access Mode. From that point on, any necessary entries are only allowed in Controlled Access Mode, whereby a MCR gate watch verifies that each person who enters also exits the Primary Area. Then, going from Controlled Access Mode to NO Access Mode does not require a re-Sweep of the area (provided the integrity of the Sweep was not lost) and this reduces the time to restore beam operations.

Blank Page

Beam Imminent Alarms

Crash Cord
Crash Buttons

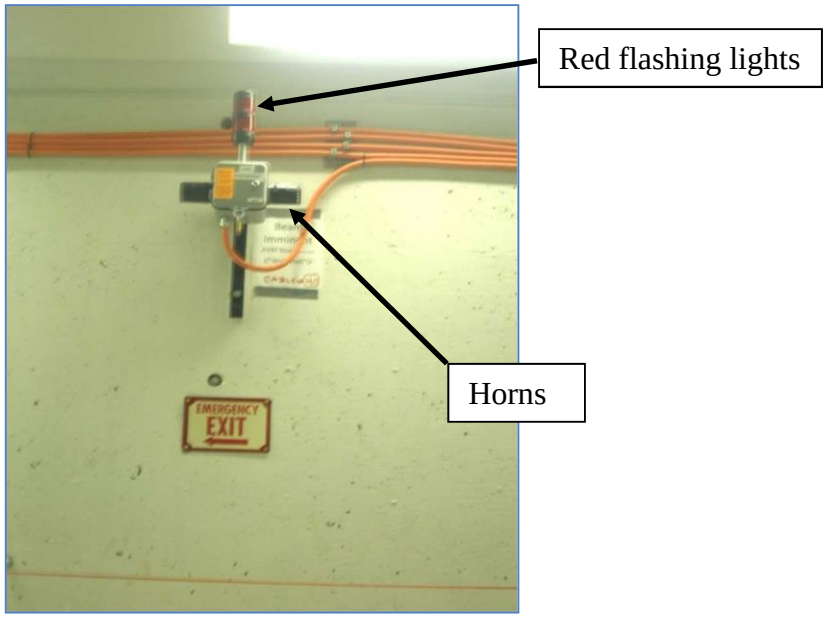
If procedures are followed, and the Sweep is properly performed, there should not be a case where an individual is mistakenly left inside a Primary Area when beam is enabled or is “imminent”. However, the C-AD complex is set up to warn personnel should this occur.

At RHIC:

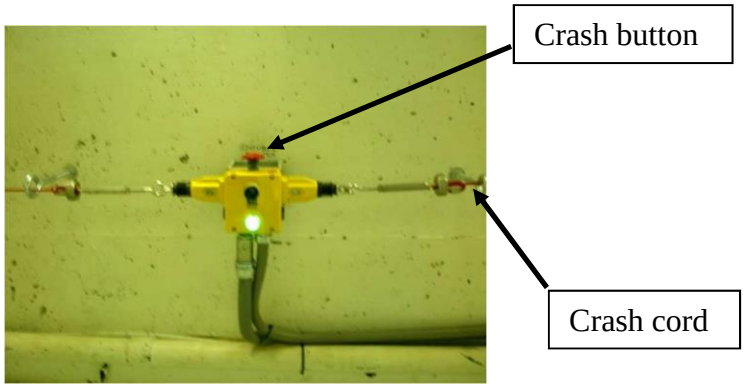
Beam Imminent Signal: Orange Strobe Light and an Audible Alarm

Your Actions: Pull Orange Crash Cord, Exit the Area Immediately. Crash cord is installed along the outer and inner walls of the RHIC tunnel.

In AGS Tunnel:



Beam Imminent Signal: Red Flashing Lights and an Audible Alarm



Your Actions:
Pull Red Crash Cord, or Push Red Crash Button, Exit the Area Immediately.
Crash cord is installed along the outer and inner walls of the AGS tunnel.

In Primary Areas throughout the C-AD complex, warning signals will alert personnel that beam is being enabled or that beam is imminent. Warning signals include orange strobe or red flashing lights, audible alarms and audible announcements. The warning signal allows for any individual who might still be inside an affected Primary Area to pull a crash cord or push a crash button, or to “crash out” of the area through the nearest ACS gate. (Note: At NSRL target room, beam imminent signal is dimming of the lights and an audible announcement).

If you see or hear a beam imminent warning signal, start for the nearest crash cord or crash button, or start for the nearest ACS exit gate. DO NOT PANIC, you have time, 60 seconds minimum.

Orange crash cord is mounted on the walls of the RHIC tunnel, RHIC experimental areas, NSRL tunnel (beam line from Booster), AGS to RHIC transfer line (AtR), U-Line and other transfer lines. Red crash cord is mounted in the AGS tunnel.

Red crash buttons are located at AGS, LINAC and Booster, NSRL target room, and along other primary beam lines. Red crash buttons are mushroom shaped.

Pushing a crash button or pulling a crash cord causes at least two critical devices (such as beam stops, steering magnets) to prevent beam.

One can always "crash out” of any Primary Area through an ACS. Keys are not needed to exit. If you see or hear a beam imminent signal or announcement and if you are already near an access gate, crash out (open the gate and exit). Crashing out an ACS gate in Controlled or Prohibited Access Mode will “crash” (prevent) beam the same as pushing a crash button or pulling a crash cord.

After you exit, notify the C-AD Main Control Room x4662.

Do not alter crash cords or crash buttons. Do not hang tools or clothing on the crash cords. This may stretch them out causing reset errors. Any modification to the Access Control System (ACS) (such as to the entry/exit gates) must be pre-approved by the C-AD Access Controls Group.

Example of a basic ACS Gate at RHIC

At RHIC, the typical gate to a primary area has ACS control boxes with lights that tell you what access control mode the gate is in.

Prohibited Access Mode *(RED)*

Controlled Access Mode *(YELLOW)*

Restricted access Mode *(GREEN)*

Inside Gate Outside Gate

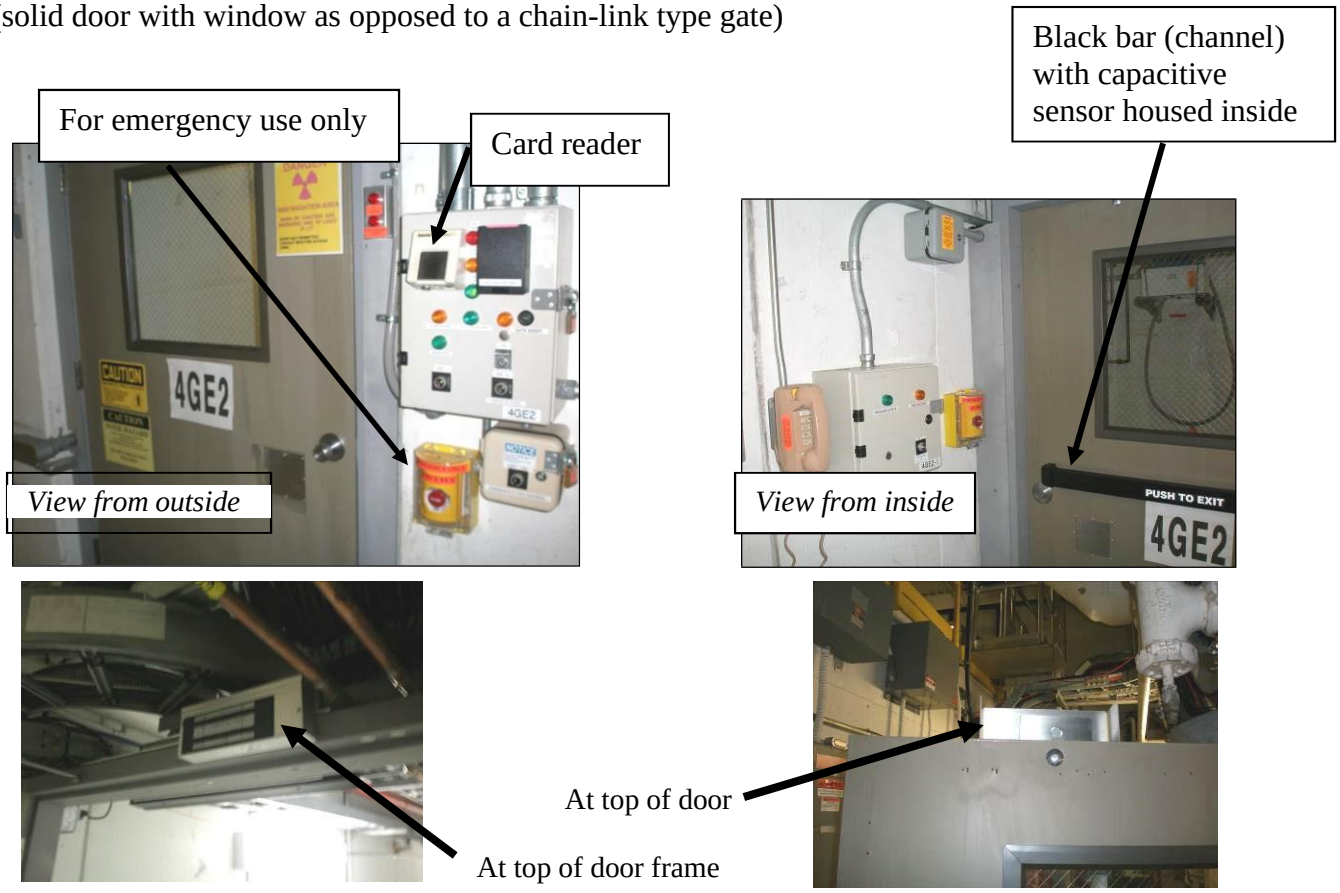
To enter during Restricted Access Mode (green light is on), use your RHIC Card Key. RHIC card keys are blue or pink:

Blue - for employees
Pink - for RHIC Users

To enter, place your card key on card reader, get small green light on reader, and open door.

To exit, turn door knob and exit (key not required to exit).

Example of a newer type ACS gate at RHIC
(solid door with window as opposed to a chain-link type gate)



With this newer type door, there is no mechanical door latch mechanism so you do not turn the door knob to enter or exit. The door is held closed by a magnet installed at the top of the door frame. To enter during Restricted Access Mode, place your RHIC card-key on the card reader (same as with the older type door). This releases the magnet and allows you to pull open the door.

To exit during Restricted Access Mode, push on the black bar with your hands, and push the door open. The black bar has a capacitive sensor housed inside of it. A person touching it will release the magnet, allowing the door to be pushed open.

With this newer type access door, 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 and you cannot get the magnet to release to open the door, lift the plastic cover and push the Red Button. This will release the magnet directly, and allow the door to be pushed open from the inside, or pulled open from the outside.

Fire alarms also de-energize door magnets so the door may be opened for exit as per NYS Building Code.

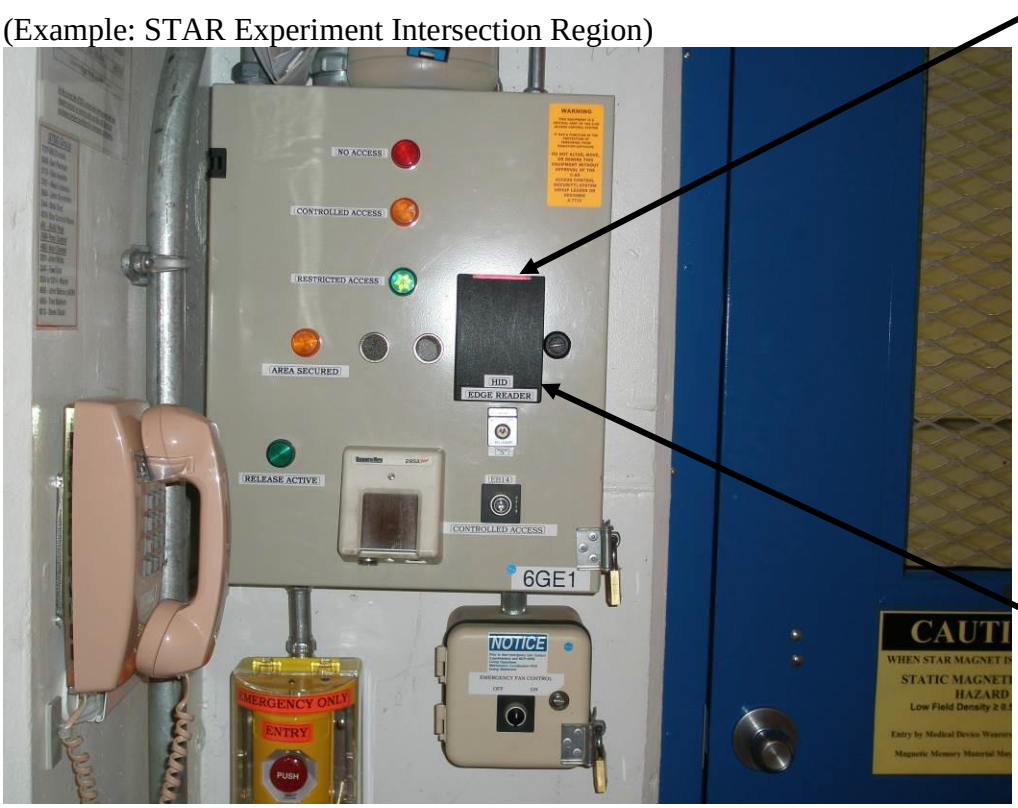
Example of ACS gate at RHIC for which access is controlled ***remotely*** by MCR during Controlled Access Mode

(Note: For Restricted Access Mode, use your RHIC Card Key to enter. Push on black capacitive bar to exit).

Controlled Access Mode - Yellow Light (second light from the top) would be ON

This procedure for entry and exit during Controlled Access Mode uses Iris Recognition, key tree, RFID and camera system, along with telephone communication. Entry AND exit from the primary area must be coordinated with MCR.

(Example: STAR Experiment Intersection Region)



Note:
You must first have your irises enrolled in order to use this system. For iris enrollment, contact C-ADTrainingGroup@bnl.gov , x7007, Bldg 911A Room A128.

Entry and exit procedure during Controlled Access Mode

1) At the access gate area, observe that the yellow Controlled Access light is on (2nd light from top).

2) At the iris reader & key tree location, from a distance of about 10 inches look into the iris reader and center the bridge of your nose with the lighted dot seen in the mirror.

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

4) Once recognized by the iris reader, choose/pull key #1 or the next sequentially available key from the Key-Tree. Turn the key 180 degrees counter-clockwise to release it.

Note:
Each key has an RFID tag attached.

5) At the access gate area, observe that the yellow Controlled Access light is on (2nd light from top).

6) Pick up the telephone and request access from MCR. Identify yourself to the MCR Operator by giving your name and ask for a release (opening) of the gate, telling them the specific gate number. For example, say "This is John Doe. Please release gate 6GE1".

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

7) Present the RFID tag (attached to the key-tree key) within approximately 1 & 1/2 inches of the RFID reader until the red bar light of the RFID reader changes to green.

Note:
Do not open the gate until you receive the green bar light on the RFID reader.

8) Open the gate and enter.

Important: You MUST take the key, with RFID tag, with you into the Primary Area. Beam cannot be enabled until all keys are properly returned to the key tree. Therefore, taking the key with you into the area is **important for your safety**. Each person entering must pull their own key from the key tree, and take the key (with RFID tag) in with them. More than one person entering under one key is a serious violation of procedure and is subject to disciplinary action.

9) To leave the Primary Area, pick up the telephone on the inside of the gate area and ask the MCR Operator for a release (opening) of the gate. For example, say "This is John Doe. Please release gate 6GE1". Wait for the indicator light on the control panel located on the inside of the gate area to illuminate BEFORE opening the door.

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

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

10) Open the gate and exit.

11) Proceed back to the iris reader for iris system logout and key replacement.

12) From a distance of about 10 inches look into the iris reader and center the bridge of your nose with the lighted dot seen in mirror.

13) Upon recognition by iris reader, put the key back into its slot of origin. 180 degree turn clockwise.

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.

Access to NSRL (Bldg. 958) Target Room - Primary Area

Building 958

Entrance doors to Target Room - Primary Area

The procedure for access to the NSRL target room is described in C-AD's NSRL User Training. It uses a somewhat similar system as the ACS gates at RHIC:

- card key (orange for Users) for Restricted Access Mode
- iris recognition, key tree and RFID system for Controlled Access Mode

although this Primary Area uses a *local* User-controlled procedure for entry & exit.

Access to tunnel areas at LINAC, AGS, BOOSTER, U-LINE and RHIC 2:00 area

Access to the above areas now requires your **Lab ID** for entry in Restricted Access (RA) and Maintenance Mode (MA). You will typically see MA during extended maintenance periods, such as the usual summer shutdowns.

All other areas of RHIC (beside 2:00 area), as well as NSRL, RF Testing Facility, LVTF and SVTF, will continue to use the RHIC Blue Card for **Restricted Access** entry.

In these areas, there will be one or two black HID RFID readers at each gate, depending on the gate.

Every gate will have at least one GATE reader, where your **Lab ID** will allow entry in RA or MA modes.

Some gates will have an additional KEY TREE reader, which will require your **Lab ID** to remove a key from the key tree in **CONTROLLED ACCESS**. The RFID attached to the key from the Key Tree will then be used at the GATE reader, along with a Simultaneous Release from MCR, for entry through the gate.

(This means that you must have your Lab ID scanned by C-AD Access Controls personnel, if it has not been done so already.

GATE readers will be labeled GATE in white capital letters, and will also typically be placed closer to the gate.

KEY TREE readers will be labeled in YELLOW capital letters, and will typically be placed closer to the key tree itself.

The types of HID RFID readers at each affected area are specified below:

B<u>OOSTER</u>

BSTGE1	GATE & KEY TREE (plus an additional GATE reader for the plug swing gate when the plug is open in RA or MA modes)

LINAC

Plug Gate	GATE & KEY TREE
Tank 1 Gate	GATE & KEY TREE

AGS

South Gate	GATE & KEY TREE
North Gate	GATE only
Conjunction Gate	GATE & KEY TREE
SWT Gate	GATE only
UGE1 (AGS Zone 5)	GATE only

-Down

UGE2 Gate	GATE only

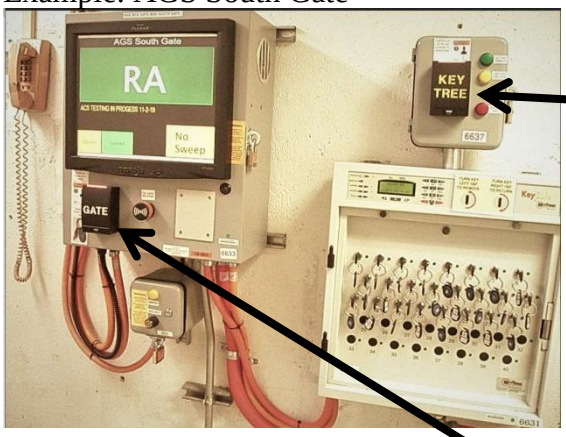
RHIC 2:00 area

2GE1	GATE only
2GE1 Rollup Door	GATE only
2GE2	GATE only
1002B	Key tree only

Please be aware that any time you get a new Lab ID, C-AD Access Controls personnel must scan the new one, as the ID numbers will be different than the replaced card.

Questions? You can contact Access Controls at ext. 7733.

Example: AGS South Gate



Use your BNL Lab ID

Use RFID tag attached to key

Tunnel Entry & Exit Procedure

RA:
- May enter and exit essentially at will using your BNL ID.
- May enter one gate and exit a different gate. Not being accounted for in RA mode.

CA:
- You must coordinate Entry and Exit with MCR.
- Use your BNL ID badge to pull a key from the key tree.
- Pull any lit key. 180 degree CCW turn. This key has an RFID tag hanging from it.

For Entry
- Pick up phone located at the gate area. Ask MCR for release of the gate: give them your name and gate name. For example, "This is John Doe, please release AGS South Gate".
- After hearing a beep, which means the gate release has been activated by MCR, dangle the RFID tag (hanging from key) at the RFID reader. Observe red bar light changes to green.
- The MCR Operator is watching remotely by camera, and logging you in. As a courtesy to MCR, show key to camera as you proceed to enter.

More than one person may enter with one opening of the door. **However**, each person must still pull their own key from the key tree using their own ID, and **each person must bring their own key-tree key with them into the Primary Area**.

The last person entering should observe that the door closes behind them.

IMPORTANT: You must bring the key-tree key (with the hanging RFID tag) with you into the AGS Tunnel (Primary Area). **This is for your safety**. Beam cannot be enabled until all key tree keys are properly scanned back into their associated key tree slot.

For Exit
- Before exiting, pick up phone located at inside of gate area and ask MCR for release. Give them your name and gate name. For example, "This is John Doe, please release AGS South Gate".
- An MCR Operator is watching remotely by camera and logging you out.
- Before turning the door handle to exit, observe that the "RELEASE" light on the control box comes on, and listen for a continuous beep as confirmation that MCR has released the gate …. then ….
- Turn door handle and exit.
  (Failure to wait for "RELEASE" light will cause a loss of Sweep and program delay.)

The last person exiting should observe that the door closes behind them.

IMPORTANT: In an EMERGENCY, turn the door handle and exit without calling MCR.

- Go back to the key tree.
- Again scan your BNL ID badge and return key tree key to same slot from which it was taken by turning 180 degrees clockwise.

First Entry into a Primary Area after Beam is Turned Off

The first entry into a Primary Area after beam has been turned off is typically made by a Radiological Control Technician (RCT) to perform a radiation survey. This is to assure that appropriate decay time has elapsed before other personnel are allowed access. Contact MCR to request a survey before first entry. Note: Some areas where experience has shown no significant residual radiation do not require a survey prior to first entry. The C-AD OPM specifies areas that do not require this survey. If you are in doubt about any particular area, contact MCR before entry.

Power Failure During Prohibited Access Mode

If a power failure occurs while in Prohibited Access Mode (e.g.: beam is on or is enabled), the Access Control System (ACS) may drop to Controlled Access Mode if the battery back-up system also fails. Since there may be residual radiation in primary areas, DO NOT attempt to enter primary areas immediately following a power failure since a Radiological Control Technician (RCT) would not have had the opportunity to first perform a survey. Contact the Main Control Room first.

Interlock Bypass

Do not take it upon yourself to bypass any system interlock.

Interlock bypassing can only be done at the discretion of the C-AD Radiation Safety Committee. Proper authorizations must be obtained prior to the bypass. The protection offered in lieu of the interlock must be equivalent. You can meet this requirement by having the Liaison Physicist and the Radiation Safety Committee Chair review and approve the bypass.

Who is Most Responsible for Your Safety?

You are the person most directly responsible for your safety. Use common sense. Never assume you know all the hazards. When in doubt, consult an expert. Contacts include the C-AD ESH Manager, ESSHQ Division, MCR, Health Physics Office, various safety committees, liaison engineers, liaison physicists, project engineers, system experts.

Safe Footwear and Long Pants

You must wear long pants (no shorts) and footwear appropriate for the areas and activities in which you are involved. The footwear should fully enclose the foot (no open-toed) 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. The applies to industrial work areas, experimental areas, chemical lab areas … etc.., which essentially means any area at C-AD other than an office type environment.

C-AD Conduct of Operations

The Collider-Accelerator Department is a "**Conduct of Operations**" facility. This means we must follow certain DOE Orders and guidelines in the operation of our accelerator facilities. It is important that staff understand we are committed by written agreement with DOE to operate under these guidelines.

It is required that we be aware of the following summarized basic principles of the Conduct of Operations agreement:

- we use written procedures for most operations
- we use trained & qualified personnel
- we require appropriate authorizations and work permits before beginning work or operations
- we must have definitive lines of authority at C-AD*

  * Responsibility for the safe and reliable operation of the C-AD complex resides with the on-duty Operations Coordinator (OC). This individual is located in the C-AD Main Control Room (MCR) in Bldg 911, x4662. The OC is the shift supervisor for the operating staff and is the focal point for all questions or issues related to accelerator operations. You may contact the OC if you have a problem or need assistance. The OC can make any necessary notifications and arrange for assistance when needed.

  During maintenance or shutdown periods, all operational related maintenance is scheduled and coordinated through the C-AD Maintenance Coordinator.

You can determine if the facility is operational or shutdown by reading this information on TV monitors located throughout the C-AD Complex.

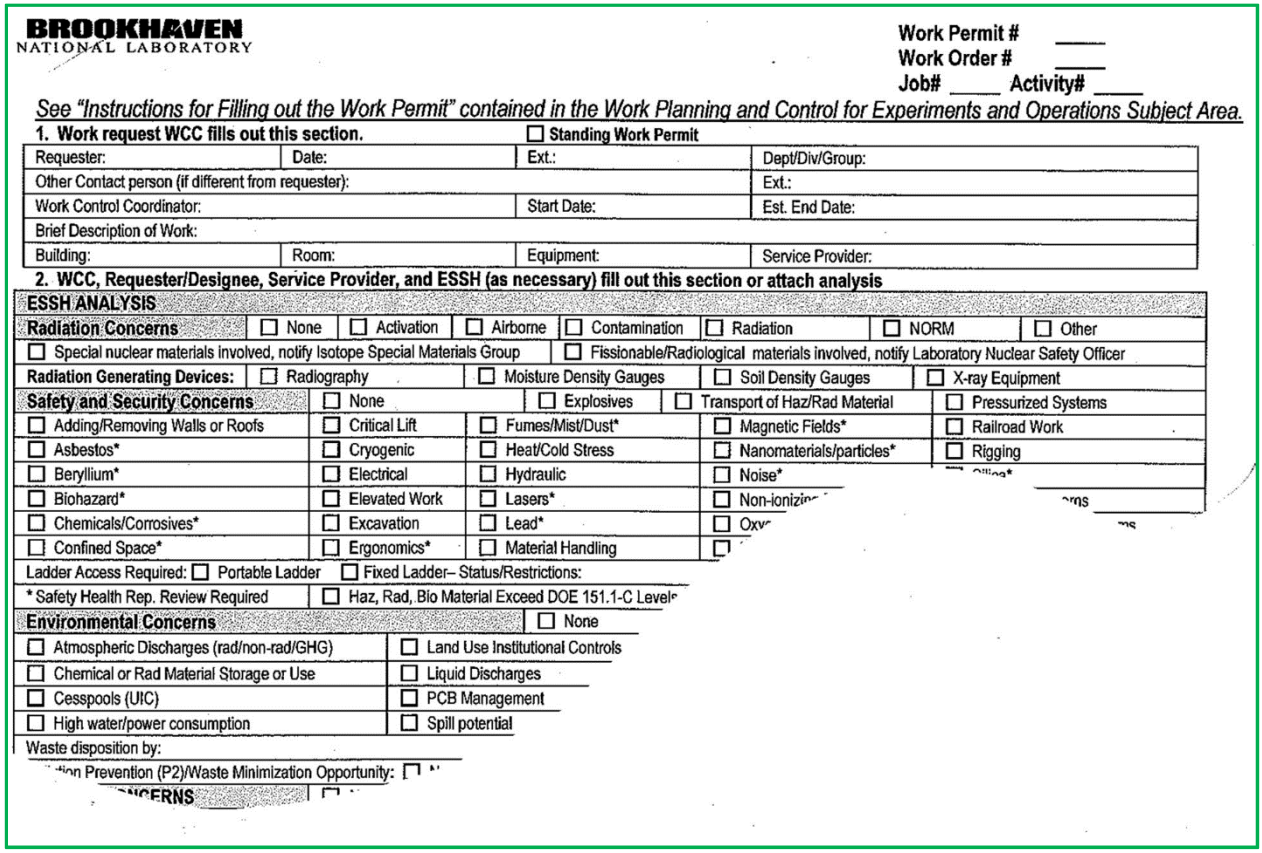
All work must be done by trained/qualified personnel and with appropriate work permits and authorizations.

All C-AD operations must have the appropriate authorization. Required authorizations are listed in the C-AD Operations Procedure Manual (OPM). Lead-personnel are appropriately trained. If requested, you must satisfy C-AD requirements for authorization (e.g., for working on a system declared as "critical").

Work Planning and Screening

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:

tion Prevention (P2)/Waste Minimization Opportunity: ☐

NCERNS ☐

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 (OPM), or
(3) Permit Planned.

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

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

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

Some work may require a combination of the processes; for example, a planned experiment will require an Experimental Safety Review, but may also need a work permit to assemble the experiment, an operating procedure (OPM) to provide instructions to operate the experiment, plus a work permit to safely dismantle the experiment.

The WCC must consider all recognized hazards, including routine hazards, during all phases of the work including estimating, planning and preparation phases and during pre-job briefs.

The Collider-Accelerator Department has designated a Work Control Manager for the department.

A list of qualified Work Control Coordinators may be obtained from SBMS. C-AD Work Control Coordinators complete additional training on work planning and must be approved by the C-AD Work Control Manager.

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". It is the responsibility or the WCC, Supervisor, Group Leader or Worker to ensure that all work is planned in accordance with C-AD procedures.

Whether or not you are a BNL or C-AD employee, if you are ever in doubt about the work control requirements for a job that you are responsible for or are involved with, contact the C- AD Work Control Manager.

Contractors and Suppliers - Job Hazard Analysis

Before the Procurement and Property Management Division (PPM) issues a purchase order for contractor, supplier, or warranty services to be performed on-site, the proposed work must be reviewed to determine if Job Hazard Analysis is required. This determination is made by a qualified WCC in collaboration with a BNL Construction Safety Engineer. Determination is based on level of ESS&H risk, and level of coordination and complexity of work.

Specific considerations for work planners and staff at C-AD:

Fire Alarm Bypass: If your work could create heat or smoke that could cause a fire alarm to initiate, AND there is no real need for the alarm, then you should ensure the work planner contacts the BNL Fire/Rescue Group (x2350) to discuss the possibility of bypassing the alarm during the work. Examples of type of work:

Using a heat gun (for example, during shrink wrapping)
Welding
Cutting
Grinding
Soldering or un-soldering

Reasons:
Fire/Rescue Group could get injured responding
Fire/Rescue Group could have a traffic accident with injuries to others
Fire/Rescue Group personnel are then not available for other emergency (e.g.: personal injury, fire … etc)

In the past, "unnecessary" alarms occurred a few times each shutdown. The problem is easily fixed by coordination with the Fire/Rescue Group (x2350).

Fire Alarm and Life Safety Systems: Any modifications to fire alarm devices (heat/smoke detectors, pull stations, bells/strobes, control panels, wiring, etc. require the approval of the BNL Fire Marshal of Fire Engineering group.

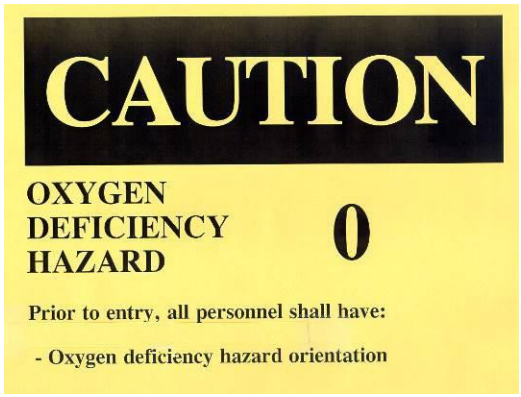
Security of Valuable Materials: If your work involves "valuable materials", then it must be secured from theft at the end of each work day when unattended. Ensure that work planning includes provisions for securing/lockup of materials at the end of the work day. Examples of valuable materials are copper, tungsten, platinum, aluminum or other metals that are targeted by thieves. Ref: OPM Procedure: "C-A Policy for Accountability and Security of Valuable Materials".

Do not prop-open doors

Keep postings visible

Many doors have safety postings on them. Postings indicate radiological, noise, magnetic field, oxygen deficiency as well as other potential hazards in areas throughout the C-AD complex. Do not prop doors open in any way that will keep the postings from being seen. In general, doors should not be propped open at all. If you have questions about a particular job or situation, contact the C-AD Work Planning Manager.

Oxygen Deficiency Hazards



After passing this C-AD Access Training, you must pass ODH training to to enter ODH Class "0" areas at C-AD.

NOTE:
Entering an ODH Class "1" area requires additional training in the use of a breathing air escape pack and personal oxygen monitor, and also requires medical clearance. This C-AD Access Training alone does not qualify you to enter Class 1 areas or to use the escape pack or personal oxygen monitor. There is currently only one ODH Class 1 area at BNL: the C-AD RHIC Refrigerator Building (Bldg. 1005R) during cryogen operations. There are currently no higher classes at BNL: no ODH Class 2, 3 or 4 areas at BNL. As always, pay attention to postings.

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

What is oxygen deficiency?

Air normally contains approximately 78% nitrogen, 21% oxygen and 1% argon. Oxygen deficiency is defined as less than 19.5 % oxygen. This happens when air in an enclosed space is displaced by another gas.

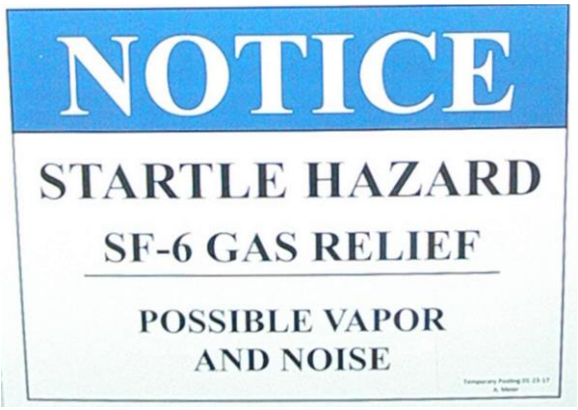
What causes oxygen deficiency?

At C-AD, cryogenic systems use large amounts of helium and nitrogen. Both liquids expand about 700-800 times when released into air as a gas. This could happen quickly with a major release such as a from a catastrophic failure. Or, the leak could also be slow, invisible and silent. In a major release, one might see a rapidly expanding white cloud and hear a "whooshing " sound. Both helium and nitrogen are colorless and odorless.

Oxygen deficient atmospheres can also be caused by: chemical reactions that consume oxygen, such as rusting metal, organic decomposition or fire; by processes or product emissions such as welding fumes or vehicle exhaust, or vapors from solvents, paints or cleaning materials that dilute oxygen concentration in the air; or by release of compressed gasses that displace air.
All of these in a confined space or area of low ventilation are significant concerns. Note: You are not being qualified by this course to enter a designated 'confined space'. Separate training is required.

Sulfur hexafluoride (SF_6) is a noncombustible, colorless gas, with a slight sulfur like odor. This gas, which is heavier than air, is used at the Tandem Van de Graff in an electrical insulating gas. The insulating gas contains 45% SF_6, 45% nitrogen and 10% CO_2. An oxygen deficiency hazard may occur in the event of a large release of this material. Since this material is heavier than air, some low laying areas such as basements and pits at that facility have been designated as an ODH Class 0 Area.

SF6 is also used at the 2 o'clock region of the RHIC tunnel. It is used in an electrical insulating gas for a high voltage system of LEReC. The SF6 volume itself does not cause the area to be characterized as an ODH area although the area is within the RHIC tunnel and is posted ODH-0 for the helium cryogen system.



Effects of Oxygen Deficiency

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

Oxygen volume %	Observed effect	Approximate length of exposure
17	•Night vision reduced •Increased breathing volume •Accelerated heartbeat	Immediate
16	•Dizziness •Tasks take up to twice as long to perform	Immediate
15	•Impaired attention, judgment impaired •Intermittent breathing, rapid fatigue •Loss of muscle control	Immediate
12	•Very faulty judgment, poor muscular coordination	10 minutes
	•Loss of consciousness, permanent brain damage	2 hours
10	•Inability to move •Nausea, vomiting	4 minutes
	•Loss of consciousness	10 minutes
6	•Spasmodic breathing, convulsions	Immediate
	•Loss of consciousness	30 seconds
	•Coma	1 minute
	•Death	5-8 minutes

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

Classification Levels of Oxygen Deficiency Hazard (ODH)

There are five classes of ODH: 0 through 4, with 0 being the least hazardous. Each classification requires controls and posting commensurate with the hazard. Classification is based on the likelihood of fatality. The likelihood of fatality is found by determining the minimum oxygen concentration from a leak of inert gas and the probability of failure of the pressure boundary.

Areas posted as ODH are normally above 19.5% oxygen but have the *potential* to expose staff to oxygen deficient atmospheres under failure or abnormal conditions.

NOTE:
Additional training is required to access to ODH Class 0 Areas at C-AD.

Areas with ODH Class 0 include:

- Buildings at RHIC with Valve Boxes:
  Support Buildings 1002B, 1004B, 1006B, 1008B
  Service Buildings 1010A and 1012A
- CeC Support Building 1002A
- Collider Tunnel when helium is >40K (the STAR Intersection Region is not an ODH area)
- Helium Compressor Building 1005H
- Helium reliquifier section of Bldg 1005E
- AGS Tunnel if the Cold Snake is operating
- Tandem Van de Graaff (SF6)
- Bldg 912 R&D Area (EEBA and NEBA)
- Bldg 1004E Compressor Building
- Cryo Pumping Facility Bldg 966
- Certain areas of Experimental Building 912
- Bldg 1010A Mezzanine

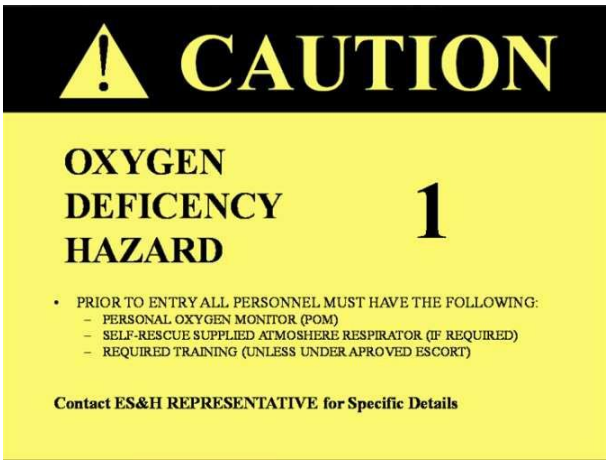
Some areas may not be posted ODH depending on operational status. As always, pay attention to postings.

ODH Classification and Controls are applied to non-confined spaces. Areas defined as a confined space are required to follow Confined Space requirements such as entry permits and atmospheric testing. Additional training and qualification are required for Confined Space entry.

ODH Class 1 Requirements

NOTE:

Entering an ODH Class "1" area requires additional training in the use of a breathing air escape pack and personal oxygen monitor, and also requires medical clearance. This C-AD Access Training alone does not qualify you to enter Class 1 areas or to use the escape pack or personal oxygen monitor. There is currently only one ODH Class 1 area at BNL: the C-AD RHIC Refrigerator Building (Bldg 1005R) during cryogen operations. There are currently no higher classes at BNL: no ODH Class 2, 3 or 4 areas at BNL. As always, pay attention to postings.



ODH Class 1 areas have greater potential for worker injury than Class 0 areas.

All entrants must carry their own breathing air escape pack and wear their own POM for measuring real-time ambient oxygen content. POMs must be worn on the outside of your clothing. Before use, users must check that the POM is undamaged, currently calibrated, functional and reading between 20.8 and 21.1 % oxygen.

For the additional required training in the use of a breathing air escape pack and personal oxygen monitor (POM) contact your supervisor or safety staff of the facility responsible for the ODH area.

Medical clearance is also required. Contact your supervisor or safety staff of the facility responsible for the ODH area, or contact BNL's Occupational Medical Clinic.

When would you evacuate an ODH Area?

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

- … if the in-place oxygen monitors activate an alarm. At the RHIC complex, the alarm is a BLUE strobe light accompanied by an audible alarm. (Exception: In RHIC building 1005H there is no audible alarm and a RED strobe indicates an ODH event. There is no audible alarm because of the high background noise in this building.) At C-AD's Bldg 912 R&D Area (EEBA and NEBA), the alarms are BLUE or WHITE strobe, and an audible alarm.

- … if a vapor cloud is observed inside the ODH area or a loud "whooshing" sound is heard, even if there is no audible alarm or strobe light activating. Note: There are no steam systems in the RHIC tunnel so a vapor cloud, although it may look like steam, should be assumed to be a cryogen fluid leak, not a steam leak.

- … if you or a coworker feel the early physical signs of oxygen deficiency. Different people may feel effects at different oxygen levels, but the early signs are generally:

    - Increased breathing volume
    - Accelerated heartbeat
    - Dizziness

- … if you are in an ODH Class 1 area (assuming you are qualified or under escort) and your personal oxygen monitor alarms, regardless of the area's ODH alarm status. Inform area personnel, don your breathing air escape pack hood and evacuate.

Evacuation procedure:

If you are qualified and are in a Class 1 ODH area don your breathing air escape pack hood. If it will take as much time to don your hood as it will to exit, then exit without donning your hood.

Check for trapped personnel in the area.

If no one is trapped:

Immediately leave the area, moving away from any vapor cloud, loud "wooshing" sound or other potential problem. The release could be a lethal freezing hazard as well as an oxygen deficiency hazard if you are close to the release point.

If someone is trapped:

In a Class 1 area you may assist them - - for no longer than one minute - - to don their air pack.

Evacuate the area and call extension 2222 or call 631-344-2222 from a cell phone as soon as possible and explain that someone is trapped. You may also pull a fire alarm pull-box if one is in the area. Do not otherwise attempt a rescue as you are likely to be the next victim. Let the professional rescuers handle it.

If the hazard is helium (lighter than air) such as at RHIC:

Stay Low.
Duck under magnets away from the cryostat relief valves to get to exits as opposed to climbing over magnets.
Do not use overpasses to cross the beam lines.
Do not use vertical (ladder) exits.
Use only horizontal exits.

If the hazard is sulfur hexafluoride (heavier than air) such as at the Tandem Van de Graff, do not exit through low areas. Leave low areas immediately.

For nitrogen: Nitrogen is denser (heavier) than air when cold, and slightly less dense (lighter) than air when warm or at room temperature. There is a potential hazard from nitrogen if working in a trench below walking level, such as in the RHIC Compressor Bldg, and if there is liquid nitrogen present in systems in the area. If there is a leak, the nitrogen would initially be denser (heavier) than air. Therefore, you would want to leave low lying areas for any indication of a leak. The nitrogen would be heavier than air until it is at room temp, at which time it is about the same density as air (slightly less dense than air).

Notify your supervisor and the facility safety group of the occurrence.

It is important to remember you must not enter or re-enter an area where an ODH event is occurring even with a breathing air escape pack. A qualified individual carries the escape pack into ODH Class 1 areas for routine entry. It is for escape in case of an event and not for entry for rescue. ODH deaths usually come in pairs. More than 50% of ODH deaths are of would-be rescuers. One or two breaths could cause loss of consciousness. Let the Fire/Rescue Group handle it.

AGS Ring Cold Snake at A20 magnet location:

A20 is a magnet number and specifies a location in the AGS ring (tunnel). The AGS ring enclosure becomes an Oxygen Deficiency Hazard Class 0 (ODH-0) area when the A20 cold snake is being cooled or is at operating temperature. If you are entering the ring under this condition the ring entrances will be posted, and you should be familiar with C-AD OPM Procedure 4.2, Procedure for AGS Access During Cooldown and Operation of the A20 Cold Snake. Some highlights are:

- Workers who traverse the region between the A15 and B5 main magnets must verify that the A20 ODH monitor is operational by viewing indicator lights at the A15 and B5 main magnets. The indicator lights will be found on the tunnel outer wall at A15 and B5.

- If the indicator lights are on, then the ODH monitor is operational and you may traverse the area.

- If the indictor lights are off then the A20 ODH monitor is not operational. If the indicator lights are off then do not enter the region between the A15 and B5 magnet without a Personal Oxygen Monitor (POM).

- If a worker observes a cloud around A20 or hears a loud noise coming from A20, or if the local ODH monitor at A20 annunciates accompanied by flashing blue lights, then the individual must evacuate the area and inform personnel in the Main Control Room (X4662). Note that the evacuation warning signs may immediately not be seen or heard at other locations around the ring, depending on how far away you are from the A20 area, however the hazard would be minimal at these further locations.

Accelerator Research & Development (R&D) Area

The C-AD R&D Area is a developing area. It is located essentially within EEBA and NEBA, which are additions to Experimental Building 912:

EEBA: East Experimental Building Addition
NEBA: Northeast Experimental Building Addition

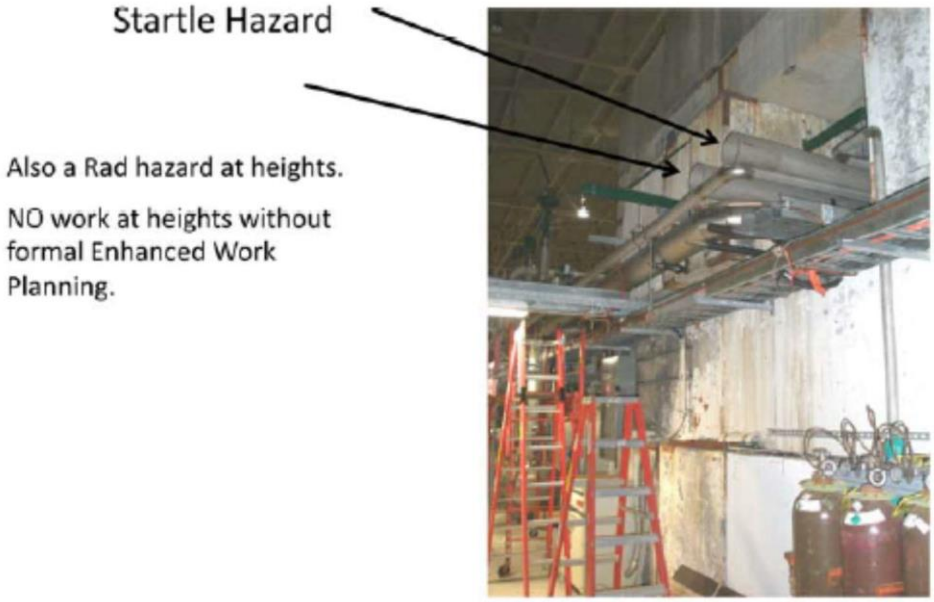
Areas and facilities within the R&D Area:
Ultrafast Electron Diffraction (UED)
Small Vertical Test Facility (SVTF)
Large Vertical Test Facility (LVTF)
VTF Refrigerator Plant & Valve Box
Cryo Control Area
Clean Room (Class 10,000 / Class 100) and Vacuum Oven
RF Testing Facility (Formally known as ERL) - RF Testing Facility Control Room (x3135)
Laser Room (Class 4)
Klystron Room
RF Control Area

General potential hazards associated with the R&D Area include:
Oxygen Deficiency Hazards
Cryogens
Confined space (at LVTF)
Lasers
RF
Radiation
High Noise
Electrical

NO work at heights without formal Work Planning. Work at heights may be a radiation hazard.

Overhead Crane Operation (hardhat required when overhead crane is in use)
Pressure Reliefs & Startle Hazard:

Large Vertical Test Facility – East side



Ultrafast Electron Diffraction (UED) facility (accelerator room, laser room, clean room)

UED Operators, UED Users and UED Laser Users are required to complete additional UED-specific training. If this applies to you, contact the C-AD Training Manager to determine what training is required.

Access to the UED accelerator/laser room is through an access gate that is interlocked closed during operation:

A Sweep is required prior to operation.

Hazards in and around UED facility:

Radiation
RF
Magnetic fields
Cryogens/Oxygen Deficiency
LOTO/Electrical
Laser (Class IV Laser Controlled Area)

UED Access Gate

As always, pay attention to tags and postings. Do not enter areas or perform work if you are unsure of the requirements for doing so.

UED oxygen level indicator

UED laser status indicator

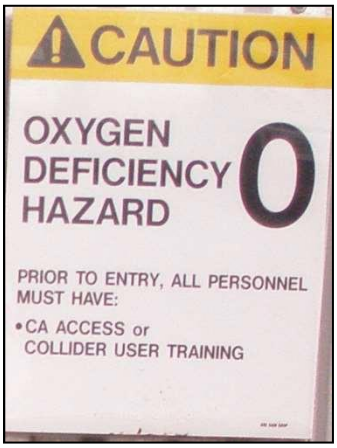
Clean Room – check with UED staff prior to entry

UED Control Room, Bldg. 967, attached to south side of EEBA

EEBA Rollup Door 3

As always, pay attention to tags and postings. Do not enter areas or perform work if you are unsure of the requirements for doing so.

Oxygen Deficiency Hazard: Entrances to EEBA and NEBA are posted ODH Class 0. The cryogen system designed and installed for LVTF uses liquid nitrogen, nitrogen gas, liquid helium and helium gas. The main ODH concern here is with the liquid nitrogen (LN). LN piping travels through EEBA and NEBA to LVTF. A LN pipe rupture, or even a slow leak, can cause a nitrogen release into the building. The UED facility uses a 50L Nitrogen Dewar. LN expands and displaces the breathing air if released.



Liquid nitrogen supply tank.
11,000 gallon capacity. For VTF.

ODH Alarms are as follows:
- EEBA & NEBA ceiling, up high, two locations: White strobe and audible horn (Note: if personnel are in the cab of the overhead crane, they should wear hearing protection in case an audible alarm activates. They may be much closer to the horn; hence higher decibel level.)
- NEBA wall near RF Testing Facility block house, one location: White strobe, no horn
- North outer wall of LVTF: Blue strobe, audible alarm
- Inside RF Testing Facility block house: Blue strobe, audible alarm
- Inside Laser Room: White Strobe, audible horn

The SVTF block house is posted ODH-0 when the Nitrogen Dewar is present. However, you may be required to wear your own Personal Oxygen Monitor (POM) for entry into this block house when SVTF is operational. Pay attention to postings. You must be authorized for SVTF entry.

When do I evacuate the building?

Any one or combination of the following requires an immediate evacuation of the ODH area (exit buildings to the outside):

- Any fixed monitor activates an alarm (white strobe, blue strobe or audible)
- Any POM alarms
- A vapor cloud is observed or a loud "whooshing" sound is heard, even if there is no audible alarm or strobe light
- You should also evacuate if you feel the early physical signs of oxygen deficiency. Different people may feel effects at different oxygen levels. Early signs are generally: Increased breathing volume, Accelerated heartbeat, Dizziness.

Prior to entering buildings:

It is good practice to be alert even prior to entering the buildings. If you are just arriving and you observe an alarm, do not enter. Only properly trained personnel with proper PPE may enter during an alarm. It is particularly important to be alert prior to entry if you are first to arrive in the morning or after a weekend.

Other support buildings and areas:

RF Testing Facility Cryo Pumping Facility
- Oxygen Deficiency Hazard Class 0
- High Noise Area with pumps operating; 8 hours max occupancy; dual hearing protection required

Bldg 966
- Radiological areas
- Compressed gas cylinders
- Vacuum systems
- Electrical systems
- Flammables
- Hydrogen gas (explosive)
- Cryogens
- Lasers
- Hot surfaces

Bldg 940 Center for Accelerator Science & Education
- Mostly office type space

Inside RF Testing Facility block house:

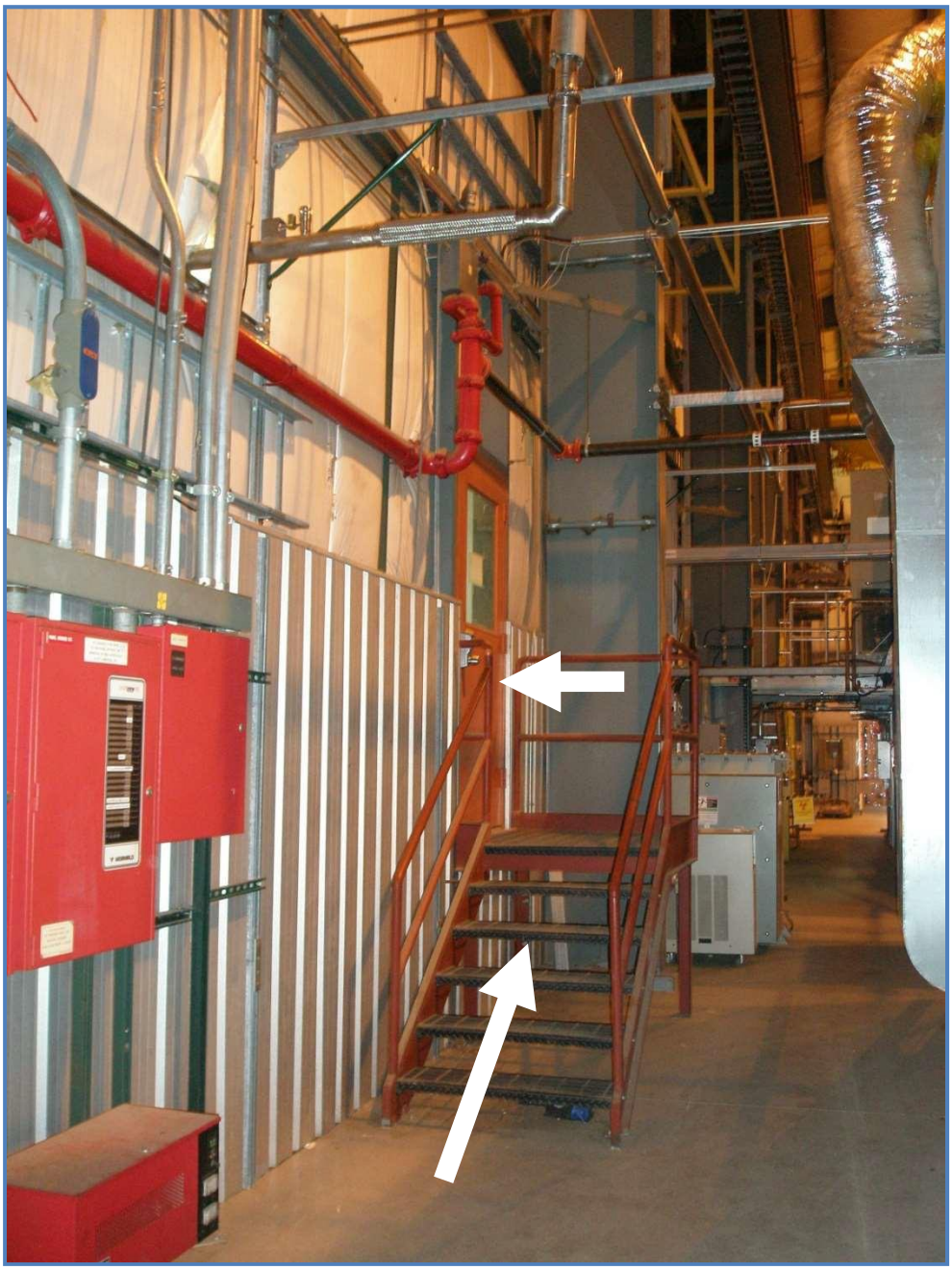
Alarms
Orange Strobe: Beam Imminent
Blue Strobe: ODH

- Pull orange crash cord if orange strobe activates and you are inside the RF Testing Facility block house; and exit immediately.

- Exit immediately if blue strobe activates – this indicated an ODH event is happening.

RF Testing Facility Control Room x3135

(Formerly known as ERL. Blockhouse repurposed for RF testing)



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Stop Work Policy

Imminent Danger

This policy allows an individual to stop work at BNL to mitigate *imminent danger* to personnel, to equipment or to the environment.

Imminent danger exists when there is a hazard that could result in death, serious injury, environmental impairment or significant damage, and when immediate action is required. The person issuing the stop-work order makes this determination. Any knowledgeable person has the authority to issue a stop-work order at BNL. At C-AD, a knowledgeable person includes anyone having unescorted access to the complex. ALL workers at BNL are required to be trained in the Lab's Stop Work Policy. The training is completed either on line (web-based: h ttps://www.bnl.gov/training/courses/web/) or is included as part of other orientation type training such as:

General Employee Training
Guest Site Orientation
Contractor/Vendor Orientation

Persons are responsible for and expected to issue a Stop-Work order for *imminent danger* whenever it is observed. For non-imminent danger situations, Management still expects that personnel call attention to any questionable or unsafe act or condition. Management takes such notification seriously and will respond.

Vertical Fixed Ladders

Vertical fixed ladders include all permanently installed vertical fixed ladders, including those to access manholes and elevator pits. It is not applicable to stairs or ship's stairs (also known as ship's ladders**)** including the alternating-step type of ship's stairs.

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

BNL has issued SBMS Subject Area "Fixed Ladders, Design, Inspection, and Use" (April 9, 2019, Rev. 1.4) to assure vertical fixed ladders are inspected for compliance to industry standards, and to assure work controls are in place for safe use. To comply with BNL requirements, existing vertical fixed ladders at C-AD have been inspected to determine if they meet industry standards. These type inspections can only be done by trained engineers and safety staff. The training for this is given by the BNL Central ESH Division.

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

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

Yellow
Ladder was inspected and some non-compliances with standards were noted. However, with the use of additional provisions, the ladder can be used safely. These ladders are marked yellow at the top and bottom entry points and have caution postings listing the problems found during the inspection. 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 (not marked or posted), then you may not use the ladder. Contact the appropriate Facility Complex Engineer, Research Space Manager or C-AD ESSHQ Division 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 cleared medically for climbing vertical fixed ladders with no limitations identified for working at heights (contact your supervisor or the BNL Occupational Medicine Clinic if you have questions)
- Before use of a yellow-marked ladder, review the caution posting to assess and identify the non-complaint issues with that specific ladder.

Supervisors: 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 or down a ladder
- Make sure you feel physically fit to use the ladder that day and that your ladder training is current
- On a vertical ladder in particular, there is always a force (your weight) that will cause you to fall off the ladder if you lose your grip or footing
- For yellow-marked ladders, review the caution posting each time you use the ladder

SBMS identifies a BNL Subject Matter Expert (SME) for Design, Installation, Inspection, Modification and Use of Fixed Ladders. All new and modified fixed ladders must be reviewed and approved by BNL Safety Engineering to ensure compliance with industry standards. If you have questions, please contact the BNL SME. The C-AD ESSHQ Group is also available to answer such questions.

International Standards

ISO 14001 (Environment)

Brookhaven National Lab has achieved registration under the International Standards Organization (ISO) Standard for Environmental Management Systems:

ISO 14001 - Environment

The Laboratory and C-AD are periodically audited by an ISO audit team. To remain in "good standing" and continue to maintain our ISO 14001 registration, we must operate in accordance with the Lab's ESSH (Environment, Safety, Security & Health) Policy. C-A Department procedures and the Lab's SBMS help assure that we continue to meet the intent of the Lab ESSH Policy and the ISO 14001 standard.

Your responsibility: Be aware that the work you perform could have significant impact on the environment or on personnel safety and health. Below are examples of how your work might have such impact. These are only examples. Details of C-AD environment, safety & health issues associated with individual jobs, materials, work areas, experimental areas, processes, experiments and machine operations are also identified through mechanisms such as work planning, training, safety review committees, Job Risk Assessments, Facility Risk Assessments, OPM procedures, group procedures and ESH Inspections.

Examples of environmental impacts:
Atmospheric discharges
Liquid discharges
Environmental noise
Hazardous waste
Radioactive waste
Mixed waste
PCBs
Regulated industrial waste
Regulated medical waste
Soil activation
Storage/use of chemicals or radioactive material
Electric power consumption to operate the complex
Water consumption to operate the complex
Radioactive materials storage
Hazardous or radioactive material spills

Examples of safety & health impacts:
Ionizing radiation
Non-ionizing radiation
Hazardous or toxic materials
Radioactive materials
Electrical energy
Explosive gases and liquids
Oxygen deficiency
Kinetic energy
Potential energy
Thermal energy
Cryogenic temperatures
High Noise
Startle hazards
Magnetic fields
Protracted/irregular hours
Natural hazards
Housekeeping hazards
Working environment hazards such as heat, cold, mold, dust
Ergonomics
Flammable or combustible materials
Rotating equipment
Lasers

If you have questions about how your work at C-AD might impact the environment, safety, security or health, there are several C-AD contacts that you may call upon:

C-AD Associate Chair for ESSHQ
ESSHQ Division Head
C-AD Environmental Coordinator
Environmental Compliance Representative
ESH Manager
Radiological Control Division Representative

BNL Environment, Safety, Security, and Health (ESSH) Policy

Environmental, Safety, Security, and Health Policy

This document is a statement of Brookhaven National Laboratory's Environmental, Safety, Security, and Health (ESSH) policy. Brookhaven Lab is a world leader in scientific research and performs this work in an environmentally responsible, safe, and secure manner.

I expect every employee, contractor, and guest to take personal responsibility for adhering to the following principles:

Environment	We protect the environment, conserve resources, and implement sustainable business practices that protect our future.
Safety	We maintain a safe workplace. We plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers, and guests.
Security	We protect people, property, information, computing systems, and facilities.
Health	We protect human health within our boundaries and in the surrounding community.
Compliance	We achieve and maintain compliance with applicable ESSH requirements.
Community	We maintain open, proactive, and constructive relationships with our employees, neighbors, regulators, the U.S. Department of Energy, and other stakeholders.
Continual Improvement	We continually improve ESSH performance.

In addition to my annual review of Brookhaven Lab's progress on ESSH goals and adherence to this policy, I invite all interested parties to provide me with input on our performance relative to this policy, and the policy itself.

Signed _____ October 13, 2021

Doon Gibbs, Director

Brookhaven National Laboratory

Spills

The C-A Department is required to report spills internally, externally or both. External organizations include NY State agencies, county agencies and DOE.

C-AD must report ***quickly*** to external agencies on spills that impact the environment. Even minor events, such as spilling any amount of oil in an outdoor area to soil or to a waterway, require reporting. If you spill any hazardous or industrial material outdoors to soil or a waterway, or anywhere inside and the spill is beyond your control, call x2222 or 911* to report the spill.
Then call: C-AD Main Control Room (x4662), the C-AD ESSHQ Division Head (x2356) or the C-AD Environmental Coordinator (x8802).

When reporting, give your name and information on spill location, type of material and approximate amount (as best as you can). **Do not leave a message on an answering machine as notification.**

The rules are such that we must *consider* reporting spills of any type or size.

When must a spill be reported by calling x2222 or 911?

- Unexpected releases of oil, hazardous substances, or radioactive materials known or suspected to have impacted the environment (including spill to the soil or a waterway, regardless of size of spill)

- Any hazardous material spill where your actions would result in exposures to chemicals above established safety limits

- Spills where you possess neither appropriate equipment nor training to mitigate the incident

- Airborne releases of hazardous materials or spills that are likely to result in an uncontrolled release of the hazardous material

When don't I have to call in a spill to x2222 or 911?

All of these must be met:

- The spill is onto an impermeable surface
- The material spilled is not highly toxic or highly volatile
- The person responding to the spill has appropriate training and materials to clean up the spill
- For petroleum based products, the volume of the spill is less than five gallons
- The spill is cleaned up immediately

The C-AD ESH Manager or C-AD Environmental Coordinator is to be contacted in the event of a spill to evaluate and coordinate the clean-up effort.

* Use x2222 or 911 from an onsite BNL phone; or (631) 344-2222 from a cell phone. Note: If you dial 911 from your cell phone you will not get the onsite BNL Fire/Rescue Group or onsite BNL Police Group. You will get the offsite county police, which may not be the best type of help you need for your situation here on site.

Removing Damaged Equipment from Service

If equipment is damaged and unsafe (such as broken ladders, frayed slings, defective power cords, leaking tanks), or is not permitted to be used at C-AD (such as wooden ladders), you must have it removed from service. If you are not sure of how to remove an item from service, contact your supervisor, the building's Facility Manager, the C-AD ESH Manager or the ESSHQ Division Head.

Waste Disposal

Improper disposal of radioactive or hazardous/industrial waste may result in fines, criminal prosecution, and facility shutdown.

- Contact the C-AD Environmental Coordinator for information on any waste.
- Contact the C-AD Environmental Compliance Representative (ECR) prior to establishing any new airborne, liquid, or solid radioactive or hazardous waste stream.

These individuals are familiar with rules, permits, authorizations and analysis requirements necessary for proper disposal.

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 States where waste from C-AD is ultimately disposed of must also be followed.

- 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 *
- Substitute environmentally friendly materials where possible
- Use minimum quantities of materials
- Segregate wastes
- Recycle whenever practical
- Do not leave unnecessary items in primary areas

* For example, we re-use radioactive lead whenever possible since it would become a "mixed waste" (hazardous and radioactive)

Each person is responsible to ensure that they handle, accumulate and dispose of waste using proper controls and documentation. All generators of hazardous or radioactive waste at C-AD must be specifically trained. Courses that could apply are:

Radioactive Waste Generator (HP-RADIGEN)
Hazardous Waste Generator (HP-RCRIGEN3)
Hazard Communication (HP-IND-200)

Hazardous waste is subject to time limits and volume limits that must be strictly adhered to. Generally, accumulation of more than 55 gallons at a satellite accumulation area is not allowed. Once the waste is moved to the C-AD Hazardous Waste Trailer, a 90-day clock starts. The waste must leave the C-AD complex within 90 days. 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.

Activated lead is an example of mixed waste. It is both hazardous and radioactive. Do not put mixed waste in radioactive waste cans. Do not mix liquids with dry radioactive waste.

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.

C-AD wishes to minimize radioactive waste in order to minimize cost and environmental impact. Ordinary clean waste such as packaging materials, coffee cups … etc should not be thrown into radioactive waste cans. This increases the radioactive waste disposal cost.

If you are ever unsure if the material you wish to throw away should be handled as hazardous or radioactive waste, then contact the appropriate individual who can make the correct determination. Contacts include:

C-AD Environmental Coordinator
C-AD Environmental Compliance Representative

Question: You have to throw out empty cans of a liquid chemical that you used to clean equipment. You realize the liquid itself may require special handling, but the containers are dry. What do you do?

Answer: Initially treat the container as hazardous waste and contact the C-AD Environmental Coordinator to learn the proper disposal procedure.

Question: You have sweepings from a building or area posted as a Radioactive Material Area. You normally place sweepings in the green 3-yard bins used for clean industrial waste and there is one nearby. What do you do?

Answer: Initially treat the sweepings as radioactive and contact Health Physics to have the sweepings checked prior to putting them in the green bins.

Radioactive waste will be detected in either the green bins or the 50-yard garbage trucks and C-AD will incur significant expense to sort the waste and remove the radioactive material. Remember that saving a few minutes by not having it checked by a Radiological Control Technician (RCT) will cost C-AD many person-hours later and could harm our reputation with stakeholders. Even low-level radioactive waste will be detected by the ultra-sensitive truck monitor. Do not assume that low level waste will be able to make its way unnoticed into the Brookhaven Town Landfill.

Compressed Gas Safety

Note: Additional BNL training is required if you handle compressed gas cylinders

All compressed gases are hazardous due to high pressure. Compressed gases may also be hazardous because they are:

Toxic: Gases that are poisonous in varying degrees ranging from extremely dangerous to life to only an irritant. Exposures to the more toxic gases can cause severe illness or death. Typical examples of harmful gases are Sulfur Hexafluoride (when exposed to high voltage can produce toxic byproducts), Carbon Monoxide, and Hydrogen Sulfide.

Flammable: A condition that results when even small quantities of a specific gas when mixed with air forms a mixture that is capable of being ignited. Once ignited, the burning gas mixture can ignite other nearby combustible materials. Typical flammable gases are Acetylene, Hydrogen, and Methane.

Corrosive: Corrosive materials can cause visible destruction or irreversible injury to human skin and eyes (similar to a burn) at the site of contact or can cause serious degradation of various construction materials, such as steel, or brass. An example of a corrosive gas is Chlorine.

Oxidizers: A gas that supports or enhances combustion. These gases must be handled with caution since they increase the potential for fire or explosion. They require special storage considerations. Typical oxidizer gases are Oxygen, Chlorine, Fluorine, and Nitrogen Oxides.

Asphyxiant (oxygen displacement): Asphyxiation is a condition which results when a gas reduces the concentration of breathable oxygen to a hazardous level in air by displacing and diluting normal air. Typically, all gases other than oxygen and air can do this. Examples are Sulfur Hexafluoride, Helium, Nitrogen and Carbon Dioxide.

Cylinder Receipt and Content Identification

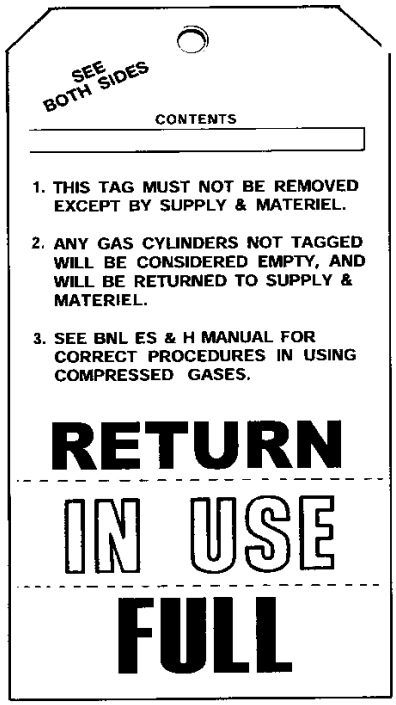
Because of the different hazards associated with different gases, it is important that cylinders be properly labeled. When a cylinder is delivered to the BNL gas warehouse, a laboratory area or a job site, it should have:

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

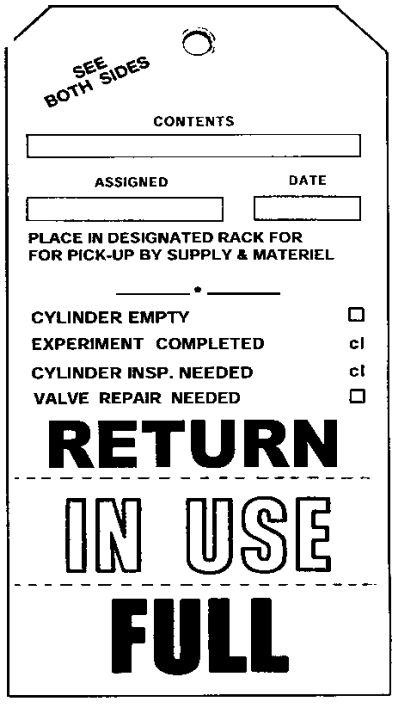
Under no circumstance should the means of identification be removed from a cylinder. The valve protection cap should remain in place until the user has secured the cylinder to a fixed support at the point of use and is ready to attach a pressure regulator to withdraw the contents.

Sometimes cylinders are received with no identification other than a color code. There is no uniformity in the identification of cylinder contents through color coding of the cylinders. Under no circumstances should such cylinders be accepted. DOT labels have a minimum of precautionary handling information and will classify the cylinder contents.

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



(Back)



(Front)

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.
- Keep cylinder caps on the cylinder whenever they are not in use.
- Transport cylinders using a cart or hand truck designed for that purpose, securing the cylinders.
- Whenever placing a cylinder in service, check the hydrostatic test date. If a cylinder is not in service it must have a hydrostatic test performed every five years.

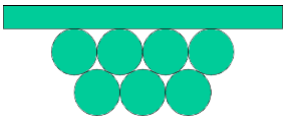
Compressed Gas Cylinder Safe Storage

- 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 with oxidizing gases.
- 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 minimum handling of other cylinders.
- Cylinders should not be stored at temperatures above 125 ^{0}F, (51 C) or near sources of heat.
- Cylinders should not be stored near highly flammable or combustible materials.
- When cylinders are being moved on a cylinder cart, pallet, or truck, they must be secured.

Safe methods for securing capped compressed gas cylinders in storage include the three-point contact system. This is done by restraining cylinders in a tight mass using a contiguous three-point system with other cylinders or solid support structure. All compressed gas cylinders shall be secured to prevent falling. An appropriate method for securing cylinders is by providing a substantial chain, which is positioned in front of, or around the cylinder(s), and secured to a solid structure.

Three Point Contact System

Wall Support



Top View

All cylinders are in contact on at least three points, either with other cylinders or with the wall.

A chain would also be used. The chain can be one of the contact points.

Fire or Other Emergency
(Medical Emergency)

The fire safety program at BNL emphasizes fire prevention through building design and through automatic protection systems.

If you suspect a fire, activate a fire alarm (use a fire alarm pull box if one is in the area) and telephone x2222 or 911*.

From a BNL on-site telephone 911 is the same as x2222. From a cell phone, use (631) 344-2222.

Either one will notify the on-site BNL Fire/Rescue Group and the on-site BNL Police Group at the same time.

Pulling the fire alarm pull-box will send a signal to the Fire House and will give the Fire/Rescue Group your general location. In the case of a fire, warn others in the area and evacuate, 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 sizes of fires. If you have any doubt, let firefighters handle the situation.

***Important:** If you dial 911 from your cell phone you will not get the onsite BNL Fire/Rescue Group or the onsite BNL Police Group. You will get the offsite county police, which may not be the best and quickest help you need for your situation here on site.

Actions to take in a Medical Emergency

If there is a non-fire emergency such as an injury or illness for which you want the quickest/immediate medical attention for you or for a co-worker:

- pull a fire alarm pull-box if one is in the area, **and**
- telephone the BNL Fire/Rescue Group (x2222 or 911 from an onsite BNL phone; or (631) 344-2222 from a cell phone), and
- *wait for the on-site BNL Emergency Medical Technician (EMT) to come to you*.

It does not have to be a fire to pull a fire alarm pull-box. You may use the fire alarm in a medical emergency. Also, still follow up immediately with a call to x2222 or 911 to let the Fire/Rescue Group know it is an injury or illness so the EMT and ambulance are dispatched to the scene. They might not send the EMT and ambulance for a fire only.

Unless an injury is very minor:
Never transport the injured person to the BNL on-site Clinic yourself. Wait for Fire/Rescue Group personnel to arrive with the EMT and ambulance. Make sure you pull a Fire Alarm pull- box (if one is in the area) to immediately let Fire/Rescue know the location of the problem, and follow up immediately with a call to x2222 or 911. If you transport the person yourself, 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.

Question: You need immediate help in an emergency such as an illness or injury, What do you do?
Answer: Pull a fire alarm box (if there is one in the area) **and** call x2222 or 911.

Question: There is a fire in your area, What do you do?
Answer: Warn others and evacuate the building; pull a fire alarm pull box.

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

Make a mental note of the following that may be in your work area:

- Exits
- Fire Alarm Pull Boxes
- Fire Extinguishers and their Type
- -AED (Automated External Defibrillator)
- Intercoms / Telephones
- Phone Emergency Notification System (PENS) IP-enabled phones
- TLD Requirements
- Conventional Safety Hazards/Postings
- Radiological Safety Hazards/Postings
- Safety Equipment
- Emergency exhaust

- Assembly Areas

Fire alarm boxes are located throughout the accelerators, at the entrances to target rooms, experimental halls, and the Collider tunnel. They are the best method to simultaneously alert MCR and the BNL Fire/Rescue Group. Pulling a fire alarm box brings the Fire/Rescue Group to your specific alarm-box location within a few minutes, and appropriate additional personnel can be summoned quickly.

Accelerator rings/tunnels and target rooms are restrictive spaces. If fire should break out, smoke could quickly impair visibility, and asphyxiation from smoke is a possibility. If fire breaks out, get out immediately. There are escape hatches in the accelerator rings. Emergency exit signs will point you to the nearest exit. Next to the escape hatches in the accelerator rings are emergency exhaust buttons that, when activated, will pull the smoke away from the hatch.

At the Collider Tunnel, vertical and horizontal emergency exits alternate and are located throughout the tunnel. At the intersection regions there are multiple horizontal exits. All exits go to the inner ring road.

Once outside a smoky area, obey the directions of the Fire Captain or of the Local Emergency Coordinator (LEC) or the Department Emergency Coordinator (DEC) if they are present. The LEC and DEC will be wearing baseball-like caps marked LEC or DEC. Do not chat with the Fire Captain or other emergency response personnel in the area. Personnel are to assemble at least fifty feet from the building or at a designated outdoor assembly area.

If you hear a Fire Alarm Bell, evacuate the area after placing equipment in a safe operating mode. C-AD Main Control Room (MCR) personnel or other shift personnel will remain on station if they have emergency duties, but will evacuate during imminent danger situations.

Note regarding Non-emergency injury:
If you are injured but do not require emergency attention, then report as soon as possible to the BNL Occupational Medicine Clinic (OMC), which is located in Building 490. Your supervisor should accompany you. If your supervisor is not available, you should call upon another member of supervision or management in your Department, Division or work 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 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.

BNL Site-Wide Sirens

Continuous: If you hear a continuous site-wide siren, go to the Indoor Assembly Area.

Indoor and Outdoor Assembly Areas are posted at building entrances.

Pulsating: If you hear a pulsating site-wide siren, evacuate the BNL site.

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

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

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

Inside the RHIC tunnel:

It has been noted that the BNL site-wide sirens 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 PHENIX intersection regions, C-AD procedure instructs MCR and CAS personnel to make an announcement over the Public Address system.

Summary of C-AD Alarm Signals

In general, for any alarm inside a building, you would place your work or operation in a safe condition and evacuate the building.

Orange strobe and audible alarm at RHIC
Beam is Imminent

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

Red flashing lights and audible alarm at AGS
Beam is Imminent

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

Blue strobe and audible alarm (Blue or White strobe and audible alarm at Bldg. 912's R&D Area)
Oxygen Deficiency Event

For Helium (at RHIC), exit the area through horizontal exit, stay low.
For sulfur hexafluoride (at the Tandem) leave low laying areas.

Move away from any vapor cloud or "whooshing" noise.

Yellow strobe and audible alarm (two-tone horn)
C*ombustible/explosive or Flammable Gas Leak*

Exit the area, report to outdoor assembly area

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

Exit the area, report to outdoor assembly area

Do not re-enter buildings unless you are qualified to do so. Wait for further instructions from the Fire Captain, Local Emergency Coordinator (LEC), Department Emergency Coordinator (DEC) or the C-AD ESH Manager.

Indoor and Outdoor Assembly Areas are posted at building entrances.

Appendix A – Sample list of Training

Sample list of training applicable to various work activities at C-AD. This is not intended to be an all-inclusive list. It is intended only as an aid in determining what training might be required for you.

Adult Cardiopulmonary Resuscitation (CPR)
Aerial Lift Operator
Back Safety
Compressed Gas Safety
Confined Space
Confined Space Atmospheric Testing
Contamination Worker
Crane Operator
Cryogenic Safety
Dispersibles Training
Donning Arc Flash Suit
Electrical Safety
Fall Protection
Fork Lift Operator
Hazard Communication
Hazardous Waste Generator Training
Ladder Safety
Laser Safety
Lock-Out Tag-Out
Machine Shop Safety
Magnetic Field Safety
Move Haz/Rad Materials Onsite in a Vehicle
Noise and Hearing Protection
ODH Class 0
ODH Class 1
Operations Lockout
Radiological Buffer Area Access
Radiological Worker
Rigging
Working on Energized Electrical Circuits or Equipment

Appendix B - List of Acronyms

List of Acronyms

AGS	Alternating Gradient Synchrotron
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
ASSRC	C-AD Accelerator System Safety Review Committee
ATF	Accelerator Test Facility
BLIP	Brookhaven Linac Isotope Producer
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
C-AD	Collider-Accelerator Department
CEC	Coherent Electron Cooling
CEE	Chief Electrical Engineer
CME	Chief Mechanical Engineer
DEC	Department Emergency Coordinator
DOE	United States Department of Energy
EBIS	Electron Beam Ion Source
EEI	Electrical Equipment Inspector
ERL	Energy Recovery LINAC
ESRC	C-AD Experimental Safety Review Committee
ESSHQ Div	C-AD Environment, Safety, Security, Health & Quality Division
FEB	Fast Extracted Beam
FS	Facility Support
HP	Health Physics
IR	Intersecting Region
LEC	Local Emergency Coordinator
LEReC	Low Energy RHIC Electron Cooling
LESHC	Lab Environment, Safety & Health Committee
LOTO	LockOut/TagOut
LVTF	Large Vertical Test Facility
MCR	Main Control Room
MIRP	Medical Isotope Research and Production Program
NBBI	National Board of Boiler & Pressure Vessel Inspectors
NFPA	National Fire Protection Agency
NMM	Nuclear Materials Management
NRTL	Nationally Recognized Testing Lab
NSRL	NASA Space Radiation Lab
OC	Operations Coordinator
ODH	Oxygen Deficiency Hazard
OJT	On-the-Job-Training
OPM	The C-AD Operations Procedures Manual
OSHA	United States Occupational Safety and Health Administration
PAAA	Price-Anderson Amendments Act
PCBs	Polychlorinated Biphenyls
QEW	Qualified Electrical Worker
RCD	BNL Radiological Control Division
RCT	Radiological Control Technician
RPPL	Radionuclide Research & Production Laboratory
RWP	Radiological Work Permit
SRD	Self Reading Dosimeter
SVTF	Small Vertical Test Facility
TLD	Thermo-luminescent Dosimeter

Appendix C - Contacts

	BNL extension	
C-AD Training	7007	
C-AD ESSHQ Division Head	2356	
C-AD ESH Manager	2905	
C-AD Main Control Room (MCR)	4662	
C-AD Work Control Manager	5798	
C-AD Health Physics Group – Bldg 923	4660	
C-AD Health Physics Group – Bldg 801	4482	
C-AD FS (RCD) Rep	4660	
BNL NMM Group	4062	
C-AD Rad Sealed Source Custodian	2356	
C-AD Maintenance Coordinator	7178	
C-AD Associate Chair for ESSHQ	5636	
C-AD Environmental Coordinator	8802	cell phone 516/924-4303
C-AD Environmental Compliance Rep	2905	cell phone 631/774-6021