

**Fire Hazard Analysis of RHIC Equipment Alcoves
Brookhaven National Laboratory**

Prepared by:

J. Levesque
J. Levesque

Reviewed by:

J. A. Eckroth
J. A. Eckroth

Date of Survey: December 27, 1995 Date of Report: March 10, 1995

Conferred with: D. Barton, R. Lambiase, T. Shea, R. Frankel

Purpose/Scope

The purpose of this assessment is to evaluate the eighteen Equipment Alcoves stationed around the RHIC ring. The assessment evaluates the fire risks, protective measures against fire, and level of compliance with DOE fire protection criteria. DOE criterions are outlined in DOE Order 5480.7A¹, "Fire Protection."

Summary

The Equipment Alcoves represent an important element in the operations of the RHIC Accelerator. The equipment within each alcove has a loss potential of (equipment, salvage and clean up) and may interrupt the RHIC research program for up to four months. The presence of smoke detection meets the DOE requirements for this level of consequence. However the impact on the experimental program will be severe and further action should be considered, but is not mandatory.

Recommendations

FHA95-RHIC-1) Due to the potential severity of the interruption to the entire RHIC Program, consideration should be given by management to acquiring a complete set of spare equipment in order to replace one Alcove. This would reduce the lost time to one month from the four month potential without adequate spares.

¹US Department of Energy Order 5480.7A, Fire Protection
2-19-93

1. Construction

The Equipment Alcoves are 15 feet by 17 feet concrete rooms with ceiling heights of approximately 12 feet. For each sextant around the ring, there are three Equipment Alcoves (labeled A, B, and C) equally spaced apart. They all have one entrance door from the ring and Alcove A and C have vertical ladder exits through the shielding to the outside. A key plan is shown in Attachment A.

The Alcoves are used to house electronic equipment in support of the RHIC Accelerator operations. Three groups within the RHIC Department share the space. The groups are Magnet Electrical Systems, Beam Line Instrumentation, and Control Systems.

1.1 Fire Barrier Integrity

The Equipment Alcoves are underground. They are windowless and are covered with an earthen berm. There is no external fire exposure. The only fire barrier is the dividing wall between the RHIC Tunnel and the Alcoves. These dividing walls are 6 inch masonry walls with a generic two-hour fire rating.

Three types of fire wall penetrations exist. First is the door. This is adequately protected by a 1 ½ hour Underwriter's Laboratory fire door. Second penetration is made by cable trays. These run at approximately 8 feet above the finished floor. The cable trays are yet to be filled. Plans are to protect these openings with an Underwriter Laboratory's approved fire rated seal bag system. The third type of fire wall penetration is from the air handling system. A fire damper is to be installed on the system to allow proper segregation of the spaces.

1.2 Windstorm Damage Potential

As a windowless structure covered by an earthen berm for radiation shielding, the roofing system is not exposed to the exterior. Therefore, no windstorm hazard exists.

2. Occupancy and Associated Fire Hazards

As for fire protection, all three occupying groups have a similar type of electronic equipment, mounted in enclosed metal racks. A preliminary layout of the Alcoves is shown in Attachment B. All equipment will be wired and protected according to the National Electrical Code. There will be no significant quantities of flammable oils (as in oil filled transformers or capacitors). Cables installed are IEEE 383 fire rated cables.

Based on this occupancy, the frequency of fire loss is low. The most probable fire will be slow developing, smokey fire from an electrical fault.

2.1 Critical Process Equipment

By DOE standards, critical process equipment is considered equipment which, if lost or damaged in a credible fire, could delay a significant component of a major program greater than six months.

The components in the Equipment Alcoves are essential to the operations of the RHIC Accelerator. Loss of an entire Alcove is credible due to the small size, presence of only fire detection and the nature of sensitive electronic equipment. The loss of an Alcove would interrupt the RHIC program. Current practices by the three groups occupying the Alcove are to stock a limited amount of spare equipment. There are not enough spares to replace an entire Alcove's contents, only one or several racks. Complete replacement of an Alcove would force emergency purchase orders and fast tracked construction. In this worst case condition, the Control Systems would be the longest to recover. Based on information supplied, recovery would take in the order of three to four months. The Magnet Electrical Group estimates recovery within in three months and the Beam Instrumentation Group within one month.

These interruption potentials are within the DOE limits of six months, as outlined in DOE 5480.7A, "Fire Protection." The DOE has the option of specifying an increased standard of three months. This increased standard has not been specified for the RHIC project.

2.2 Special Occupancies

The Alcoves house high value electronic equipment. This falls into DOE Order EV0108. Since the loss potentials for programmatic interruption are more than the limits for mandatory application of this Order (i.e., programmatic interruption greater than three months), smoke detection is required for early fire warning.

2.3 Unique Fire Hazards

With Magnet Enclosure facilities, a smokey electrical fire is the typical scenario. The structures do not allow easy ventilation for fire fighting operations. As a result, special smoke removal systems have been introduced to aid in smoke removal. Exhaust fans are at the mid points between exits. Fresh air make up supplies are provided at the entrance points. This system is manually activated at the entrances to the Magnet

Enclosure to allow emergency forces and operator to purge the Magnet Enclosure. There is a plan to incorporate automatic actuation of the smoke removal system by the Magnet Enclosure's smoke detection circuits. This is not a mandatory requirement. A minimum velocity of 100 linear feet per minute is developed across the Magnet Enclosure face to ensure capture of smoke when the purge system operates.

Other than potential smoke removal and access concerns, no special fire hazards require special precautions.

3. Fire Protection/Suppression Features

Due to the presence of high valued electronic equipment, there will be smoke detection provided. Although the area is less than 400 square feet, one photoelectric and one ionization type spot smoke detect is being installed. Photoelectric and Ionization type detectors are sensitive to different ranges of particle generation from smoke. Both types are being included to provide more flexibility in detection. Fire detection and manual fire alarms are installed and connected to a separate fire alarm zone than the smoke detectors. This will allow flexibility in fire alarm response and handling of fire protection impairments for the facility. The fire alarm system complies with NFPA 72 for a style 7D propriety system. The systems annunciate back at the BNL Fire/Rescue Group and at Security Headquarters.

Fire Hydrants are within 300 ft. of the facilities. Given that the tunnels are difficult to access, standpipes have been provided within the Magnet Enclosure. Outlets and a four-inch main are directly outside the entrance to each Alcove.

BNL site water system is a well gridded combination domestic and fire system. Direct drive pumps supply the system. A single One million gallon elevated gravity tank and a second 350,000 gallon tank provides stability to the system. Supplies can provide more than 1000 g.p.m. at a minimum 20 psi residual pressures from the nearby mains. This is adequate for the fire load.

Portable multipurpose fire extinguishers will be provided according to NFPA 10. An option that maybe invoked is to place fire extinguishers on the work carts entering the facility and not place extinguishers in the tunnel.

BNL has a full time, paid Fire/Rescue Group. A minimum staffing of six responds to fire incidents. Their level of training meets Firefighter II as defined by the National Fire Protection Association and International Fire Service Training Association. Two 1,500 g.p.m. pumpers, one command vehicle, one heavy rescue and one ambulance would be available from the on-site forces. A mutual aid agreement exists with Suffolk County fire departments. This provides a five minute maximum response time for on-site

forces, with a 15 minute off-site response from the three closest neighboring departments.

4. Fire Loss Potentials

The Equipment Alcoves do not contain a sufficient amount of combustibles to propagate combustion away from the area of origin. In addition, they are enclosed within a two-hour fire rated structure. Only the cable trays provide a continuous path. The use of fire stopping and IEEE 383 cable mitigates this concern.

The anticipated fire would be an electrical overload within a rack. The damage to the rack would be localized and self-containing. Heat, soot and smoke would quickly fill the Alcove and result in damage to other equipment. Based on equipment values (see attachment C), the projected clean up costs from smoke and heat, the losses would be approximately \$500k.

Since the Alcoves are not provided with automatic suppression, the Maximum Credible Fire Loss (fire with suppression in service and fire department intervention) is considered equal to the Maximum Possible Fire Loss (fire with suppression out of service and no fire department intervention) of \$500k and four months programmatic interruption.

Due to the severity of the interruption to the entire RHIC Program (four months), DOE requires some method to reduce this impact. Consideration should be given by management to acquiring a complete set of spare equipment in order to replace one Alcove. This would reduce the lost time to one month. There are other operational benefits derived from ample spares. A more expensive, and therefore excluded, alternative is to provide fire suppression at each of eighteen locations. This would present a total cost of more than \$900k.

5. Security Considerations

There are no concerns regarding this topic.

6. Exposure Fire

The Alcoves are sufficiently isolated from other structures. There is no exposure to another facility or from external fire sources.

7. Environmental Impact due to a fire (including water run off)

Toxic materials, and biological agents are not involved in this project. Radioactive components are not present.

8. Prefire and Emergency Planning

The Brookhaven National Laboratory Emergency Plan includes the generic and site specific emergency plan for the AGS facility. BNL's Fire/Rescue Group makes periodic prefire planning tours and maintains a response book for the facility.

9. Life Safety Concerns

The Alcoves are a special purpose industrial occupancy by chapter 29 of the Life Safety Code. Materials that could cause a fast spreading fire are not present and combustible loading is low. The facility is further being defined as a low hazard occupancy.

The special purpose industrial occupancy section allows the occupancy load to be defined by the actual use. During normal and maintenance operations the occupancy would not exceed 10 people between exits, and would not exceed 40 for the entire tunnel.

Exits are provided to meet the Life Safety Code as outline in the overall facility analysis done in 1992.

All exits discharge on to open, public areas. Based on the projected occupancy load, there are no restrictions on the direction of door swing.

Emergency lighting is provided by generators at major facility structures (ex. 1002, 1004, 1005, 1008, 1010, 1012).

Attachment A

**RHIC Equipment Alcoves
Locations Around the Ring**

NORTH BOUNDARY



WM. FLOYD PARKWAY

FUTURE EXPERIMENTAL AREA 1010

1012 FUTURE MAJOR FACILITY HALL

1011 EQUIP. AREA / W EXIT

SUPPORT BLDG

1001

EQUIP. AREA

NARROW ANGLE HALL 1002

NEUTRINO EXPERIMENT 1101

RHIC

1009

1003

MAJOR FACILITY HALL 1001

OPEN AREA 1004

RING ROAD

1005S
1005R
1005H

R.F. EQUIP.

1007

WIDE ANGLE HALL 1006

B COLLIDER CENTER

1000W

1000E BEAM INJECTION

1000P

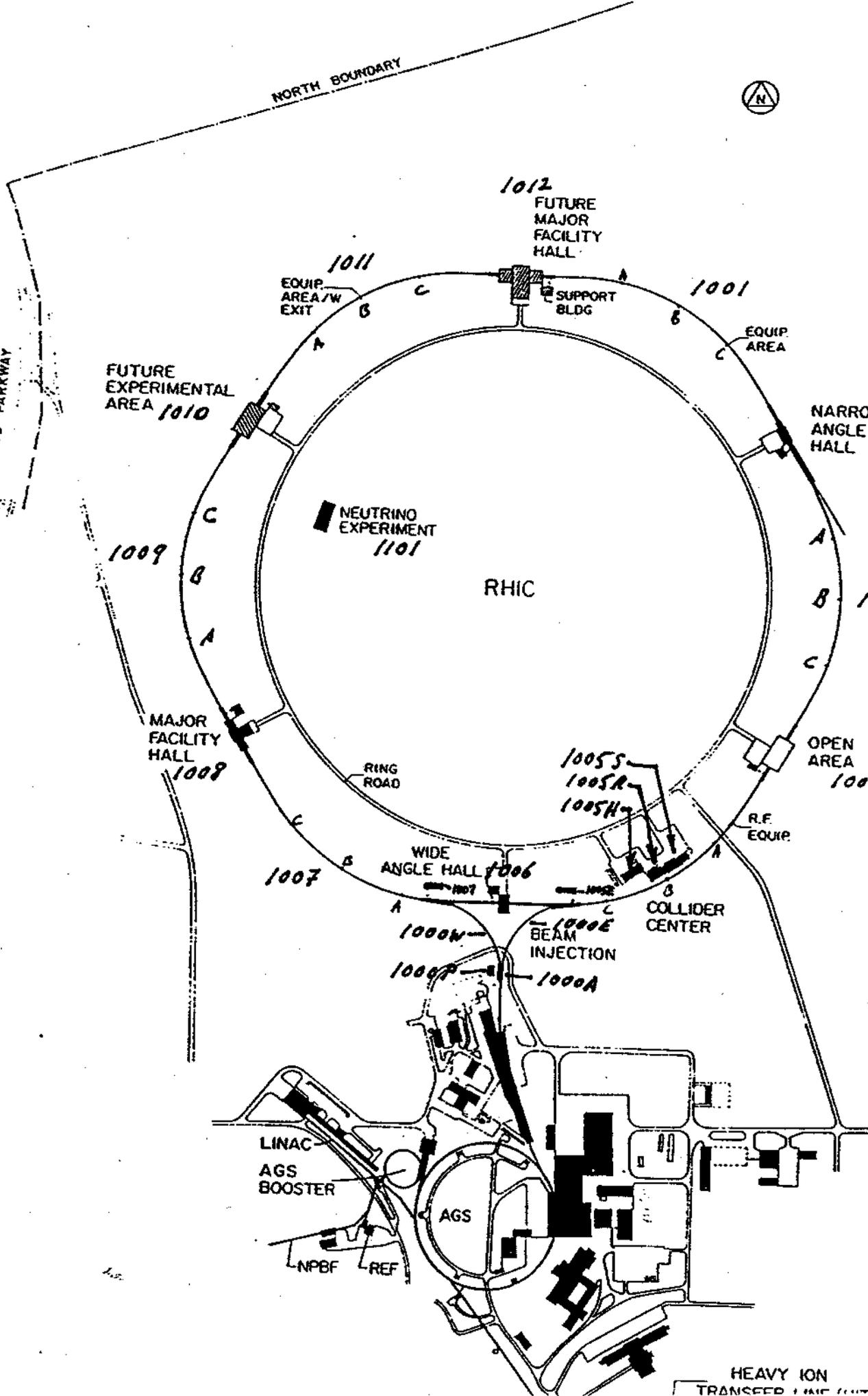
1000A

LINAC
AGS BOOSTER

AGS

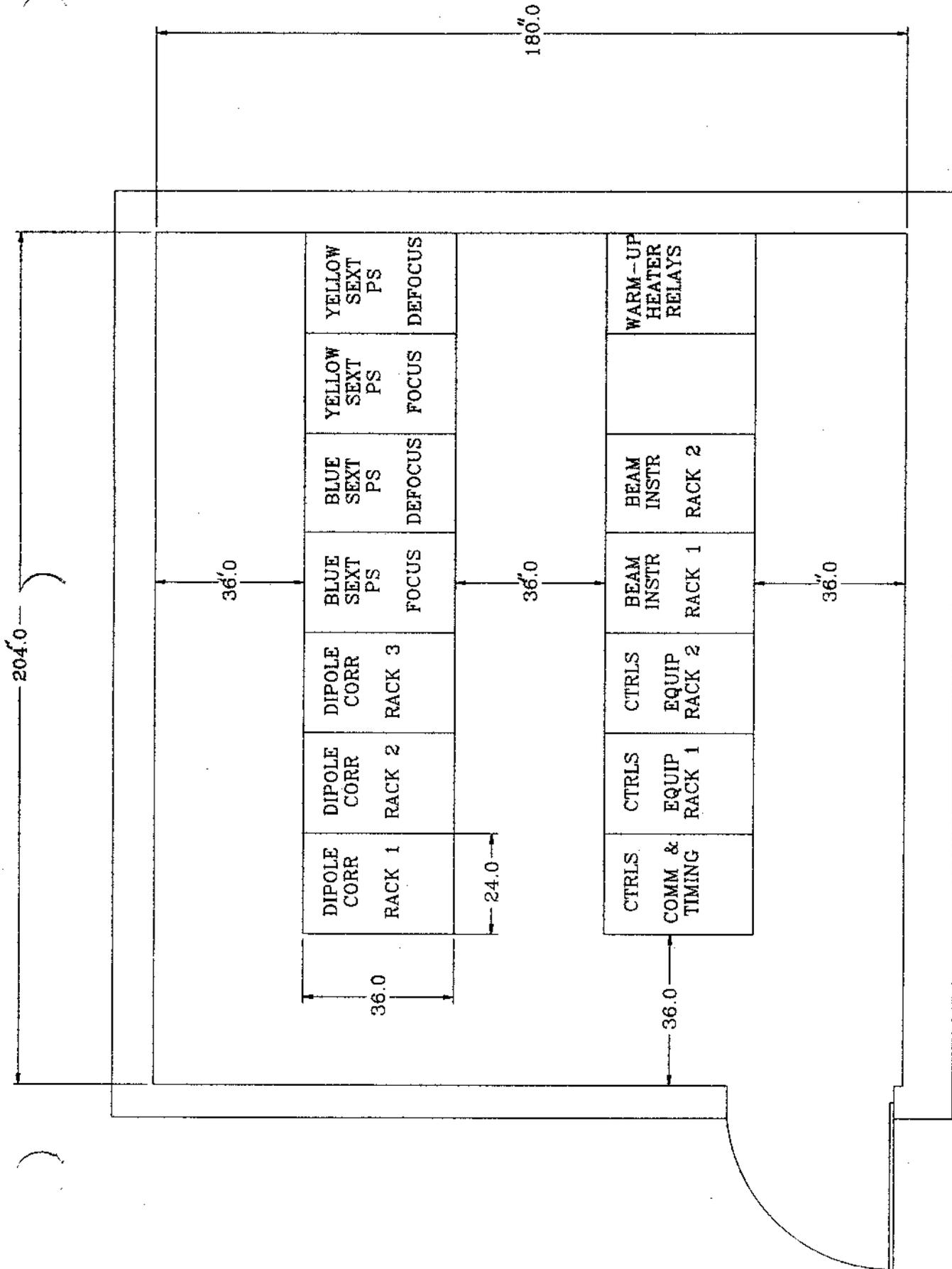
NPBF REF

HEAVY ION TRANSFER LINE

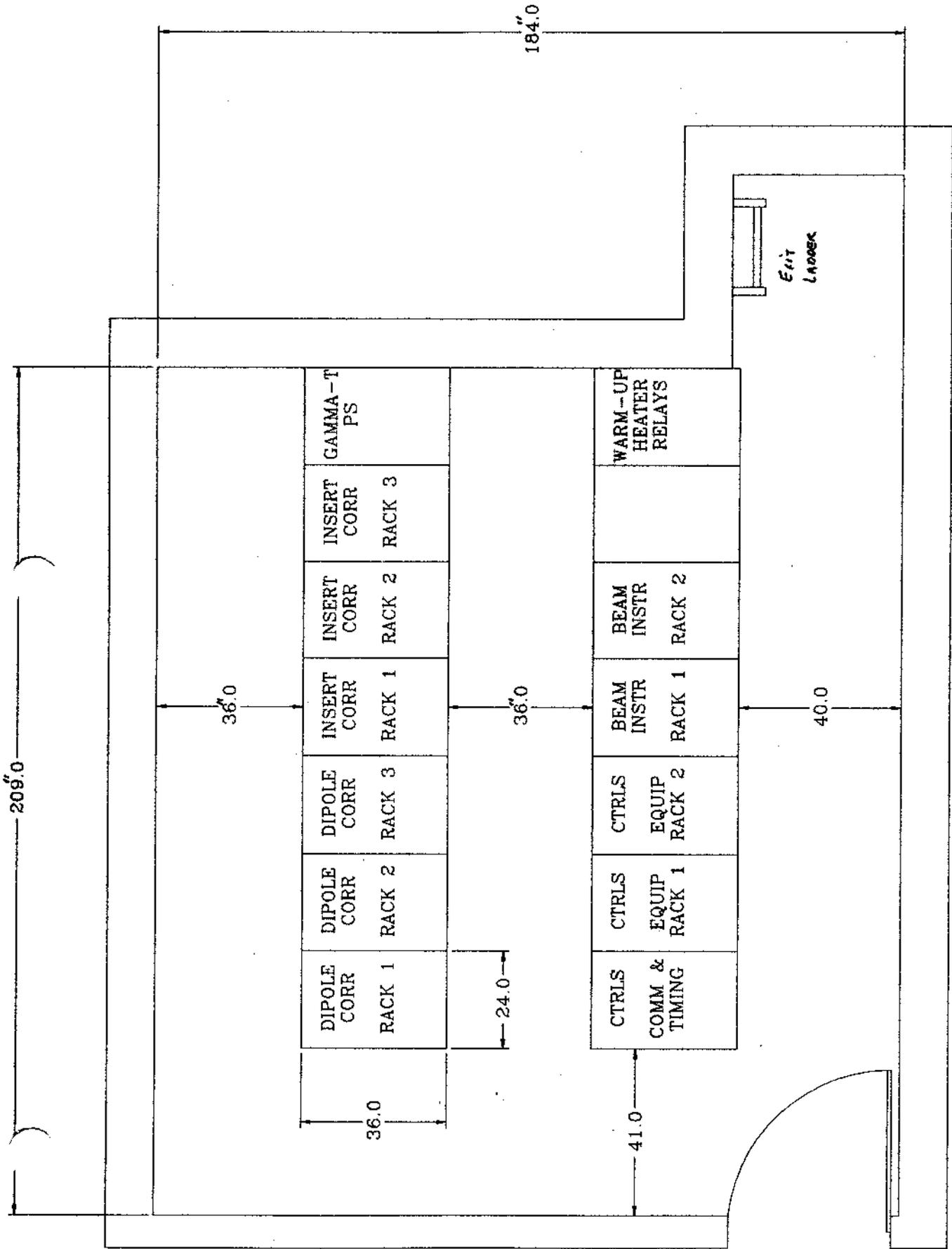


Attachment B

Alcove Preliminary Layouts



Alcove B



Alcoves A & C

Attachment C

Cost & Equipment for Alcoves

The following table summarizes the loss potentials for the Alcoves.

Group	Loss Potential (does not include clean up)	Programmatic Delay without spares (with spares)
Magnet Electrical Systems (magnet power supplies)	\$120k	Three months (2 weeks)
Beam Instrumentation	\$100 to 250k	One months (One month)
Control Systems	\$100k to 150K	Three to Four months (One month)