Preliminary Hazard Analysis Report

Core Facility Revitalization (CFR) Project
Brookhaven National Laboratory

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by:
Brookhaven Science Associates

Preliminary Hazard Analysis Report

Core Facility Revitalization (CFR)

Submitted:

Date: 8-5-16

R. Costa
F&O Operational Excellence Manager
Brookhaven National Laboratory

Concurrence:

Date: 8.5.16

S. Cannella
Project Manager
Brookhaven National Laboratory

Approval:

Date: 8-5-16

P. Caradonna
Project Director
Brookhaven National Laboratory

Date: 8-5-16

L. Nelson
Federal Project Director
DOE Brookhaven Site Office

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TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ACGHI.....American Conference of Governmental Industrial Hygienists
ACM .....Asbestos-Containing Material
ADA.....Americans with Disability Act
BNL.....Brookhaven National Laboratory
CDR .....Conceptual Design Report
CFR.....Code of Federal Regulations
CFR.....Core Facility Revitalization
CSC.....Computational Science Center
DOE .....U.S. Department of Energy
ES&H.....Environment, Safety and Health
HRP.....Hazard Removal Project
IH .....Industrial Hygiene
IPT.....Integrated Project Team
ISM .....Integrated Safety Management
LOTO.....Lockout/Tagout
NESHAPS.....National Emission Standards for Hazardous Air Pollutants
NFPA .....National Fire Protection Association
NSLS.....National Synchrotron Light Source
OSHA.....Occupational Safety & Health Administration
PHAR.....Preliminary Hazard Analysis Report
RADCON.....Radiological Control
RCT.....Radiological Control Technician
RHIC.....Relativistic Heavy Ion Collider
RACF.....Relativistic Heavy Ion Collider - ATLAS Computing Facility
RWP.....Radiological Work Permit
SBMS.....Standards Based Management System
SME .....Subject Matter Expert

1.0 INTRODUCTION

This Preliminary Hazard Analysis Report (PHA) has been prepared in accordance with principles of DOE Order 413.3B Program and Project Management for the Acquisition of Capital Assets; the BNL Integrated Safety Management (ISM) Plan; Brookhaven National Laboratory (BNL) Environment, Safety and Health Policy; and BNL's Standards-Based Management System (SBMS), for the Core Facility Revitalization (CFR), in support of Critical Decision 1 (CD-1) approval. This report shall be updated throughout the design and engineering phase as needed.

Mission success mandates planning and safeguards that insure the environment, safety and health of building occupants, workers performing the demolition and construction, our guests and the neighboring public. Assurance of this objective starts by conducting a preliminary hazard analysis to identify anticipated hazards in conjunction with the planned work.

This Preliminary Hazard Analysis Report describes the initial efforts and results of the core ISM functions whereby work to be performed is studied to:

1. Identify the fundamental hazards;
2. Assess underlying environment, safety and health risks; and
3. Institute planning that mitigates the identified hazards during the design and construction project phases.

The Preliminary Hazard Analysis Report is the launching pad for successive and iterative hazard assessment stages as the project proceeds from preliminary design through construction.

2.0 PROJECT OVERVIEW

BNL is a multi-program laboratory situated on over 5,200 acres on eastern Long Island, New York. Over 2,700 employees and 3,500 guests conduct research in basic and applied science at BNL each year. This includes research in physics, nuclear medicine, and environmental sciences, as well as supporting nuclear nonproliferation and Department of Homeland Security missions. The multitude of missions places significant demands on premium laboratory space.

The purpose of the CFR at BNL is to correct deficiencies in the Lab's computing infrastructure that serves missions for nuclear physics and high energy physics at the Relativistic Heavy Ion Collider (RHIC)-ATLAS Computing Facility (RACF) and an emerging gap in the ability to serve the growing data management and analysis needs of the user facilities serving Basic Energy Sciences, Biological and Environmental Research, Nuclear Energy, Computational Science Center (CSC) and other Laboratory programs. Upgrades to our infrastructure are needed to store, manage, and analyze the massive amounts of data we expect to gather from our user programs as the National Synchrotron Light Source-II (NSLS-II) beamline build-out and operations mature and as the Center for Functional Nanomaterials brings additional sophisticated instruments online.

BNL has proposed three alternatives on the BNL site. The first is to do nothing. The second is to construct a new building. The third is to renovate and revitalize B725 – the former home to the NSLS-I.

Building a new facility poses similar hazards already encountered at BNL. Many years of design and operational experience lead to a high level of confidence that all significant hazards are identified and that controls will be put into place that have proven to be effective. There are no unique hazards related with the function of this facility.

The use of B725 includes repurposing a significant portion of the building for use as a new computing facility with associated support space and new infrastructure.

This project will also enable more sustainable, economic, and efficient management of physical assets in support of our mission by revitalizing aging, substandard building infrastructure. This project will enhance the mission readiness of the Lab by providing the infrastructure and facilities required for advanced scientific computing to analyze, model, simulate, and predict complex phenomena, including the potential that exascale simulation and data will provide in the future.

The objective of the proposed CFR Project is to provide newly renovated and modern computing facilities, offices and support functions within the existing B725 facility (formerly NSLS-I) or in a new facility. New modern and reliable cooling and power infrastructure shall be provided with capabilities for expansion and incremental growth. Robust backup capabilities shall be provided for both power and cooling. Strategies shall be incorporated that provide for efficient data center configurations and accommodate BNL's needs as a research institution for future flexibility. Existing life-safety systems shall be upgraded and select exterior building system replacements (roof, windows, etc.) shall be included. Americans with Disability Act (ADA) compliance upgrades will be completed within the renovated areas.

2.1 Purpose of Preliminary Hazard Analysis

This CFR Project PHA identifies the critical existing facility, demolition, and construction hazards that may be encountered and construction hazards for a new facility. It serves as the guidance for further reconnaissance, sampling, testing, air monitoring and hazard analysis as the project design advances to assure the project is designed, planned and conducted safely with minimum environmental impact. The PHA is a living document that will be reviewed and revised as new information is obtained and as otherwise necessary until the project is complete.

The following building-related Environment, Safety & Health (ES&H) issues have been considered for B725 to provide an initial reference point for ES&H and design basis criteria:

- Existing building chemical, biological and radiological materials and uses in locations where construction will occur.
- Existing building material/component hazards (asbestos, silica, cadmium, lead dust and lead based paint).
- Knowledge of prior spills and contaminated areas (mercury, radioisotopes, other hazardous materials).

- Noise impact to building occupants and workers.
- Potential disruption of services to building occupants.
- Settled metal dusts on elevated horizontal surfaces and inside HVAC ducting.
- Use of internal combustion construction equipment inside the facilities.
- Elevated/overhead work.
- Life safety systems.
- Fire protection systems.
- Demolition and construction in occupied and operating facility.
- Air emissions and other environmental requirements.
- Soil and groundwater contamination potential.
- Perchlorate salt potential.
- Electrical distribution system.

Design and project planning that address the above ES&H issues will provide a basis for the laboratory renovation in Building 725 to be performed safely.

If a new facility is chosen the construction will use standard safeguards and construction techniques. BNL has a mature construction safety program, with recent experience in constructing buildings at the site including the 65,000 gsf Research Support Building, the 94,500 gsf Center for Functional Nanomaterials Building, and the 87,700 gsf Interdisciplinary Science Building. Lessons learned from these three projects as well as from other construction projects in the DOE complex, coupled with the existing safety program, will control this risk at the facility. Typical construction hazards are anticipated at the construction site. Management and control of construction hazards will follow the requirements in 10 CFR Part 851, Appendix A, Functional Area 1, Construction Safety and the BNL SBMS Construction Safety subject area.

3.0 ENVIRONMENT, SAFETY & HEALTH (ES&H) MANAGEMENT

The Project Manager, with support from a BNL core team of ES&H Subject Matter Experts (SMEs) that provide the technical project support and guidance, will monitor the construction site for compliance with BNL, DOE, Occupational Safety & Health Administration (OSHA), and other applicable ES&H requirements. Monitoring activities will include validation of the contractor's safety and health program, apprising the contractor of environmental and safety requirements pertaining to the construction project, conducting and documenting frequent periodic inspections to verify contractor safety compliance, and ensuring that the construction subcontractor meets ongoing ES&H submittal requirements. The Project Manager will report to the Federal Project Director, and the Federal ES&H Representative, any safety issues, such as Occurrence Reports, in a timely manner by e-mail or phone and will also report the issues in accordance with BNL Occurrence Reporting Procedures as appropriate.

Contractors and their subcontractors performing demolition and construction work for the Laboratory renovation will become mission partners and will be required to embrace BNL ES&H philosophy through binding contract language. Contract and procurement specifications

will lay the foundation for contractor and lower tier subcontractor ISM participation including 10 CFR 851, Worker Safety and Health Program. Contractors and subcontractors shall be required to attend Contractor Vendor Orientation. BNL ES&H requirements may be found to exceed construction and industry standards. Where this is the case, specific contract language binds the contractor to these performance criteria.

3.1 Project Communications

- Environment, Safety & Health Issues – ES&H issues identified will be documented on the Construction Safety Inspection Checklist and processed in accordance with the CFR Construction Health & Safety Plan and Construction Management Plans. All ES&H issues will be tracked until corrected and verified by the F&O Construction Safety Engineers. Issues shall be reviewed at weekly project meetings. Issues unable to be resolved will be referred to the Integrated Project Team.
- Safety Awareness Meetings – Organized by the Construction Foreman for all personnel and subcontractors involved or affected by the work. Prior to the start of work the Phased Hazard Analysis / Safe Work Plans (PHA/SWP) will be reviewed and acknowledged by all affected employees.
- Tool Box Meetings – Organized by the Construction Foremen to brief workers on ES&H issues or specific work-planning safety requirements weekly, as a minimum. Attendance by all affected workers is required and must be conducted prior to performing potentially hazardous work or more often as needed. The Construction Foreman must document subject matter and attendance list of workers. In addition, daily plan of the day meetings are held; these meetings are informal and may include discussions on ES&H, the project, etc.
- CFR IPT Meetings – Organized by the Federal Project Director and attended by appropriate members. Used as a forum for communication of construction status and coordination with Technical, ES&H, and Project Management.
- Building Occupants – Nuisance or hazardous work operations, byproducts of work and changes in the status of building systems (e.g., fire alarms, utilities) shall be closely coordinated with the building manager to insure occupants are fully informed and protected.

4.0 PROJECT SCOPE AND OVERVIEW OF WORK

The objective of the proposed CFR Project is to provide newly renovated and modern computing facilities, offices and support functions in a new facility or within the existing B725 facility (formerly NSLS-I). New modern and reliable cooling and power infrastructure shall be provided with capabilities for expansion and incremental growth. Robust backup capabilities shall be provided for both power and cooling. Strategies shall be incorporated that provide for efficient data center configurations and accommodate BNL's needs as a research institution for future flexibility. Existing life-safety systems shall be upgraded and select exterior building system replacements (roof, windows, etc.) shall be included. ADA compliance upgrades will be completed within the renovated areas.

The demolition and construction work undertaken to address this renovation will involve typical demolition and construction hazards routinely encountered by personnel managing and conducting the work. Additional hazards associated with prior use of chemicals, biological materials or radiological materials may also be encountered. These are evaluated in the hazard analysis process. Tables 1 and 2 summarize the variety of hazards known, anticipated, and suspected that are addressed during the ongoing project hazard analysis and safety management process.

5.0 HAZARD IDENTIFICATION

A preliminary hazard and safety analysis has been performed to establish the initial environmental and safety basis and design criteria for the CFR. This report has been developed utilizing the data gathered during the NSLS-I hazard characterization and its subsequent hazard removal project which was part of its decommissioning.

5.1 NSLS-I Hazard Removal Project (Pre-CFR)

NSLS decommissioning conceptual studies were performed by BSA dating back to 2012. In August 2014 BSA assigned a Project Manager to lead NSLS hazard removal planning and execution. These hazard removal activities constitute much of the scope of what is typically referred to as decommissioning. The NSLS was turned over to the Hazard Removal Project (HRP) team on April 1, 2015. Work and project demobilization was complete on March 31, 2016. It is noteworthy that the HRP was executed with a perfect safety record; there were no worker injuries of any kind.

With the exception of residual dispersible metals on the first floor and in the Building 725 HVAC systems, all hazards were removed from the NSLS.

The following sections summarize hazard materials identified and removed during the HRP and residual hazards identified.

5.1.1 Non-Radiological Hazard Removal

The non-radiological hazards identified during characterization along with a summary of their removal are provided below:

Beryllium Components: Beryllium windows were installed at several locations in the NSLS including the beamlines and some accelerator components (i.e. X-Ray RF cavities).

All beryllium windows were removed and disposed as hazardous waste and post removal surveys performed to demonstrate the absence of residual beryllium. Tools and equipment used to remove beryllium windows were also disposed as hazardous waste. No further action needed.

Dispersible Metals: Dispersible metals were found throughout the NSLS. Dispersible lead, the primary contaminant of concern, was found at levels in excess of the BNL housekeeping standard of 40µg/sq ft. These conditions, attributable to the oxidation and handing of over

600,000 pounds of lead over 30 years of NSLS operation, were found on both the first and second floors of Building 725. Lead contamination on the first floor is much more pervasive than that observed on the second floor. Dispersible cadmium was also found but at a comparatively limited extent. Internal dispersible lead contamination was also found in all of the Building 725 HVAC systems.

Extensive contamination remains on exposed horizontal surfaces throughout the 1st Floor and in the Building 725 HVAC systems and limited contamination on the second Floor.

Biohazards*:* Biological specimens were found during facility walk-throughs in a small number of locations. All biohazards found in the NSLS were removed and disposed. No further action needed.

Chemicals and Experimental Samples: Small but numerous quantities and experimental samples were found in the debris left behind in the NSLS which were removed and disposed. In addition, the limited chemical inventory used in conjunction with the HRP was either consumed or transferred. No further action needed.

Confined Spaces*:* A small number of confined spaces associated with the research infrastructure were noted in addition to those associated with F&O's Building 725 infrastructure. The shielded cave in the Booster enclosure was dismantled and all remaining confined spaces in Building 725 labeled in accordance with BNL requirements. No further action needed.

Potential Sources of Electrical and Mechanical Energy: An enormous volume of installed research systems and equipment were turned over with the NSLS facility to the HRP team including electric power distribution equipment, power supplies, instrumentation, cables, racks, etc., experimental cooling water systems, compressed air systems and vacuum systems. Removal of the electrical and mechanical commodities that were part of the research systems is substantially complete. These systems have been physically and permanently removed at their points of interface with the Building 725 infrastructure. However, there are two locations on the X-Ray tunnel mezzanine where research equipment remains, X-27/27 and X-15.

Lead Shielding: Over 500,000 pounds of bare, uncoated previously used as radiation shielding remained in the facility. The lead shielding was the source of lead contamination found throughout the facility. Following the shutdown of the NSLS on September 30, 2014, this lead was no longer a usable component but a hazardous waste subject to the requirements in the Resource Conservation and Recovery Act (RCRA) enacted in 1976. Except as noted below, all lead shielding has been removed from the NSLS. The removed lead was recycled with the exception of approximately 200 pounds that were transferred to the BNL Waste Management Facility for disposal as mixed waste.

The X-17 hutch contains steel encased lead that does not pose a risk or facility hazard; there is no safety or industrial hygiene driver for X-17 removal. In addition, there are inaccessible locations at many HVAC penetrations on top of the X-Ray tunnel mezzanine with bare, lead sheet that must be removed. It is estimated that 400 pounds of lead (total) remains in these locations.

Magnetic Fields: Numerous magnets remained in the NSLS as subcomponents to ion pumps installed throughout experimental systems on the first floor and in a small number of VUV-Ring and X-Ray Ring insertion devices. All ion pumps and insertion devices removed from the NSLS and dispositioned (either recycled or disposed as radioactive waste). No further action needed.

Nanomaterials: Experimental hutch exhaust ducts potentially impacted with nano-materials were identified. Subsequent investigations conducted during HRP execution confirmed that unbound nano-materials were never used in the NSLS (i.e. there is no risk of residual nano-materials in the NSLS). The ductwork in question was nonetheless removed. No further action needed.

Residual Oil and Freon: Numerous pumps, refrigerators, air conditioning units, etc. were left in the facility. All aforementioned equipment was removed and disposed and Freon was evacuated from refrigeration systems remaining in place. No further action needed.

Laboratory Hoods and Sinks: Laboratory hoods and sinks were largely emptied of their contents. However, they had not been inspected and sampled in accordance with BNL standard operating procedures representing an unknown. Laboratory hoods and drains have been sampled and laid up in accordance with BNL standard operating procedures to preserve the option for their future use (no mercury, radioactive contamination or perchlorates were found). No further action needed.

Unknowns: There was an enormous volume of materials, equipment and debris that was left behind in the NSLS facility. The generally poor housekeeping conditions, lack of documentation and its haphazard distribution across the first floor potentially masked hazardous or radioactive materials hidden within this debris field. All material, equipment and debris left behind at facility turnover to the HRP was removed and disposed. No further action needed.

5.1.2 Radiological Hazards

The NSLS facility was carefully characterized to identify radioactive and potentially radioactive equipment and materials. The HRP carefully evaluated and used valuable operating experience gained at the SLAC National Accelerator National Laboratory in the development and implementation of its characterization plan. Survey and release of more than one million pounds of accelerator equipment and associated commodities from the Radioactive Material Control Areas (RMCA) left in the NSLS was completed.

Radiological characterization conclusions are summarized as follows:

- There was no evidence of loose radioactive contamination across the 30-year NSLS operating life; this was confirmed during the course of facility characterization.
- Radioactive equipment was found and the potential for activation products was noted in high beam loss locations in the Linac, Booster, VUV Ring, X-Ray Ring and Transport Lines. All of this equipment was housed in RMCAs posted and managed in accordance with the BNL Radiological Control Manual. Measure dose rates, when found, were in the μR per hour range and only slightly in excess of background. The radiation dose

rates and potential exposure of the workers involved with the HRP were below the threshold warranting personnel monitoring.

- There were eleven depleted uranium shutters installed in the VUV Ring.
- Several radiological sources remained in the facility.

All equipment was removed from the RMCAs and surveyed. Equipment meeting the release criteria provided in the Manual (i.e. indistinguishable from background) was recycled, and equipment and materials with detectable activity were disposed as radioactive waste. The depleted uranium shutters were removed during June 2015 and shipped in early April 2016 for disposal at the at the DOE NNSS disposal facility. There is no radioactive material remaining in Building 725 and the facility has been de-posted. No further action needed.

5.1.3 As-Found Hazards

Additional hazards found during HRP execution and summaries of their disposition are noted below:

Asbestos: Asbestos was found in six laboratory fume hoods; other suspect areas including countertops, pipe fitting thermal insulation and spray-on coatings in the Booster and Linac areas were sampled and determined to be free of asbestos. Laboratory hoods containing asbestos were labeled in accordance with BNL requirements. No further action needed.

Copper Beryllium Components: Copper beryllium components were found in the NSLS RF systems. These were in addition to the beryllium windows noted during facility characterization. All copper beryllium components were removed and disposed as hazardous waste. Tools and equipment used to remove beryllium windows were also disposed as hazardous waste. No further action needed.

Dispersible Beryllium: Dispersible beryllium was found in the X-17 hutch. This loose contamination was apparently created when one of the X-17 beamlines was partially disassembled and removed for reuse at NSLS-II. Dispersible beryllium was removed and confirmed via sampling and analysis. All wipes, tools and equipment used to remove the dispersible beryllium were disposed as hazardous waste. No further action needed.

5.2 Hazardous Materials

Table 1 provides a hazardous material summary.

Table 1: Hazards Analysis Summary – Hazardous Materials

Hazardous Material/ Contaminant	Source or Location	Comments
Asbestos	• Lobby ceiling ACM • Roof flashing	• Asbestos ceiling to be removed by F&O outside scope of project. Flashings will be addressed by CFR roof replacement scope of work.

Table 1: Hazards Analysis Summary – Hazardous Materials		
Hazardous Material/ Contaminant	**Source or Location**	**Comments**
	• Other o Mastic materials o Wire insulation o Window and door caulking / putty o Fire proofing	• Though not identified, sampling will take place as needed and abatement performed by F&O or an specialty contractor as appropriate.
Lead and lead dust (oxidized lead)	• Majority of the first floor's ground surfaces are above the BNL *housekeeping* standard • Horizontal surfaces (tops of structural members, ledges, top surfaces of electrical and mechanical equipment, etc.) • Overhead & walls • Lobby and first floor nonindustrial/scientific areas • X-17 Hutch, nonhazardous in current state • Internal surfaces of HVAC	• All first floor residual lead on surfaces to be removed and/or encapsulated. • Horizontal surfaces typically above the BNL *housekeeping* standard. Surfaces will be removed and/or encapsulated. • Overhead & walls are generally less than BNL housekeeping standard & general public standard • Lobby and first floor non-industrial/scientific areas are below the BNL housekeeping standard & general public standard. • The X-17 hutch contains steel encased lead that does not pose a risk or facility hazard; there is no safety or industrial hygiene driver for X-17 removal. • HVAC ductwork internal surfaced have been found to be above BNL general public standard, some above BNL housekeeping standard. These will be removed and/or cleaned.
Lead paint	• On all building painted components, materials, and equipment.	Sampling shall be completed by the F&O Industrial Hygiene (IH) Representative.
PCBs	• Transformer/capacitor oil • Light ballasts • PCB containing paint	Prior to demolition activities, each of these potential PCB sources are to be verified as absent at each work location. PCBs will be abated and disposed of by BNL prior to demolition.
Mercury	• Mercury relay switches • Fluorescent bulbs • Wall thermostats • Sink traps & sanitary lines	Sampling will be performed prior to demolition/construction; however some monitoring or sampling may not be feasible until demolition/construction proceeds. All sink traps shall be removed by BNL prior to demolition; if mercury is found to be present, disposal will be by BNL. IH will be present during demolition stage to monitor.

5.3 Radiological Hazards

There is no radioactive material remaining in Building 725 and the facility has been de-posted.

5.4 Job Hazards

Table 2 provides a summary of general work and physical hazards for both project workers and building occupants and pedestrians. This table also lists some key project work task hazards with corresponding controls.

Table 2: Hazards Analysis Summary – Job Hazards

Activity	Task	Hazards	Hazard Controls
General Project Activities	Building Access – occupants and pedestrians	• Falling objects • Trips, slips, and falls • Flying dust and debris • Noise • Fire – emergency egress • Lead dust exposure	• Physical barriers around construction areas • Establish clean areas and use step-off pads to prevent lead contamination from the work area • Appropriate signage directing pedestrians and building occupants where to walk and where access is prohibited • Advance and ongoing communications to building occupants/users • Physical enclosures, containment, and ventilation engineering controls • Facility emergency lighting • Emergency egress path identification (signs) be posted in construction and in affected work areas
General Project Activities NOTE: The Hazards and Controls in this section apply to all project activities.	Project site access – project personnel	• Falling objects • Trips, slips, and falls • Flying dust and debris • Noise • Fire – emergency egress • Lead dust exposure	• Physical barriers • Establish of clean areas and use of step-off pads to prevent lead contamination from the work area • CFR site access policy • Using “wet methods” to reduce dust • Appropriate signs and warnings posted • Eye protection • Hearing protection • Hard hats • Safety footwear and reflective vests • Safety awareness program including routine safety meetings/briefings/postings • Respiratory program by IH • Fire extinguishers provided in construction area • Disposable shoe booty’s and Tyvek clothing

Table 2: Hazards Analysis Summary – Job Hazards			
Activity	**Task**	**Hazards**	**Hazard Controls**
		• Exposure to various hazardous contaminants	• Responsible individual (e.g., job supervisor, crew lead, project lead) will review the site characterization data • Contractor develops and implements a comprehensive site specific HASP, including exposure prevention measures, accepted by BSA • IH to conduct real time mercury monitoring when working with sinks, sink traps, drains and associate plumbing in the labs, additional work planning will be implemented based on results • Implementation of asbestos, lead, and silica compliance work plans to ensure acceptable threshold occupational exposure limits for IH hazards set in OSHA 29CFR1926, 29CFR1910, and American Conference of Governmental Industrial Hygienists (ACGIH) *Threshold Limit Values*® (TLV)
		• Exposure to Radiological hazards	• Radiological hazards shall be abated by specialty contractor prior to demolition, disposal by BNL • Address work changes through Job Hazard Analysis and Radiation Work Permit when needed • Survey and clearance by Facility Support (FS) will be required • FS coverage required for activities involving previously unexposed surfaces during demolition and construction
		• Changes in hazards such as stairs or scaffold, or controls such as flagging, postings or designated walkways	• Regular project site evaluation by a safety professional and project engineer for continued integrity of physical hazard controls, access controls, postings, barriers, etc.
	Vehicle movement servicing the project locations	• Contact/collision with project vehicle traffic and movement of materials, and heavy equipment • Contact/collision with non-project vehicles, pedestrians, building occupants accessing buildings	• Reflective vests • Use of qualified/certified operators • Use of experienced flagger/traffic control person as appropriate • Establish, clearly mark, and enforce pedestrian routes • Heavy equipment spotters • Establish designated work zone areas • Audible back up alarms on heavy equipment • Enforce traffic safety rules for drivers and pedestrians • Establish waste removal loading areas

Table 2: Hazards Analysis Summary – Job Hazards			
Activity	**Task**	**Hazards**	**Hazard Controls**
	Use of hand tools	• Pinches, punctures, lacerations • Noise • Flying debris and dust	• Use appropriate hand protection, e.g., leather gloves for general activities, puncture/cut resistant for handling sharp materials • Eye, face, respiratory, and hearing protection as required for type of tool used • Training and certification to the level required for specific tools • Inspect tools and PPE prior to use
	Use of ladders	• Falls	• Use alternate access means if possible, e.g., man lift or scaffold, with required training and inspections as appropriate • Follow good ladder use practices and use of buddy or securement to steady ladders longer/higher than 6 feet • Ladder inspections prior to use • Fall protection when working from fixed ladders
	Working 6 feet or higher above floor	• Falls	• 100% tie-off above 6 feet in elevation using approved safety harness and safety engineering approved tie off point
	Equipment operation	• Excessive noise	• Required use of hearing protection consistent with 29CFR1926.52 and American Conference of Governmental Industrial Hygienists (ACGIH) *Threshold Limit Values*® (TLV)
	Lifting Activities	• Dropped Load	• Implementation of the BSA accepted HASP • A detailed, site-specific rigging plan developed by a qualified person and approved by the BSA Hoisting and Rigging Inspector • All lifting equipment and operations must be conducted in accordance with applicable ANSI standards and DOE and OSHA requirements • Qualified riggers • Barricading of lift areas • Tag/Guide lines • Qualified 29CFR1926.1428 signal person
	Working with electricity	• Shock • Electrocution • Arc flash	• Use of GFCI • Use of temporary wiring hung on insulators • Implementing NFPA 70E and Lab Electrical Safety requirements, which ever are more stringent

Table 2: Hazards Analysis Summary – Job Hazards			
Activity	**Task**	**Hazards**	**Hazard Controls**
	Work in confined spaces	• Loss of consciousness, asphyxiation, physically wedged/trapped, entrapment	• Comply with BNL Confined-Space Entry Program and work permit system (contractor program in site specific safety plan) • Provide atmospheric testing, adequate ventilation, lighting, and egress • Rescue provisions and procedures in place prior to entry
Specific project activities	Drilling/chipping into existing surfaces	• Contact with existing electrical conduit, wiring, duct banks, equipment • Mechanical and plumbing systems within/under/behind surface	• Aggressive Penetration Permit • Survey, drawing reviews • Penetration Permit • LOTO (including verification of zero energy)
	Drilling/chipping/cutting into masonry, metal, wood, plaster, or other building components	• Flying objects, debris • Eye, face, respiratory • Noise • Laceration, pinch, smash • Silica	• Eye and face protection • Ventilation engineering controls • Air monitoring and respiratory protection (with established baseline) as needed • Wet misting • Hearing protection • Gloves and foot protection
	Torch cutting/ welding/ grinding	• Fire • Hot slag • Airborne fume • Physical hazards associated with compressed flammable gas and oxygen	• Fire watch • Proper heat and fire resistant apparel and gloves • Face, eye and respiratory protection • Ventilation engineered controls • Use of a Hot Work Permit • Welding screens and blankets • Implement the SBMS Fire Safety Subject Area • Provide fire extinguishers • Proper gas cylinder storage
	Demolition debris and construction material removal and movement	• Block or restrict fire exits and corridors • Safe movement in/around occupancy areas, aisles, corridors • Struck by material being removed or moved • Compromising facility structural integrity by removing load bearing walls and supports	• Project management preplans staging and movement routes for equipment, waste, and materials • Develop fire evacuation plans • Project management develops plan for safely conducting materials removal (including ensuring structural integrity) and movement • Use spotters and flaggers just as with traffic control

Table 2: Hazards Analysis Summary – Job Hazards			
Activity	**Task**	**Hazards**	**Hazard Controls**
	Asbestos abatement	• Airborne asbestos • Friable asbestos • Proper waste handling and disposal	• Engineering controls • Respiratory protection • Wet method removal • Proper PPE • Worker and waste container decontamination techniques • Proper disposal • Implementation of asbestos compliance work plan. (Follow OSHA, EPA, BNL, NYS Code rule 56)
	Move and store existing laboratory/shop equipment prior to and following renovation	• Damage equipment • Ventilation standards • Chemical storage • Contamination • Musculoskeletal injury • Struck by equipment • Lacerations/factures	• Pre-planning and Coordinate with and involve researchers in transition • Perform Environmental Safety Review prior to transition move • Coordinate temporary moves with Building Managers and ES&H representatives • Decontamination (wipe down) of equipment prior to movement • Proper lifting methods, and use of material handling equipment • Proper PPE
	Relocation of experimental equipment and work	• Chemical hazards • Electrical hookups • Security • Code/Standards violations due to relocation causing unintentional unanalyzed hazards	• Coordinate temporary relocation with Building Managers, ES&H representatives and researchers • Pre-planning and pre-construction activities • Proper work planning through work permit and SBMS

5.5 Safety

Safety concerns that have received significant consideration during the preliminary hazard assessment include:

- De-energizing building systems
- Elevated work (worker hazard)
- Overhead work (occupant hazard)
- Demolition/construction work in congested interior spaces in close proximity to building occupants and building guests

Best practices (works shift adjustments, use of fencing and barricades, zero energy verification of systems, etc.) learned during recent laboratory renovation work in occupied buildings at BNL will be applied to the planning and design process for the CFR.

5.6 Utilities

The design shall focus on the protection of building utilities and workers. As-built drawings will be consulted, as available, but verification of location and utility status in each work location shall be accomplished. The SBMS Procedure for Concrete and Masonry Penetrations will be a critical component of safeguarding existing utilities and workers.

5.7 Fire Protection

Fire protection and life safety hazards have been evaluated. Assessments of hazards were based upon earlier Fire Hazard Analysis documentation for the building, a walkthrough of the facilities and on best practices from recent laboratory renovation work in occupied buildings at BNL.

Obstructions to egress may periodically occur as a result of construction in various locations. These changes will be planned so that safe exiting will be maintained throughout the work. The BNL Fire Protection Engineering group shall review and approve all building egress changes. These plans shall include the posting of signage for modified egress paths prior to commencement of work. The BNL Project Manager will be responsible for planning egress paths and code signage, and for monitoring the contractor's execution of the program. The Local Emergency Plan will be modified and communicated throughout the project as conditions change. The BNL Protection Engineering Group will be responsible for reviewing and approving the plans and providing direction as to how code compliance may be achieved.

Hot work operations present an ignition hazard. All hot work (welding, cutting, grinding, torching, etc.) will require the contractor to obtain a BNL Hot Work permit. Hot work permits are only issued after a fire department visit confirms working conditions and mitigating measures are adequate (i.e. fire extinguisher at work site, fire watch present, combustibles removed, lead paint removed, fire detectors protected/out of service, sprinklers protected, etc.)

Conditions may periodically require that existing fire detection/alarm and/or fire sprinkler systems are impaired during work. In no event will both the fire alarm system and the fire sprinkler systems be impaired concurrently. Unless specifically approved by the Protection Engineering Group, impairment of either system will only occur during a work day, and will be restored to service prior to workers leaving the building. Workers impairing the system shall be responsible for performing fire watch duties while the system is impaired. Where the impaired system will be out of service for more than 4 hours in a 24 hour period, an approved fire watch will be required in accordance with SBMS Fire Safety Subject Area. The BNL Protection Engineering Group will review each instance of system impairment. System impairments shall be consistent with impairment guidelines in NFPA 25, Inspection, Testing & Maintenance of Water Based Fire Protection Systems, Safeguards during Construction, NFPA 51B, Fire Prevention during Welding, Cutting, and Other Hot Work, and SBMS Fire Safety Subject Area.

The fire protection requirements listed above will be included in the construction contract specifications.

The contract specifications shall specifically address the following issues:

- The contractor shall be responsible for the protection of BNL property within the work site during construction;
- Rubbish must be promptly and safely disposed of every day;
- Adequate precautions must be taken for cutting and welding; and
- The contractor is responsible for providing fire watch personnel when required as part of their contract and shall not overextend the human performance capability of fire watchpersons through extensive shift lengths.

5.8 Environmental

The Environmental Protection representative (air, water, and site restoration) will participate in hazard assessment walkthroughs of the project. Materials shall be recycled to the greatest extent possible.

Air

Pre-demolition/renovation asbestos abatement of building systems or components must be done according to NESHAPS notification and removal requirements.

Water

The existing domestic water system may be extended to provide make-up water for new mechanical systems as required. These make-up water lines will be connected to water lines that are isolated from the rest of the domestic water system by backflow preventers or new backflow preventers will be provided. Condensate drains will be provided as required. Existing floor drains will be drained.

Sanitary

There is the potential of mercury, radiological, and other volatile organic contamination in the waste water piping, especially the plumbing traps. Prior to trap disassembly, an IH and RADCON Representatives will be present to determine the presence of mercury/RAD using established methods and calibrated equipment. All plumbing traps will be assumed to contain mercury/RAD unless proven otherwise. Removed traps shall be contained within a suitable waste container and disposed of appropriately. BNL will perform all work involving mercury/RAD removal and disposal.

5.9 Demolition Waste Management

Various building materials/components may be Special Industrial (e.g. asbestos, asbestos-containing material), RCRA (e.g. lead dust, Universal Waste Fluorescent bulbs, hazardous batteries) or TSCA wastes (e.g. PCB's). Also where walk-downs or other activities, such as the reconnaissance level survey for hazardous materials, reveal miscellaneous non-recyclable/ reusable hazardous items stored in the building, a hazardous waste determination will be made by BNL and waste material will be managed by BNL and the contractor in accordance with BNL's SBMS procedures to ensure compliant accumulation and disposal. Any radiological waste encountered will be processed in accordance to BNL's SBMS procedures.

6.0 CONSTRUCTION SAFETY

Some of the primary safety issues involved with this project are listed below. This Hazard Analysis Report provides additional detail on these job hazards:

- Elevated Work Hazards: Renovation may require the installation of scaffolding in the building for surface preparation, drilling of the reinforcement inserts, painting operations, and ceiling/ductwork installation. Falling hazards will need to be mitigated.
- Trips, slips, and falls.
- Electrical Hazards: The laboratory renovation work involves localized demolition or exposure of existing walls and structures, which bear the risk of contact with existing electrical conduits.
- Silica Dust Exposure: Work related to the demolition grinding and cutting of the concrete/ masonry/plaster board surfaces will create a dust exposure that needs to be mitigated.
- Noise: Work associated with the demolition/construction activities of the concrete/ masonry drilling will require mitigation measures to minimize the impact of noise.
- Chemical/ Biological/ Radiation Hazard Exposure: The laboratory renovations may contain hazards that will be exposed during the laboratory renovation effort and will be processed in accordance with BNL's SBMS procedures.
- Work in Occupied Buildings: Special emphasis will need to be given to work occurring in occupied spaces, so that building occupants and other workers are properly protected from the proximate construction via engineered barriers, signage and coordination of work.
- Soft Tissue Damage: Some of the work occurs in enclosed areas, requiring manual handling of construction materials that might otherwise be hoisted with equipment.
- Steam and Pressure Hazards: Work on pressurized systems will be eliminated by the use of Lockout/Tagout (LOTO) procedures.

6.1 Nuisance Mitigation for Building Occupants and On-Site Neighbors

Demolition and construction work hazards are anticipated and will be controlled as indicated in Tables 1 and 2. The controls will be designed to additionally encompass protection of building occupants and pedestrians passing by the buildings or accessing the buildings. Some of the work tasks, in addition to presenting hazards to workers or others in proximity to the work, may additionally create disruptions for the building occupants adjacent to the work and will be coordinated with the Facility Project Manager.

6.2 Noise Mitigation

Protection of workers is outlined in the tables above. Much of the work will generate noise levels that range from nuisance to hazardous in nature. BNL and contractor ES&H staff will monitor noise levels associated with noisy operations of an extended nature that can impact building occupants. Possible measures that may be employed to protect the general Lab population and building occupants include:

- Good communications between project management and the Facility Project Manager
- Continual briefings and updates for building occupants
- Adequate signs describing what, where, and when work is planned
- Advance knowledge of critical occupant activities that may be impacted
- Construction of noise barriers
- Restricting access to exterior locations
- Performing uncharacteristically loud operations during off-peak hours
- Temporary closure of affected building areas
- Provide noise reduction ear plugs and/or ear muffs for extremely annoying operations such as drill, power actuated tools, and roto-hammer use on building

6.2.1 Significant Noise and Vibration Producing Work

Operations that will pose a significant challenge to control with engineering controls and that represent the greatest nuisance noise potential are the concrete drilling/cutting in the existing walls and slabs. Based on industrial hygiene and safety assessment and communications with building occupants, project management will determine which of the above mitigation alternatives best address the nuisance at hand. Vibrations created during the project will be addressed through work planning and coordinated through the Complex with all that may be affected.

6.3 Dust Mitigation

Most demolition and construction activities generate some level of dust. Hazardous airborne particulates and dusts will be addressed under respective specific hazardous materials compliance plans as outlined in Tables 1 and 2. Primary control of hazardous dusts as well as nuisance dusts shall be accomplished using physical containment barrier enclosures, ventilation engineering controls, and wet work methods where feasible.

Occupied building areas adjacent to project work zones will be monitored by BNL and contractor IH and safety staff for general construction-related dusts to ensure that nuisance tracking or air dispersion into occupied areas does not occur. Containment, ventilation engineering controls, and wet work methods will also be used as necessary to control nuisance airborne particulates and dust.