

**Fire Hazard Analysis
Building 1012
Future Experimental Hall**

Brookhaven National Laboratory

Prepared by:



R. Wheeler,
Hughes Associates, Inc.

Project Review by:

M. Kretschmann PE, Fire
Protection

Concurrence:

Department Chair

Date of Last Survey: None
Date of Report: August 2007

CONFERRED WITH:

Michael Kretschmann, PE	Fire Protection Engineering
Joe Levesque, Manager	Emergency Services Division

TABLE OF CONTENTS

1.0	OVERVIEW AND RECOMMENDATIONS	1
1.1	Purpose and Methodology	1
1.2	Summary	3
1.3	Findings and Recommendations	4
1.3.1	New Findings and Recommendations	4
1.3.2	Outstanding Recommendations from Previous Reviews.....	5
2.0	SCOPE	5
3.0	LOCATION	6
4.0	CONSTRUCTION.....	6
4.1	Occupancy Classification.....	6
4.2	Construction Type.....	6
4.3	Passive Fire Protection.....	7
4.3.1	Fire Areas.....	7
5.0	FIRE PROTECTION	7
5.1	Automatic Fire Suppression Systems	8
5.1.1	Site Water Supply	8
5.1.2	Building Water Supply and Fire Department Connection.....	8
5.1.3	Sprinkler Systems	8
5.1.4	Fire Standpipe Systems.....	8
5.1.5	Other Suppression Systems.....	8
5.2	Fire Alarm Systems.....	9
5.2.1	Building Fire Alarm System	9
5.2.2	Site Fire Alarm System.....	9
5.3	Automatic Detection Systems.....	9
5.4	Fire Extinguishers	10
5.5	Smoke Exhaust System.....	10
6.0	FIRE HAZARDS	10
6.1	Special Occupancies	10
6.1.1	Instrumentation and Data Processing Equipment.....	10
6.1.2	Vital and Important Records Storage.....	11
6.1.3	Trailers and Portable Structures.....	11
6.1.4	Cooling Towers.....	11
6.1.5	Electrical Substations.....	11
6.1.6	Flammable Liquid & Gas Storage	11
6.1.7	Cables and Raceways.....	11
6.2	Housekeeping in Vital Areas	12
6.3	Building Materials	12
6.4	Exterior Exposure Hazards	12
6.5	Natural Phenomenon Hazard Exposure	12

6.5.1	Lightning Potential.....	12
6.5.2	Windstorm Potential	13
6.5.3	Brush Fire Potential	13
6.5.4	Earthquake Potential	13
6.5.5	Flooding Potential.....	13
6.6	Toxic Fire Potential.....	13
6.7	Biological Fire Potential	14
6.8	Radiation Fire Potential	14
7.0	PRE-FIRE AND EMERGENCY PLANNING	14
7.1	Protection of Essential Safety Class Systems	14
7.2	Protection of Vital Programs	14
7.3	Protection of High Value Property	14
7.4	Critical Process Equipment.....	14
7.5	Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL)....	15
7.5.1	MPFL Scenario	15
7.5.2	MPFL Calculation.....	15
7.5.3	MCFL Scenario.....	16
7.5.4	MPFL/MCFL Summary.....	16
7.6	Recovery Potential.....	16
7.7	BNL Fire/Rescue Group	16
7.8	Fire Apparatus Accessibility.....	17
7.9	Security Considerations Related to Fire Protection.....	17
8.0	LIFE SAFETY CONSIDERATIONS	17
8.1	Occupancy Load Factor and Calculations	17
	Occupancy load factor and calculations	17
8.2	Means of Egress.....	18
8.2.1	Number and Arrangement of Exits.....	18
8.2.2	Capacity of Exits.....	19
8.2.3	Travel Distance	19
8.2.4	Common Path of Travel.....	19
8.2.5	Dead Ends	19
8.2.6	Security Considerations Related to Fire Protection.....	19
8.2.7	Separation of Means of Egress	20
8.3	Exit Signs and Emergency Lighting	20
8.4	Emergency Roof Exits	20
8.5	Egress through Adjoining/Intervening Spaces.....	20
8.6	Exit Discharge.....	20
8.7	Horizontal Sliding Doors	20
8.8	Fire Escape Ladders	21
8.9	Door Heights.....	21
8.10	Discharge to Roofs.....	21
8.11	Barriers.....	21
8.11.1	Occupancy Separations.....	21
8.11.2	Incidental Use Areas	22

8.11.3	Separation of Means of Egress	22
8.11.4	Exit Access Corridors	22
8.11.5	Vertical Opening Barriers	22
8.11.6	Egress Stairways	22
8.12	Fire Protection Systems Required by Code	23
8.13	Operational Requirements that are Required by Code	23
9.0	REFERENCE DOCUMENTS	23
9.1	National Fire Protection Association	23
9.2	FM Global Loss Prevention Data Sheets	24
APPENDIX A – FHA FIGURE		1
APPENDIX B – LIGHTNING RISK CALCULATION.....		1
APPENDIX C – DETERMINATION OF WILDFIRE HAZARD SEVERITY		1

1.0 OVERVIEW AND RECOMMENDATIONS

1.1 Purpose and Methodology

A Fire Hazard Analysis (FHA) was performed for Building 1012 the Future Experimental Hall, located at the 12 O'clock position on the RHIC ring at the Brookhaven National Laboratory (BNL), Upton, NY. This report fulfills the requirement for documentation of an FHA as outlined in DOE Order 420.1, Facility Safety. This FHA assesses the risk from fire in Building 1012 to ascertain whether the facility meets the objectives of DOE Order 420.1 and the Brookhaven National Laboratory (BNL) Fire Safety Program. The Phobos experiment consists of Building 1012 that is part of the RHIC tunnel area and Building 1012A which is the support building. The fundamental goal of the BNL Fire Safety Program is to control fire risks such that:

1. Public and employees are not unreasonably endangered by fire;
2. Vital Laboratory missions are maintained without significant interruption from fire;
3. Property losses are limited to less than \$1 million dollars per occurrence, and lower when justified by cost-effective, risk reduction measures;
4. Damage to the environment is averted; and
5. The potential for occurrences of fires are avoided whenever economically feasible.

This FHA is an evaluation of the fire hazards (1) that expose Building 1012 and (2) that are inherent in the building or operations. The adequacy of the fire safety features in the building and the degree of compliance of the facility with specific fire safety provisions in DOE orders, and related engineering codes and standards, were determined. The results of the analyses are presented in terms of the fire hazards present, the potential extent of fire damage, and the impact on employee and public safety.

The general approach taken to complete this evaluation involved the identification of fire hazards in the building and the fire protection features required to mitigate the adverse consequences of a fire. A determination was made as to the adequacy of the proposed fire protection features to effectively control the fire hazards. Concerns for the protection of safety systems, critical processes, and life safety of building occupants from fire were essential considerations in the analysis. Compliance was determined by a comparison of existing conditions found during the site visits with current code requirements. Where conflicting requirements were found the more conservative requirements were used in this evaluation.

The MPFL scenario was based on a qualitative consideration of several factors; the potential to reach flashover conditions based on combustible loading and the geometry of the space(s) under consideration; adequacy of passive protection features; and continuity of combustibles.

The MCFL scenario is one in which automatic suppression systems function as designed. Since properly designed and installed sprinkler systems should limit the fire growth and/or damage to the design area of the system, this floor area is used in the determination of MCFL potentials when protected by automatic sprinkler systems. Without sprinkler protection the MCFL is the same as the postulated MPFL for that area.

MPFL and MCFL potentials were determined based on an average dollar density of the building replacement value divided by the floor area of the building. Building values were obtained from 2004 replacement costs. The content and equipment values were calculated based on the following assumptions:

- An average of \$20/ft² for content and equipment value within predominantly office or support areas.
- An average of \$100/ft² for content and equipment value within the industrial and experimental areas of the building, assuming no high dollar equipment present.

The above cost assumptions are considered adequately conservative to address the requirement to include decontamination and cleanup costs.

A qualitative assessment of the risk presented by conditions found to be deficient was also performed and is included in Section 1.3, Findings and Recommendations. This assessment was made by assignment of a risk assessment code (RAC). The RAC methodology is used in a number of industries as a tool to qualitatively prioritize deficiencies and corrective actions and is derived as follows:

1. Hazard Severity. An assessment of the worst potential consequence, defined by degree of occupational injury, illness or property damage which is likely to occur as a result of the deficiency. Hazard severity categories shall be assigned by roman numerals according to the following criteria:
 - a. Category I. May cause death, permanent total disability, or loss of a facility/asset.
 - b. Category II. May cause permanent partial disability, temporary total disability in excess of 90 days (severe injury or severe occupational illness), or major property damage.
 - c. Category III. May cause minor injury, occupational illness, or property damage.
 - d. Category IV. Presents minimal threat to personnel safety or health, or property, but is still in violation of a standard.
2. Mishap Probability. The probability that a hazard will result in a mishap or loss, based on an assessment of such factors as location, exposure (cycles or hours of operation), affected populations, experience, or previously established statistical information. Mishap probability shall be assigned an English alphabet symbol according to the following criteria:
 - a. Subcategory A. Likely to occur immediately or within a short period of time. Expected to occur frequently to an individual item or person or continuously to a fleet, inventory or group.

- b. Subcategory B. Probably will occur in time. Expected to occur several times to an individual item or person or frequently to a fleet, inventory or group.
 - c. Subcategory C. May occur in time. Can reasonably be expected to occur some time to an individual item or person or several times to a fleet, inventory or group.
 - d. Subcategory D. Unlikely to occur.
3. Risk Assessment Code. Using the matrix shown below, the RAC is expressed as a single Arabic number that is used to help determine hazard abatement priorities.

Hazard Severity	Mishap Probability			
	A	B	C	D
I	1	1	2	3
II	1	2	3	4
III	2	3	4	5
IV	3	4	5	6

RAC Definitions

- 1-Critical
- 2-Serious
- 3-Moderate
- 4-Minor
- 5 & 6-Negligible

1.2 Summary

Building 1012, the Future Experimental Hall is supported by Building 1012A the support building.

The buildings were constructed in the late 1980's and have not been operational. They have the following square footages:

- o Building 1012 8818 square feet
- o Building 1012A 6492 square feet

The descriptions are based on field surveys, a review of the as-built documents, and discussions with BNL staff. This assessment and FHA demonstrates general achievement of a reasonable and equivalent level of fire safety that meets DOE improved risk objectives, except as noted within this document.



Overview of the BNL

This Fire Hazards Analysis (FHA) has been performed to comprehensively assess the risk from fire in Buildings 1012 and 1012A. The FHA includes an analysis of the fire and life safety features of the facility to determine the level of compliance with DOE Order 420.1 Fire Protection objectives.

Based on the analysis, it has been determined that the Phobos Experiment is generally in compliance with DOE Order 420.1 Fire Protection objectives. The following recommendations are the result of this evaluation.

1.3 Findings and Recommendations

1.3.1 New Findings and Recommendations

Finding: Buildings 1012 and 1012A are not provided with lightning protection systems.

Hazard Severity	I
Mishap Probability	C
Risk Assessment Code	2

Recommendation HAI-07-1012-01: Lightning protection systems should be installed in accordance with NFPA 780 for the Buildings 1012 and 1012A (See Section 6.6.1).

Finding: The east center door in Building 1012A is marked “not an exit” and is a viable exit to the exterior of the building.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Recommendation HAI-07-1012-02: The “not an exit” sign should be replaced with an exit sign (See Section 8.2.1).

Finding: The weeds near the exterior cable trays have the potential of resulting in a significant impact to the operational status of the experiment.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Recommendation HAI-07-1012-04: The weeds should be cut to reduce any potential impacts to the cable trays.

The following is a summary of recommendations and their relative priority.

Rec.No.	Recommendation	RAC
HAI-07-1012-1	Lightning Protection System	2
HAI-07-1012-2	Exit door in Building 1012A	4
HAI-07-1012-3	Door into experimental area	5
HAI-07-1012-4	Weeds near cable trays	4

1.3.2 Outstanding Recommendations from Previous Reviews

None

2.0 SCOPE

This FHA is based on information supplied by the Accelerator Department staff, a survey of the facility conducted in July 2007, and a review of available drawings.

The following codes and standards were utilized for this evaluation:

The Building Code of New York State 2002 Edition (BCNYS)

International Code Council (ICC), International Building Code (IBC) 2003 Edition;

ICC, International Fire Code (IFC) 2003 Edition

National Fire Protection Association (NFPA) Codes, Standards, and Recommended Practices – See Section 9 (Reference Documents) of this report for a complete list.

3.0 LOCATION

Building 1012 is located in the central region, along the RHIC ring at the 12 O'clock position at the Brookhaven National Laboratory (BNL). BNL is a 5,000 acre site owned by the Department of Energy and operated by Brookhaven Science Associates. BNL is located in Upton, New York.

4.0 CONSTRUCTION

4.1 Occupancy Classification

Building 1012, the Future Experimental Hall is classified by the BCNYS as “Factory Industrial F-2 Low Hazard”. NFPA 101 (3.3.168.10) classifies this building as “Special Purpose Industrial”. Building 1012A, the support building is classified by the BCNYS as “Factory Industrial F-2 Low Hazard” and by NFPA 101 as Industrial.

4.2 Construction Type

The buildings consist of the following:

Building	Wall Construction	Roof Construction	BCNYS Construction Type	IBC Construction Type	Size (square feet)
1012	Poured Concrete	Poured Concrete	Type IIB	Type IIB	8818
1012A	Metal panel on unprotected steel	Metal deck on unprotected steel	Type IIB	Type IIB	6492

Life Safety Code

The LSC does not specify a minimum construction type for these occupancies. Thus, the existing construction complies with LSC requirements.

Building Code of New York State

Section 503 and Table 503 of the BCNYS contain criteria for the allowable height and area of buildings based on their occupancies and construction type.

The buildings are under the base allowable areas for the occupancies and two construction types. The allowable increase of areas of buildings that have more than 25 percent of their perimeter on a public way is not necessary for any of the buildings.

International Building Code

Based on the occupancies of the buildings and the construction types, the areas of the buildings are within the base square footages permitted by Table 503 of the IBC. The allowable area increased permitted by Sections 506 and 507 do not need to be applied.

4.3 Passive Fire Protection

Passive fire protection features include fire-resistive construction, fire doors, fire windows, and fire and smoke dampers. The features are provided to limit fire spread and damage from the area of fire origin to other portions of the building.

4.3.1 Fire Areas

Buildings 1012 and 1012A are not separated by fire barriers.

Buildings 1012 and 1012A comply with the codes of record with respect to occupancy separations. There are no areas in these facilities that are defined as incidental or accessory occupancy use areas as noted in BCNYS “§302.1.1” or NFPA 101 §6.1.14.1.2 and “§6.1.14.1.3.”

A fire area is defined as a portion of a building that is bounded by a combination of fire-resistive walls and floor/ceiling assemblies, and/or exterior walls. In DOE facilities, fire areas are typically provided for property protection. The Implementation Guide for DOE Order 420.1 requires credited fire areas to be separated from the remainder of the building by a minimum of 2-hour fire barriers (walls and horizontal assemblies). Fire areas may also be provided for compliance with building code limitations for building additions.

5.0 FIRE PROTECTION

Existing fire protection systems that provide protection to full or segmented portions of this facility can be classified in four categories; Automatic Fire Suppression Systems, Fire Alarm, Automatic Detection Systems, and Fire Extinguishers. The following is a description of the existing installed systems in the building.

5.1 Automatic Fire Suppression Systems

5.1.1 Site Water Supply

BNL has a combination domestic and fire protection water supply system. The system is supplied by several deep wells and is stabilized by two elevated water storage tanks (one 1 million gallon and one 300,000 gallon capacity). The wells have electric primary drivers and a limited number have backup internal combustion drivers. The system can sustain three days of domestic supply and a maximum fire demand (4,000 gallons per minute (GPM) for 4 hours) for BNL with two of the system's largest pumps out of service and one storage tank unavailable. The piping distribution network is well gridded. The distribution system in the vicinity of Building 1012 has a static supply pressure of approximately 85 pounds per square inch (PSI) at low elevated tank levels; and approximately 100 psi normally. The water supply system in the area can supply about 5,500 GPM at 20 PSI (based on the Water Distribution Model Analysis developed by the Fire Protection Engineering Group during the summer of 2004.)

Frost proof Fire hydrants are provided within 300 ft of the entrances of the building. Frost proof hydrants are needed since the frost line extends to 4 feet below the surface in the winter. BNL and the local Suffolk County Fire Departments use National Standard Thread couplings.

BNL's Plant Engineering Division maintains the water supply system. BNL's Fire/Rescue Group conducts valve inspections on the distribution system to ensure reliability of firefighting water supplies.

5.1.2 Building Water Supply and Fire Department Connection

Building 1012 and Building 1012A are provided with automatic sprinklers throughout the buildings. A single 6-inch fire department connection is provided for the 4-inch Reliable Model E alarm check valve for the automatic sprinklers in Buildings 1012 and 1012A. It appears that a six-inch fire department connection was utilized since it also feeds the hose connections in the tunnel.

5.1.3 Sprinkler Systems

Buildings 1012 and 1012A are protected with automatic sprinklers.

5.1.4 Fire Standpipe Systems

Building 1012 is provided with inside hose connections, in the tunnel area. The connections are fed from a 4-inch system with the hose connections spaced approximately every 100 feet in the experimental area.

5.1.5 Other Suppression Systems

There are no other fire suppression systems in the buildings.

5.2 Fire Alarm Systems

5.2.1 Building Fire Alarm System

The Building is provided with an automatic fire alarm system, refer to Section 5.3. The main fire alarm panel is a Thorne Multi Zone 20, panel 182.

5.2.2 Site Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage using a fault tolerant server infrastructure based multiplexed Site Fire Alarm System. The system is an Andover Continuum; installed in 2005 (Andover is a part of Simplex Grinnell). The system complies with the requirements of NFPA 72 defined as a Style 6 Class "A" System.

Two mirrored servers are located in separate buildings. If the lead server fails the system automatically switches over to the working server. The Site Fire Alarm System operates on a fault tolerant high speed Ethernet infrastructure that utilizes network switches and fiber wiring between each of the major components.

The Site Fire Alarm System monitors fire alarm panels located throughout BNL by using the existing site telephone cable plant. RS232 signals are sent via full duplex line drivers. Each fire alarm panel has two channels connected to the Site Fire Alarm System. The panels are divided into 9 communication "loops." It is currently monitoring 9,700 points. Response time from alarm at the panel to alarm indication at the Central Station is less than 82 seconds, which is within the 90 seconds allowed by NFPA 72.

The main console is at the Firehouse, Bldg. 599. This station monitors all fire alarm signals, trouble and communication status alarms. A satellite station is provided at Safeguards and Security, Bldg. 50, and receives only the fire alarm signals. If the Firehouse does not acknowledge an alarm within 90 seconds, the satellite station at Bldg. 50 will receive an audible indication to handle the alarm. A second satellite station is provided at AGS Main Control Room, Bldg. 911, and receives only the fire alarm signals from the RHIC/AGS accelerator buildings. A team of Collider-Accelerator Control Room operators and Health Physics Support personnel respond during accelerator operating times.

5.3 Automatic Detection Systems

The following automatic fire alarm systems are present in the Phobos Experimental area:

- The high bay area of Building 1012A is provided with four smoke/heat detectors.
- The entrance tunnel to the experimental area is provided with 2 pairs of smoke/heat detectors.
- The tunnel/experimental area are provided with 12 smoke/heat detector pairs.

5.4 Fire Extinguishers

Fire extinguishers are provided in the buildings. The location and placement of portable fire extinguishers is in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

5.5 Smoke Exhaust System

None.

6.0 FIRE HAZARDS

Fire hazard potentials are classified into the following major categories; Special Occupancies, Unique Fire Hazards, Housekeeping in Vital Areas, Building Materials, Exterior Exposure Hazards, Natural Phenomenon Hazard Exposure, Toxic Fire Potential, Biological Fire Potential, and Radiation Fire Potential. The following is an evaluation of Building 1012 for each category.

6.1 Special Occupancies

Special occupancies include: instrumentation and data processing equipment, vital and important records, trailers, cooling towers, electrical substations, flammable liquid and gas storage, cables and raceways. The special occupancies applicable to Phobos Experimental area are expanded upon in Sections 6.1.1 thru 6.1.7, below.

6.1.1 Instrumentation and Data Processing Equipment

DOE/EP-0108 established levels of protection for Instrumentation and Data Processing equipment and the facility in which it is housed. The facility contains minimal amounts of instrumentation and data processing equipment.

Automatic Smoke Detection Protection

Computer equipment rooms or areas that exceed the \$250,000 limit established by DOE require smoke detection. There are no computer rooms in this facility.

Automatic Sprinkler Protection

Computer equipment rooms or areas that exceed the 1 million dollar value limit require sprinkler protection. There are no computer rooms in this facility.

Fire Barriers

DOE requires fire barriers if the value of the structure and contents exceeds \$50 million. No fire barriers are required by this DOE standard in this facility.

6.1.2 Vital and Important Records Storage

Vital records are those records which are essential to the mission of an important program and which, if lost, could not be reproduced or obtained elsewhere. Important records are those records possessing a high value to the mission of an important program but which, if lost, could be reproduced or reconstructed with difficulty or significant extra expense.

Based on the above definitions, there are no vital or important records in this facility.

6.1.3 Trailers and Portable Structures

None

6.1.4 Cooling Towers

None

6.1.5 Electrical Substations

The transformers and switchgear are arranged to comply with the recommendations contained in Factory Mutual Loss Prevention Data Sheet 5-4 for fire protection. The transformers do not present an exposure hazard to the facility or to each other, and are separated by two filled concrete block fire barrier walls and adequate drainage is provided. Details on the transformers are below:

Transformer No.	Power (kVA)	Oil
1012A-TRNF	2500/3500	326 gallons

This transformer is located approximately 25 feet from Building 1012A. A diesel generator with an integral 300 gallon fuel tank located in the base of the generator is located approximately 12 feet from this transformer.

6.1.6 Flammable Liquid & Gas Storage

The use of flammable liquids in Building 1012 is minimal. The quantity of flammable gases and liquids in the facility is less than the limits mandated by BCNYS Table 307.7(1) "*Maximum Allowable Quantity per Control Area of Hazardous Materials Posing a Physical Hazard.*" Use of flammable liquids is in accordance with BNL ES&H Standards (found at <https://sbms.bnl.gov/ld/ld08/ld08d481.pdf>).

6.1.7 Cables and Raceways

High voltage and low voltage, control, and signaling cables are segregated throughout the building in accordance with NEC requirements. The cabling is located in conduits, raceways and to a lesser extent within cable trays. Most of the power and control cables and wiring in the

building have Hypalon jacketing which has low-toxicity, low-smoke, and self-extinguishing ratings. The use of this jacketing will minimize fire propagation and smoke generation in the event of a fire. Polyvinyl Chloride (PVC) and other flammable types of insulation and jacketing have been kept to a minimum, in accordance with the fire protection program.

Cable and raceways are easily accessible for manual fire fighting. Cable tray fires are not fast spreading. Unique Fire Hazards

There are no unique hazards at this facility.

6.2 Housekeeping in Vital Areas

Good housekeeping and control of combustibles was observed during this survey. The Collider-Accelerator department self-inspection program (Tier I) monitors routine experimental aspects. The BNL Plan Review Process screens conventional construction operations.

6.3 Building Materials

No exposed polystyrene insulation or other highly combustible building materials are used in the construction or operations at Building 1012. Therefore, no special fire protection precautions are required for this facility.

6.4 Exterior Exposure Hazards

Any exterior structure, area or piece of equipment that is subject to harmful effects from, or can cause harmful effects to this facility is defined as an exterior exposure. Exterior exposures can be categorized as elements outside of the facility, and as components of the facility.

There are no significant exterior fire exposures to Building 1012 or Building 1012A.

6.5 Natural Phenomenon Hazard Exposure

Natural Hazards can be classified into five hazard categories: lightning, windstorm, wild fire, earthquake and flooding. The following is an evaluation for each category.

6.5.1 Lightning Potential

Based on NFPA standard 780 a lightning protection system is required for Building 1012A. Refer to Appendix B that shows that the expected lightning frequency (Nd) is **0.0034** and the tolerable lightning frequency (Nc) is **0.0003**. Based on NFPA 780, If $N_d > N_c$, a lightning protection system should be installed in Building 1012A (**See Recommendation HAI-07-1012-01**). Appendix B that shows that the expected lightning frequency (Nd) is **0.0018** and the tolerable lightning frequency (Nc) is **0.0003** for Building 1012B, thus a lightning protection is being recommended. (**See Recommendation HAI-07-1012-01**)

6.5.2 Windstorm Potential

The Long Island area basic wind speed (3-second gust) is 120 MPH based on Factory Mutual Data Sheet 1-28 and BCNYS Figure 1609.4. The ground roughness exposure category for the area is 'Exposure B.' Based on the calculations this building should have roof assemblies classified as "Class 90" rated assemblies.

6.5.3 Brush Fire Potential

Building 1012 was not included in the "*BNL Wildland Fire Interface Survey Report*," dated August 2002.

An analysis was completed consistent with the requirements and guidelines of NFPA 1144 *Protection of Life and Property from Wildfire* (2002) to determine the wildfire risk to Building 1012. The risk assessment was conducted in accordance with the Wildfire Hazard Severity Form checklist of NFPA 1144. The checklist is a summary of typical desirable characteristics found in various wildfire hazards analyses. Elements include emergency response ingress and egress, type of vegetation, topography, building construction and roofing materials, available fire protection, and utilities.

Based on the analysis, the hazard from wildfire to Building 1012A is "LOW" (score of 25, with 40 being the cut-off for low hazard). Specifics of the Wildfire Hazard Severity Analysis are shown in Appendix C of this report.

6.5.4 Earthquake Potential

The seismic damage potential for this facility is classified as low based on a Natural Hazards Analysis produced for the BNL campus titled "*DOE Accelerator Order 5480.25 Implementation Plan for Brookhaven National Laboratory National Phenomena Hazards Evaluation*" dated April 1994. A low seismic classification means that the buildings and fire protection systems are not required to comply with seismic design standards.

6.5.5 Flooding Potential

Flood potential from bodies of water overflowing their normal levees is low for the BNL area. The flooding potential for this facility was classified as low in a Natural Hazards Analysis report produced for the BNL site, dated April 1994, titled "*DOE Accelerator Order 5480.25 Implementation Plan for Brookhaven National Laboratory National Phenomena Hazards Evaluation*."

Groundwater runoff from a severe rainstorm could be a concern for Building 1012 due to the surrounding terrain. However, further evaluation is beyond the scope of this analysis.

6.6 Toxic Fire Potential

There are no known toxic materials present in the building that present a release potential due to fire. There were no identified PCB's within the building.

6.7 Biological Fire Potential

There are no known biological materials present in the building that present a release potential due to fire.

6.8 Radiation Fire Potential

The Collider-Accelerator Department accelerators are classified as low-hazard accelerator facilities, defined as those with the potential for no more than minor on-site and negligible off-site impacts to people and the environment. They are dependent upon external energy sources; that is, electrical power, that can be easily terminated. The primary hazard is prompt ionizing radiation that is limited to regions where the beam is maintained and is in existence only when a beam is present. Buildings 1012A and 1012B do not have any radiation fire potential.

7.0 PRE-FIRE AND EMERGENCY PLANNING

The BNL Fire Department maintains an adequate pre-fire plan book for this facility (http://intranet.bnl.gov/emergencyservices/runcards/main_i.asp). The pre-plan was reviewed as part of this analysis.

7.1 Protection of Essential Safety Class Systems

There are no essential safety class systems associated with these facilities.

7.2 Protection of Vital Programs

The operations associated with this facility are not considered to be a DOE vital program. Therefore, no special fire protection precautions, beyond those that are described in this report, are required for this facility. The equipment within the building is critical to the operation of the RHIC ring.

7.3 Protection of High Value Property

High value equipment is generally regarded as any single item that is valued at \$1 million or more, or where the loss of a single item could result in a loss of program continuity of greater than six months.

There is no high value equipment in this facility at this time.

7.4 Critical Process Equipment

By DOE standards, critical process equipment is considered to be equipment which, if lost or damaged in a fire, could delay a significant component of a major program for a period in excess of 6 months.

By the above definition there is no equipment that meets these criteria at this time.

7.5 Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL)

The MPFL, as defined in DOE Order 420.1, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential, assuming the failure of both automatic fire suppression systems and manual fire fighting efforts. The fire loss estimate includes the replacement cost of equipment and property and any applicable decontamination and cleanup costs.

In accordance with the BNL Fire Safety Program, protection is required for facilities having an MPFL in excess of established thresholds as follows:

- When the MPFL exceeds \$1 million an automatic sprinkler system designed in accordance with applicable NFPA standards is required;
- When the MPFL exceeds \$25 million, a redundant fire protection system is required such that, despite the failure of the primary fire protection system, the loss will be limited to \$25 million; and
- When the MPFL exceeds \$50 million, a redundant fire protection system and a 3-hour fire resistance rated barrier are required to limit the MPFL to \$50 million.

7.5.1 MPFL Scenario

The buildings are considered to be one fire area and thus a single MPFL calculation is being performed for each. The area selected is the experimental area within the RHIC tunnel.

Combustible loading throughout the area could conservatively be sufficient to potentially reach flashover conditions for heat release rates and fire duration, in light of combustibles from the cabling.

Flashover indicates that the temperature inside these limited areas would be sufficiently hot to cause multiple fuel package ignitions within the space and result in loss of all contents. Associated compartment temperatures at flashover are generally accepted to be between 500°C (900°F) to 600°C (1100°F). Flashover is generally defined as the transition from a growing fire to a fully developed fire. Fully developed fires impose extensive thermal and physical stresses on fire barriers, the failure of which could lead to fire spread throughout the area.

7.5.2 MPFL Calculation

Building 1012 has a replacement value of approximately \$3.5 M (\$3,227,341). The building value was obtained from 2004 replacement costs. The average dollar density of the building is the replacement value divided by the floor area of the building $\$3,227,341/8818 \text{ ft}^2 = \$366/\text{ft}^2$.

The content and equipment value is calculated based on the following assumptions:

- An average of \$20/ft² for content and equipment value within predominantly office areas, which does not apply to Building 1012.

- An average of \$100/ft² for content and equipment value within the industrial areas of the building.

A single MPFL fire is likely to destroy the entire building if the automatic sprinkler system was inoperable.

MPFL Summary

Attribute	Value
Building Value	\$3,500,000
Contents	\$1,000,000
MPFL Total	\$4,500,000

7.5.3 MCFL Scenario

The MCFL, as defined in DOE Standard 1066-99 Fire Protection Criteria, is the value of property within a fire area, unless a fire hazard analysis demonstrates a lesser (or greater) loss potential. This assumes that all installed fire protection systems function as designed, and the effect of emergency response is omitted except for post-fire actions.

A single MCFL fire is likely to damage approximately 2000 square feet of the building (Building 1012), assuming the sprinkler system is operational: 2000 square feet x \$366/square feet = \$732,000, rounded up to \$800,000.

7.5.4 MPFL/MCFL Summary

Fire Area	MPFL	MCFL
Building 1012	\$4,500,000	\$800,000

7.6 Recovery Potential

Critical process parts have been identified by the Department. Critical process parts are those items essential to the operations of the facility that require a long lead-time for replacement. Recovery potential is based on the ability to produce and replace equipment for the Phobos experiment.

7.7 BNL Fire/Rescue Group

The BNL Fire/Rescue Group is a full time, paid department. Minimum staffing is five firefighters and one officer per shift. The firefighters are trained to meet Firefighter Level III by International Fire Service Training Association standard, National Fire Protection Association (NFPA) Fire Fighter Level II standard, and (NFPA) Hazardous Material Technician Level and they are Suffolk County Certified Confined Space Rescuers.

The BNL Fire/Rescue Group also provides emergency medical services to an on-site population of 3200 people. A minimum of two members per shift hold New York State "Emergency Medical Technician - D" certifications ("D" is for defibrillation). Normally all five

firefighters have EMT status. The Group operates a New York State Certified Basic Life Support ambulance. Medivac services are available to BNL via the Suffolk County Police Department. Additionally the Fire/Rescue Group has two 1500 GPM "Class A" Pumpers, one Rescue Vehicle for initial hazardous material incident response and heavy rescue operation, and one Incident Command Vehicle.

The single Fire Station is located on the west side of the BNL Site. Response time to the most remote section of the BNL Site is less than eight minutes. Response time to the Building 1012 complex is estimated at 5 minutes or less.

BNL participates in the Suffolk County Mutual Aid Agreement. This allows the resources from over 130 departments to assist BNL. BNL is also a member of the Town of Brookhaven Foam Bank. BNL has a mutual aid agreement for hazardous material incidents with the Town of Brookhaven and Stonybrook University.

7.8 Fire Apparatus Accessibility

Fire apparatus accessibility is adequate for the facility. Current parking lot configurations allow access by apparatus in the event of an emergency.

7.9 Security Considerations Related to Fire Protection

The facility has limited security measures that restrict access (locked doors). Provisions have been made for Fire/Rescue access via provision of master keys.

8.0 LIFE SAFETY CONSIDERATIONS

Life safety considerations for this facility include means of egress consisting of exit access, exits and exit discharge, exit signage, and emergency lighting. This building is required to comply with the state building code and NFPA 101[®], the Life Safety Code (LSC). The requirements of both the 2002 edition of the Building Code of New York State (BCNYS) and the 2006 edition of the LSC have been applied to this analysis. It should be noted that the BCNYS is not intended to apply to existing structures. Appendix K of the BCNYS addresses alterations to existing structures. This building was likely constructed to comply with the version of the Life Safety Code NFPA 101 in effect at the time of construction; early 1980's. DOE now requires all buildings to conform to local building codes and NFPA 101.

8.1 Occupancy Load Factor and Calculations

Occupancy load factor and calculations

The following table summarizes the occupant load calculations based on both the BCNYS Table 1003.2.2.2 and NFPA 101 Table 7.3.1.2. An occupant load factor of 300 sq ft per person was applied to special-purpose industrial and mechanical/electrical equipment areas the 100 square feet for a Business occupancy was not used for this evaluation since the office areas are

incidental to the overall size of the building. Factors for these spaces are not specified in the LSC.

Table 8.1-1

Occupant Load Calculation- Special Purpose – Building 1012

Location	Occupancy Load Factor (per person)		Area (feet)	Occupant Load Calculations	
	BCNYS	NFPA		BCNYS	NFPA
Building 1012	100 gross	300 gross	8818	89	30
TOTAL			8501	89	30

Occupant Load Calculation- Industrial – Building 1012A

Location	Occupancy Load Factor (per person)		Area (feet)	Occupant Load Calculations	
	BCNYS	NFPA		BCNYS	NFPA
Building 1012A	100 gross	100 gross	6492	65	65
TOTAL			6539	65	65

The total building occupant load for code compliance purposes is less than the occupant load permitted.

8.2 Means of Egress

The means of egress for the building meets the present code requirements for number and arrangement of exits, capacity of exits, travel distance, common path of travel, dead ends, and security considerations related to egress. The following subsections discuss each of the elements.

8.2.1 Number and Arrangement of Exits

The LSC requires that a floor with an occupant load of 500 or fewer persons must have a minimum of two means of egress [§7.4.1.1]. Additional exits may be required for compliance with exit capacity or arrangement of exits criteria.

Building 1012

There are two exits from the experimental area. The main entrance is the primary exit and a secondary exit is located at I-09Q3. The exits are separated by approximately 260 feet.

Building 1012A

There are adequate exits from this support building. The mezzanine section is provided with two well separated exits from this area. The stairways are enclosed.

8.2.2 Capacity of Exits

The egress capacity provided from a floor or portion thereof must be sufficient to accommodate the occupant load. The egress capacity for an egress component is based on the width of the component. For stairways, the factor of 0.3 in. of stair width per person is applied. For doors, ramps, corridors, and other level components, the factor of 0.2 in. of width per person is applied.

Street floor exits (i.e., First Floor) must be sufficient for the occupant load of the street floor plus the required capacity of stairs discharging through the street floor [LSC §40.2.3.3]. The building meets this criterion.

The available exit capacity of Buildings 1012 and 1012A exceeds the occupant load based on the BCNYS (Table 1003.2.3) and NFPA 101 (Table 7.3.3.1) for stairways and other egress components in a non-sprinklered facility.

8.2.3 Travel Distance

Buildings 1012 and 1012A egress paths do not exceed the BCNYS and NFPA 101 travel distance limitations. NFPA 101 (Table 40.2.6 and Section 40.2.6.3) limits egress travel distance to 400 feet in this type of sprinklered Industrial Special Purpose occupancy (Building 1012), and 250 feet for an industrial occupancy (Building 1012A).

8.2.4 Common Path of Travel

The building meets the common path of travel criteria found in Section §40.2.5.3 in the Life Safety Code. Since Buildings 1012 and 1012A are protected with automatic sprinklers the allowable common path of travel distance of 50 feet for an unsprinklered building is increased to 100 feet for this special purpose occupancy and industrial occupancy.

8.2.5 Dead Ends

Per Section 40.2.5.2 (industrial occupancy) and 39.2.5.2 (business occupancy) of the Life Safety Code, and the Fire Code of New York State (FCNYS) (Table 1010.17.2) a dead end corridor cannot exceed 50 feet. The buildings are in compliance with these criteria.

8.2.6 Security Considerations Related to Fire Protection

The building does not have special access controls that restrict egress or fire rescue ingress.

8.2.7 Separation of Means of Egress

Where exits or exit access doors are required, they must be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area served [LSC §7.5.1.3.2; BCNYS §]. The building is provided with primary exits that meet this requirement.

8.3 Exit Signs and Emergency Lighting

Exit signage is required in accordance with Section 7.10 of the LSC. Exit signs should be placed in corridors and in rooms required to have at least two means of egress. Internally-illuminated exit signs and exit placards are provided in the building.

Emergency lighting for means of egress is required in accordance with Section 7.9 of the LSC. Emergency lighting is required in industrial occupancies [§40.2.9.1] except special-purpose industrial occupancies without routine human habitation. Emergency lighting modules with battery packs are generally provided in the buildings, and are adequate.

8.4 Emergency Roof Exits

A means of escape is defined as a way out of a building or structure that does not conform to the strict definition of means of egress but does provide an alternate way out [LSC §3.3.152]. The buildings have no such arrangement.

8.5 Egress through Adjoining/Intervening Spaces

Exit access from rooms or spaces is permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served and the intervening rooms or areas are not spaces identified under Protection from Hazards (e.g., storage rooms) [LSC §7.5.1.6]. The buildings complies with this requirement.

8.6 Exit Discharge

Exits are required to terminate directly at a public way or at an exterior exit discharge. The LSC permits a maximum of 50 percent of the required number of exits to discharge inside the building provided the level of discharge is fully-sprinklered or the area of discharge is sprinklered and separated from the remainder of the building by fire barriers [§7.7.2.2; §7.7.2.4]. All exits for Buildings 1012 and 1012A discharge to a public way.

8.7 Horizontal Sliding Doors

Approved, existing horizontal-sliding or vertical-rolling fire doors are permitted in means of egress under the following conditions [LSC §40.2.2.2.4]:

- They are held open by fusible links.
- The fusible links are rated at not less than 165°F.

- The fusible links are located not more than 10 ft above the door.
- The fusible links are in immediate proximity to the door opening.
- The fusible links are not located above a ceiling.
- The door is not credited with providing any protection for life safety purposes (i.e., property protection only).

There are no horizontal exit doors utilized in Building 1012.

8.8 Fire Escape Ladders

Fire escape ladders complying with 7.2.9 are permitted in industrial and business occupancies [§40.2.2.10; §39.2.2.10]. Fire escape ladders are permitted as means of egress only where one of the following conditions exists:

- Access to unoccupied roof spaces as permitted by 7.2.8.3.4.
- Secondary means of egress from boiler rooms or similar spaces subject to occupancy not to exceed three persons who are all capable of using the ladder.
- Means of egress from towers and elevated platforms around machinery or similar spaces subject to occupancy not to exceed three persons who are all capable of using the ladder.

Fire escape ladders are not provided in the building.

8.9 Door Heights

Means of egress are required to provide a headroom clearance of not less than 6 ft 8 in. at doorways [LSC §7.1.5.1]. The existing doors meet this requirement.

8.10 Discharge to Roofs

Exits are permitted to discharge to roofs or other sections of the building where the following criteria are met and with approval by the authority having jurisdiction [LSC §7.7.6]:

- The roof/ceiling assembly construction has a fire-resistance rating not less than that required for the exit enclosure.
- A continuous and safe means of egress from the roof is available.

There are no exits to the roof in this building.

8.11 Barriers

8.11.1 Occupancy Separations

Occupancy separations are not required for Buildings 1012 and 1012A since there is a single occupancy for the buildings.

8.11.2 Incidental Use Areas

Incidental use areas or hazardous areas are considered those spaces that pose a relatively higher hazard than the predominant occupancy of the area in which they are located. Such spaces are not necessarily classified as high-hazard (Group H) occupancies. Hazardous areas include general storage rooms, boiler or furnace rooms, and maintenance shops. The LSC requires hazardous areas to be separated from adjoining areas by a 1-hour fire resistance-rated barrier without windows or protected by automatic fire suppression systems [LSC §8.7.1.1]. Rooms with severe hazards such as maintenance shops with woodworking and painting are required to have both fire barrier enclosure and automatic fire suppression.

There are limited rooms associated with Building 1012 and 1012A.

8.11.3 Separation of Means of Egress

The exits within the building are separated and meet the separation criteria within NFPA 101.

8.11.4 Exit Access Corridors

Exit access corridor walls are typically constructed of concrete masonry and extend from the floor to the underside of the floor slab above. Fire resistance-rated corridor walls are not required in existing industrial occupancies [LSC §40.3.6].

The BCNYS requires exit access corridors serving a Group F occupancy in non- or partially-sprinklered buildings to be enclosed with 1-hour fire partitions [BCNYS Table 1004.3.2.1]. This does not apply in this sprinklered building.

There are no exit access corridors in the buildings, thus this criterion does not apply.

8.11.5 Vertical Opening Barriers

Not applicable to Buildings 1012 and 1012A.

8.11.6 Egress Stairways

Vertical openings, including stairways, are required to be enclosed with fire-resistive construction to limit fire and smoke spread to other floors.

Vertical openings must be enclosed or protected in accordance with LSC Section §8.6 unless otherwise permitted by the following [§40.3.1]:

1. Unenclosed vertical openings in accordance with 8.6.8.2 shall be permitted.
2. Exit access stairs shall be permitted to be unenclosed in two-story, single-tenant spaces that are provided with a single exit in accordance with §39.2.4.2(5).
3. Unprotected vertical openings shall be permitted in buildings complying with all of the following:

- a. Where protected throughout by an approved automatic sprinkler system in accordance with §9.7.1.1(1);
- b. Where no unprotected vertical opening serves as any part of any required means of egress; and
- c. Where required exits consist of exit doors that discharge directly to grade in accordance with §7.2.1, outside stairs in accordance with §7.2.2, smokeproof enclosures in accordance with §7.2.3, or horizontal exits in accordance with §7.2.4.

The there are no protected egress stairways for the buildings.

8.12 Fire Protection Systems Required by Code

Automatic sprinkler protection is not required to address life safety conditions found in the building.

8.13 Operational Requirements that are Required by Code

When performed, cutting and welding operations in the building are required to be conducted in accordance with NFPA 51B, *Standard for Fire Prevention during Welding, Cutting, and Other Hot Work*, 2003 Edition.

There are no other fire protection related operational requirements required by code.

9.0 REFERENCE DOCUMENTS

9.1 National Fire Protection Association

NFPA 10, *Standard for Portable Fire Extinguishers*, 2002 Edition

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2002 Edition

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 Edition

NFPA 51B, *Standard for Fire Prevention during Welding, Cutting, and Other Hot Work*, 2003 Edition

NFPA 70, *National Electrical Code*[®], 2005 Edition

NFPA 72[®], *National Fire Alarm Code*[®], 2002 Edition

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2002 Edition

NFPA 101[®], *Life Safety Code*[®], 2006 Edition

NFPA 220, *Standard on Types of Building Construction*

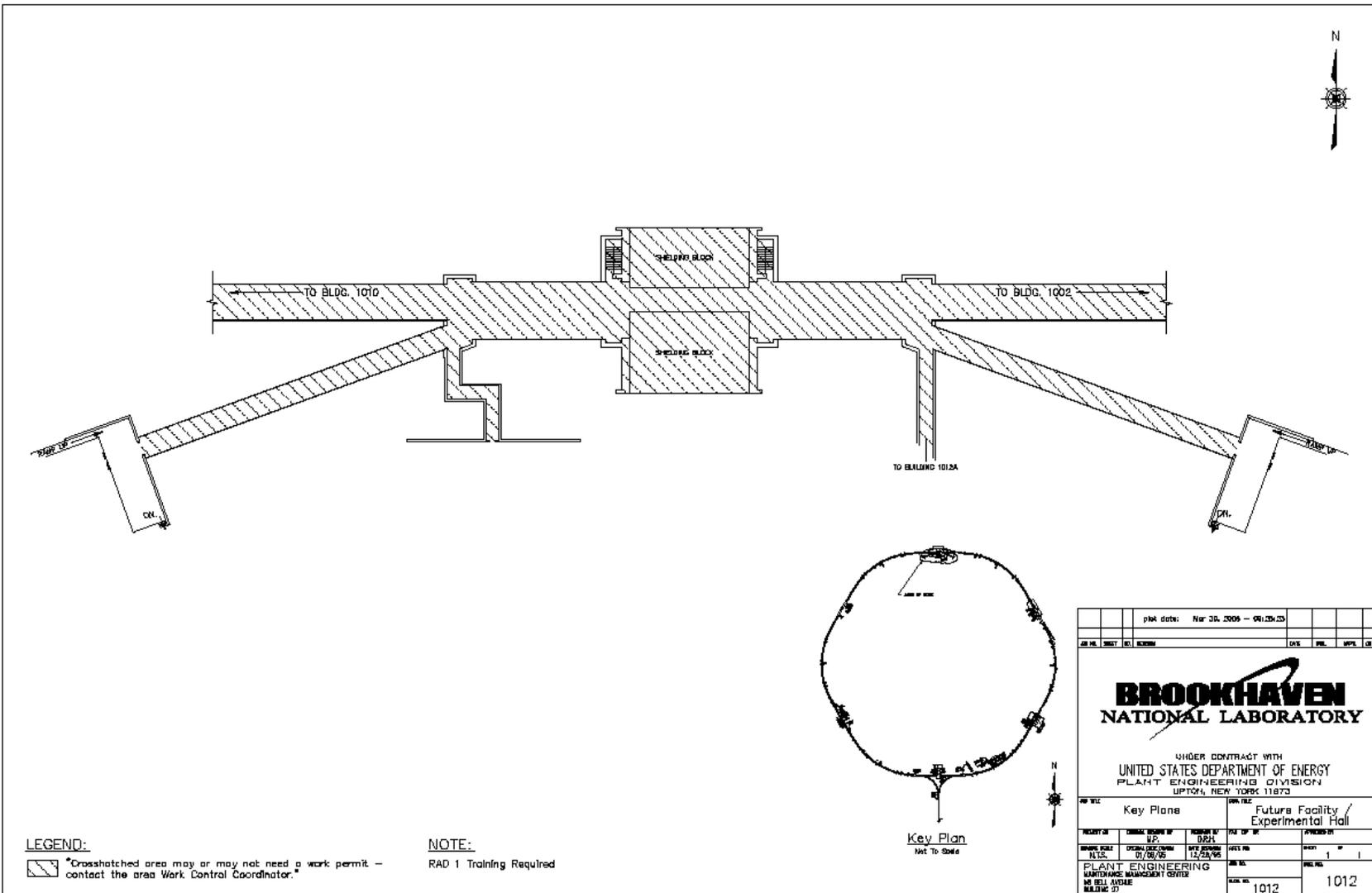
NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2004 Edition

NFPA 1144, *Standard for Protection of Life and Property from Wildfire*, 2002 Edition

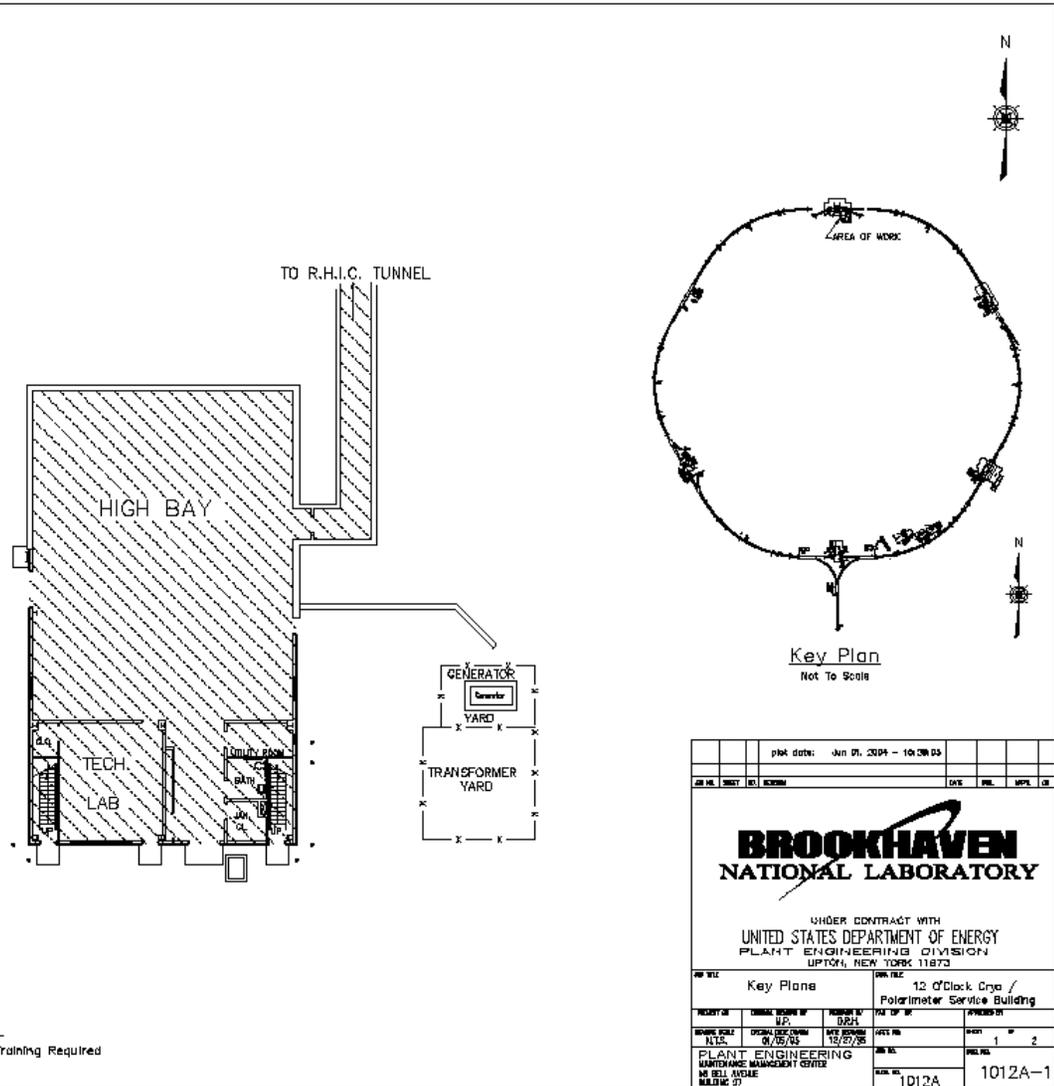
9.2 FM Global Loss Prevention Data Sheets

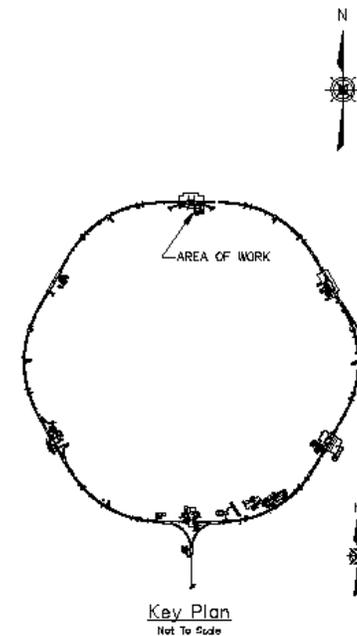
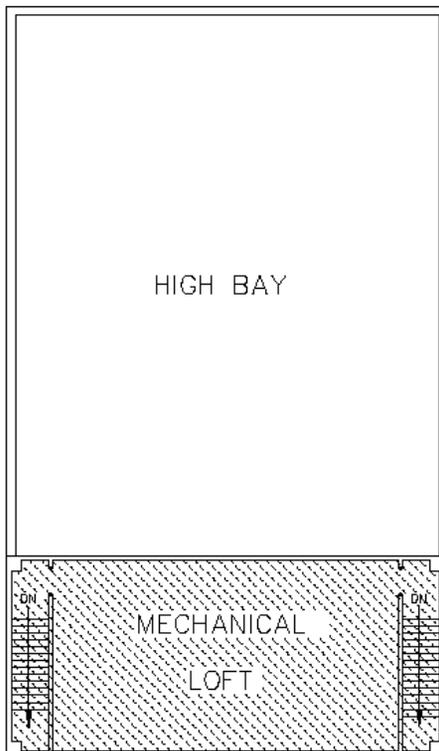
None.

APPENDIX A – FHA FIGURE



plot date: Nov 30, 2006 - 09:29:23							
DATE	TIME	SCALE	BY	CHKD	APPV	DATE	TIME
BROOKHAVEN NATIONAL LABORATORY							
UNDER CONTRACT WITH UNITED STATES DEPARTMENT OF ENERGY PLANT ENGINEERING DIVISION UPTON, NEW YORK 10986-11873							
Key Plans				Future Facility / Experimental Hall			
PROJECT NO.	ISSUE NUMBER OF N.E.	ISSUED BY	DATE OF N.E.	PROJECT NO.	ISSUE NO.	DATE	TIME
1125	01/05/06	DRJ	12/29/06		1		
PLANT ENGINEERING MAINTENANCE MANAGEMENT CENTER 40 BELL AVENUE BUILDING 27				DATE NO.		1012	





LEGEND:

 *Crosshatched area may or may not need a work permit - contact the area Work Control Coordinator.*

NOTE:

RAD 1 Training Required

plot date: Jun 02 2004 - 09:10:40					
DR	REV	BY	DATE	CHK	APP
BROOKHAVEN NATIONAL LABORATORY					
UNDER CONTRACT WITH UNITED STATES DEPARTMENT OF ENERGY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973					
NO TITLE			NO TITLE		
Key Plans			12 O'clock Cryo / Polarimeter Service Building		
PROJECT NO.	DESIGN NUMBER	ISSUED BY	DATE OF ISSUE	APPROVED BY	
	1012A	DBH	12/27/06		
ISSUE NO.	ISSUE DATE	ISSUE BY	ISSUE NO.	ISSUE DATE	
1	12/27/06	DBH	2	12/27/06	
PLANT ENGINEERING MAINTENANCE MANAGEMENT CENTER 400 BELL AVENUE BUILDING 37			ISSUE NO.	ISSUE NO.	
			1012A	1012A-M	

**APPENDIX B –
LIGHTNING RISK CALCULATION**

BUILDING 1012

The expected lightning frequency (Nd) is **0.0034** and the tolerable lightning frequency (Nc) is **0.0003**. Based on NFPA 780, If $N_d > N_c$, a lightning protection system is not required.

BUILDING 1012A

The expected lightning frequency (Nd) is **0.0018** and the tolerable lightning frequency (Nc) is **0.0003**. Based on NFPA 780, If $N_d > N_c$, a lightning protection system is not required.

EXPECTED LIGHTNING STROKE FREQUENCY FROM NFPA 780 ANNEX L

$$N_d = (N_g)(A_e)(C_1)(10^{-6})$$

$N_d =$ = yearly average flash density in the region where the structure is located

$(N_g) =$ = the yearly lightning strike frequency to the structure

$(C_1) =$ = the environmental coefficient

$(A_e) =$ = the equivalent collective area of the structure in square meters from calculation below

Length (L) Feet
 Width (W) Feet
 Height (H) Feet

Figure H.4.2(a) Results sq. meters

Figure H.4.2(b) Results sq. meters

Table H.4.3 Determination of Environmental Coefficient C_1

Relative Structure Location	C_1
Structure located within a space containing structures or trees of the same height or taller within a distance of $3H$	0.25
Structure surrounded by smaller structures within a distance of $3H$	0.5
Isolated structure, no other structures located within a distance of $3H$	1
Isolated structure on a hilltop	2

Assume

Figure H.4.2(a) Calculation of the equivalent collective area for a rectangular structure.

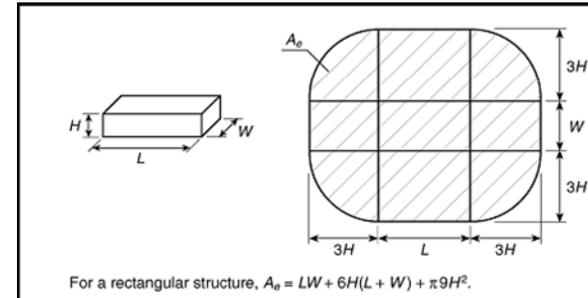
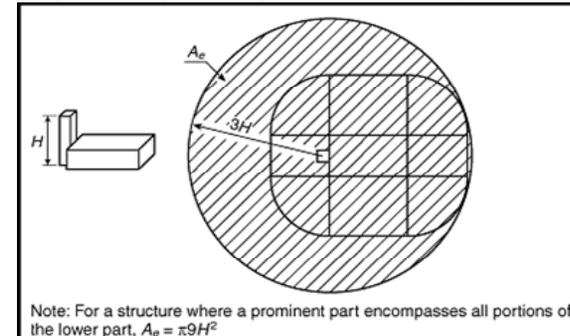


Figure H.4.2(b) Calculation of the equivalent collective area for a structure where a prominent part encompasses all portions of the lower part of the structure.



= input required

TOLERABLE LIGHTNING FREQUENCY FROM NFPA 780 APPENDIX L

$$N_c = \frac{1.5 \times 10^{-3}}{C}$$

where $C = (C_2)(C_3)(C_4)(C_5)$.

$$N_c = 0.0003$$

Assume
0.5

C_2 — Structural Coefficients			
	Roof		
Structure	Metal	Nonmetallic	Flammable
Metal	0.5	1.0	2.0
Nonmetallic	1.0	1.0	2.5
Flammable	2.0	2.5	3.0

Assume
2.0

Structure Contents	C_3
Low value and nonflammable	0.5
Standard value and nonflammable	1.0
High value, moderate flammability	2.0
Exceptional value, flammable, computer or electronics	3.0
Exceptional value, irreplaceable cultural items	4.0

Assume
1.0

Structure Occupancy	C_4
Unoccupied	0.5
Normally Occupied	1.0
Difficult to evacuate or risk of panic	3.0

= input required

Assume
5.0

Lightning Consequence	C_5
Continuity of facility services not required, no environmental impact	1.0
Continuity of facility services required, no environmental impact	5.0
Consequences to the environment	10.0

EXPECTED LIGHTNING STROKE FREQUENCY FROM NFPA 780 ANNEX L

$$N_d = (N_g)(A_e)(C_1)(10^{-6})$$

$N_d =$ = yearly average flash density in the region where the structure is located

$(N_g) =$ = the yearly lightning strike frequency to the structure

$(C_1) =$ = the environmental coefficient

$(A_e) =$ = the equivalent collective area of the structure in square meters from calculation below

Length (L) Feet
 Width (W) Feet
 Height (H) Feet

Figure H.4.2(a) Results sq. meters

Figure H.4.2(b) Results sq. meters

Table H.4.3 Determination of Environmental Coefficient C_1

Relative Structure Location	C_1
Structure located within a space containing structures or trees of the same height or taller within a distance of $3H$	0.25
Structure surrounded by smaller structures within a distance of $3H$	0.5
Isolated structure, no other structures located within a distance of $3H$	1
Isolated structure on a hilltop	2

Assume

Figure H.4.2(a) Calculation of the equivalent collective area for a rectangular structure.

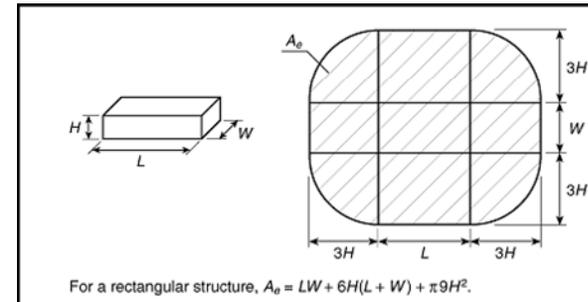
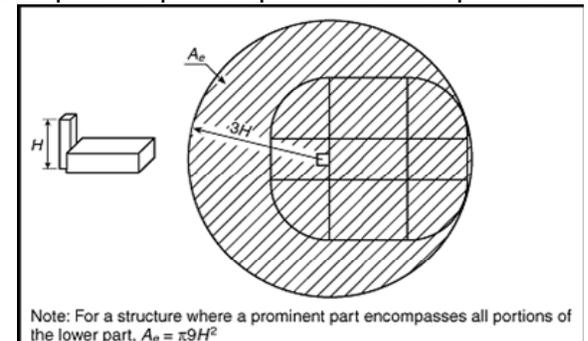


Figure H.4.2(b) Calculation of the equivalent collective area for a structure where a prominent part encompasses all portions of the lower part of the structure.



= input required

TOLERABLE LIGHTNING FREQUENCY FROM NFPA 780 APPENDIX L

$$N_c = 0.0003$$

$$N_c = \frac{1.5 \times 10^{-3}}{C}$$

where $C = (C_2)(C_3)(C_4)(C_5)$.

Assume
0.5

C_2 — Structural Coefficients			
	Roof		
Structure	Metal	Nonmetallic	Flammable
Metal	0.5	1.0	2.0
Nonmetallic	1.0	1.0	2.5
Flammable	2.0	2.5	3.0

Assume
2.0

Structure Contents	C_3
Low value and nonflammable	0.5
Standard value and nonflammable	1.0
High value, moderate flammability	2.0
Exceptional value, flammable, computer or electronics	3.0
Exceptional value, irreplaceable cultural items	4.0

Assume
1.0

Structure Occupancy	C_4
Unoccupied	0.5
Normally Occupied	1.0
Difficult to evacuate or risk of panic	3.0

= input required

Assume
5.0

Lightning Consequence	C_5
Continuity of facility services not required, no environmental impact	1.0
Continuity of facility services required, no environmental impact	5.0
Consequences to the environment	10.0

APPENDIX C – Determination of Wildfire Hazard Severity

Using NFPA 1144

WILDLAND FIRE RISK AND HAZARD SEVERITY ASSESSMENT FORM
Appendix A, Figure A.4.2 from NFPA 1144

BUILDING 1012 and 1012A

<u>ELEMENT</u>	<u>POINTS</u>
A. Means of Access	
1. Ingress and egress	
a. Two or more roads in/out	0√
b. One road in/out	7
2. Road width	
a. ≥ 24 ft	0
b. ≥ 20 ft and < 24 ft	2√
c. < 20 ft	4
3. All-season road condition	
a. Surfaced road, grade <5%	0√
b. Surfaced road, grade > 5%	2
c. Non-surface road, grade < 5%	2
d. Non-surface road, grade > 5%	5
e. Other than all-season	7
4. Fire Service Access	
a. ≤ 300 ft with turnaround	0√
b. > 300 ft with turnaround	2
c. < 300 ft with no turnaround	4
d. ≥ 300 ft with no turnaround	5
5. Street Signs	
a. Present	0√
b. Not present	5
B. Vegetation (Fuel Models)	
1. Characteristics of predominate vegetation within 300 ft.	
a. Light (e.g., grasses, forbs, sawgrassess, and tundra) NFDRS Fuel Models A,C,L,N,S, and T	5
b. Medium (e.g. light brush and small trees) NFDRS Fuel Models D,E,F,H,P,Q, and U	10√
c. Heavy (e.g. dense brush, timber, and hardwoods) NFDRS Fuel Models B,G, and O	20
d. Slash (e.g. timber harvesting residue) NFDRS Fuel Models J,K, and L	25
2. Defensible space	
a. More than 100 ft of vegetation treatment from the structures	1
b. 71 ft to 100 ft of vegetation treatment from the structures	3
c. 30 ft to 70 ft of vegetation treatment from the structures	10√
d. < 30 ft of vegetation treatment from the structures	25

C. Topography Within 300 of Structures

- | | |
|----------------------|----|
| 1. Slope < 9% | 1√ |
| 2. Slope 10% to 20 % | 4 |
| 3. Slope 21% to 30% | 7 |
| 4. Slope 31% to 40% | 8 |
| 5. Slope > 41% | 10 |

D. Additional Rating Factors

- | | |
|--|----------|
| 1. Topographical features that adversely affect wildland fire behavior | 0-5 [0√] |
| 2. Areas with a history of higher fire occurrence than surrounding areas due to special situations | 0-5 [0√] |
| 3. Areas that are periodically exposed to unusually severe fire weather and strong dry winds. | 0-5 [0√] |
| 4. Separation of adjacent structures that can contribute to fire spread | 0-5 [0√] |

E. Roofing Assembly

- | | |
|-----------------|----|
| 1. Class A roof | 0√ |
| 2. Class B roof | 3 |
| 3. Class C roof | 15 |
| 4. Nonrated | 25 |

F. Building Construction

- | | |
|--|----|
| 1. Materials | |
| a. Noncombustible/fire-resistive siding, eaves, and deck | 0√ |
| b. Noncombustible/fire-resistive siding and combustible deck | 5 |
| c. Combustible siding and deck | 10 |
| 2. Building setback relative to slopes of 30% or more | |
| a. >= 30 ft to slope | 1√ |
| b. < 30 ft to slope | 5 |

G. Available Fire Protection

- | | |
|---|----|
| 1. Water source availability | |
| a. Pressurized water source availability | |
| 500 gpm hydrants <= 1000ft apart | 0√ |
| 250 gpm hydrants <= 1000ft apart | 1 |
| b. Nonpressurized water source availability | |
| >= 250 gpm continuous for 2 hours | 3 |
| < 250 gpm continuous for 2 hours | 5 |
| c. Water unavailable | 10 |

- 2. Organized response resources
 - a. Station \leq 5 miles from structure 1√
 - b. Station $>$ 5 miles from structure 3
- 3. Fixed fire protection
 - a. NFPA 13 0√
 - b. None 5

H. Placement of Gas and Electric Utilities

- 1. Both underground 0√
- 2. One underground, one aboveground 3
- 3. Both aboveground 5

I. Total 25

Hazard Assessment	Total Points
Low hazard	< 40
Moderate hazard	40-69
High hazard	70-112
Extreme hazard	> 112

A Wildfire Severity Level of 33 = A **LOW** Hazard

WILDLAND FIRE RISK AND HAZARD SEVERITY ASSESSMENT FORM
Appendix A, Figure A.4.2 from NFPA 1144

BUILDING 1012B

<u>ELEMENT</u>	<u>POINTS</u>
A. Means of Access	
1. Ingress and egress	
a. Two or more roads in/out	0√
b. One road in/out	7
2. Road width	
a. ≥ 24 ft	0
b. ≥ 20 ft and < 24 ft	2√
c. < 20 ft	4
3. All-season road condition	
a. Surfaced road, grade < 5%	0√
b. Surfaced road, grade > 5%	2
c. Non-surface road, grade < 5%	2
d. Non-surface road, grade > 5%	5
e. Other than all-season	7
4. Fire Service Access	
a. ≤ 300 ft with turnaround	0√
b. > 300 ft with turnaround	2
c. < 300 ft with no turnaround	4
d. ≥ 300 ft with no turnaround	5
5. Street Signs	
a. Present	0√
b. Not present	5
B. Vegetation (Fuel Models)	
1. Characteristics of predominate vegetation within 300 ft.	
a. Light (e.g., grasses, forbs, sawgrassess, and tundra) NFDRS Fuel Models A,C,L,N,S, and T	5
b. Medium (e.g. light brush and small trees) NFDRS Fuel Models D,E,F,H,P,Q, and U	10√
c. Heavy (e.g. dense brush, timber, and hardwoods) NFDRS Fuel Models B,G, and O	20
d. Slash (e.g. timber harvesting residue) NFDRS Fuel Models J,K, and L	25
2. Defensible space	
a. More than 100 ft of vegetation treatment from the structures	1
b. 71 ft to 100 ft of vegetation treatment from the structures	3
c. 30 ft to 70 ft of vegetation treatment from the structures	10√
d. < 30 ft of vegetation treatment from the structures	25

C. Topography Within 300 of Structures

- | | |
|----------------------|----|
| 1. Slope < 9% | 1√ |
| 2. Slope 10% to 20 % | 4 |
| 3. Slope 21% to 30% | 7 |
| 4. Slope 31% to 40% | 8 |
| 5. Slope > 41% | 10 |

D. Additional Rating Factors

- | | |
|--|----------|
| 1. Topographical features that adversely affect wildland fire behavior | 0-5 [0√] |
| 2. Areas with a history of higher fire occurrence than surrounding areas due to special situations | 0-5 [0√] |
| 3. Areas that are periodically exposed to unusually severe fire weather and strong dry winds. | 0-5 [0√] |
| 4. Separation of adjacent structures that can contribute to fire spread | 0-5 [0√] |

E. Roofing Assembly

- | | |
|-----------------|-----|
| 1. Class A roof | 0 |
| 2. Class B roof | 3 |
| 3. Class C roof | 15 |
| 4. Nonrated | 25√ |

F. Building Construction

- | | |
|--|-----|
| 1. Materials | |
| a. Noncombustible/fire-resistive siding, eaves, and deck | 0 |
| b. Noncombustible/fire-resistive siding and combustible deck | 5 |
| c. Combustible siding and deck | 10√ |
| 2. Building setback relative to slopes of 30% or more | |
| a. >= 30 ft to slope | 1√ |
| b. < 30 ft to slope | 5 |

G. Available Fire Protection

- | | |
|---|----|
| 1. Water source availability | |
| a. Pressurized water source availability | |
| 500 gpm hydrants <= 1000ft apart | 0√ |
| 250 gpm hydrants <= 1000ft apart | 1 |
| b. Nonpressurized water source availability | |
| >= 250 gpm continuous for 2 hours | 3 |
| < 250 gpm continuous for 2 hours | 5 |
| c. Water unavailable | 10 |

- 2. Organized response resources
 - a. Station <= 5 miles from structure 1√
 - b. Station > 5 miles from structure 3
- 3. Fixed fire protection
 - a. NFPA 13 0
 - b. None 5√

H. Placement of Gas and Electric Utilities

- 1. Both underground 0√
- 2. One underground, one aboveground 3
- 3. Both aboveground 5

I. Total 65

Hazard Assessment	Total Points
Low hazard	< 40
Moderate hazard	40-69
High hazard	70-112
Extreme hazard	> 112

A Wildfire Severity Level of 33 = A **LOW** Hazard