Fire Hazard Analysis
Building 927
North Experimental Tunnel

Brookhaven National Laboratory

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1.0 OVERVIEW AND RECOMMENDATIONS

1.1 Purpose and Methodology

A Fire Hazard Analysis (FHA) was performed for Building 927, the North Experimental Tunnel at 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 927 to ascertain whether the facility meets the objectives of DOE Order 420.1 and the Brookhaven National Laboratory (BNL) Fire Safety Program. 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 927 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.

Maximum Possible Fire Loss (MPFL) and Maximum Credible Fire Loss (MCFL) potentials were also evaluated. 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 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. Both MPFL and MCFL fire

loss estimates are to include the replacement cost of equipment and property and any applicable decontamination and cleanup costs.

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 $\$20/ft^2$ for content and equipment value within non-laboratory or expermental areas.
- An average of $\$100/ft^2$ for content and equipment value within the industrial and light experimental areas of the building.

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 927, the North Experimental Tunnel, was constructed in 1971 and is 1,236 square feet. This square footage figure is only for Building 927 and does not include the tunnel area. This FHA addresses Building 927 as well as most of the U line tunnel (not included in the square footage).

Fast proton beams are extracted to perform fixed-target experiments via the U line in Building 927. The Fast External Beam (FEB) exits the AGS via the H-10 extraction magnet.

The fast beam then enters the V line, which leads to the g-2 experiment, or it is directed to the U line which is roughly parallel to the AGS to the RHIC transfer line where additional fast beam experiments are performed. Experiments in the U line are typical fixed target type surrounded by detectors, by means of which the interactions can be reconstructed.

Overview of the BNL

This Fire Hazards Analysis (FHA) has been performed to comprehensively assess the risk from fire in Building 927, the North Experimental Tunnel. 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 Building 927 generally complies 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: The use of ½ inch pipe nipples and elbows in Building 927 is in conflict with the requirements in NFPA 13.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Recommendation HAI-06-927-01: The use of ½ inch pipe nipples and elbows should be evaluated by the authority having jurisdiction for their continued use in Building 927, (See Section 5.1.3).

Photograph #1 – ½ inch pipe nipples

Finding: The existing automatic sprinklers and standpipe should be hydraulically pressurized to verify the integrity of the systems.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

Recommendation HAI-06-927-02: The standpipe and sprinkler piping shall be flushed and hydraulically pressurized per National Fire Protection Association (NFPA) codes to verify the integrity and operability of the systems. (See Section 5.1.3/5.1.4)

Finding: The existing automatic sprinklers should have a flushing examination and hydraulically pressurized to ensure the operability of the system.

Hazard Severity	III
Mishap Probability	C
Risk Assessment Code	4

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

Rec.No.	Recommendation	RAC
HAI-06-927-1	Use of ½ inch pipe nipples and elbows	4
HAI-06-927-2	Flushing and hydraulically pressurizing of the sprinkler and standpipe piping	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 November 2006, 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.
- Factory Mutual Property Loss Prevention Data Sheets – See Section 9 (Reference Documents) of this report for a complete list.

3.0 LOCATION

Building 927 is located in the central west region of 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.

Photograph #2 – Entrance into Building 927

4.0 CONSTRUCTION

4.1 Occupancy Classification

Building 927, the North Experimental Tunnel is classified by BCNYS (Sec. 306.1) as “Factory Industrial F-2 Low Hazard” occupancy.” NFPA 101 (3.3.152.8.3) classifies this buildings as “Industrial, Special Purpose” occupancy.

4.2 Construction Type

The tunnel has a uniform cross section of approximately 10 feet and is constructed of a poured-in-place concrete floor and walls with the tunnel section consisting of 10 foot corrugated steel tunneling with reinforced concrete transition points and flooring that is approximately 1’-6” thick along the center line that acts as a foundation for the beam line and also as a walking surface.

Photograph #3 – Interior View of Building 927

Photograph #4 – Interior View of Tunnel Section

The building construction type is most nearly either BCNYS Type IIA or IIB and NFPA Type II (111) or II (000). This is an underground structure with concrete and corrugated walls that do not have a known fire resistive rating. Engineering judgment would indicate a minimum 1 to 2 hour rating, but there is no documentation of this configuration. The construction type can conservatively be classified a Type IIB (not protected) since the exact fire resistive properties of the tunnel are not known. However, based on engineering judgment, the construction type could easily be classified Type IIA.

The primary combustible loading in the building consists of power supplies for the U Line that includes RF amplifiers, magnet power supplies, rectifiers and regulators for DC power. None of the materials are highly flammable and, with the possible exception of small amounts of control cable, all are expected to self-extinguish upon the de-energizing of electric power without propagation to other equipment.

There are single tier steel cable trays with approximately 50% fill located along the tunnel wall at approximately 6 feet from the floor. The cables are AC/DC power cables and signal/control COAX. Photographs 2 and 3 provide details on the single level cable trays. The cable trays are not provided with bags of vermiculate. At this time a recommendation is not being submitted to provide cable tray protection.

Life Safety Code

The LSC does not specify a minimum construction type for existing special purpose industrial occupancies [§39.1.6; §40.1.6]. The LSC permits an occupant load of not more than 1,000 persons and located at the level of exit discharge to be within a building of Type II(000) construction regardless of automatic sprinkler protection [LSC Table 13.1.6]. Thus, the existing construction easily 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 BCNYS permits an increase in allowable areas for buildings that have more than 25 percent of their perimeter on a public way or open space having a minimum width of 20 feet [IBC, §506.2]. The area increase due to frontage is determined in accordance with the following equation:

$I_f = 100[F/P - 0.25]\ W/30$, where:

I_f = Area increase due to frontage.

F = Building perimeter which fronts on a public way or open space having 20 feet open minimum width (feet).

P = Perimeter of entire building (feet).

W = Width of public way or open space (feet). The width (W) must be at least 20 feet and W/30 cannot exceed 1.0.

Building 927 is 1236 square feet, which meets the base area of 37,500 square feet for Type IIA and 23,000 square feet for Type IIB.

The applicable height and area limitations for Group F-2 are provided in Table 4.2-1.

Table 4.2-1. Allowable Height and Areas for BCNYS Group F-2

	Group F-2	
	Type IIA	**Type IIB**
Base Height	65 ft 5 stories	55 ft 3 stories
Base Area (ft^2)	37,500	23,000

International Building Code

Based on an F2 occupancy and Type II-B construction, Table 503 of the IBC permits the maximum allowable area to be 21,000 square feet and a height of 2 stories.

Section 506 and 507 of the IBC contain allowable area increases based on the location of the building and sprinkler protection, if provided. The areas limited by Table 503 can be increased due to frontage and automatic sprinklers based on the following:

$A_a = At + [A_t I_f / 100] + [A_t I_s / 100]$, where:

A_a = Allowable area per floor

A_t = Allowable floor area per Table 503

I_f = Area increase due to frontage (percent) as calculated in accordance with 506.2

I_s = Area increase due to sprinkler protection (percent) as calculated in accordance with Section 506.3.

$I_f = 100[F/P - 0.25] W/30$, where:

I_f = Area increase due to frontage

F = Building perimeter which fronts on a public way or open space having 20 feet open minimum width

P = Perimeter of entire building

W = Width of public way

Thus:

$I_f = 100[2640/2640 - 0.25] 30/30$

$I_f = 75\%$

And

$A_a = 21,000 + [21,000 \times 75/ 100] + [0 / 100]$

$A_a = 21,000 + 15,750$

$A_a = 36,750$ square feet

The result of 36,750 square feet exceeds the actual building square footage.

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

Building 927 is not subdivided.

Building 927 complies with the codes of record with respect to occupancy separations. There are no areas in this facility 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.

Polyethylene bags containing vermiculite are not positioned on the single tier cable trays in the tunnel. At this time a recommendation is not being submitted to provide protection of the cable trays. This is based on the relatively low fill of the trays and the fire suppression in the tunnel.

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 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 927 has a static supply pressure of 52 pounds per square inch (PSI) at low elevated tank levels; 65 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 into the tunnel. 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 927 is protected with automatic sprinklers at the ceiling. The sprinklers are fed via an underground connection near U line; the sprinklers and standpipe system are fed from the same common line.

5.1.3 Sprinkler Systems

The building is protected with automatic sprinklers at the ceiling. A number of the sprinklers are fed from the sprinkler feeder via a ½ inch pipe nipple and elbow. See Recommendation HAI-06-927-01.

5.1.4 Fire Standpipe Systems

The building is provided with a standpipe system. The sprinklers and standpipe are fed from a common header.

5.1.5 Other Suppression Systems

There are no other fixed fire suppression systems in Building 927.

5.2 Fire Alarm Systems

The facility has a fire alarm system that is connected to the Site fire Alarm system.

5.2.1 Building Fire Alarm System

The Building 927 fire alarm system consists of two heat detectors located at the beginning of U line conforming to NFPA 72.

5.2.2 Site Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage using a fault tolerant sever 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

Automatic detection systems are provided as follows:

- Two heat detectors located at the beginning of U Line.

5.4 Fire Extinguishers

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

5.5 Smoke Exhaust System

- The building is not provided with a manual smoke exhaust system.

6.0 FIRE HAZARDS

Fire hazard potentials are classified into four 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 927 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 Building 927 are expanded upon in Sections 6.1.1 thru 6.1.7, below.

There are a number of magnets in the tunnel, located along the beam; most are water or air cooled. Dipole magnets are high value equipment (in the range of $200K each), that can take up to 6 months to replace. The ceiling above the magnets is protected with automatic sprinklers. Features of the tunnel include:

- RF Amplifiers are located at various locations throughout the tunnel
- The U beam is the primary beam in this building. Bender magnets do bend a new line (V) that is currently idle. U line continues after V line.
- Another bender magnet (WD-1) splits U into W line. U and W then continues in the tunnel at 536 and 537.
- W line continues until it is split into X and Y lines that are part of the 1000 complex.

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 does not contain any significant instrumentation or data processing equipment and does not exceed any of the thresholds in DOE/EP-0108 for smoke detection, automatic sprinklers or fire barriers beyond the present level of protection.

Automatic Smoke Detection Protection

Computer equipment rooms or areas that exceed the $250,000 limit DOE establishes require smoke detection protection. There are no computer rooms associated with Building 927, and no smoke detection systems.

Automatic Sprinkler Protection

Computer equipment rooms or areas that exceed the 1 million dollar value limit require sprinkler protection. There are no computer rooms associated with the building.

Fire Barriers

DOE requires fire barriers if the structure and contents exceed 50 million dollar value. 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 records essential to the mission in this tunnel/beam facility.

6.1.3 Trailers and Portable Structures

There are no trailers or portable structures associated with Building 927.

6.1.4 Cooling Towers

There are no cooling towers associated with this facility.

6.1.5 Electrical Substations

Transformers do not present an exposure hazard to the facility.

6.1.6 Flammable Liquid & Gas Storage

The use of flammable liquids in the Building 927 is minimal. The quantity of flammable gases and liquids in the facilities are 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 are 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, low voltage, control, and signaling cables are segregated throughout the building in accordance with NEC requirements. The cabling is located in conduits, raceways and primarily 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.

The single tier cable trays are easily accessible for manual fire fighting. Cable tray fires are not fast spreading. There is no early warning provided for the cable trays, thus the time to detection of a cable fire will be delayed, but manageable based on the automatic sprinklers in the tunnel. Recovery time to repair damaged cables is expected to be less then 3 months, as the cable trays in Building 927 are not excessive.

6.2 Unique Fire Hazards

The power supplies, RF amplifiers, magnet power supplies, and rectifiers/regulators for the DC power do not present any unique fire hazards. The power supplies are air, water or helium cooled.

6.3 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.

6.4 Building Materials

No significant amounts of exposed polystyrene insulation or other highly combustible building materials are used in the construction or operations at Building 927. Therefore, no special fire protection precautions, beyond those that are generically described in this section, are required for this facility.

6.5 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 exterior fire exposures to Building 927, which is an underground tunnel and experimental area.

6.6 Natural Phenomenon Hazard Exposure

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

6.6.1 Lightning Potential

Based on NFPA standard 780 the lightning damage potential of the North Experimental Tunnel is minimal for this mostly below ground facility refer to Appendix B.

6.6.2 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. This does not apply to this underground facility.

6.6.3 Brush Fire Potential

Based on the criteria presented for evaluating fire potentials from Wildland in the "*BNL Wildland Fire Interface Survey Report,*" dated August 2002, there is no brush fire risk potential exposure to Building 927.

Additionally, 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 927. 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 927 is "LOW" (score of 30, with 40 being the cut-off for low hazard). Specifics of the Wildfire Hazard Severity Analysis are shown in Appendix C of this report.

6.6.4 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 Plane 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.

6.6.5 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 Plane for Brookhaven National Laboratory National Phenomena Hazards Evaluation.*"

Groundwater runoff from a severe rainstorm could be a concern for Building 927 due to the surrounding terrain. However, further evaluation is beyond the scope of this analysis.

6.7 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.

6.8 Biological Fire Potential

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

6.9 Radiation Fire Potential

By the nature of the operations of the accelerator, various pieces of equipment can become activated. Since this is an ion accelerator, any levels are low. This activation is not expected to pose a significant environmental impact in the event of a fire since the material will not be easily disbursed. No other radioactive materials are used or stored in the North Experimental Tunnel.

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 this non-nuclear facility.

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.

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.

Based on this definition there is no high value equipment located within Building 927. The power supplies, RF amplifiers, magnet power supplies have value and somewhat unique, but do not approach the definition of high value. There are a number of spare power supplies across the Site that could be used if needed.

7.4 Critical Process Equipment

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

By the above definition, the power supplies would be critical, but due to their redundancy and relative ease of replacement, do not present an unacceptable risk to the booster mission.

There are a few specialized magnets utilized in this tunnel. It is not likely that a loss of any one of these devices would cause an outage to exceed 6-months.

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

A single MPFL scenario is considered for Building 927 which has a fire area of 1,236 square feet, the FHA also includes the U line tunnel which is not included in the above square footage.

Building 927

The tunnel is considered one fire area and thus a single MPFL calculation is being performed. The area contains the equipment for the North Experimental Tunnel, and the amount and continuity of combustible material is low.

Combustible loading throughout the building could conservatively be sufficient to potentially reach flashover conditions for heat release rates and fire duration. Flashover indicates that the temperature inside the area 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. This comparison is conservative since the areas where the combustibles are located within the building represent a relatively large volume, making flashover unlikely, but possible, and only if there would be significant transient combustibles in any particular area (which would be a gross failure of the combustible loading program).

7.5.2 MPFL Calculation

The tunnel has a replacement value of approximately $11,000,000 ($10,735,619). 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 \$11,000,000/1,236 ft^2 = \$8,899/ft^2 which is not a realistic value. Since this value also includes equipment within the U line, a more reasonable value to utilize for this FHA is \$625/ ft^2 which is consistent with the FHA's conducted for the other tunnels.

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

- An average of \$20/ft^2 for content and equipment value within predominantly office areas, which does not apply to Building 927.
- An average of \$100/ft^2 for content and equipment value within the industrial and experimental areas of the building.
- There were no available replacement costs provided for the equipment within Building 927. For the purposes of this FHA the value is assumed by the author to be approximately \$25,000,000, based on the uniqueness of the various magnets and power supplies.

MPFL Summary

Attribute	Value
Building Value*	\$11,000,000
Contents*	\$25,000,000
MPFL Total	\$36,000,000

*For this MPFL calculation, Building 927 is considered a single fire area. Continuity of combustibles is not generally present throughout the building, but considering the size of the tunnel, a very conservative 100% MPFL is appropriate and is a consistent approach. The MPFL value is within the DOE limits.

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.

The maximum credible fire scenario is one in which the fire protection systems function as designed. For the North Experimental Tunnel, it is assumed the automatic sprinklers and heat detection system functions as designed and provides for an adequate fire department response. Since the tunnel is protected with automatic sprinklers, a MCFL determination via a sprinkler design area could have been performed. However, for this analysis, a fire is postulated to start due to transient combustibles near the bending magnet that causes severe damage to this magnet and the surrounding area. This MCFL method was utilized because of the higher concentration of value in this area. The damage to the tunnel is expected to be approximately 1,000 square feet, due to the limited continuity of combustibles.

MCFL Summary

Attribute	Value
Building Value	$625,000
Contents	$275,000*
MCFL Total	$900,000

*Estimated damage to the Bending Magnet and nearby equipment.

7.5.4 MPFL/MCFL Summary

Fire Area	MPFL	MCFL
Building 927	$36,000,000	$900,000

7.6 Recovery Potential

Within the North Experimental Tunnel, critical process parts have been identified by the Department. Critical process parts are those items essential to the operations of the booster that require a long lead-time for replacement. Recovery potential is based on the ability to produce and replace electronic equipment and the various power supplies.

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 Building 927 is estimated at 5 minutes.

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. Roadways are located on the north, east and south sides of the building.

7.9 Security Considerations Related to Fire Protection

The facility has limited security measures to restrict access (locked doors). Provisions have been made for Fire/Rescue access via provision of master key. The main entrances to the tunnel have a locked system that the FD can defeat for emergency access. There are door knobs/or break glass devices to permit egress in an emergency in the highly unlikely event someone is within the tunnel when it operates.

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 state building codes 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 latest version of the Life Safety Code NFPA 101 at the time of construction; 1971. DOE now requires all building 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 occupancy 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. Factors for these spaces are not specified in the LSC.

Table 8.1-1
Occupant Load Calculation

Location	Occupancy Load Factor (per person)		Area (feet)	Occupant Load Calculations	
	BCNYS	NFPA		BCNYS	NFPA
Building 927	100 gross	300 gross	1236	12	4
TOTAL			1236	12	4

The total building occupant load for code compliance purposes is 12 occupants based on the BCNYS or 4 per the NFPA 101. However, this loading calculation is misleading in that it does not include the U tunnel. Based on the limited number of personnel in Building 927 and the tunnel at any one time, the occupant loads are well within the BDNYS and NFPA 101 criteria. The maximum occupancy is not expected to exceed 20 under most normal activities, and generally would be less than 6.

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 provide the egress detail for 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.

The tunnel has four exits leading to the exterior, at the following locations:

- UGE-1
- UGE-2
- UGE-3
- UDE-1

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 easily meets this criterion, based on the low number of occupants.

The available exit capacity of Building 927 easily exceeds the occupant loading based on the BCNYS (Table 1003.2.3) and NFPA 101 (Table 7.3.3.1) for stairways and other egress components in a partially sprinklered facility. The occupant load factors are not needed to be applied due to the low occupancy of the tunnel, thus the minimum 36 width would apply per Section §7.3.4.1.

8.2.3 Travel Distance

Building 927 egress paths do not exceed the BCNYS and NFPA 101 travel distance limitations. BCNYS (Table 1004.2.4) limits egress travel distance to 300 feet in this type of un-sprinklered F-2 occupancy. NFPA 101 (Table 40.2.6 and Section 40.2.6.3) limits egress travel distance to 300 feet in this type of un-sprinklered Industrial Special Purpose occupancy.

The tunnel has four points of exit in the tunnel, spaced every 400 to 600 feet, thus 600 feet divided by 2 equals 300 feet which is equal to 300 feet.

8.2.4 Common Path of Travel

The building meets the common path of travel criteria found in Table 40.2.5 in the Life Safety Code. Since the building is not completely protected with automatic sprinklers the allowable common path of travel of the first floor is conservatively 50 feet.

8.2.5 Dead Ends

Per Table 40.2.5 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 building is in compliance with this criterion.

8.2.6 Security Considerations Related to Fire Protection

The building does not have special access controls to restrict egress or fire rescue ingress, other than those for a typical tunnel.

8.2.7 Separation of Means of Egress

Where two 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 four exits that are compliant, 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 provided on a limited basis in the building/tunnel.

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 building has 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 building complies with this requirement. Intervening rooms through which required egress occurs are accessory and not a higher hazard to the area served.

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]. The criterion does not apply to Building 927.

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 §39.2.2.2.7; §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 927.

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 that discharge to the roof of the building.

8.11 Barriers

8.11.1 Occupancy Separations

Occupancy separations are not required for Building 927 since there is a single occupancy for the building.

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 no such rooms associated with Building 927.

8.11.3 Separation of Means of Egress

Not applicable to Building 927.

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].

There are no exit access corridors in Building 927, thus this criterion does not apply.

8.11.5 Vertical Opening Barriers

Not applicable to Building 927

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 [LSC §39.3.1.1; §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.

These are not required to be enclosed since they do not exceed 2 stories.

8.12 Fire Protection Systems Required by Code

Automatic sprinkler protection is not required to address 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

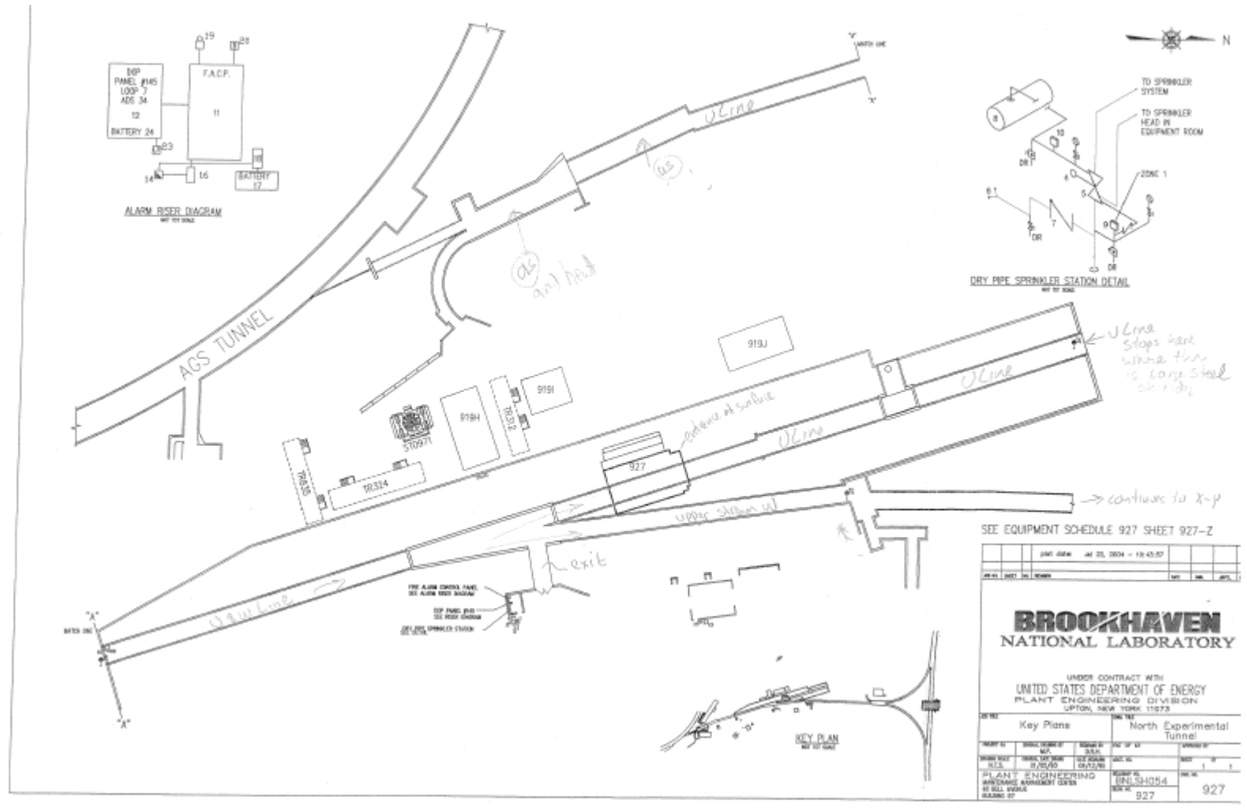
9.2 FM Global Loss Prevention Data Sheets

None.

9.3 Other

Wildland Fire Interface Survey, Managing the Woods Today to Manage the Fire Tomorrow, Sean Vaz, Joe Levesque, August 2002

APPENDIX A – FHA FIGURES



Building 927

APPENDIX B –

LIGHTNING RISK CALCULATION

The expected lightning frequency (Nd) is **0.0** and the tolerable lightning frequency (Nc) is **0.0002**. Based on NFPA 780, If Nd > Nc, a lightning protection system should be installed.

Values of 0.00 were used for (A_e) because the tunnel is underground.

EXPECTED LIGHTNING STROKE FREQUENCY FROM NFPA 780 ANNEX L

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

N_d = 0.0000 = yearly average flash density in the region where the structure is located

(N_g) = 2.0 = the yearly lightning strike frequency to the structure

(C_1) = 0.25 = the environmental coefficient

(A_e) = 0 = the equivalent collective area of the structure in square meters from calculation below

Length (L)	0	Feet
Width (W)	0	Feet
Height (H)	0	Feet

0.25

Figure H.4.2(a) Results 0 sq. meters

Figure H.4.2(b) Results 0 sq. meters

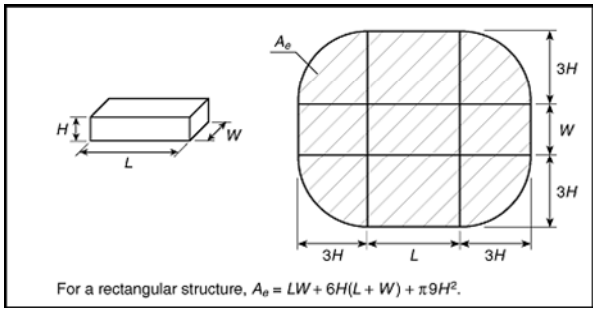
Table H.4.3 Determination of Environmental Coefficient C_1

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

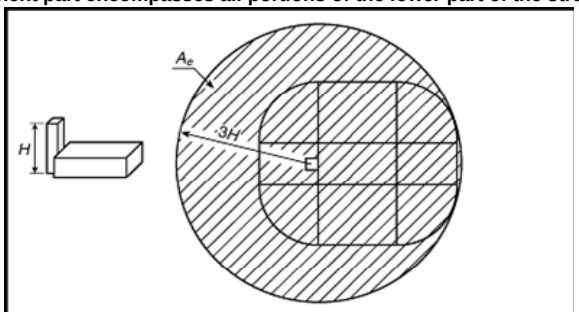
0.25

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



For a rectangular structure, $A_e = LW + 6H(L + W) + \pi 9H^2$.

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.



Note: For a structure where a prominent part encompasses all portions of the lower part, $A_e = \pi 9H^2$

= 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 = **0.0002**

Assume **1.0**

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

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

= input required

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

ELEMENT	POINTS
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√ (underground structure)
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**	**30**

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

A Wildfire Severity Level of 30 = A **LOW** Hazard