Preliminary Fire Hazard Analysis

for the

Core Facility Revitalization (CFR) Project
Brookhaven National Laboratory (BNL)

Project No. 17-SC-73

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Fire Protection Assessment / Fire Hazard Analysis
Building 725, Formerly National Synchrotron Light Source
Brookhaven National Laboratory

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Purpose/Scope

The purpose of this Assessment is to comprehensively and qualitatively assess the risk from fire within Building 725, (Former NSLS) to ensure DOE fire safety objectives are met. DOE fire protection criteria are outlined in DOE Order 420.1C. The Fire Protection Assessment includes identifying the risks from fire and related hazards (direct flame impingement, hot gases, smoke migration, fire-fighting water damage, etc.).

Summary

Building 725 formerly housed the National Synchrotron Light Source. The NSLS program was transitioned to NSLS II in the fall of 2014 and an extensive decommissioning and cleanup project ensued. The experimental areas, including the X-ray and VUV ring areas along with the first floor laboratories were emptied of their contents and the building was turned back over to the Central Complex as vacant space awaiting heavy metals contamination cleanup and final repurposing and reoccupancy of the space. The current plan includes an IBC Level 1 renovation (cosmetic) of the second floor office spaces along with construction of a new Computational Sciences data center in the first floor area that formerly housed the VUV ring. The remainder of the building is vacant awaiting funding for future renovations and reoccupancy.
The planned use of the facility is described in the "Occupancy and Associated Fire Hazards" section below. These descriptions are based on field surveys, a review of the planned and completed installations, and discussions with MPO project staff. This assessment and FHA demonstrates the achievement of a reasonable and equivalent level of fire safety that meets DOE improved risk objectives.

Recommendations:

1) Continued from previous revision: Provide a fire resistive barrier to fully enclose the HVAC duct that passes through the North East Central egress stair in the Phase II addition.

2) Continue to pursue funding for the complete fire alarm system replacement. Currently only the main fire alarm panel and a few duct detectors have been funded for replacement. The reconfiguring of the space requires a thorough analysis and redesign of the system along with replacement of the 35 year old detectors, wiring, notification appliances and components.

3) Conversion of the numerous dry pipe sprinkler systems to wet pipe sprinklers.

4) Installation of wet pipe sprinklers in the non-sprinklered areas of the building including the former X-ray beam tunnel area.

5) Improving the emergency generator response so that power loss to emergency circuits (lighting, exit signs, etc.) is reduced below the required 10 second maximum.

6) Analyze and review codes compliance for proposed renovations and construction

7) Provide for required fire separation between mechanical spaces, proposed data facilities, and floors

Analysis

Scope

The Assessment and Analysis of Building725 is divided into two areas; the existing office/support and mechanical spaces, and the proposed data center. This analysis includes discussions with F&O and MPO staff, a review of the facility, and a review of construction drawings and specifications.

1. Location

Building 725 is located in the eastern region of Brookhaven National Laboratory (BNL). BNL is 5,000 acre site owned by the Department of Energy and operated by Brookhaven Science Associates. BNL is located in Upton, New York.

Figure 1: Aerial view of BNL highlighting the B-725 location.

2. Construction

B-725 has been constructed in several phases, with 120K sq. ft. for the first floor and 38K sq. ft. for the second floor. Construction of each phase is similar and overall is considered Type IIB. The floors are poured concrete, the exterior walls are non-combustible insulated metal panels, and the roof is an insulated metal deck assembly. (Note that the original roof system was changed from a Factory Mutual Class I built-up tar roof system being fully nailed to the deck (also considered non-combustible). Structural support is by non-fire protected steel . The perimeter of the facility has a two-story office mezzanine constructed of poured concrete on metal deck. Plans for a third floor in the original Phase I area never materialized but the two story office area steel work originally had a 2-hour fire rating.

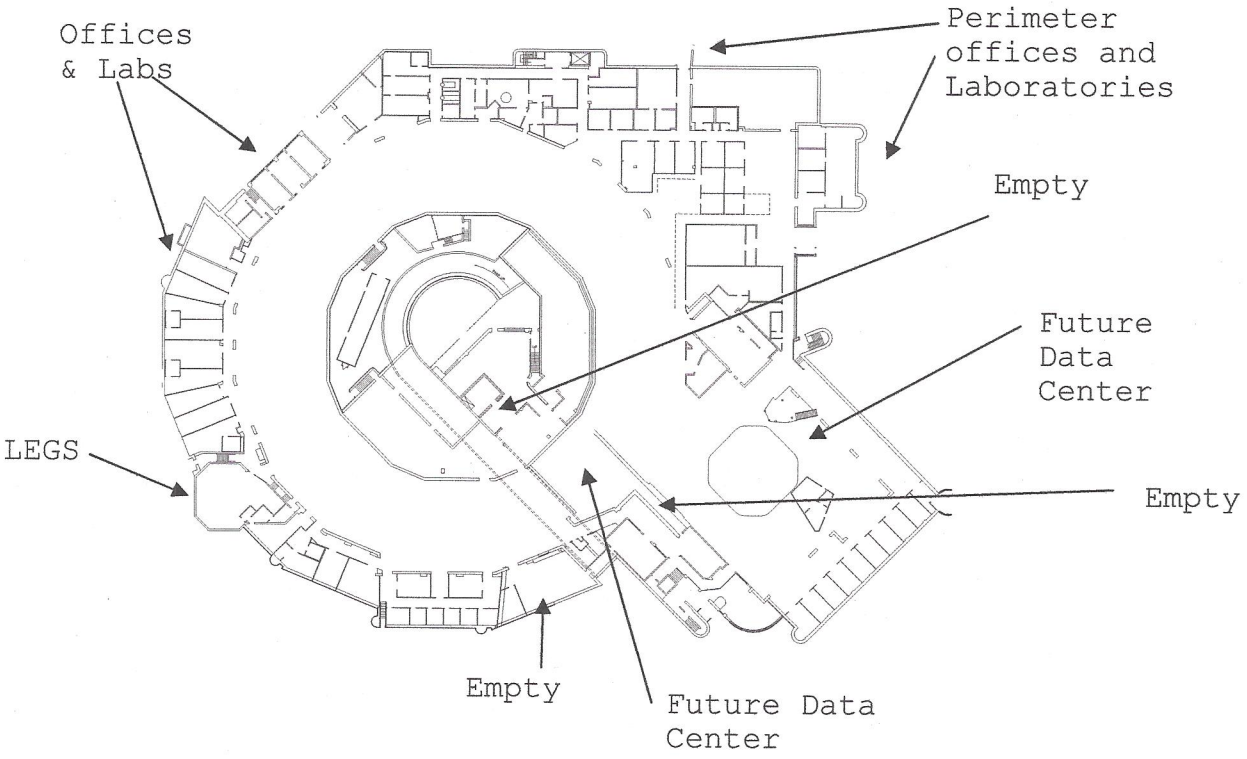

Figure 2: Diagram B-725 First Floor

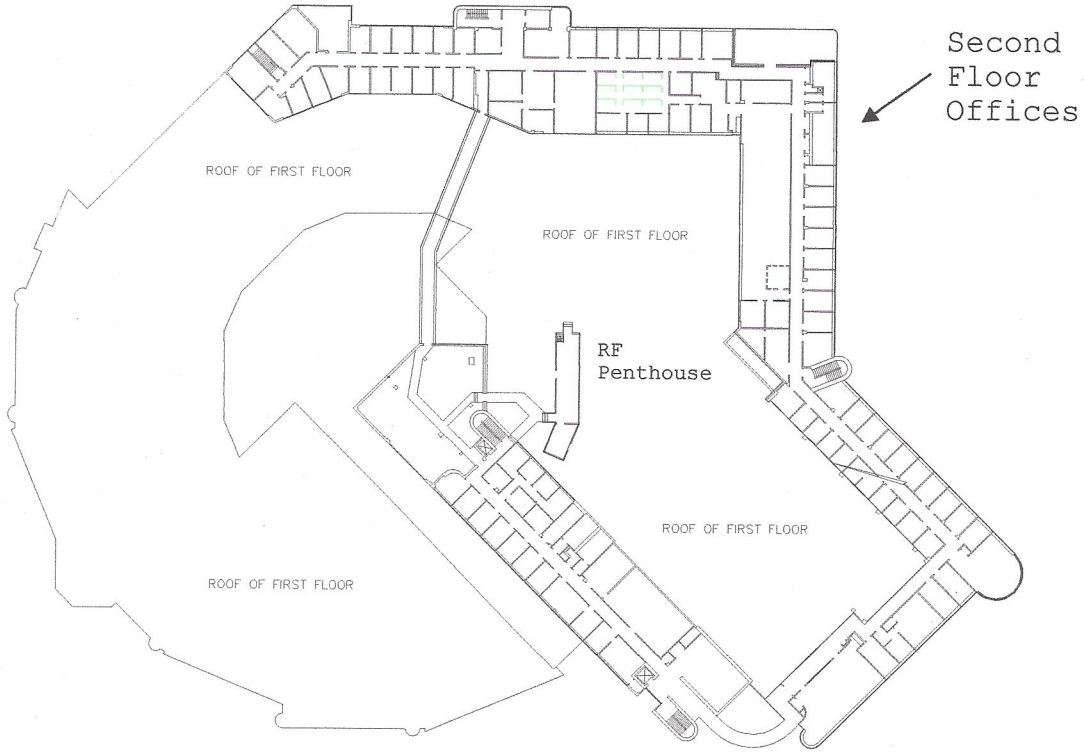

Figure 3: Diagram of B-725 second floor offices.

2.1 Fire Barriers

For protection of the occupants during egress, the stairways are required to be 1-hour fire rated enclosures by the Fire Code of NYS (FCNYS) and NFPA Life Safety Code. The North East center stair does not meet this requirement because unprotected HVAC ductwork penetrates the space within the stairwell (see Recommendation # 1). The stairway enclosure provides an adequate smoke barrier, but does not meet fire barrier requirements. This is a minor deviation due to the low combustible loading in the area and the sprinkler protection provided.

To protect the facility from an electrical transformer fire in the center courtyard, fire barriers are present along the transformer yard south wall and at the doorways located at both ends of the walkway across the courtyard. The interior of the area exterior wall and air dampers are also fire rated. The original design followed Factory Mutual Loss Prevention Data Sheet 5-4. Note that the transformer yard will possibly be removed during proposed renovations.

Each mechanical equipment room was designed with a one-hour fire rated barrier but their integrity has not yet been inspected and verified as intact.

The former NSLS Control Room has been emptied of its contents and the former fire shutter on the window between the X-ray floor and the Control Room has been disabled.

For the original building construction, the main lobby was provided with fire rated shutters on a second floor mezzanine that overlooked the lobby. In addition, the adjacent office was provided with fire rated shutters for the window that overlooked the mezzanine. With Phase II construction, the second floor mezzanine was extended as a walkway around the lobby providing pedestrian access to the new second floor office wing. At that time, the fire shutters were removed or bolted in place to prevent inadvertent operation in the pedestrian walk way. To provide protection in accordance with the Life Safety Code, the new atrium created by the Phase II construction required that the doorways on the walkway be provided with smoke barriers (fusible links on door closures). Current codes require door closure upon activation of the fire alarm system.

Constructed during the Phase II addition, a second floor corridor overlooks the former VUV ring. The panes of glass in this section of corridor have wire glass in steel frames. With the presence of sprinklers on both sides of the viewing glass, the fire separation is considered adequate.

Portions of the exterior insulated metal panel (manufactured by A.H. Robins) were enclosed inside the building with the Phase II and Phase III additions. Due to their UL Large Scale Room Corner ratings, flame spread was considered adequate for interior finishes. The only area where an improvement was made was a Phase II arrangement where the second floor corridor overlooks the former VUV floor. Fire rated gypsum board was directly screwed to the panels to afford a thermal barrier improving flame spread ratings and fire barrier ratings.

2.2 Windstorm Damage Potential

The insulated metal decks were originally designed to withstand 90 mph windstorms per the New York State Building Code and Factory Mutual I-90 rating in effect at the time of construction. Previously reinsulated areas of the roof were fully nailed and also complied with the preceding windstorm ratings. Note that current codes require exterior coverings to maintain integrity utilizing a 120 mph design wind speed.

3. Occupancy and Associated Fire Hazards

When originally constructed, the building was classified by the NFPA Life Safety Code as a mixed use Business 'B' and Special Industrial Occupancy. Since the accelerator systems and components have been removed, the occupancy classification has been changed to a 'B' – Business occupancy. The current proposal is for the building to be utilized as offices for administrative support, engineering support, and use by experimenters along with a dedicated data center facility. Several dry type labs are present but are currently vacant awaiting decontamination.

4. Building value

Utilizing the FIMS database (2/2016), the building has an assigned replacement value of $92,130,258. This is based upon 156K sq. ft. and a replacement value of approximately $590 per sq. ft. This does not include the cost of demolition, utilities, or legacy hazardous waste removal.

5.0 Computational Sciences Data Center (Proposed)

The proposed renovation of the former VUV ring area includes the construction of a high performance computing and data center currently at the 60% Preliminary design stage. This facility is projected to be the cornerstone of the BNL Computational Sciences Initiative, one of the 5 pillars of the BNL Scientific focus.

5.1 Computing Facility Fire Protection Strategy

The design, construction, and operation of this proposed facility shall be in compliance with the following standards:

- DOE O 420.1C, Chapter 2 – Fire Safety
- DOE STD 1066 (2012)
- NFPA 75
- FM Global Data Sheet 5-37 for computer facilities
- IBC (2015 ed.) / BCNYS (2016 ed.)

Because of the importance of this facility to the core BNL mission, the fire protection construction strategy includes the three main concepts of early detection, fire suppression, and segregation / compartmentation. After construction a robust fire inspection and hazard reduction program is envisioned.

5.2 Detection

The computing facility fire detection strategy is to utilize a fully addressable fire alarm panel with an air aspirating, very early warning detector array. This system will be designed to optimize detection in the proposed hot and cold computer aisle design and account for the unique airflow patterns created by such a design. The detector placement shall be configured to capture and detect smoke transients for early warning. The HVAC design shall include duct smoke detection that triggers fan shutdown upon activation to prevent the system from pushing smoke throughout the area.

5.3 Fire suppression-

The Fire Sprinklers shall be a dry pipe, double interlocked, preaction type system, zoned for each compartment. The triggering Inputs include the smoke detection system along with the loss of system air pressure in order to open the main sprinkler valve and flood the piping system.

In accordance with the applicable codes and standards, the design density is 0.20 gpm/sq.ft. over 2500 sq. ft. Additionally, consideration will be given to the installation of a gaseous suppression system to protect the sensitive computer equipment.

5.4 Compartmentation-

The Data Center shall be partitioned into fire separated areas of approximately 5K-10K square feet each with walls having a minimum of a 1 hour 'F' rating. .

The Maximum Permissible Fire Loss / Maximum Expected Fire Loss has not yet been calculated. The equipment is commercial off-the-shelf (COTS) but a fire would result in a significant programmatic impact including shut down for 6 months- 1 year. Stored data loss with difficult, if not impossible data recovery is predicted

The above ceiling environmental air return (plenum) is to be free of combustible materials. All wiring is to be in conduit. Luminaires are to be wired with protected MC Cable. If this is adhered to, then above ceiling detection is not required.
The area below the raised floor environment is to be devoid of any installation. If this is adhered to, then underfloor detection not required.

A separate fire rated compartment for the tape data robots is proposed.

Emergency lighting and signage is powered by either the UPS/flywheel or an emergency generator / battery backup. Life safety features shall have a minimum 90 minute run time. As per the applicable codes, the fire detection system shall have to be backed up with a minimum of a 24 hour battery capacity.

5.5 Cable and Cable Trays –

The computer racks are to be wired via overhead cable trays with vertical or horizontal separation of power and data cables. All cable are proposed to be LSZH rated

6.0 Construction Features
6.1 Cooling Towers

Roof mounted cooling towers are provided for this facility's HVAC system and for past experimental processes (magnet cooling, power supply cooling). The cooling towers are standard industrial towers, constructed of all metal, and are not a fire concern. They are currently idle and a few have been abandoned in place awaiting demolition.

6.2 Flammable Liquid & Gas Storage

The use of flammable liquids is minimal and limited to dry lab type quantities. Use of flammable liquids follows BNL Fire Safety Subject Area and quantities are monitored by the CMS for fire code requirements.

6.3 Housekeeping in Vital Areas

For this high value facility, good housekeeping and control of combustibles is achieved. The self-inspection program (Tier I) monitors routine aspects. The BNL Plan Review Process screens conventional construction operations.

6.4 Highly Combustible Building Materials

The building's exterior insulated walls are constructed using an Underwriter's Laboratory insulated wall panel, listed for construction not needing sprinkler protection.

No significant amounts of exposed polystyrene insulation or other highly combustible building materials are used in other areas of construction or operations at the NSLS.

7. Fire Protection/Suppression Features

7.1 Site Water System

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 350,000 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 gpm for 4 hours) for BNL with two of the system's largest pumps out and one storage tank unavailable. The piping distribution network is well gridded. The distribution system in the area of B-725 has a static supply pressure of 65 psi. The combination domestic and fire water supply system can supply 1,378 gpm at 60 psi (based on test results from a 8/18/97 test). This supply is adequate for the automatic sprinkler system in the building.

Given the high value of the facility, the reliability of water supplies was improved by providing for two separate supplies; one from the north of the facility and one from the south. A set of Post Indicator Valves (PIV) allows the isolation of the north and south feeds prior to entering the facility.

Fire hydrants are provided within 300 ft. 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 Energy and Utilities 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.

7.2 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, (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 2700 people. A minimum of two members per shift hold New York State "Emergency Medical Technician" certifications. Normally all five firefighters have EMT status. The Group operates a New York State Certified Basic Life Support ambulance. Medevac services are available to BNL via the Suffolk County Police Department.

Additionally the Fire/Rescue Group has one 1500 gpm "Class A" Pumper, one 2000 gpm 95' quint, 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 B-725 is estimated at 5 minutes.

BNL participates in the Suffolk County Mutual Aid Agreement which 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 Stony Brook University.

7.3 Site Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage by an Underwriter Laboratory listed multiplexed Site Fire Alarm System. The system complies with the requirements of NFPA 72 for a Style 7D System.

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 Police Headquarters, 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.

All alarms are immediately transmitted to Fire/Rescue for response. Duct Smoke detections are supervisory alarm signals (allowed by NFPA 72) and do not ring fire alarm bells, yet still summon the fire department.

7.4 Fire Extinguishers

Fire extinguishers installed throughout the facilities in accordance with NFPA 10. While hose stations are provided around the facility, they are not provided with hose. They are intended for Fire/Rescue Group use only and do not provide credit for reducing fire extinguisher placement.

7.5.1 Fire Department Standpipe

Fire department standpipes are provided on the perimeter of the former X-Ray Ring, former VUV Ring and in the stairwells. All other areas are accessible by fire department hose lines from the exterior of the facility.

7.5.2 Fire Detection and Suppression

Ceiling mounted spot-type smoke detection is provided in the former X-Ray Ring, former VUV ring, former Control Room, and former RF Power Supply areas. Detectors were installed to activate the pre-action sprinklers which are currently being converted to wet pipe sprinklers.

Elevator lobbies are provided with smoke detection to facilitate elevator recall in compliance with ANSI elevator safety codes.

Duct smoke detection is provided in the air-handling units as per NFPA 90. Note however that the alarm signals are treated as supervisory alarms.

8.0. Fire Protection Special Topics

8.1 Fire Protection of Vital Programs

The operations associated with this facility are projected to be a DOE vital program and the fire protection design strategy has been outlined in section 5.1.

8.2 Fire Protection of High Value Property

Outside of the Data Center, there are no individual systems or components that are considered high value (i.e., exceeding $1 million each).

8.3 Protection of Essential Safety Class Systems

There are no essential safety class systems associated with this non-nuclear facility.

9. Fire Loss Potentials

Fire loss potentials are classified into two major categories; the maximum possible fire loss and the recovery potential. The loss potentials for B-725 are expanded upon in sections 9.1 and 9.2, below.

9.1 Maximum Possible Fire Loss (MPFL)

The Maximum Possible Fire Loss (MPFL) for B-725 is estimated to be in excess of $10 million. MPFL estimates are based on a fire in which active fire suppression systems fail (sprinklers, clean agent fire suppression, manual interior fire fighting efforts). While the value of the facility is in excess of $90 million dollars, continuity of combustibles is lacking. The facility is non-combustible, the interior structures are predominately non-combustible, and contents do not contain many combustibles. Combustibles primarily consist of localized material. Cable trays with combustible cables represent one of the far-reaching combustible materials. However, cables are slow burning and do not produce much heat. They will produce heavy smoke conditions and leave corrosive particulate. Clean up will be extensive and detailed. Clean up will represent most of the cost in recovering from this large building fire.

9.2 Recovery Potential

It is unforeseeable that a credible fire in Building 725 would result in a shutdown of the facility for an excessive period of time (greater than 6 months). Special process spares are in place to provide replacements for long lead items. Computer files (for the accelerators and for vital records) are backed up and stored in another fire area away from the Computer Room. Engineering drawings are backed up and stored in another building.

9.3 Exposure Fire Potential

B-725 is located in the eastern part of BNL. To the north is Bldg. 535, a one story with basement masonry walled building. Established roadways provided engineered features that help protect the facility from a potential wildland fire and exposure fires from other facilities. The roof systems are UL Listed will not ignite from the anticipated burning brands produced in a brush fire.

The electrical substation in the courtyard of Bldg. 725 has been previously analyzed against Factory Mutual Data Sheet 5-4 on fire protection from electrical substations. The installed fire protection is adequate to minimize the damage to the building in the event of a transformer fire.

No other facilities pose a fire exposure to B-725.

10.0 Security Considerations Related to Fire Protection

The facility has security measures to restrict access, including card readers. Provisions have been made for Fire/Rescue access via card reader programming, provision of master key, or installation of interlocked crash doors.

11. Environmental Impact Due to a Fire (Including Water Runoff)

11.1 Toxic Incident

There are no known materials in B-725 that, if involved in a fire, would result in a significant quantity of toxic material being created and released. However, surface lead contamination is noted throughout the building. In the event of a fire lead could be vaporized and dispersed. Fire preplans for B-725 contain information and would lead to proper precautions and clean up. Dispersion outside of the facility is not practical due to the limited combustibles, the large interior space, and the presence of sprinklers.

12. Pre-fire and Emergency Planning

The BNL Fire Department maintains an adequate pre-fire plan book for this facility as part of the Firehouse Response Card System.

A Local Emergency Plan is maintained for the building.

12.1 Fire Apparatus Accessibility

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

Access to the center courtyard and to the north avenue of the NSLS are via 10 ton bridges. While fire apparatus have weights up to 20 tons, structural engineers for the original construction have indicated that the occasional use by fire trucks (once every few years) does not endanger the structure.

13. Life Safety Considerations

DOE mandates the use of NFPA 101, the Life Safety Code. Major life safety considerations for this former industrial facility include the following components: means of egress components and capacity, number and arrangement of the means of egress, travel distances to exits, discharge from the exits, and emergency lighting and marking of the means of egress.

The likelihood of a fast spreading fire is remote, given the nature of combustibles within the facility. Hence the facility is considered to be an "ordinary hazard occupancy."
Travel distances to exits from points inside the building are within the 300-foot limit of Life Safety Code for sprinklered Business Occupancies. There is a clear path from the courtyard in the center of the building, over a ramped roadway, to the street ("public way").

The permitted occupant load is based on floor area and on occupant load factors. The occupant load factor for Business occupancy is 100 sq.ft. /person. The permitted occupant load for the building is 1,400 people, based on a conservative estimate that 5,200 of the building's 162,156 sq.ft. are tunnels and mechanical rooms.

Emergency power is provided to the lighting throughout the facility. Sodium lights used for emergency power are provided with incandescent elements to provide light during the restrike time. The emergency power source is an existing emergency generator located north of Bldg. 725. The generator is tested by Facilities and Operations in accordance with NFPA 110 but does not meet the maximum 10-second transfer time.