

NSLS II

Conceptual Design Preliminary Life Safety Code Review

Prepared by:

HDR Architecture Inc.

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1.0 CODE ANALYSIS

1.1 General

1.1.1 Introduction

This report serves as the Program of Record Phase Fire Protection Analysis Report for National Synchrotron Light Source II at Brookhaven National laboratories, Upton, New York. It is intended to identify minimum requirements for the building as mandated by the applicable codes and standards, user needs, or required operations as requested by BNL. This document will be used as a reference by the design team and BNL throughout subsequent phases of the project.

1.1.2 Purpose

The purpose of this report is to summarize the fire protection and life safety requirements contained in the codes and standards applicable to the project. This report identifies the minimum code requirements that will provide an acceptable level of fire/life safety. Measures, which result in an increased level of fire/life safety are not discussed. Requirements regarding accessibility for the disabled and other disciplines, except for fire alarm requirements, are outside the scope of this report and are not discussed.

This report is limited to the most restrictive requirements contained in the codes listed in this report. Throughout the report, code reference sections are provided in parenthesis following each requirement to facilitate review of the provisions in detail.

1.2 Applicable Codes and Standards

The facility design will be in accordance with the codes, standards and guidelines as listed above. Where there is a conflict between two or more codes, the most stringent requirement will be used.

1.3 Occupancy Classifications

1.3.1 Main Use

NYSBC section NYSBC 304.1 classifies the overall building occupancy as a Group B (Business) occupancy, this includes the Ring Building including the Linac and RF Buildings, the four Lab Office Buildings and the Central Lab Office Building. Other accessory use spaces within the NSLS II will be classified as shown in Table 1.1 below.

Table 1.1 Building Classification.

Space	Code Ref.	Occupancy Classification
Ring Building, Central Lab Office Building, Lab Office Buildings, Linac, RF Building	NYSBC 304.1	Group B, Business
Auditorium	NYSBC 303.1	Group A-1, Assembly with fixed seating
Breakout Rooms and Conference Rooms over 750sf	NYSBC 303.1	A-3, Assembly without fixed seats
Chemical and Gas Storage over the amount allowed per control area.	NYSBC 307.4 NYSBC 307.5	H2 or H-3 High Hazard Storage.

Per NYSBC Sec. 302.2, Accessory Use Areas are not required to have fire barrier separation if the accessory use area is < 10% of the area of the story in which it is located. Per NYSBC Table 302.3.3 note d. accessory assembly use A-3 area is not considered a separate occupancy from the main occupancy if the floor area of the given assembly use is less than 750sf. Per Section 303.1 an assembly area with less than 50 occupants will not be considered a separate occupancy from the main occupancy.

1.3.2 Separations between Occupancies

In accordance with table 302.3.3 of the NYSBC separations between occupancies shall be as follows:

- Between “B” Occupancy and A-1 Occupancy: Two hour fire barrier wall separation and 1 1/2 hour door separation, unless it is less than 50 occupants than no separation is required.
- Between “B” Occupancy and A-3 Occupancy: Two hour fire barrier wall separation and 1 1/2 hour door separation, unless it is less than 10% of floor area, or less than 750sf, than no separation is required.
- Between “B” Occupancy and H-2 Occupancy: two hour fire separation and 1 1/2” hour door separation.
- Between “B” Occupancy and H-3 Occupancy: one hour fire separation and 3/4 hour door separation.

NYSBC section 302.3.3 exception (1) allows one hour rated separation deduction for a fully sprinklered building.

1.4 Construction

1.4.1 Type of Construction

The NSLS II will be a Type IIB construction per NYSBC section 602.2, unprotected non-combustible. Type II-B also requires fully non-combustible (and therefore inorganic), construction which is also beneficial to a laboratory-use based project.

1.4.2 Allowable Area

The main building will be classified as a two story building and will have an unlimited fire area per NYSBC section 507.3 because it has a automatic fire sprinkler system and will be surrounded on all sides with a 60ft wide yard or public way.

The Central Lab Office Building (CLOB) will three stories but part of it outside the Ring Building will be separated from the rest of the building with a two hour fire wall construction as defined in NYSBC section 705 and table 705.4(a) for Type II construction. The maximum area of the CLOB, outside the Ring Building, will be a minimum of 69,000sf before area modifications. The maximum height will be 55 feet above grade plane. The following illustrates the maximum allowable individual floor and overall building gross square footage possible under Type II-B construction, if all of the additional area modifications are used, Per NYSBC Chapter 5:

The governing NYSBCC Sec. 503 area increase formula is:

$$A_a = A_f + \frac{A_t I_f}{100} + \frac{A_t I_s}{100}$$

where:

A_a = Allowable area/floor (sf)

A_t = Tabular area/floor in accordance w/ Table 503 (= 23,000 gsf for Type II-B)

I_f = Area increase due to frontage (%) as calculated in accordance w/ Sec. 506.2 (see calculation below; 80%)

I_s = Area increase due to sprinkler protection (%) as calculated in accord w/ Sec. 506.3 (200% for multi-story building)

The specific value for the frontage increase indicated by the “ I_f ” value in the area increase formula above is:

$$I_f = 100((F/P)-0.25)(W/30) ;$$

$$I_f = 100((73/100)-0.25)(300/30)$$

$$I_f = 100(.48)(1)$$

I_f = 48% Area increase due to frontage

F = Bldg perimeter which fronts on a public way or open space w/ > 20ft open width (expressed as 73%. This includes the auditorium portion where it is more than 20’ from adjacent walls.)

P = Perimeter of entire bldg. (expressed as 100%)

W = Minimum width of public way or open space (based on the approximately 100ft of open space on three sides, but shall not exceed 1)

THEREFORE, the increased maximum allowed area per floor is :

$$A_a = (23,000) + \frac{(23,000)(.48)}{100} + \frac{(23,000)(200)}{100}$$

(Type II-B construction):

$$A_a = 23,000 + 11,040 + 46,000$$

$$A_a = 80,040 \text{ gsf/flr}$$

Per NYSBC Sec. 506.4, the total building allowed area is (3x) the total single floor allowed area, therefore the total allowable building area based on Type II-B construction would be:

$$\text{TOTAL ALLOWED BLDG.AREA} = 80,040 \text{ gsf/flr} \times 3 = 240,120 \text{ gsf}$$

(Type II-B, “B” occupancy)

1.4.3 Mezzanines – (NYSBC section 505)

Section 505.1: A mezzanine(s) in compliance with this section shall be considered a part of the floor below. Such mezzanines shall not contribute to the building area or number of stories regulated by Section 503.1. The area of the mezzanine shall be included in determining the fire area defined in Section 702. The clear height above and below the mezzanine floor shall be 7'-0" clear minimum.

Section 505.2 Area Limitations: The aggregate area of a mezzanine or mezzanines with in a room shall not exceed one-third of the area of the room in which it is located.

Section 505.3 Egress: There shall be two independent means of egress where the common path of travel does not exceed the limitations set forth in section 1004.2.5. There will be exits from the mezzanines based on exiting distances, there should be an exit every 600 feet.

Section 505.4 Openness: A mezzanine shall be open and unobstructed to the room within which it is located, except for walls not more than 42" high, columns and posts.

1.4.4 Control Areas – (NYSBC section 414.2)

Control Areas shall be areas within the building where quantities of hazardous materials not exceeding the maximum quantities allowed by this code are stored, dispensed, used or handled.

Wall Construction – NY SBC 414.2.1: The control areas need to be separated from each other with a 1 hour Fire barrier Wall (per section 706) or as called for in Table 414.2.2.

Floor construction – NY SBC 414.2.3: The floor construction and the construction supporting the floor shall have a 2 hour fire resistance rating.

Number of Control Areas per floor is governed by NY SBC Table 414.2.2 and is summarized below in Table 1.2.

Table 1.2 Control Areas per Floor.

Floor Level	Number of Control Areas
Below Grade	3
Above Grade First floor	4
Above Grade Second Floor	3
Third Floor	2

1.4.5 Minimum Fire Resistance Ratings for TYPE II-B

The minimum fire resistance ratings for Type II-B construction is given in NYSBC Tables 601 & 602. the applicable data is shown in Tables 1.3 and 1.4 below.

Table 1.3 Fire Resistive Rating Requirements for Building Elements.

Building Element	(Hours)
Structural Frame (Including columns, girders, trusses)	0
Bearing Walls:	
Exterior	0
Interior	0
Nonbearing walls and partitions:	
Exterior	(SEE TABLE 15.8.4)
Nonbearing walls and partitions:	
Interior	0
Floor Construction (Including supporting beams and joists)	0
Roof Construction (Including supporting beams and joists)	0
Per NYSBC Section 707: Exit Enclosures – 707.4 (connecting less than 4 stories)	1
Shafts – at floor Penetrations (connecting no more than two floors)	0
Shafts – at floor Penetrations (connecting more than two floors) Shafts are not required from a mezzanine to the floor below	1
Corridors – NYSBC Table 1004.3.2.1, greater than 30 Occupant Load With sprinklers	0
Control Areas – NYSBC 414.2, from each other	1

TABLE 1.4 Fire-Resistive Rating Requirements for Exterior Walls On Fire Separation Distance.

Fire Separation Distance	Type of Construction	Rating (hours)
< 5ft	II-B	1
≥ 5ft < 10ft	II-B	1
≥ 10ft < 30ft	II-B	0
≥ 30ft	II-B	0

1.4.6 Protection of Openings

General opening protective ratings in accordance with NYSBC Table 715.3 are as follows:

Table 1.5 Protective Ratings of Openings.

Wall Type	Protective Rating
2-hour fire walls and fire barriers:	
Chemical storage rooms (NFPA 30-4-4.1.2)	1-1/2 hrs
1-hour fire barriers:	
Shaft exit enclosure and exit passageway walls	1
Other fire separation wall assemblies	3/4
Chemical storage rooms (NFPA 30-4-4.1.2)	3/4
Fire partitions:	
Corridor walls	1/3
Other fire partitions	3/4
Exterior Wall Openings: (NYSBC Table 704.8)	See Table 15.8.5

The maximum area of unprotected openings permitted in an exterior wall in any story may not exceed the following values. Note that per IBC Sec. 704.8.1, buildings that are fully sprinkled in accordance with Sec. 903.3.1.1, the “Unprotected” values are used in lieu of the “Protected” values. Fire separation distance is defined as the distance measured from the building face to the closest interior lot line, to the centerline of the street or public way or to an imaginary line between two buildings on the same property

Table 1.6 Unprotected Opening in Exterior Walls

Fire Separation Distance ft	Percentage of Exterior Wall Area (unprotected Values)	Percentage of Exterior Wall Area (Protected Values)
0 to 3	Not permitted	Not permitted
Greater than 3 to 5	Not permitted	15 %
Greater than 5 to 10	10 %	25 %
Greater than 10 to 15	15%	45%
Greater than 15 to 20	25 %	75 %
Greater than 20 to 25	45 %	Not limited
Greater than 25 to 30	70 %	Not limited
Greater than 30	Not limited	Not limited

1.5 Interior Finishes

1.5.1 Interior Finish Flame Spread Ratings

Interior flame spread rating shall be established in accordance with NYSBC Sec. 803 & Table 803.4 - “Sprinkled” values

- Vertical exits and exit passageways: Use Group B Class B
- Exit access corridors and other exitways: Use Group B Class C
- Rooms and enclosed spaces: Use Group B Class C
- Plastics: Foam plastics installed as interior trim or finish shall comply with NYSBC Sec 2604.
- Acoustical Ceilings: Acoustical ceiling materials exposed within a plenum space shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84.
- Plenum Wire: All wiring within plenum spaces shall conform to Article 300.22 of NFPA 70, National Electrical Code.

1.5.2 Interior Floor Finish/Covering Classifications

Finished floors or floor covering materials of a traditional type, such as wood, vinyl, linoleum, terrazzo and other resilient floor covering materials are acceptable, and shall comply with NYSBC Sec. 804.5.

Carpeting and similar materials should comply with the DOC FF-1 "pill test" (CPSC 16 CFR, Part 1630).

Where building is equipped throughout with an automatic sprinkler system, class II are permitted where Class I materials are required.

1.6 Means of Egress

1.6.1 Exits

The minimum number of exits is based on occupancy in accordance with NYSBC Sec. 1005.2.1. All rooms and spaces within each story shall be provided with and have access to the minimum number of approved independent exits as required by Table 1.7.

Table 1.7 Minimum Number of Exits for Occupant Load.

Occupancy	Minimum # of Exits
1 - 500	2
500 – 1,000	3
Over 1000	4

Exit Access is established by NYSBC Section 1004. Maximum Travel Distance shall be in accordance with NYSBC Sec. 1004.2.4 & Table 1004.2.4. The maximum length of exit access travel, measured from the most remote point in an area to an exit, should not exceed the values in Table 1.8.

Table 1.8 Exit Access Travel Distance.

Occupancy	w/ Sprinkler System (feet)
Assembly (A), Storage (S-1)	250
Business (B)	300
High Hazard Storage (H2)	100
High Hazard Storage (H3)	150

Based on the above information and the circumference of approx. 2600 feet the number of exit access points into the Ring Building is 5 doors at a maximum of 600feet apart.

Dead Ends are limited by NYSBC Sec 1008.8.5. The maximum dead-end distance shall not exceed 20 feet, except for “B” and “F” occupancies where the limit is 50 feet in a fully sprinkled building.

Common Path of Travel is limited by NYSBC Sec. 1004.2.5. The maximum common path of travel should not exceed the limits of Table 1.9.

Table 1.9 Maximum Common Path of Travel.

Occupancy	Common Path of Travel
Assembly (A)	75 ft
Business (B), including Labs and Mechanical spaces	100 ft
High Hazard H-2 or H-3	25 ft

Egress Width is established by NYSBC Table 1003.2.3. Using the sprinkled building values, the required egress widths are as follows:

- Stairways: 0.2 inches/person
- Other Egress Components: 0.15 inches/person
- Exit Access Corridor Width Minimum: 44 inches (NYSBC Sec. 10043.2.2; 24 inches for access to electrical, mechanical or plumbing systems, 36 inches with a required occupant capacity of <50.)
- Doors shall not reduce the required width to less than one-half during the swing, and no more than 7 inches when fully open.

Exit or Exit Access Doorway Arrangement is governed by NYSBC Sec. 1014.2.1, Exception 2. Where a building is equipped throughout with an automatic sprinkler system in accordance with Sec. 903.3.1.1 or 903.3.1.2, the separation distance of the exit doors or exit access doorways shall not be less than one-third of the length of the maximum overall diagonal dimension of the area served.

Vertical Exit Enclosures must have fire ratings in accordance with NYSBC 707.4. Interior exit stairways and interior exit ramps shall be enclosed with fire barriers. Exit enclosures shall have a fire-resistance rating of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories.

Horizontal Exits are governed by NYSBC Sec. 1005.3.5. A horizontal exit shall not serve as the only exit from a portion of the building, and not more than one-half of the total number of required exits from a portion of the building. The horizontal exit shall be separated by a fire wall complying with Sec 705 or a fire barrier

Exit Discharge requirements are established by NYSBC Sec. 1006. All exits should discharge directly to the exterior of the building. The exit discharge shall be at grade or shall provide direct access to grade. The exit discharge shall not re-enter a building. Exception #1 states that a maximum of 50 percent of the number and capacity of the exit enclosures is permitted to egress through areas on the level of exit discharge provided all of the following area met:

- Exits discharge to a free and unobstructed way to the exterior of the building, which is readily visible and identifiable from the point of termination of the exit enclosure.
- The entire area of the level of discharge is separated from areas below by construction conforming to the fire-resistance rating for the exit enclosure.

1.6.2 Egress Capacity and Width

The occupant load of a room, space or floor shall be determined using the occupant load factors from NYSBC Sec 1003.2.2 as shown in Table 1.10.

Table 1.10 Maximum Floor Area Allowances per Occupant

Use	ft ² /person
Offices, Industrial (Labs)	100 gross
Conference Rooms (Tables & Chairs)	15 net
Loading Docks, Storage, Mechanical/Electrical Rm.	300 gross

1.6.3 Doors

Doors shall meet the requirements of NYSBC 1003.3.1 and 1005.3.1. Two exits or exit access doorways from any space shall be provided where one of the following conditions exists:

- The occupant load of the space exceeds the values in Table 1.11
- The common path of egress travel exceeds the limitations of Section 1004.2.5 shown in Table 1.10.
- Where required by NYSBC Table 1003.2.1

Table 1.11 Spaces with One Means of Egress

Occupancy	Maximum Occupant Load
Assembly (A) , Business (B)	50
High Hazard Storage (H2 and 3)	3

The minimum clear door width is 32 inches as established by NYSBC 1003.3.1.1 and 1005.3.1. Where a pair of doors are provided, at least one of the doors should provide a minimum clear width opening. The maximum width of a door leaf 48 inches.

Floor elevations at door openings is set by NYSBC Sec. 1003.1.4. The floor shall be the same elevation on both sides of the door, and level except for exterior landings, which are permitted a slope of 2%. Thresholds at doorways shall not exceed 1/2 inches. (NYSBC 1003.3.1.6)

Door Swing is specified by NYSBC section 1003.3.1.2. All means of egress doors regardless of occupancy shall swing in the direction of egress where serving a room with an occupant load of 50 or more persons, and for all H occupancy rooms. All egress doors shall be readily open-able from the side from which egress is made without the use of a key or special knowledge or effort (NYSBC Sec. 1003.3.1.8).

Latches and Panic Hardware are specified by NYSBC Sec 1003.3.1.8.3. A latch or other fastening device on a door should be provided with a knob, handle, exit device or other simple releasing device having an obvious method of operation under all lighting conditions. Doors shall be open-able with no more than one releasing operation. The releasing mechanism for any latch shall be installed between 34 inches and 48 inches above the finished floor.

1.6.4 Stairways

Stairways shall comply with NYSBC sections 1003.3.3.1 through 1003.3.3.12.1.

The minimum clear width of stairways is to be determined by Table NYSBC 1003.2.3 – Stairways, but not less than 44inches per 1003.3.3.1. Protruding Objects are limited by NYSBC sections 1003.2.5.1, 1003.5.4 and 1104.

Stair construction (NYSBC 1003.3.3.5) shall be of materials consistent with the construction type.

The minimum dimension of landings measured in the direction of travel shall be equal to the required width of the stairway. (NYSBC Sec 1003.3.3.4)

Minimum Headroom (NYSBC Sec. 1003.3.3.2): 80 inches.

Maximum Height Between Landings (NYSBC Sec. 1003.3.6): 12 feet.

Treads and Risers (NYSBC Sec. 1003.3.3.3):

- Maximum riser height - 7 in
- Minimum riser height - 4 in
- Minimum tread depth - 11 in

Stair Dimensions (NYSBC Sec. 1003.3.3.3.1): Stair dimensions should be uniform. Variation between treads or risers should not exceed 3/8 in.

1.7 Elevators

Elevators shall be designed in accordance with NYSBC section 1003.2.13.3. All passenger elevators shall be accessible in accordance with ADAAG, and ANSI A117.1.

1.8 Ramps

Ramps shall be designed in accordance with NYSBC section 1003.3.4.