Fermilab

PRELIMINARY ARCHITECTURAL CODE ANALYSIS

FOR Mu2e BUILDING

Mu2e BUILDING

Batavia, Illinois

middough

OAK BROOK, IL

Middough Project No. FNA1301

Rev	Date	By	Checked	Approved	Description
A	5/16/13	MY	FTH		Issued for Client Review
B	7/12/13	MY	FTH		Re-issued for Client Review

A. OVERALL PROJECT DESCRIPTION

1. Overall Description:

a. The project consists of a new single story Mu2e Building with a basement/underground lower level. Located on the main floor, are the entrance vestibule, the break room, elevator, enclosed stairs, men & women single-use toilet facilities, the Electrical Power room, the Data acquisition room, the Mechanical Room, and the high-bay truck unloading area with access to the lower level. On the lower basement/underground level and connected to an underground transport enclosure tunnel, are the Solenoid Production, Solenoid Transport & Solenoid Detection Areas, Mechanical and Electronics Rooms. The basement/underground lower level is not normally occupied except for periodic maintenance, adjustments and experiment setup activities.

2. Proposed Building:

a. Proposed Height: 32'-6"

b. Proposed Use: A basement/underground experimental space housing Solenoid Equipment, with a truck unloading area, electrical and mechanical support spaces on the Main Floor.

c. Proposed Areas:

   a. Ground Floor: Approx. 13,000 SF

   b. Lower Level: Approx. 14,300 SF

d. Proposed Occupancy: F-2 Low-Hazard Factory Industrial

e. Proposed Construction Type: Above ground construction is Type II-B non-combustible Construction (Metal Building system with unprotected steel) while the basement is constructed of cast-in-place concrete. ~~underground portions of the building shall be of Type I non-combustible construction.~~

f. Sprinklered: All levels of the Mu2e building will be fully sprinklered per recommendations from Fire Protection/Life Safety Analysis prepared by AON Fire Protection Engineering on May 28, 2013.

g. Envelope: Insulated Metal Panel System over Steel Frame

B. APPLICABLE CODES (as provided by Fermilab)

Building Code:	2009 International Building Code
Life Safety:	2009 NFPA 101 – Life Safety Code
Mechanical Code:	2009 International Mechanical Code
Electrical Code:	2008 National Electric Code & NFPA 70
Plumbing Code:	2004 Illinois Plumbing Code
Fire Code:	2009 International Fire Code
Accessibility Code:	2009 IBC with ANSI117.1-2003 (by Reference), 2010 ADAAG & 1997 Illinois Accessibility Code
Energy Conservation:	2009 International Energy Conservation Code *Alternatively:* ANSI/ASHRAE/IESNA 90.1 – 2007 (by reference from IECC)

Unless noted otherwise, all references to code sections are from the 2009 edition of the International Building Code.

C. USE & OCCUPANCY CLASSIFICATION

1. Background

A Fire Protection/Life Safety Analysis for the Fermilab Mu2e Building was prepared by AON Fire Protection Engineering on May 28, 2013. This report classifies the entire building as F-2 Low-hazard Factory Industrial occupancy. This classification is consistent with other buildings of similar use on the project site.

2. Mu2e Facilities:

a. Classification: F-2: Low-hazard Factory Industrial

b. Code Section 306.3

F-2: Factory Industrial – Low Hazard Occupancy: *Factory industrial uses that involve the fabrication or manufacturing of noncombustible materials which during finishing, packing or processing do not involve a significant fire hazard shall be classified as F-2 occupancies and shall include, but not limited to, the following:* (306.1):

- *Beverages: up to and including 16-percent alcohol content*
- *Brick and masonry*
- *Ceramic products*
- *Foundries*
- *Glass products*
- *Gypsum*
- *Ice*
- *Metal products (fabrication and assembly)*

Clarification: While code section 306.3 does not specifically address Solenoid experimental functions within the proposed Mu2e building, this code classification would be applicable as long as the proposed experiment functions and support areas "involve the fabrication of noncombustible materials which during processing do not involve significant fire hazard". **This assumption will be verified with the owner in the next design phase to demonstrate that the proposed Mu2e facility meets the criteria for F-2 occupancies per section 306.3. In addition, the quantities of hazardous materials within the facility shall not exceed the maximum allowable quantity limits for control areas set forth in Tables 307.1(1) and 307.1(2).**

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3. Conclusion:

In the sections below, requirements for F-2 will be used to demonstrate compliance, though level of fire hazard of the experiment needs to be verified with Fermilab.

D. UNDERGROUND BUILDING CONSIDERATION (405)

The owner's Fire Protection/Life Safety Analysis prepared by AON Fire Protection Engineering on May 28, 2013 makes reference to provisions of the Building code related to underground buildings. Upon further analysis of section 405 of the building code, it is determined that only building spaces having a floor level used for human occupancy more than 30 feet below the finished floor of the lowest level of exit discharge, are classified as Underground Buildings. **Therefore, the Mu2e Building would not be considered an underground building since the lowest floor level (at EL. 721'-0") used for human occupancy is less than 30 feet (25'-6" proposed) below the finished floor (at EL. 746'-6") of the lowest level of exit discharge.**

However, Fermilab FESS Design Guide for Fire Safety may require the compliance with NFPA 520 Standard on Subterranean Spaces. This requirement will need to be confirmed and addressed by AON.

405.1 General – Underground Buildings

The provisions of this section apply to building spaces having a floor level used for human occupancy more than 30 feet below the finished floor of the lowest level of exit discharge .

E. SPRINKLERS (Sect. 903 and 405)

1. **Section 903.2:** An automatic sprinkler system is not required for type F-2 occupancy.
2. **Section 405.3:** An automatic sprinkler system is required for an underground building.

Conclusion: ~~Further analysis of the building code is required to determine the classification of the building as an underground building to evaluate whether a sprinkler system is required.~~ **Owner has elected to sprinkle all levels of the Mu2e building. Automatic Fire Sprinkler System, fire detection & alarm system, portable fire extinguishers, emergency power and standby power systems requirements are detailed in the Fire Protection/Life Safety Analysis prepared by AON Fire Protection Engineering on May 28, 2013.**

F. CONSTRUCTION TYPE (per IBC Table 601)

The proposed building design consists of a steel structure with metal siding and roof and without any fire-proofing of the structural components. The overall structure complies with Construction Type II-B per Table 601.

G. HEIGHT & AREA LIMITATIONS (Sect. 503-504)

1. **Area.**
   a) Proposed Ground Floor Area: Approx. 13,000 SF
   b) Proposed Lower Level Area: Approx. 14,300 SF

   Maximum allowable for F-2 of Type II-B construction (Table 503)
   - 23,000 SF (non-sprinklered)
   - 92,000 SF (sprinklered with 300% increase per Sect. 506.3) > 14,300 SF
2. **Height.** Proposed Building height = 32'-6".

   Maximum allowable height for F-2 of Type II-B construction (Table 503)

b. 36" min for exit passageways serving an occupant load of less than 50.

c. 24" min. corridor width for access to and utilization of electrical, mechanical or plumbing systems or equipment.

5. Common path of egress travel – according to section 1014.3, in occupancies other than Groups H-1, H-2 and H-3, the common path of egress travel shall not exceed 100 feet (sprinklered).

6. Door encroachment (per Sect. 1005.2): Doors, when fully opened, and handrails shall not reduce the required means of egress width by more than 7 inches. Doors in any position shall not reduce the required width by more than one-half. Other nonstructural projections such as trim and similar decorative features shall be permitted to project into the required width a maximum of 11/2 inches on each side.

   Comment: Swings for Doors 017A & 017B, that are currently encroaching on the required width for exit passageway 017, will need to be reconfigured.

7. Stairways (1009):

   a. Min. width (for occupant load of more than 50): 44 inches

   b. Min. width (for occupant load of less than 50): 36 inches

   c. Risers: Min. 4 inch, max. 7 inch.

   d. Tread: Min. 11 inch

   e. Landing: required at top and bottom of stairs and intermediate point if rise is greater than 12'-0"

      i. Width: Not less than width of stairs.

      ii. Length (in direction of travel): not less than width of stairs, need not exceed 48 inches.

      iii. Door intrusions: Doors opening onto a landing shall not reduce the landing to less than one-half the required width. When fully open the door shall not project more than 7 inches into a landing.

   f. Handrails (1012): Required on both sides of stairs.

      i. Max. Projection: Handrails may project into the minimum required stairway width no more than 4 ½ inch at or below handrail height.

      ii. Height: 34 inches to 38 inches

      iii. Extensions: Handrails shall extend horizontally 12" min. beyond the top riser and continue to slope for the depth of one tread beyond the bottom riser plus 12" min. horizontal extension. (Illinois ADA Requirement)

   g. Guardrails (1013): Required on open side of stair and landing.

      i. Max. Opening between pickets to be less than 4 inches.

      ii. Height: 42 inches.

8. Boiler, Incinerator and Furnace rooms (1015.3):

   Boiler incinerator and furnace rooms where the area is over 500 square feet, and any fuel-fired equipment exceeds 400,000 Btu/hr. input capacity … shall comply with:

   a. Have min. 2 exits access doors

IT LOOKS LIKE WE HAVE 3/4 width clearance ON CDR DRWGS

- 3 stories – 55 feet (non-sprinklered)
- 4 stories – 75 feet (sprinklered with increase per Sect. 504.2) > 1 stories - 32'-6"

Conclusion: The proposed building is well below the allowable height and area limitation.

H. OCCUPANCY LOAD (Calculated) – Section 1004.1.2 – Table 1004.1.1

1. **Lower Level:**
   a. Experiment Areas: 14,300 / 100 = **143 People** (based on 100 sf/occupant for industrial areas)
2. **Ground Level:**
   a. Industrial area: 9,400 SF / 100 = 94 People (based on 100 sf/occupant for Industrial areas)
   b. Mechanical/Electrical Equipment Rooms: 1,000+2,600 / 300 = 12 People (based on 300 sf/occupant for Mechanical Equipment areas)
   c. Total Ground Level calculated Occupancy Load: Approx. **106 People**
3. **Total calculated Occupancy Load for the Mu2e building: Approx. 249 People**

I. MEANS OF EGRESS (per IBC, Chapter 10)

Main Floor and Lower Level Life Safety Drawings will be prepared to review compliance with applicable Life Safety and Accessibility code requirements.

1. Max. Travel Distance (per Table 1016.1)
   a. Use Group F-2 sprinklered = 400 feet

2. Dead End Corridor (1018.4) – *only applicable to buildings and areas required to have more than one exit.*
   a. Use Group F-2 sprinklered = 50 feet

3. Minimum number of exits required (per Table 1021.1)
   a. Occupant load of 1- 500: 2 exits (except as modified by Section 1021.2)
   b. *1021.2: Single Exits: Occupancies shall be permitted to have a single exit in buildings otherwise required to have more than one exit if the areas served by the single exit do not exceed the limitations of Table 1021.2:*
      i. *First Story (F occupancy): maximum 49 occupants and 100 feet travel distance (increase from 75' to 100' per footnote d with sprinkler system).*
   c. Spaces with one Exit (Table 1015.1): Maximum Occupant Load = 49 for "F-2" Occupancy

4. Width of corridors (per Sect. 1018.2)
   a. 44" min for exit passageways serving an occupant load of more than 50.

b. Exit access doors shall be separated by a horizontal distance equal to one-half the maximum diagonal dimension of the room. Second exit access doorway may be a fixed ladder or an alternating tread device (ships ladder).

Comment: The proposed mechanical room (approx.1,000 sf) houses AHU with furnace components in excess of 600,000 BTU/hr each. Therefore, a second means of egress is required.

9. Exit Enclosures (1022):

The code requires interior exit stairs to be enclosed.

1022.1 Enclosures required. Interior exit stairways and interior exit ramps shall be enclosed with fire barriers constructed in accordance with Section 707 or horizontal assemblies … Exit enclosures shall have a fire-resistance rating of not less than … 1 hour where connecting less than four stories. The number of stories connected by the exit enclosure shall include any basements but not any mezzanines. Exit enclosures shall lead directly to the exterior of the building with an exit passageway conforming to the requirements of Section 1023, … An exit enclosure shall not be used for any purpose other than means of egress.

Exceptions:

a. *In all occupancies, other than Group H and I occupancies, a stairway is not required to be enclosed when the stairway serves and occupant load of less than 10 and the stairway complies with: … The stairway is open to not more than one story above its level of exit discharge…*

1022.6 Exit Enclosures exterior walls. Exterior wall of an exit enclosure shall comply with the requirements of Section 705 for exterior walls. Where nonrated walls or unprotected openings enclose the exterior of the stairway and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building exterior walls within 10 feet horizontally of a nonrated wall or unprotected opening shall have a fire-resistance rating of not less than 1 hour. … The construction shall extend vertically from the ground to a point 10 feet above the topmost landing of the stairway or to the roof line, whichever is lower.

h. **Conclusion:** Since the calculated occupancy load is more than 10 on the lower basement/underground level, the stairway serving the lower level does need to be enclosed with a 1-hour enclosure and a discharge door on the ground level.

However, the Fire Protection/Life Safety Analysis prepared by AON Fire Protection Engineering on May 28, 2013 recommends that exit stairways be enclosed in 2-hour fire rated construction. Fermilab to confirm if Middough should design 2-hour fire rated stair enclosures in lieu of the 1-hour fire rated enclosures required by IBC.

PREFER 2-HOUR WITH 90 MIN. TO BE CONSISTENT

Comment: The Exit stairway (002/102) previously exits into the elevator lobby per the original design. A second door has been ~~need to be~~ added on the ground level to discharge directly to the outside~~, or alternatively an exit passageway will need to be provided in compliance with section 1023~~.

10. Exit Passageways (1023):

1023.1 Exit passageway.

Exit passageways serving as an exit component in a means of egress system shall comply with the requirements of this section. An exit passageway shall not be used for any purpose other than as a means of egress .

1023.2 Width.

The width of exit passageways shall be determined as specified in Section 1005.1 but such width shall not be less than 44 inches, except that exit passageways serving an occupant load of less than 50 shall not be less than 36 inches in width.

1023.5 Openings and Penetrations.

... Elevators shall not open into an exit passageway.

Conclusion: The elevator lobby cannot function as an exit passageway, therefore stair 002/102 needs to discharge directly to the exterior, and an exterior door is required from the staircase.

Comment: Stair 114 currently discharges to the exterior of the building at grade. However, two doors from adjoining rooms that were previously ~~are~~ discharging through the staircase to the exterior has been eliminated. ~~Fermilab's Life Safety consultant stated that a fire rated door is required at the top of the stairs essentially creating an Exit Passageway. This will need to be evaluated further.~~

J. FIRE-RESISTANCE RATING REQUIREMENTS for Exterior walls Based on Fire Separation Distance (Table 602)

Fire Separation Distance	"Group F-2", Type IIB construction (per Table 602)
<5'	1 hr
5'<X<10'	1 hr
10'<X<30'	0 hr
>30'	0 hr

Currently there are no buildings located within the fire separation distance, therefore exterior construction does not need to be fire rated.

K. FIRE-RATED SEPARATION

- No Fire-separation of use-groups is required since the building has a single F-2 occupancy.
- Fermilab FESS Design Guidelines require the provision of 2-Hour Fire-rated construction for Labyrinths. Fermilab to confirm areas to classified as Labyrinths at the Mu2e building.
- Fire-rated construction separation requirements for Electrical/Power Rooms will be addressed in the next phase of the project when detailed electrical equipment information becomes available.
- The Fire Protection/Life Safety Analysis prepared by AON Fire Protection Engineering on May 28, 2013 recommends that rooms containing equipment for standby or emergency power be enclosed in 2-hour fire rated construction.

L. PLUMBING FIXTURE COUNT

As large portions of the building are unoccupied during normal operation, the minimum plumbing fixture count will be based on the **actual maximum number of anticipated full-time employees**, rather than the calculated occupant load. This is consistent with section 890.810 (a) 2 of the Illinois Plumbing Code. Even though the building is open to the public, areas such as the power supply

room, the mechanical room and the Basement/underground experimental areas are non-occupied spaces with only incidental human occupancy.

In accordance with section 890.810 (b) 1 of the Illinois Plumbing code:

Restroom facilities and drinking fountains shall be provided for all employees within each place of employment. The minimum numbers of fixtures provided shall be based on the maximum number of male and female employees working at any one time, as shown in Appendix A: Table B.

In calculating the following minimum plumbing fixtures required, it is tentatively assumed that no more than 30 Employees will be occupying the Mu2e building at any given time. The client will need to verify the validity of this assumption.

OCCUPANCY	W/C	LAV	DRINKING FOUNTAIN
Women (15)	1 Required	1 Required	-
Men (15)	1 Required	1 Required	-
	-	-	1 Required

Drinking Fountains:

Illinois Plumbing Code Section 890.APPENDIX A, TABLE B, FOOTNOTE 4:

Whenever a drinking fountain is required by this code, bottled drinking water or a water dispensing faucet (water station) may be substituted for a drinking fountain, provided drinking water is accessible to the public. When bottled drinking water is provided in lieu of a drinking fountain, the bottled water used must be commercially sealed in accordance with the Illinois Bottled Water Act [815 ILCS 310] or must comply with the Department's Public Area Sanitary Practice Code (77 Ill. Adm. Code 895

Conclusion:

Men & Women single-use washrooms will be provided. An accessible hi-low drinking fountain will be provided.

M. ACCESSIBILITY REQUIREMENTS per 2010 ADAAG:

1. General Requirement:

The building is subject to compliance with 2010 Standards for State and Local Government Facilities: Title II per *paragraph 35.151 New construction and alterations (a) Design and construction.*

(1) Each facility or part of a facility constructed by, on behalf of, or for the use of a public entity shall be designed and constructed in such manner that the facility or part of the facility is readily accessible to and usable by individuals with disabilities, if the construction was commenced after January 26, 1992.

2. Accessible Route Requirements (US ADAAG 206):

206.2.3 Multi-Story Buildings and Facilities: At least one accessible route shall connect each story and mezzanine in multi-story buildings and facilities.

Exceptions:

a. *In private buildings or facilities that are less than three stories or that have less than 3000 SF per story, an accessible route shall not be required to connect stories ….* ***– This exception applies to private buildings and facilities and is not applicable to this project.***

b. *Where a two story public building or facility has one story with an occupant load of five or fewer persons that does not contain public use space, that story shall not be required to be connected to the story above or below.* ***(Per definition: Occupant Load = The number of persons for which the means of egress of a building or portion of a building is designed. –The occupant load of the second floor exceeds 15, therefore this exception is not applicable)***

Conclusions: Per ADAAG 206.2.3 and 1997 Illinois Accessibility Code section 400.310, an elevator serving the lower basement level is required to provide an accessible route to the lower level.

3. General Exceptions (US ADAAG - 203):

203.1 General: Sites, buildings, facilities, and elements are exempt from these requirements to the extent specified by 203.

203.5 Machinery Spaces. Spaces frequented only by service personnel for maintenance, repair, or occasional monitoring of equipment shall not be required to comply with these requirements or to be on an accessible route. Machinery spaces include, but are not limited to, elevator pits or elevator penthouses; mechanical, electrical or communications equipment rooms; piping or equipment catwalks; water or sewage treatment pump rooms and stations; electrical substations and transformer vaults; and highway and tunnel utility facilities.

Basement/Underground Experiment Areas: The basement/Underground experiment areas (including the underground transport enclosure tunnel, the Solenoid Production, Solenoid Transport, Solenoid Detection, Equipment Areas, Mechanical and Electronics Rooms) are normally unoccupied equipment areas with only incidental human occupancy for maintenance, service and adjustments, which makes it exempt from the requirements of the US ADAAG. Therefore, no accessible route needs to be provided within this space.

Main/Ground Floor: The main floor contains an open office area which makes it non-exempt from the requirements of the US ADAAG. Therefore, an accessible route needs to be provided to this space.

4. Accessible Fixture Requirements

a. Where lavatories are provided, Section 1109.2.3 states that at least 5 percent, but not less than one lavatory must be accessible. – The new restroom fixtures will comply with the ADAAG.

b. Section 1109.2.2 states that where water closets are provided, at least one wheelchair-accessible toilet must be provided. – The new restroom fixtures will comply with the ADAAG.

N. CONCLUSION

Fermi will need to address/confirm the following code items/assumptions. ~~During the next phase of the project,~~ Main Floor and Lower Level Life Safety Drawings ~~shall be~~ will be prepared to ~~ensure review~~ compliance with applicable Life Safety and Accessibility code requirements.

a. Confirm that the proposed Mu2e facility meets the criteria for F-2 occupancies per section 306.3 and that the quantities of hazardous materials within the facility shall not exceed the maximum allowable quantity limits for control areas set forth in Tables 307.1(1) and 307.1(2).

b. According to the definitions of 2009 IBC, the Mu2e Building would not be considered an underground building since the lowest floor level (at EL. 721'-0") used for human occupancy is less than 30 feet (25'-6" proposed) below the finished floor (at EL. 746'-6") of the lowest level of exit discharge. However, AON will need to address compliance with NFPA 520 Standard on Subterranean Spaces if Fermilab confirms that it is applicable to the Mu2e Building.

c. Swings for Doors 017A & 017B will need to be reconfigured to avoid encroachment on the required width for exit passageway 017.

d. The Fire Protection/Life Safety Analysis prepared by AON Fire Protection Engineering on May 28, 2013 recommends that exit stairways be enclosed in 2-hour fire rated construction. Fermilab to confirm if Middough should design 2-hour fire rated stair enclosures in lieu of the 1-hour fire rated enclosures required by IBC.

e. Fermilab FESS Design Guidelines require the provision of 2-Hour Fire-rated construction for Labyrinths. Fermilab to confirm areas to be classified as Labyrinths at the Mu2e building.

f. In calculating the minimum number of plumbing fixtures required, it is tentatively assumed that no more than 30 Employees will be occupying the Mu2e building at any given time. Fermilab will need to verify the validity of this assumption.