Pelli Clarke Pelli Architects

Transbay Transit Center

Fire Life Safety Strategy

132241

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Appendices

1 Introduction

1.1 Overview

This Fire Fire Life Safety Strategy Report provides an overview of the fire protection systems and features that will be included in the Transbay Transit Center (TTC) project in San Francisco, California.

The primary intent of this document is to coordinate the fire protection approach among all design and design/build disciplines. It is the intent of this report to document concepts and approaches included in the design process, as well as, key aspects of the passive and active fire and life safety systems as required by the applicable codes and standards. In conceptual terms, this report ultimately describes the interaction of these systems in the context of an overall approach to achieving the level of safety intended by the adopted codes.

1.2 Building Description

The Transbay Transit Center (TTC) is the cornerstone project of the Transbay District Redevelopment Area which will transform a neighborhood formerly divided by freeways, into a vibrant new mix of residential and commercial uses in the heart of downtown San Francisco. The new 1-million-square-foot transit hub will span 4 city blocks and provide intercity, regional, and commuter bus services for 4 major transit providers at the ground and bus deck levels.

Underground, the new transit center will have a concourse level for passenger circulation, retail, and transport services. Below the lower concourse, a platform level will provide access to 6 terminal tracks for the new High-Speed Rail (HSR) service from Southern California and Caltrain commuter rail service from the Peninsula and San Jose. Retail, restaurants, bike parking, and a seamless pedestrian design will provide both commuters and local residents needed services in the District. A signature 5-acre park will grace the roof of the transit center, providing valuable and inviting open space in the extremely dense neighborhood.

The building is divided into transit and non-transit uses. Transit uses consist of the Bus Deck, the Grand Hall, and the Caltrain and California High Speed Rail areas in the two basement levels.

The height of the highest normally occupied level is 74 feet 9 inches above the lowest level of fire department vehicle access. In the event a roof park restaurant with mezzanine is included in the design, the highest normally occupied level will be 83 feet above the building's lowest fire department access, potentially requiring high-rise building requirements (Refer to RFI #5 for details). The below grade train platforms are 45 feet 8 inches below the lowest level of exit discharge.

The roof will be an occupied level with an outdoor park consisting of assembly areas such as lawns, open amphitheaters, café, children's play areas, etc.

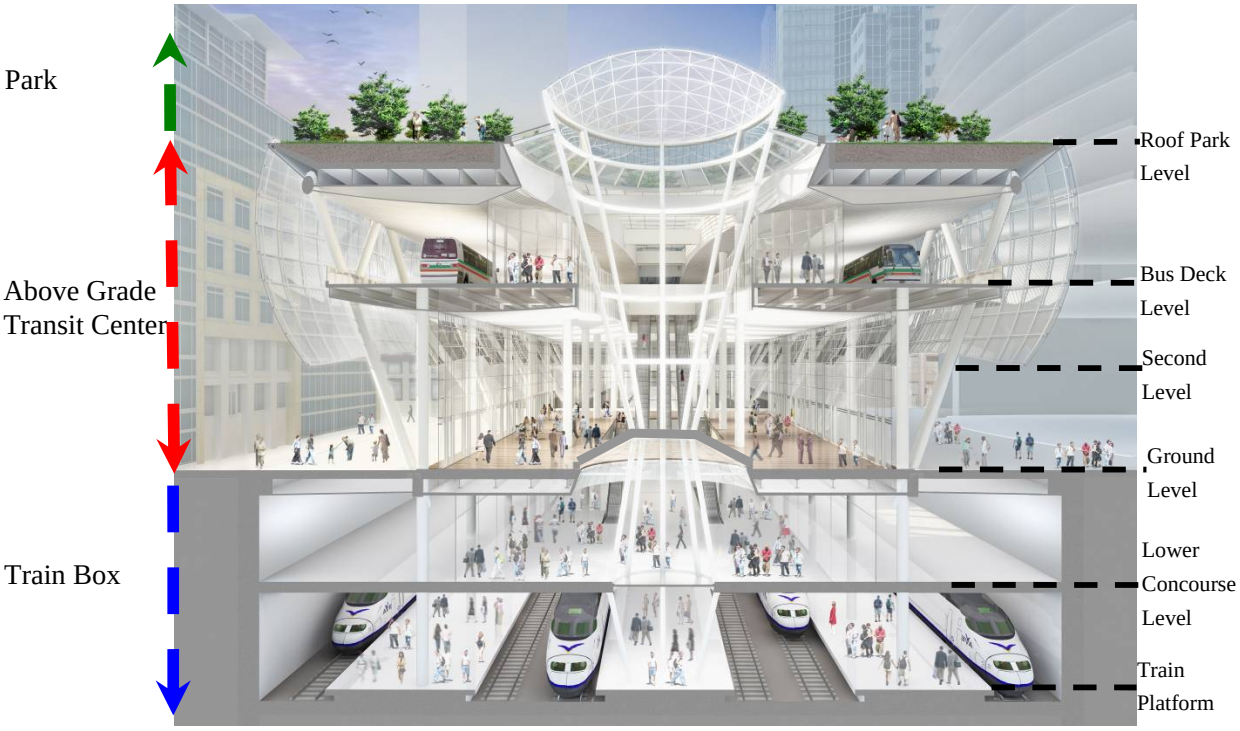


Figure 1: Building Section

1.3 Design Team

Owner	Transbay Joint Powers Authority 201 Mission Street, Suite 2100 San Francisco, CA 94015 (415) 597-4620
Design Architect	Pelli Clarke Pelli Architects 1056 Chapel Street New Haven, CT 06510 (203) 777-2515
Executive Architect	Adamson Associates, Inc. 17383 W. Sunset Boulevard, B-200 Pacific Palisades, CA 90272 (310) 230-0088
Structural Engineer of Record	Thornton Tomasetti 6151 W. Century Boulevard, Suite 928 Los Angeles, CA 90045-5318 (310) 665 0010
Structural Design Engineer	Schlaich Bergermann and Partner LP 555 8th Avenue, Suite #2402

	New York, NY 10018 Phone +1(212)255 3682
Civil Engineer Geotechnical Engineer Fire Life Safety Code Consultant Planning consultant Risk Consultant	Arup North America Ltd. 560 Mission Street, 7th Floor San Francisco, CA 94105 (415) 957-9445
MEP Engineer of Record	WSP Flack + Kurtz 405 Howard Street, Suite 500 San Francisco, CA 94105 (415) 398-3833

1.4 Authority Having Jurisdiction

The Transbay Joint Powers Authority (TJPA) is the governing body that will own and operate the TTC. The TJPA is a Regional Authority enacted by the State of California and is the Authority Having Jurisdiction (AHJ) for the remaining building code permissions to TJPA facilities. The San Francisco Fire Department (SFFD) is the Authority Having Jurisdiction (AHJ) for Fire and Life Safety issues as mandated by the California State Fire Marshal.. The San Francisco Department of Building Services (DBI) is retained by TJPA to perform code review and inspection services and will provide recommendations to TJPA for permitting for the TTC.

2 Codes and Standards

2.1 Design Criteria

The 2007 California Building Code with San Francisco Amendments (hereafter SFBC) will apply to the base building. NFPA 130 has been applied as the design criteria for the transit areas of the TTC building which include the bus deck, the below grade transit facility that includes the lower concourse and the train platforms (See Figure 2). The application of NPFA 130, in lieu of Section 433 of the SFBC, to the transit areas has been established through an alternate method of design, known as Administrative Bulletin 005, a local equivalency. Where NFPA 130 refers to other standards for issues not addressed by NFPA 130 directly such as, but not limited to, construction type, fire resistance, interior finish etc., the SFBC will be used as the reference code.

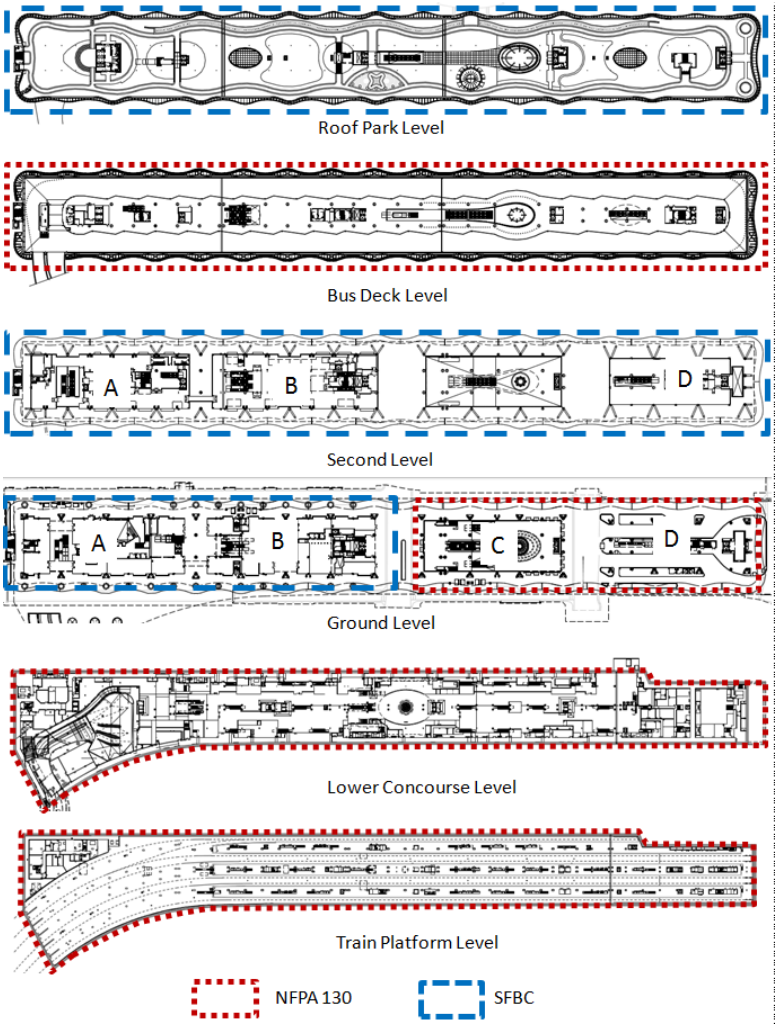


Figure 2: Design Criteria for respective levels of the station.

2.2 Code and Standards

- 2007 San Francisco Building Code (2007 California Building Code as adopted and amended by City of San Francisco), hereafter SFBC.
- 2007 San Francisco Fire Code (2007 California Fire Code as adopted and amended by the City of San Francisco), hereafter SFFC.
- NFPA 10: Portable Fire Extinguishers – 2005 Edition
- NFPA 12: Carbon Dioxide Extinguishing Systems – 2005 Edition
- NFPA 13: Installation of Sprinkler Systems – 2002 Edition
- NFPA 14: Installation of Standpipe and Hose System – 2003 Edition

- NFPA 16: Installation Foam-water Sprinkler and Foam-water Spray Systems – 2003 Edition
- NFPA 20: Installation of Stationary Pumps for Fire Protection – 2003 Edition
- NFPA 22: Water Tanks for Private Fire Protection – 2002 Edition
- NFPA 24: Installation of Private Fire Service Mains and Their Appurtenances – 2002 Edition
- NFPA 70: National Electrical Code – 2005 Edition
- NFPA 72: National Fire Alarm Code – 2010 Edition
- NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems – 2007 Edition (Applicable to the Bus Deck, the Below Grade Transit Facility and connecting concourses)
- NFPA 750: Water Mist Fire Protection System – 2006 Edition
- NFPA 2001: Clean Agent Fire Extinguishing Systems – 2004 Edition
- Americans With Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
- ADA Standards for Transportation Facilities (Effective Nov 2006).
- CPUC General Orders (GO)
- Recommended Emergency Preparedness Guidelines for Elderly and Disabled Rail Transit Passengers, UMTA

Note: SFBC and SFFC have supplements dated on October 23, 2008 and January 1, 2009. The latest supplement is effective from August 1, 2009 in accordance with Building Standards Bulletin 09-01 by the State of California.

2.3 Definition: Transit vs. Non-Transit

2.3.1 Transit Occupancies

Transit occupancies are defined as places where persons embark or disembark a fixed rail vehicle or public bus. These include train platforms and waiting areas, bus deck areas (including waiting areas) and the connecting concourses. Adjacent occupancies such as retail, offices, mechanical rooms, etc. that connect to circulation concourses or the train platforms will be part of the transit space. However, for these defined spaces the design occupant loads will be based on the occupant load factors per the SFBC. Back-of-house areas that provide support functions to the main transit areas are considered non-transit spaces.

2.3.2 Non-Transit Occupancies

Non-transit occupancies define places that are not directly related to the train or bus services or do not directly connect to the transit spaces. These include, but are not limited to:

- Ground level offices and retail
- Second floor food court, waiting areas, retail and office spaces
- Park Level
- Back-of-house spaces (e.g. SOC, MEP rooms at Lower Concourse and Train Platform level)

3 Key Issues

The key issues are a summary of the local equivalencies and code interpretations applicable to the TTC where there are code non-compliances or clarifications of specific code sections. The following sections are a summary of the issues. Full documentation can be found in Appendix A

3.1 Request for Local Equivalencies (RFLE)

3.1.1 RFLE #1: NFPA 130 in lieu of San Francisco Building Code for the Bus Deck Level

The third above grade level of the TTC building is the Bus Deck Level. The Bus Deck will be used by AC Transit, Muni, Golden Gate Transit, and Greyhound. The Bus Deck will be accessed via open stairs and escalators, typical of a transit station environment, with large open circulation concourses.

There are numerous similarities between a fixed guideway transit facility and a bus facility such as: operational uses, occupant characteristics, passenger flows, openness, fire loads, etc. It is considered reasonable then that NFPA 130, the Standard for Fixed Guideway Tansit and Passenger Rail Systems, is more appropriate for a bus facility than the general requirements of the SFBC. The use of NFPA 130 for the Bus Deck better addresses the unique nature and functionality for the proposed use. In addition, this standard is more current with issues in transit facilities than SFBC Section 433 (relating to transit stations), and therefore would be a better design guide. It is based upon this premise, that NFPA 130 (2007 Edition) will be applied as the design criteria not only for the trains station, but also for Bus Deck Level of the building.

However, because not all aspects of the Bus Deck meet the exact definition of a fixed guideway transit facility per NFPA 130 or SFBC Section 433, a specific strategy has been developed as a Local Equivalency and presented to the San Francisco Board of Examiners (BOE) on March 23rd 2009.

Request for Local Equivalency #1 was approved by the BOE and is presented in Appendix A.

3.1.2 RFLE #2: NFPA 130 in lieu of Section 433 of San Francisco Building Code

NFPA 130 is one of the first standards to address the design of fixed guideway transit facilities. This standard is revised on a regular basis to reflect “current industry practice” and is recognized as one of the “go to” standards for transit facility design.

Section 433 of the CBC and SFBC also addresses the design of fixed guideway transit facilities. This section of the CBC was brought into effect in

the early 1990's and was adapted from an earlier version of NFPA 130. Thus, Section 433 consists of an older version of NFPA 130 and has not been updated to reflect recent developments.

Although NFPA 130 and SFBC Section 433 have similar requirements, NFPA 130, which is continuously updated reflects the current industry knowledge and best practices. Therefore, NFPA 130 (2007 Edition) has been adopted for the underground train station. NFPA 130 has also been adopted for the Bus Deck Level, as documented in RFLE #1.

This issue was presented to the San Francisco Board of Examiners (BOE) on March 23rd 2009 and was approved. For details refer to Request for Local Equivalency #2 in Appendix A.

3.1.3 RFLE #3: Performance Based Structural Fire Engineering

As a Type IB building, the main structural frame is required to achieve a 2-hour fire resistance per SFBC Table 601. However, as permitted by Sections 104A.1 and 104A.2.8 of the SFBC, a performance-based structural fire engineering assessment is proposed to provide an engineered level of fire protection to specific members based on the actual fire hazard and structural fire response. This is in lieu of applying the prescriptive level of passive fire protection (i.e. fire proofing) to the structure.

A performance-based approach is proposed for the following structural elements:

- Basket V-Columns
- "Light" Columns in the Grand Hall (Ground to Bus Deck Level)
- Diagonal Braces and Perimeter Gravity Columns at the East and West Ends of the Bus Deck Level

Request for Local Equivalency #3 was signed-off and approved by a Peer Review Panel, SFFD and DBI on May 11, 2011 and is provided in Appendix A for reference.

3.1.4 RFLE #4: Exterior Opening Protection and Fire Spread

The exterior walls of the building need to be protected by a 1-hour fire-resistance rated wall in accordance with SFBC Table 602 where the separation distance from the property line or the center line of the street is less than 30 feet. The building setback from the adjacent property line or the street center line determines the extent of openings in accordance SFBC Table 704.8.

The building will be located anywhere from 10 ft to more than 30ft to the adjacent property lines depending on the level of the building being considered, with portions of the building overhanging the right of way.

In general, Levels 1-2 are more than 20ft to the adjacent property lines. However, at the Bus Deck Level the building cantilevers out so that the bus level and park level overhang the street, toward adjacent properties. This extension of the building at the upper levels encroaches over the existing public way. The result is the edge of the bus deck slab falling within 10 to 15 feet (varies along the length of the building) to the nearest property line or street center line. The basket enclosure (i.e. glass façade) encroaches even further into this zone, where the perimeter of the basket enclosure is 0-5 feet from the proposed building property line. This condition is represented in Figure 3.

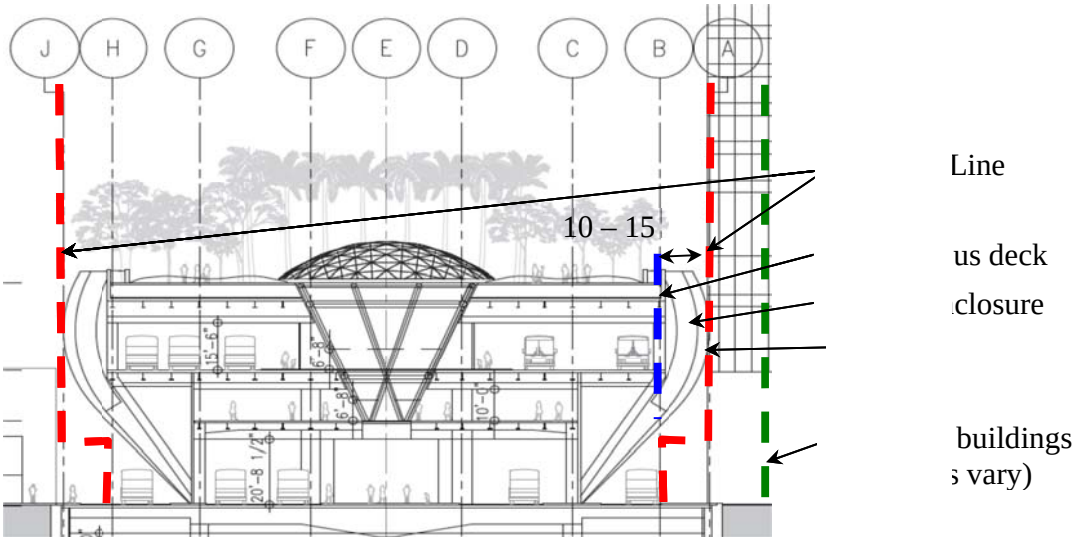


Figure 3: Depiction of building location relative to the public way and proposed property lines

The basket enclosure (i.e. glass façade) of the building will be defined as a canopy and will meet the requirement of SFBC Chapter 3202. The canopy is non- combustible and is a permissible projection over the right of way under this section of the SFBC.

For the purpose of addressing the opening protection requirements, a datum to measure the fire separation distances must be defined. At the ground level and Level 2, the vertical exterior walls are proposed to be used as the datum. At the bus deck level the edge of the bus deck slab is proposed to be used as the datum because this is where a bus could be parked immediately adjacent to the edge of the building.

There are specific areas at the bus deck level that don't meet the opening criteria (i.e. unlimited exterior opening). A fire spread assessment was conducted to determine the hazard of fire spread between buildings.

Request for Local Equivalency #4 was approved by the SFFD and DBI on June 28, 2010 and is provided in Appendix A for reference.

3.1.5 RFLE #5: Public Address System used for Fire Alarm Paging

An occupant notification system consisting of speakers listed for fire alarm service will not provide intelligible information in high noise, large volume spaces such as in the Great Hall, Bus Deck, Lower Concourse, and Train Platforms. However, the day-to-day public address (PA) system designed by the acoustical (SMW) and electrical engineers (WSP F+K) has been designed to utilize high fidelity audio performance equipment, notably loudspeaker systems and amplification equipment. To satisfy the building's functional needs, the PA system in the Great Hall, Bus Deck, Lower Concourse, and Train Platform has been designed such that voice messages in these spaces (i.e. high noise, large volume areas) will need to be intelligible to commuters and operating personnel. This will allow building occupants to better hear voice pages, and thus enable the operation of normal Transit Center functions.

This public address (PA) system, however, does not use components, equipment, or wiring that is currently listed for fire alarm and thus does not meet the specific NFPA 72 requirements for monitoring of integrity. However, the PA system will be designed such that it meets the intent of NFPA 72 (e.g. system monitoring, speaker wire monitoring, emergency power, wire survivability, etc.).

Request for Local Equivalency #5 was approved by the SFFD and DBI on December 19, 2011 and is provided in Appendix A for reference.

3.1.6 RFLE #6: Fire Fighter Fresh Air System – Withdrawn

3.1.7 RFLE #7: Park Stair Pressurization

The rooftop park, as clarified in RFI #1, is considered an outdoor assembly, open to the sky, and as such, meets the definition of an outdoor smoke protected assembly. Under this arrangement, the application of the exit width factors permitted in Section 1025.6.3 would be appropriate. Although the RFI was deemed acceptable, the City of San Francisco interpreted that Section 1025.6.3 requires that the egress from the rooftop park should remain smoke free through the exit stair shafts meeting the requirements of 1025.6.2.1. An equivalency has been prepared to justify that a positive pressure differential for the stair enclosures serving the park (S301, S401 and S601) meets the intent of Section 1025.6.2.1 for this given application. Note: Vestibules are not considered necessary in the design to meet code intent. Stair S201 is not pressurized, as it only serves the Park Level and is outside the building envelope on all other levels.

Request for Local Equivalency #7 was approved by the SFFD and DBI on June 13, 2012 and is provided in Appendix A for reference.

3.2 Request for Interpretations (RFI)

This section summarizes items that have been documented with DBI/SFFD that are interpretations of code sections related to specific design elements in the TTC building.

3.2.1 RFI #1: Park Level Exiting

The fire hazard in spaces open to sky, or open to atmosphere, is significantly different than a fire in an enclosed space inside a building. A fire on the Park Level is not confined by walls and a ceiling. Buoyancy causes the smoke to rise and ventilate freely to the sky. The effect of venting to the sky provides a significant safety benefit as compared to most buildings. Occupants would be provided significantly more time to egress as compared to occupants located in enclosed building spaces who are escaping into a (smoke-protected) stair shaft.

The *outdoor smoke protected assembly* provisions of the SFBC (Section 1025.6.3) have been applied to justify the use of the reduced stair and door egress width at this level. Additionally, occupant load factors have been applied to the park occupancies to define a design occupant load.

Refer to Request for Interpretation #1 in Appendix A for full details.

Request for Interpretation #1 was approved by the SFFD and DBI on December 24, 2011 and is provided in Appendix A for reference.

3.2.2 RFI #2: Elevator Hoistway Opening Protections and Elevator Lobbies

The building has 4 sets of public elevators with glass hoistway doors located at Gridlines 8, 16, 24.9, and 32 that connect the Lower Concourse Level through to the Roof Park Level. An additional single public elevator is also provided at Gridline 1 connecting Ground to Park Level.

Because all the public and service elevator hoistways pass through a 2 hour floor assembly, all elevator hoistways are required to be 2 hours in accordance with Section 707.4. Hoistway openings will be a minimum of 1 ½-hour rated fire-smoke curtains serving as hoistway door opening protection per Section 715.4.

In addition to an elevator shaft enclosure, the State Fire Marshal amendments require elevators in Group A occupancies serving more than 2 floors to be provided with lobbies at each level per Section 707.14.1. Elevators lobbies will either be provided via fire partitions or via a fire-smoke curtain across the hoistway doors. The fire-smoke curtain across the hoistway door satisfies both the fire-resistance rating for the hoistway door opening (per shaft opening requirements Section 715.4) and the smoke containment requirements for elevator lobbies per Exception 7 of Section 707.14.1. To strictly comply with

Exception 7 the fire curtains will be installed in accordance with ICC ES AC 77 (see attached).

Enclosed elevator lobbies are not required at ground level per Exception 1 of Section 707.14.1. Elevators connecting only two levels (e.g. elevators connecting the Platforms to the Lower Concourse) are not required to have enclosed elevator lobbies.

At the Roof Park Level, enclosed elevator lobbies are proposed to be omitted because this level is open to sky. Any fire or smoke on the level is not expected to enter the shaft, but rather will vent direct to outside.

Generic configurations of these arrangements are provided in Figure 4. The specific approach for each elevator at each level will be addressed in the architectural drawings.

Request for Interpretation #2 has been approved by SFFD and DBI on February 7, 2012.

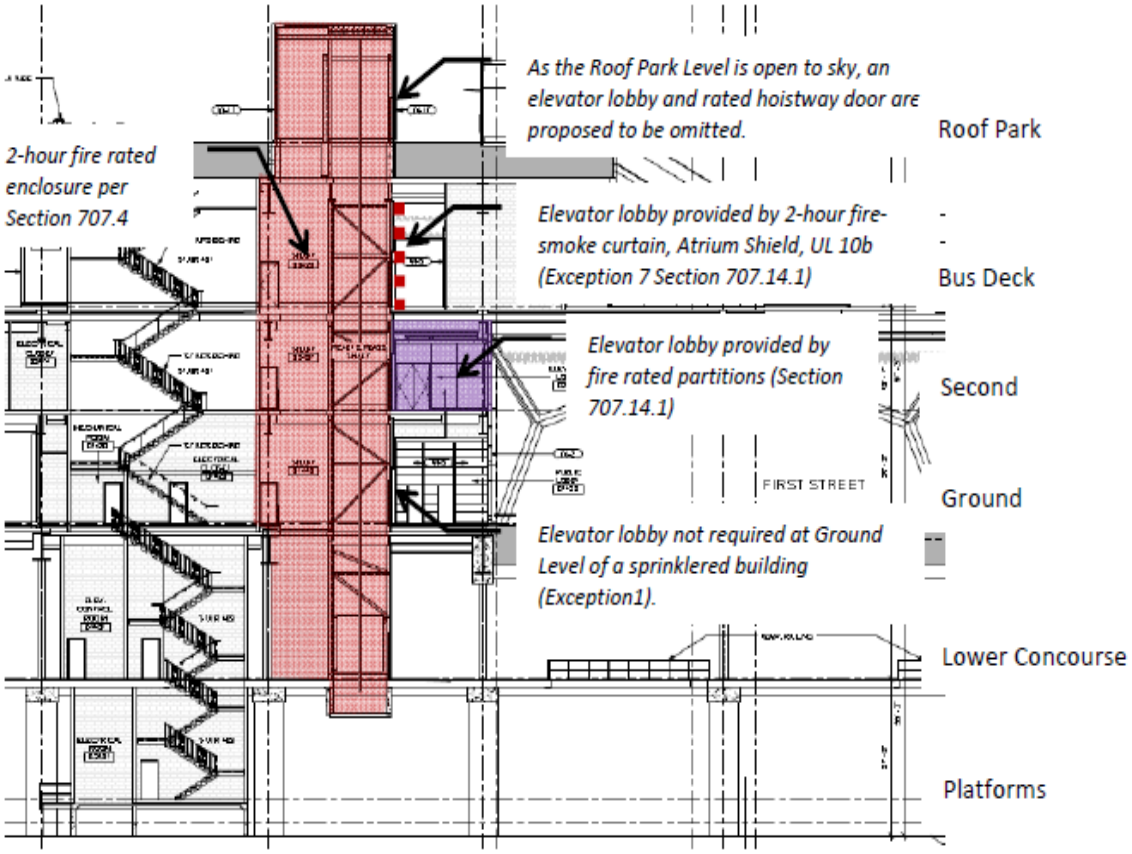


Figure 4: Proposed public elevator lobby strategy for TTC.

3.2.3 RFI #3: Bus Deck Automatic Fire Sprinkler System Design Criteria

The 3rd level of the Transbay Transit Center (TTC) is an elevated, fully covered, bus terminal for passenger pick up and drop off. Above the bus terminal is the open, Rooftop Park. Because the Bus Deck is part of a fully sprinklered building and is covered, the Bus Deck is required to be provided with a sprinkler system in conformance with the applicable codes – the 2007 California Building and Fire Codes (CBC and CFC) as adopted by the City of San Francisco Department of Building Inspection (DBI) and the San Francisco Fire Department (SFFD). DBI and SFFD have acknowledged and accepted that the Bus Deck is permitted to be designed in accordance with NFPA 130, Standard for Fixed Guideway Transit Systems. (See RFLE #1)

In order to design the sprinkler system, the CBC and CFC refer to NFPA 13, Standard for the Installation of Sprinkler Systems, 2002 edition. As part of the design process, it is necessary to classify the hazard in accordance with NFPA 13, as approved by the SFFD. Because a bus fire can be shielded, the SFFD have indicated that the hazard of the bus deck could be beyond the capabilities of Ordinary Hazard (OH) Group II sprinkler systems and that the design should consider a superior system such as Extra Hazard. The SFFD has indicated that the system may need to be Extra Hazard Group II. This equivalency presents justification that the sprinkler system meets the intent of code with a design per EH Group I requirements.

Request for Interpretation #3 is pending approval by the SFFD.

3.2.4 RFI #4: Emergency Stretcher Elevator

All the elevators in the TTC project are proposed to comply with the medical emergency requirements per Section 3002.4a. This permits emergency responders to use any elevator of their choice. However, there are limited situations where the emergency responders may need to either transfer from one elevator to another before reaching grade, or alternatively use an adjacent stair/escalator to ascend or descent one flight before reaching an elevator with a destination to grade.

Request for Interpretation #4 is pending approval by the SFFD/DBI

3.2.5 RFI # 5: Enclosed Mezzanine 75 feet Above Lowest Level of Fire Department Access

The second level of the rooftop restaurant will be at an elevation of approximately 83 feet above the building's lowest fire department access. The City of San Francisco Department of Building Inspection would not classify this deck area, which is open to sky, as a "level" in the application of the definition of High Rise. However, the 2nd Level also includes an enclosed area that is used for storage and "back of house" support services. In contrast to the deck, this enclosed area constitutes building space that, as a story or

mezzanine, could deem the structure as High Rise. The building already contains a number of high rise features and provisions that improve safety beyond the code minimum. This RFI was written for clarification that the mezzanine space does not constitute a hazard such that it is necessary to provide the remaining high rise features.

Request for Interpretation #5 is pending approval by the SFFD/DBI

3.2.6 General Code Interpretations

This section summarizes general code provisions for fire life safety and their applications that are atypical or have a considerable impact on the design of the project.

3.2.7 Grand Hall Large Floor Opening Protection

The Grand Hall is a large, open double height space that is atmospherically interconnected to the bus deck and the roof park. See Figure 5. *Note: No other areas of the TTC are open to the Grand Hall.* Within the Grand Hall space, there are open stairs and escalators that extend from the Roof Park Level to Ground Level. These open stairs/escalators serve as part of the means of egress for the Bus Deck Level, which is permitted by NFPA 130 (the governing life safety standard for the bus deck as agreed in RFLE #1). The open stairs that connect the bus deck to the roof park via the skylight do not serve as part of the means of egress system at that level in accordance with the SFBC. The roof park is served by several, independent exit stair enclosures.

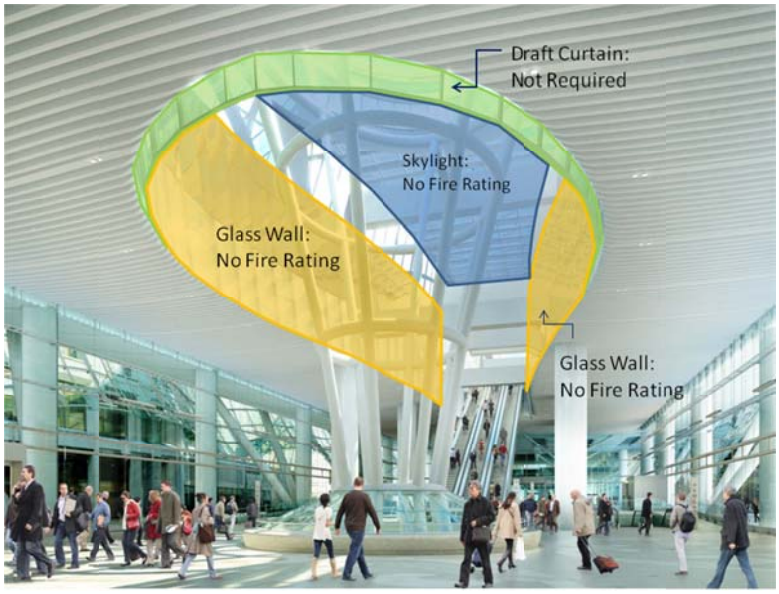


Figure 5: Grand Hall opening protection

Exception 7 to Section 707.2 of the SFBC allows unprotected openings connecting only two floors where the following conditions are met:

1. It is not part of the required means of egress system.
2. It is not concealed within the building construction.
3. It is not open to a corridor in Group I and R occupancies.
4. It is not open to a corridor on non-sprinklered floors.

5. It is separated from floor openings serving other floors by construction conforming to required shaft enclosures.

In this case, there are open stairs in the Grand Hall that interconnect Ground-, Bus Deck- and Roof Park-levels. However, roofs are traditionally not considered in the determination of level interconnection, since they are unenclosed spaces and present significantly lower fire hazards/risks. In the case of the TTC, the roof is an occupiable space (i.e. park) and thus some consideration needs to be given to this condition.

- The roof is similar to an outdoor smoke protected assembly in that it is open to sky, and thus does not require smoke control (RFI #1).
- Exiting from the roof is provided via enclosed exit stairs evenly distributed along the length of the park. The Grand Hall stairs accessing the park from the bus deck are for normal access only (i.e. not required for egress).
- The park is essentially independent of all other building areas. This condition is the same as the Grand Hall connecting only two levels and represents the same hazard.

Therefore, the large opening in the Grand Hall will be unprotected (i.e. not enclosed in a fire rated shaft) in accordance with the exceptions of Section 707.2 of the SFBC

For floor slab opening protection discussed in NFPA 13, Section 8.15.4.4 allows omitting the sprinkler protection for openings with a width of 20 feet or greater and an area of 1,000 square feet or greater. The openings between the bus deck slab meet these requirements. Therefore, draft curtains and sprinkler protection around the large opening are not required.

In conclusion, the large opening in the Grand Hall will be unprotected (i.e. no fire rated shaft enclosure). Draft curtains and associated sprinkler protection will not be provided.

4 Construction

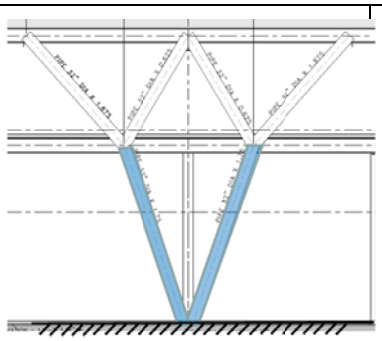
4.1 Construction Classification

1. Construction Type: Type IB
   - Building occupancy classification: Group A-3, Non-separated use
   - Allowable Height: 12 stories (Includes automatic sprinkler system increase)
   - Building Area: Unlimited
2. Structural Fire Resistance Requirements
   - Structural Frame: 2-hours with the exceptions noted in Item 3 below.
   - Columns: 2-hour with the exceptions noted in Item 3 below.
   - Floors: 2-hour
   - Roofs*: 1-hour (not including structural members)

     *The park is an occupiable roof and therefore considered a floor. Thus, the roof park level will achieve a 2-hour fire resistance. The roof exceptions for the supporting primary and secondary beams 20 feet above the floor do not apply. However, where portions of the roof are non-occupiable space, then the fire resistance rating can be 1-hour.
3. Request for Local Equivalency #3 – Structural Fire Engineering
   - A performance based approach to determine an engineered level of fire resistance has been performed for select steel elements of the TTC structure. The analysis and results for RFLE #3 is documented in a two volume report under separate cover, and has been approved by a Peer Review Panel, SFFD and DBI. Table 1 summarizes the results from this analysis.

Table 1: Engineered Fire Protection for Select Steel Elements in TTC – RFLE #3

Element/Location	Proposed Fire Protection Strategy
Basket V-Columns	• A 2-hour fire resistance will be achieved by filling the V-columns with plain, light weight concrete. • Reinforcement will not be required for the concrete infill due to the inherent robustness of the structure with the loss of 2 V-columns and a vertical column. • The structure's robustness in fire has been demonstrated in a progressive collapse analysis. This approach has been agreed with the Peer Review Panel in a meeting dated May 27th, 2010. Details of the progressive collapse analysis are available in the Design



Development Blast Resiliency Assessment Report dated February 2010.

"Light Columns" in Grand Hall Grid 19-25

Light Columns at <u>Train Platform to Ground (<21.5')</u>

- Based on the close proximity of the light columns to a potential train fire or retail kiosk fire scenario, 2-hour fire protection is required at the Train Platform Level, Lower Concourse and up to 21.5ft from the Ground Level finished floor. This will be achieved by a combination of concrete-infill and intumescent paint.

Light Columns at <u>Ground (>21.5') and Bus Deck Level</u>

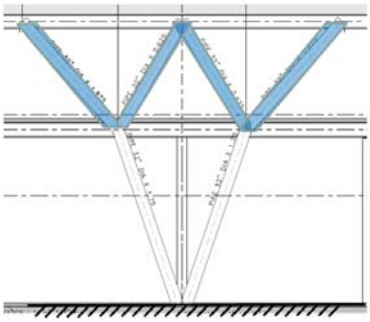
- The light column structure in the Grand Hall no longer has inherent architectural features that provide permanent setbacks for potential kiosk fires adjacent to the light columns at Ground Level. Thus, fire protection will be required at least 21.5ft above the finished floor. Above 21.5ft, fire protection will <u>not</u> be required.

- The light column structure at the Bus Deck level is provided with inherent architectural features that offer permanent setbacks for potential kiosk fires. Thus, fire protection will <u>not</u> be required at the Bus Deck Level.

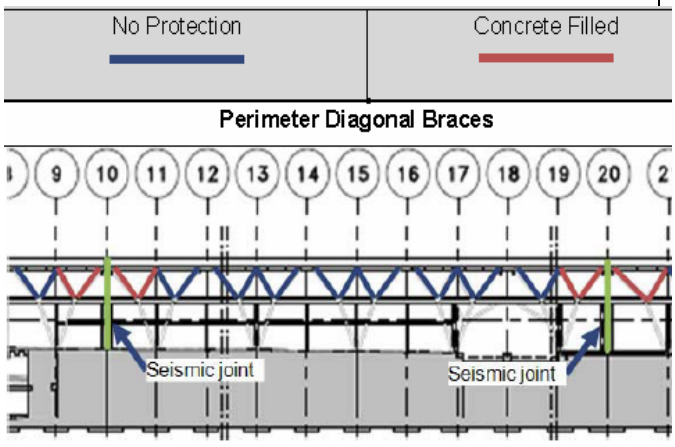
- This analysis assumes that fuel packages (retail kiosks) within the Grand Hall are limited to a plan area of 114 ft² and are separated from adjacent kiosks by 12'. The kiosks are also assumed to consist of 500kW/m2 of fuel (e.g. newsstands, sunglass huts, sandwich stands, etc.)

Diagonal Braces and West/East End Perimeter Gravity Columns

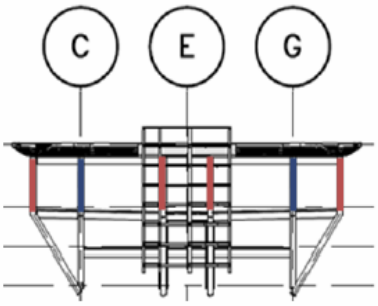
(Bus Deck Level)



- A 2-hour fire resistance is required for two diagonal braces either side of each seismic joint. The 2-hour fire resistance will be achieved by filling the braces with plain, light weight concrete with carbonate aggregates.
- All other diagonal braces will be left unprotected
- Gravity columns at Gridlines 1 and 33.5 at the Bus Deck Level (except those located at Gridline C/C.3 and Gridline G/F.7) will require 2-hour fire protection. This will be achieved by filling the columns with plain, light weight concrete with carbonate aggregates.



Perimeter Gravity Columns – West/East Ends



4.2 Exterior Walls

1. Exterior walls will have a 1-hour fire-resistance-rating where fire separation distance is less than 30 feet. Refer to RFLE #4 for property line determination.
2. Fire resistance ratings for exterior walls will be rated for exposure from the interior and exterior independent of separation distances.

3. Fire window assembly fire protection ratings are 45 minutes where required assembly rating is 1 hour.
4. The maximum area of openings permitted in an exterior wall in any story of buildings equipped throughout with an automatic sprinkler system will not exceed the values set forth in Table 2.

Table 2: Maximum Area of Exterior Wall Openings

Fire Separation Distance =X (feet)					
0 < X ≤ 3	3 < X ≤ 5	5 < X ≤ 10	10 < X ≤ 15	15 < X ≤ 20	20 < X
Not Permitted	15%	25%	45%	75%	No Limit

5. Exterior walls at Ground Level and Second Level, and the setback distances from the property line or the centerline of the street are depicted in the drawings in Appendix A. At these two levels all walls are at greater than 20 feet from the property line or the street center line. In accordance with Table 2 these walls can have unlimited openings.
6. The elevator lobby in the bus plaza is located 67 feet from the street ROW; therefore, the walls of the lobby will not be fire-resistance-rated.
7. Exterior walls facing 1st Street and Fremont Street, beneath the building, are facing a street. Separation distance from these exterior walls to the street centerline are greater than 20 feet, therefore these walls can have unlimited openings. No fire protection is necessary.
8. Opening protection at the bus deck level is addressed in RFLE #4 (refer to Appendix A). An engineering assessment was used to determine the incident heat flux at the property line. The assessment showed that the heat flux levels are greater than the prescribed limits. Thus, sprinklers 6 ft on center between Grids 27-33.5, on the north side of the building, at the Bus Deck level (refer to Figure 6) will be provided to achieve an equivalent level of protection.

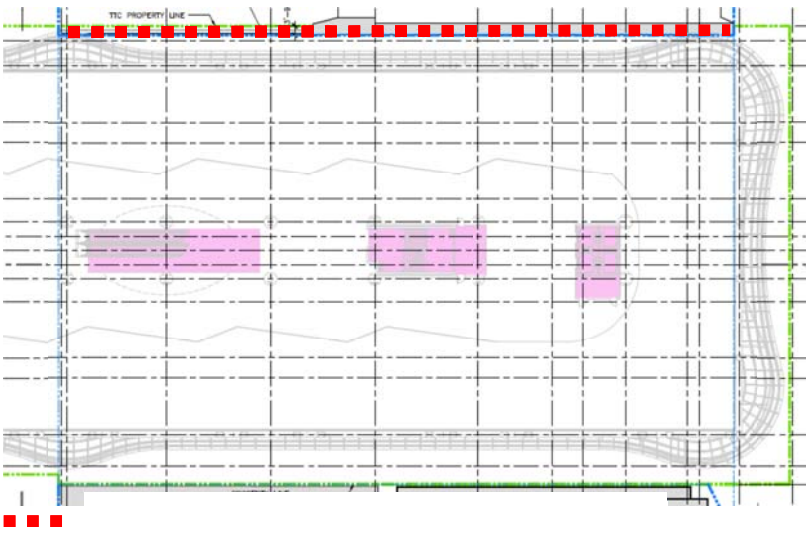


Figure 6: Sprinklers 6 ft on center between Grid 27-33.5, north side, at the Bus Deck level

4.3 Interior Walls and Partitions

4.3.1 Fire Barrier

1. Fire barriers shall extend from the top of the floor/ceiling assembly below to the underside of the floor or roof slab or deck above and shall be securely attached thereto. Such fire barriers shall be continuous through concealed spaces, such as the space above a suspended ceiling.
2. Fire ratings for walls
   - Shaft enclosure – 2 hours
   - Exit enclosure – 2 hours
   - Incidental Use Areas – 1 hour, 2 hours or 3 hours (See Section 5.2)
3. Fire ratings for openings
   - 2-hour barrier: 90 minutes
   - 1-hour barrier: 1 hour
   - Power substation having a 3-hour fire resistance rating: 3 hours (Note: openings to public spaces are not permitted)
   - Windows shall have a 45 minutes fire-resistive-rating for a 1-hour fire-resistance-rated barrier. For the openings in the 2-hour fire-resistance-rated wall, windows will not be used.

4.3.2 Fire Partitions

1. Fire partitions shall extend from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, slab or deck above or to the fire-resistance-rated floor/ceiling or roof/ceiling assembly above, and shall be securely attached thereto.
2. Fire partitions will be constructed at corridor walls.
3. Fire partitions will have a 1-hour fire-resistive rating (except for corridors defined in Section 7.13)
4. Where the corridor ceiling is constructed as required for fire partitions, the corridor walls will be permitted to terminate at the upper membrane of such ceiling assembly.

4.3.3 Smoke Partitions

1. Smoke partitions shall extend from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke
2. Smoke partitions do not require a fire rating unless otherwise specified
3. Penetrations and joints will be sealed to limit the free passage of smoke.

4.3.4 Shaft Enclosures

1. Shaft Enclosures will have a 2-hour fire-resistance rating. Since the floor assembly has a 2-hour fire resistance rating, shaft enclosures will have a 2 hour fire-resistance rating regardless of the number of stories.
2. Openings in a shaft enclosure will be protected by approved fire doors and fire shutter assemblies having a 90-minute fire-resistance rating.
3. Doors will be self- or automatic closing by smoke detection.
4. Open stairs and escalators regularly used by the public in the transit occupancies are not required to be enclosed (NFPA 130).
5. Refer to RFI #2 for proposed strategy for elevator enclosures

4.4 Opening Protection in Fire/Smoke Barriers or Partitions

4.4.1 Fire Dampers

1. Fire dampers used for ducted and un-ducted air openings will be installed at penetrations of:
   - Area separation walls or occupancy separation walls,
   - Fire-resistive construction of corridors serving as a means of egress,
   - Shaft enclosures,
   - Ceilings of fire resistive floor-ceiling or roof-ceiling assemblies,
2. The operating temperature of fire damper actuating device shall be approximately 50°F above the normal operating temperature within the duct system, but not less than 160°F.
3. The operating temperature of the actuating system device may be increased to no more than 286°F when located in a smoke control system.

4. Fire damper will have at least 90-minute fire protection rating for fire barriers and shaft enclosures. Refer to Section 4.3.1 for fire rating of dampers.
5. Fire dampers will be provided for penetrations through fire partitions where the size of the duct exceeds 100 square inches.

4.4.2 Smoke Dampers

1. Not less than Class II, 250°F smoke dampers for ducted and un-ducted air openings will be installed at penetrations of:
   - Area separation walls or occupancy separation walls,
   - Fire-resistive construction of horizontal exit walls or corridors serving as a means of egress,
   - Shaft enclosures,
   - Fire barriers
   - Smoke barriers,
   - Elevator lobbies (where provided),
2. Smoke dampers may be omitted at openings that must be maintained open for proper operation of a mechanical smoke-control system, provided that adequate protection against smoke migration, in the event of system failure, has been provided.
3. The smoke damper will close upon actuation of dedicated smoke detectors on either side of the opening.

4.4.3 Combination Fire/Smoke Dampers

1. Combination Fire/Smoke Dampers may be permitted where both are required.
2. Fire-Smoke combination dampers will be provided for penetrations through fire partitions where the duct has an opening serving the corridor.

4.4.4 Permitted Openings through Floors

1. Openings in floors for escalators or stairs are permitted provided the area of the opening does not exceed twice the horizontal projected area of the escalator or stairway, the building is sprinklered and the stairs/escalators are not used for egress. For the transit areas of the building, stairs and escalators are permitted as a means of egress per NFPA 130.
2. The opening will be protected by draft curtains (either permanent or automatic drop down) with closely spaced sprinklers on the outer perimeter of the draft curtain at each opening.

3. Sprinkler systems will be installed in accordance with Section 8.15.4 of NFPA 13. (Refer to Figure 7)
4. The permitted openings between floors are limited to 4 stories for Group A occupancies per SFBC Section 707.2 Ex.2.1.

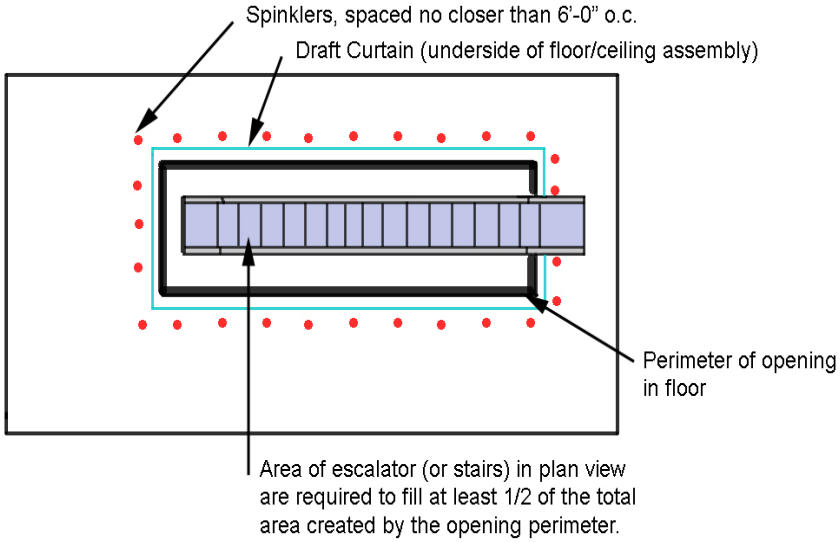


Figure 7: View of Escalator through Floor Opening

5. Floor slab opening protection will NOT be provided in the Grand Hall. Refer to Section 3.2.7 of this report for justification.

4.4.5 Glass Floors

1. The glass floor in the Lower Concourse floor slab at Grid line 23, is an occupiable surface. Thus, the glass floor and supporting structure will be 2-hour rated.
2. The glass floor [GF-1] at the roof park level (Gridlines 19.1 to 22), between the Grand Hall Skylight and the Glass Box is occupiable space. Thus, this space is considered floor construction and is required to achieve a 2-hour resistance. Based on a performance-based analysis by the structural engineers (SBP), the cable trusses are not required to maintain stability in the fire limit state and, thus, will not be fire-protected ("fire-proofed"). The glass floor panels will be listed for 2-hour fire resistance. The framework of 12"x4" HSS supporting the glass panels are effectively protected from a fire below by the 2-hour glass panels, and therefore, will not be provided with further fire resistive materials. Refer to SBP report, "W-12, Structural Glazed Floor System" dated 8/03/2011 for calculation details.
3. The glass floor/opening in the Grand Hall floor between the Lower Concourse and the Grand Hall [GF-2] will be 2 hour rated.

4.5 Awnings and Canopies

1. The exterior basket enclosure [RSC-1] is classified as an awning or canopy in accordance with SFBC Section 3202 (refer to Request for Local Equivalency #4 in Appendix A), and therefore will not be fire rated.
2. The supporting structure of the basket enclosure ("façade enclosure") will be non-combustible and will be designed in accordance with SFBC Sections 3202.3.1 and Chapter 16.

4.6 Skylights

1. The skylight at the top of the Grand Hall [SL-1], the East Skylight [SL-2], and the "Glass Box" [CW-3], (as shown in Figure 8) and the West Skylight [SL-3] (not indicated) are defined as "Skylights" under SFBC Section 2405.
2. The supporting structure elements for these features will be non-combustible and meet the structural design requirements in SFBC Chapter 16.
3. If light transmitting plastics are used, they will comply with the requirements in SFBC Section 2610.

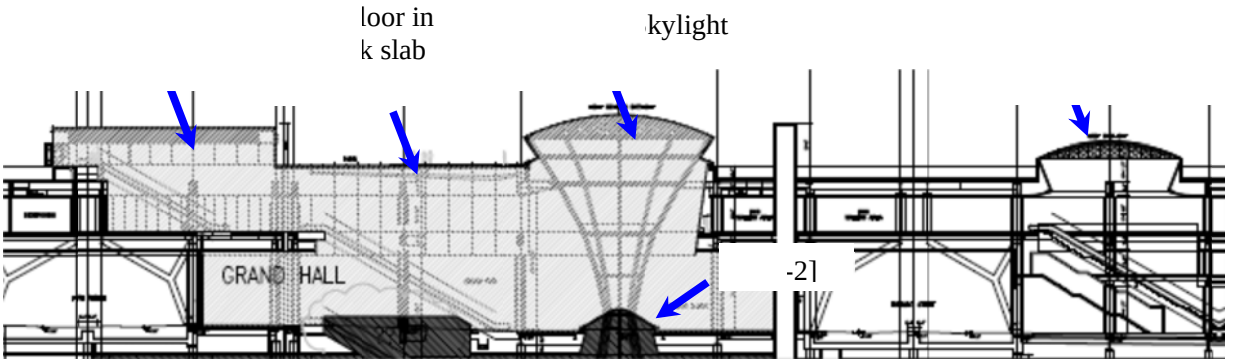


Figure 8: Grand Hall Skylight, Glass Box and east Skylight

5 Occupancy Separation

5.1 Occupancy Classification

Occupancies will be classified in accordance with those listed in Table 3.

Table 3: Occupancy Classification

Use	Group
Bus or Train Platforms	A-3
Bus, Train, Taxi Waiting Areas	A-3
Assembly	A-3
Park Occupancies*	A-5
Restaurants	A-3
Mechanical Room	F-1/H-3**
Retail Stores and Kiosks	M
Storage Rooms	S-1
Taxi Parking (Lower Concourse)	S-2
Offices	B

* Park occupancies have been assigned similar classifications from Chapter 10.

** Refer to Section 5.3 for the emergency generator fuel storage

5.2 Occupancy Separation

1. Transit buildings will be separated from all adjacent non-transit buildings by a 3-hour fire wall in accordance with Section 5.2.3.5 of NFPA 130 (which is consistent with the SFBC for separation between separate buildings). Since the TTC is considered as a transit building, a form of fire separation will be required between any adjoining buildings.
2. Non-separated Use
   - The TTC building will use the non-separated use provision of SFBC Section 508.3.2. This means that separation between different occupancy classifications is not necessary other than those specified herein.
   - No separation is required between occupancies other than those specified in Sections 5.2.3 and 5.2.4 of this report.
3. Transit related occupancy separations per NFPA 130 (i.e. Train Platforms, Lower Concourse and the Bus Deck levels only)
   - All power substations (i.e. transformer vaults) – 3-hours
   - Electrical control rooms, auxiliary electrical rooms, and associated battery rooms – 2-hour from all other occupancies

- Trash rooms – 1-hour minimum from all other occupancies
- Public to Non-public separation (i.e. mechanical/electrical rooms) – 2-hour
- The glass enclosure separating the Bus Deck from the Grand Hall
  - No fire separation is necessary between this use and the circulation areas. Refer to Section 3.2.7 for justification.
- Station agent booth or platform control rooms
  - No fire separation is necessary

4. Incidental Uses
   - Stationary storage battery systems having a liquid capacity of more than 100 gallons used for facility standby power, emergency power or uninterrupted power supplies – 1-hour in Group B, F, M, and S occupancies or 2-hour in Group A occupancies.
   - Fire Command Center – 1-hour (Unless otherwise requested by SFFD)
   - Standby power and its transfer switch for smoke control system – 1-hour
   - Generator Fuel Storage Rooms (H-3) – 3 hours
   - Fire Pump Room – 2 hours
5. Horizontal Occupancy Separations
   - Grade Plane – 2 hours between above and below grade portions of the building. Refer to Section 4.4 for opening protection.
   - Bus Deck to the Roof Park – 2 hour (refer to Section 4.1.2)

5.3 Hazardous Materials

1. Fuel oil for the emergency generator (No. 2 Diesel) will be specified with Class II combustible liquid.
2. Two fuel oil storage tanks will be provided in two separate control areas. The storage tanks are 2,000 gallons each. As the fuel tanks exceed 660 gallons each, the tank rooms in which they are stored will be classified as Group H-3. Thus, the following protection features will be provided:
   - In accordance with Exception 2 of Section 415.3 of the CBC, the fuel tank rooms need not be located on the outer perimeter because the area of the room is less than 1,000 square feet.
   - The fuel tank room will be separated by a 3-hour fire resistance rated wall from the remainder of the building.
   - In accordance with Section 2704.2.2 of the CFC, secondary containment is required. Secondary containment will be designed

to contain a spill from the largest vessel plus the design flow volume of the fire protection water. The containment can contain the flow for a period of 20 minutes. The secondary containment can be replaced with double-wall storage tank.

- Drainage systems will be provided in accordance with Section 2704.2.2.6 of the CFC.
- Automatic leakage alarm will be provided.
- Normal and emergency tank venting will be provided in accordance with Section 3404.2.9.6.2 of the CFC. The vents will be terminated to the outdoor air.
- Mechanical ventilation will be provided in the tank storage room in accordance with Section 2704.3 of the CFC.

6 Interior Finishes

6.1 Wall and Ceiling Finishes

1. Interior wall and ceiling finishes will have a flame spread or smoke development index per the following occupancy groups specified in Table 4 and the indices specified in Table 5.

Table 4: Interior Finish Requirements*

Occupancy Group	Exit Enclosures and Exit Passageways	Corridors	Rooms and Enclosed Spaces
B/M	B	C	C
A	B	B	C/A**
F/S	C	C	C

* Based on a sprinklered building

**NFPA 130 Section 5.10.1.1 requires Class A for these areas located at the Train Platforms, Lower Concourse and the Bus Deck.

Table 5: Flame Spread and Smoke Developed Indexes

Category	Flame Spread	Smoke Developed
A	0-25	0-450
B	26-75	0-450
C	76-200	0-450

2. Interior wall and ceiling finishes, other than textiles, will be tested in accordance with NFPA 286 and will comply with SFBC Section 803.2.1.

6.2 Interior Floor Finish

1. Interior floor finish and floor covering materials in exit enclosures, exit passageways and corridors will not be less than Class II.
2. Floor covering materials in all areas will comply with ASTM E 648 and having a smoke density rating of less than 450 per ASTM E 84.

6.3 Combustible Materials in Type I-B Construction

1. Floor sleepers, bucks and nailing blocks will be constructed of non-combustible materials.
2. Wood finish flooring will be attached directly to the embedded or fire-blocked wood sleepers.

3. Combustible insulating boards not more than a half-inch thick can be used for Type I construction where attached directly to a noncombustible floor assembly.

6.4 Decorative Materials and Trim

1. Fixed or movable walls and partitions, paneling, wall pads and crash pads for decoration, acoustical correction, surface insulation will be considered interior finish if they cover 10 percent or more of the wall or of the ceiling area.
2. Curtains, draperies, hangings and other decorative materials suspended from walls or ceilings in Group A occupancies will meet the flame propagation performance criteria of NFPA 701.
3. Fabric Partitions suspended from the ceiling and not supported by the floor will be non-combustible or meet the flame propagation performance criteria of NFPA 701.
4. The permissible amount of non-combustible decorative materials will not be limited.
5. The permissible amount of combustible decorative materials meeting the flame propagation performance criteria of NFPA 701 will not exceed 10 % of the aggregate area of walls and ceilings.
6. Trim: Class C combustible trim excluding handrails and guard rails will not exceed 10 % of the specific wall or ceiling area on which it is attached.

7 Means of Egress

7.1 Introduction

The TTC building has a combination of transit and non-transit related occupancies.

- For the transit areas (Bus Deck, below grade train facility, and connecting concourses at Ground) NFPA 130 will be used to define the occupant load and exit capacity in these respective areas as agreed in RFLE #1 and #2.
- For the non-transit areas, the occupant load factors in the SFBC will be applied. The occupant load will be determined by the calculation with the occupant load factors in accordance with Chapter 10 of the San Francisco Building Code. For the Park, the occupant load has been defined by application of occupant load factors that are noted in Table 6 and agreed in RFI#1. For the detailed information on exiting from the Roof Park refer to Section 3.2.1.

The egress strategy and building emergency exiting assessment is documented in greater detail in the Emergency Exiting Report dated May 2013. The following sections provide a brief summary of requirements. The Emergency Exiting Report should be referenced for details.

7.2 Occupant Loads

7.2.1 Transit Areas

1. The Train Box occupant loads will be defined in accordance with the methodology in NFPA 130 (2007 Edition).
2. The Bus Deck and Bus Plaza at Ground Level will be designed in accordance with NFPA 130 (2007 Edition) with a modification to the occupant load calculation methodology so that it applies to the bus deck operation.
3. Areas adjoining transit areas (i.e. train or bus platforms etc) such as retail kiosks or tenant spaces will be loaded using the occupant load factors as required by NFPA 130 Section 5.5.5.5 and are noted in Table 6.
4. Train concourses will not be assigned an occupant load factor due to non-simultaneous use, except if part of the train load is waiting in designated “waiting areas” at the concourse level.

7.2.2 Non-Transit Areas

For non-transit areas the occupant load factors per Chapter 10 of the SFBC and as summarized in Table 6 will be used.

Table 6: Occupant Load Factors

Use	**Occupant Load Factor**
General	
Assembly Concentrated (Chairs only not fixed) Unconcentrated (Tables and chairs)	 7 net 15 net
Office, Food Preparation, Circulation, Retail Kiosks	100 gross
Retail Areas Basement and grade floor area Other floor	 30 gross 60 gross
Storage Areas	300 gross
Taxi Parking (Lower Concourse)	200 gross
Mechanical Equipment Rooms	300 gross
Other Park Specific Uses*	

Restaurants, Cafe (Tables and chairs)	15 net
Kitchens	200 gross
Retail Store	60 gross
Walking Surfaces (Hard surfaces)	100 gross
Lawns or picnic areas	100 gross
Designated entertainment zones Tables and chairs Concentrated chairs Standing	 15 net 7 net 5 net

* The agreed occupant loads are documented in Request for Interpretation #1 (refer to Appendix A).

7.3 Egress Width

7.3.1 General

1. Egress Convergence
   - Where means of egress from floors above and below converge at an intermediate level or a level of discharge, the capacity of the means of egress from the point of convergence will be greater or equal to the sum of the largest occupant load from the floor above and below.
   - Doors and signage will be used at the level of convergence to clearly indicate the exit path to prevent occupants from re-entering the building per SFBC Section 1011

7.3.2 Transit Occupancies

In accordance with NFPA 130 the requirements of this section apply to the means of egress for the Bus Deck, Lower Concourse and Train Platforms.

1. Evacuation Times
   - Evacuation time from the bus and train platforms will be less than or equal to 4 minutes
   - Evacuation time from the most remote point on the platforms to a point of safety (exterior of building at Ground Level is one example) will be less than or equal to 6 minutes
2. Platforms, Corridors, and Ramps Capacity and Width
   - Minimum Clear Width: 44 inches
   - Capacity: 2.08 pim (people/inch-minute)
   - Travel Speed: 124 fpm (feet/minute)

     200 fpm for Concourses
3. Stairs and Escalators Capacity and Width

- Minimum Clear Width: 43 inches (applies to any enclosed stairs)
- Capacity: 1.41 pim (people/inch-minute)
- Travel Speed: 48 fpm (feet/minute)
- In calculating the egress capacity of escalators, one escalator at each level and per platform will be considered as out-of-service.

7.3.3 Non-Transit Occupancies

1. The clear width of stairs will be limited in accordance with Section 7.5.1 of this report.
2. The clear width of doors will be limited in accordance with Section 7.4.1 of this report.
3. For Groups B,F,S, and M the total width of means of egress in inches will not be less than the total occupant load served by the means of egress multiplied by the factors.
   - Stairways – 0.2 inches per occupant
   - Doors – 0.15 inches per occupants
4. For Group A Assembly Without Smoke Protection
   - Stairways – 0.3 inches per occupant
   - Doors – 0.2 inches per occupant
5. For Group A Outdoor Smoke-Protected Assembly (applicable to the park)
   - Stairways – 0.08 inches per occupant
   - Doors – 0.06 inches per occupant

7.4 Doors

7.4.1 Door Width and Height

1. Transit occupancies
   - Minimum clear width of each door: 36 inches
   - Maximum means of egress capacity: 2.27 pim (people/inch-minute)
2. Non-Transit Occupancies
   - Minimum clear width of each door: 32 inches
   - Minimum clear width of one leaf for a door includes two doors without a mullion: 32 inches
   - Maximum width of a swinging door leaf: 48 inches
   - Minimum height of doors: 80 inches

- Clearance under the bottoms of doors will be three quarter inches in accordance with Table 1-11.4 of NFPA 80.

7.4.2 Projection into clear width

1. There will not be projections into the clear width lower than 34 inches above the floor or ground.
2. Projections into the clear opening width between 34 inches and 80 inches above the floor or ground will not exceed 4 inches.

7.4.3 Door Swing

1. Egress doors will be side-hinged swinging or horizontal sliding.
2. Doors will swing in the direction of egress travel where serving an occupant load of 50 or more person.
3. The opening force for interior side-swinging doors without closers will not exceed 5-pound force
4. For other side-swinging, sliding and folding doors, the door latch will release under 15-pound force. The door will be set in motion under 30-pound force, and swing to full-open position under 15-pound force.
5. Doors in electrical rooms with equipment rated more than 1,200 amperes and over 6 feet wide that contain over current devices, switching devices, or control devices will swing in the direction of egress.

7.4.4 Revolving Doors

1. Each revolving door will be capable of collapsing into a book-fold position with parallel egress paths providing an aggregate width of 36 inches.
2. A revolving door will have at least 10 feet space from top of stairs or escalators.
3. Each revolving door will have a side-hinged swinging door in the same wall and within 10 feet of the revolving door.
4. Each revolving door will be credited with no more than 50-person capacity.

7.4.5 Power-Operated Doors

1. Where means of egress doors are operated by power, the design will be that the door is capable of being opened manually in the event of power failure.
2. The forces required to open these doors manually will not exceed 30-pound in motion and 15-pound in a full-open position.

7.4.6 Horizontal Sliding Doors

1. The doors will be power operated and will be capable of being operated manually in the event of power failure.
2. The force required to operate the door will not exceed 30 pounds to set the door in motion and 15 pounds to close the door or open it to the minimum required width.
3. The door assembly will have an integrated standby power supply.

7.4.7 Landings

1. Landings will have a width not less than the width of stairway or the door.
2. When a landing serves an occupant load of 50 or more, doors will not reduce the landing to less than one-half its required width.
3. Landings will have a length measured in the direction of travel of at least 44 inches.

7.4.8 Door Arrangement

1. Space between two doors in a series will be 48 inches minimum plus the width of a door swinging into the space.
2. Door in a series will swing either in the same direction or away from the space between the doors.

7.4.9 Panic and Fire Exit Hardware

1. Panic hardware will be installed at each door with a latch or lock in a means of egress from a Group A, or assembly area not classified as an assembly occupancy (i.e. Less than 50 people are classified as Group B).
2. Panic hardware will be installed at each door in electrical rooms with equipment rated more than 1,200 amperes and over 6 feet wide that contain over current devices, switching devices, or control devices.

7.5 Fare Collection Equipment in Transit Areas

7.5.1 Gate-type fare collection

1. Minimum clear width when deactivated:
    a. 18 inches clear width as and below a height of 38 inches
    b. 28 inches clear width above a height of 38 inches
2. Maximum console height : 39 inches
3. Capacity: 50 people per minute (ppm)

7.5.2 Turnstile-type fare collection

1. Minimum clear width: 18 inches clear width
2. Maximum height: 35 inches at turnstile bar
3. They shall free wheel in the direction of egress when deactivated
4. Capacity: 25ppm (people per minute)

7.5.3 Electronically operated

1. If a required means of egress, the fare gate equipment shall release, permitting unimpeded travel in the direction of egress upon power failure, ground fault condition, activation of fire alarm, manual activation from a constantly attended control room

7.6 Emergency Exit Gates in Transit Areas

1. Emergency exits gates shall be provided for at least 50% of the required emergency exit capacity unless fare collection equipment provides unobstructed exiting under all conditions
2. Turnstiles are not considered “unobstructed”
3. Egress capacity of emergency exit gates will be designed in accordance with the requirements in Section 7.3.2 of this report.

7.7 Enclosed Exit Stairways

1. The width of exit stairways will be designed with the factors in Section 7.3.2 of this report, but such width will be 44 inches or more.
2. Stair riser height: 7 inches maximum, 4 inches minimum
3. Stair tread depth: 11 inches minimum
4. Stairway doors other than the exit discharge doors will be permitted to be locked from stairway side, but be capable of being unlocked simultaneously without unlatching upon a signal form the fire command center or failure of electrical power.
5. The width of landing at the top and bottom of each stairway will not be less than the width of stairways.
6. The minimum width of stairway landing will be 44 inches.

7.8 Handrails

1. Handrail height will be between 34 inches and 38 inches.
2. Clear space between a handrail and a wall or other surface will be a minimum of 1.5 inches.

3. The clear width between handrails will be 36 inches minimum. Projections into the required width of stairways and ramps at each handrail will not exceed 4.5 inches at or below the handrail height.

7.9 Guards

1. Guard will be provide along open-sided walking surface, stairways, ramps and landings that are located more than 30 inches above the floor or grade below.
2. Guard will not be required at vertical openings in the performance area of stages and platforms.
3. Guard height will be at least 42 inches.
4. Open guard will have balusters or ornamental patterns. The openings will not be larger than 4 inches in diameter.

7.10 Exit Access

7.10.1 Egress through intervening spaces

1. Egress through adjoining or intervening spaces will be allowed where such adjoining rooms or areas are accessory to the area served, are not a high-hazard occupancy and provide a discernible path of egress travel to an exit.
2. Egress will not pass through kitchens, storage rooms, closets or spaces used for similar purpose.

7.10.2 Common Path of Egress Travel

1. Group B, F and S occupancies – 100 feet maximum.
2. Group M – 75 feet maximum.
3. Group A – 30 feet maximum.
4. Group A (Outdoor Smoke-protected Assembly) – 50 feet maximum.
5. Group A (Train and Bus platforms) – Will not exceed 82 feet or one train or bus length, whichever is greater.

7.11 Exit and Exit Access Doorways

7.11.1 Spaces Requiring Two Means of Egress

1. In Group A, B, and F-1 occupancies, the occupant load exceeds 49.
2. In Group S occupancies: the occupant load exceeds 29.
3. The common path of egress travel exceeds 100 feet for Group B, F and S occupancies.

4. Boiler, incinerator and furnace rooms have the area of over 500 square feet and any fuel-fired equipment exceeds 400,000 Btu input capacity.
5. Refrigeration machinery rooms have the area of over 1,000 feet.
6. Rooms or spaces containing a refrigerant evaporator and maintained at a temperature below 68 °F and have 1000 square feet or more.

7.11.2 Clearance

1. Required exits will be located in a manner that makes their availability obvious. Exits will be unobstructed at all times.

7.12 Maximum Travel Distance

1. Group A (train and bus platforms): Maximum travel distance to a point at which a means of egress route (such as an enclosed stair, an open stair or escalator) leaves the platform will be less than 300 feet.
2. Group A (excluding train and bus platforms) occupancies: 250 feet
3. Group A (Outdoor Smoke-protected Assembly): Unlimited
4. Group B occupancies: 300 feet
5. Group M, F-1 and S-1: 250 feet
6. Group S-2: 400 feet
7. Group H-3 (Fuel Storage):150 feet

7.13 Corridor

1. A fire-resistance-rated corridor is not required for Group A, B, F, M, and S.
2. Corridor Width
   - General corridors – 44 inches minimum
   - With a occupant capacity of less than 50 – 36 inches minimum
   - Electrical, mechanical or plumbing systems or equipment – 24 inches minimum
3. Dead Ends
   - Group B and F – 50 feet
   - Group A (excluding train and bus platforms), M, and S – 20 feet

7.14 Number of Exits

1. All rooms and spaces within one story will be provided with the minimum number of exits required by Table 7.

Table 7: Maximum Number of Exits for Occupant Load

Occupant Load*	Minimum Number of Exits (per story or platform)
1-500	2
501-1,000	3
More than 1,000	4

* Number of occupants per floor or occupants per train or bus platform.

2. Where two exits or exit assess doorway are required the separation distance of the exit doors or exit access doorways will not be less than one-third of the length of the maximum overall diagonal dimension of the area served.
3. Where three or more exits or exit access doorways are required at least two exit doors or exit access doorways will be arranged for two exits or exit access doorways.

7.15 Vertical Exit Enclosures

1. The enclosed vertical exits in the building are noted in Table 8. All exits discharge at ground level.

Table 8: Enclosed stairs and levels accessed

Stair	From	Levels Accessed
Stair 201-A	Park	Park
Stair 201-B	Park	Park
Stair 301	Park	Park, Bus Deck, Second Level
Stair 401	Park	Park, Bus Deck, Second Level
Stair 601-A	Park	Park, Bus Deck, Second Level
Stair 601-B	Park	Park, Bus Deck
Stair 202	Second Level/B2	Second Level, B2, B1
Stair 304	Second Level/B2	Second Level, B2, B1
Stair 603	Second Level	Second Level
Stair 202	B2	B2, B1
Stair 203	B2	B2, B1
Stair 303	B2	B2,B1
Stair 304	B1	B1
Stair 403	B2	B2, B1
Stair 501A	B2	B2, B1, B1-Mezzanine
Stair 502A	B2	B2, B1, B1-Mezzanine
Stair 801	B2	B2, B1
Stair 802	B2	B1
Stair 803	B2	B2, B1

Stair 804	B2	B1
Stair 901	B1	B1

2. Stair 201-A/B at the west end of the building will be protected as depicted schematically in Figure 9. This stair will have no openings.

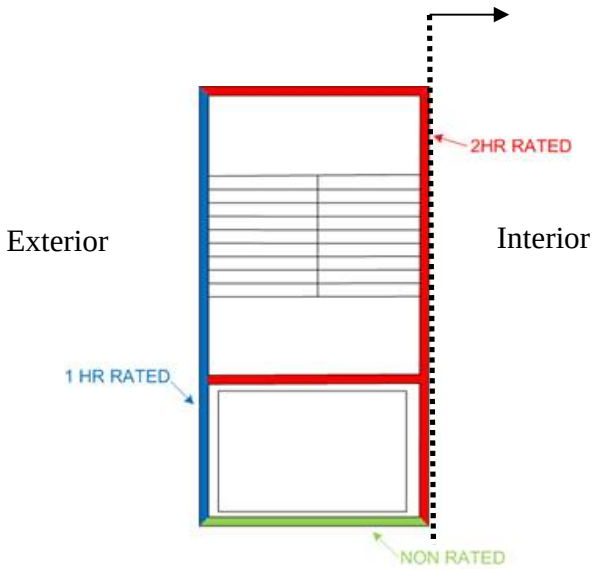


Figure 9: Stair 201-A/B fire separation requirements

3. Exit enclosures that access more than one level will have a fire-resistance rating of 2 hours.
4. 2-hour exit enclosure opening protection will have a fire-resistance rating of 90 minutes.
5. Penetrations into and openings through an exit enclosure are prohibited except for required exit doors, sprinkler piping, standpipes, and electrical raceway.
6. Where non-rated 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 non-rated wall or unprotected opening will have a fire-resistance rating of not less than 1 hour.
7. To comply with RFLE #7, Stairs S301, S401 and S601 will be provided with a positive pressure differential to limit smoke spread into these stairs serving the Park Level (i.e. outdoor smoke protected assembly space). The pressurization system will be designed in accordance with the agreed criteria in RFLE #7.

7.16 Exit Passageways

1. Exit passageway enclosures will have walls, floors and ceilings of a 2-hour fire-resistance rating.
2. Exit enclosure opening protection will have a 90-minute fire-resistance rating.
3. Elevators will not open into an exit passageway.
4. Penetrations into and openings through an exit enclosure are prohibited except for required exit doors from normally occupied spaces (corridors or hallways), equipment and ductwork necessary for independent pressurization, sprinkler piping, standpipes, and electrical raceway.
5. Normally unoccupied rooms (i.e. storage and mechanical/electrical rooms) are not permitted to open directly into exit passageways.

7.17 Exit Discharge

1. Exits will discharge directly to the exterior of the building.
2. The exit discharge will be at grade or will provide direct access to grade.
3. Up to 50 percent of the number of stairs and occupant load, exit enclosure will discharge occupants into a lobby or similar space with all of the following conditions:
   - The egress path must be unobstructed and readily apparent from the termination of the exit enclosure.
   - The lobby must be separated by a fire-resistance rating equal to the exit enclosure.
   - The egress path from the exit enclosure is sprinklered.
4. The exit discharge will not reenter a building.
5. The exit discharge will provide a direct and unobstructed access to a public way.
6. The exit discharge will be sufficiently open to the exterior so as to minimize the accumulation of smoke and toxic gases.

Exit discharge for the enclosed stairs in Table 8 will discharge to the exterior of the building. Figure 10 shows that the exit discharge will have direct access to a public way. The exits discharge at the exterior of the building at grade, however, the bus deck slab cantilevers over the sidewalk ~35 feet above. Smoke from a fire at ground or second would spill and deflect at the slab above. This area is sufficiently open that smoke would not accumulate and affect the exit discharge. Because occupants have direct access to the public way and the area is sufficiently open this configuration meets the intent of the SFBC.

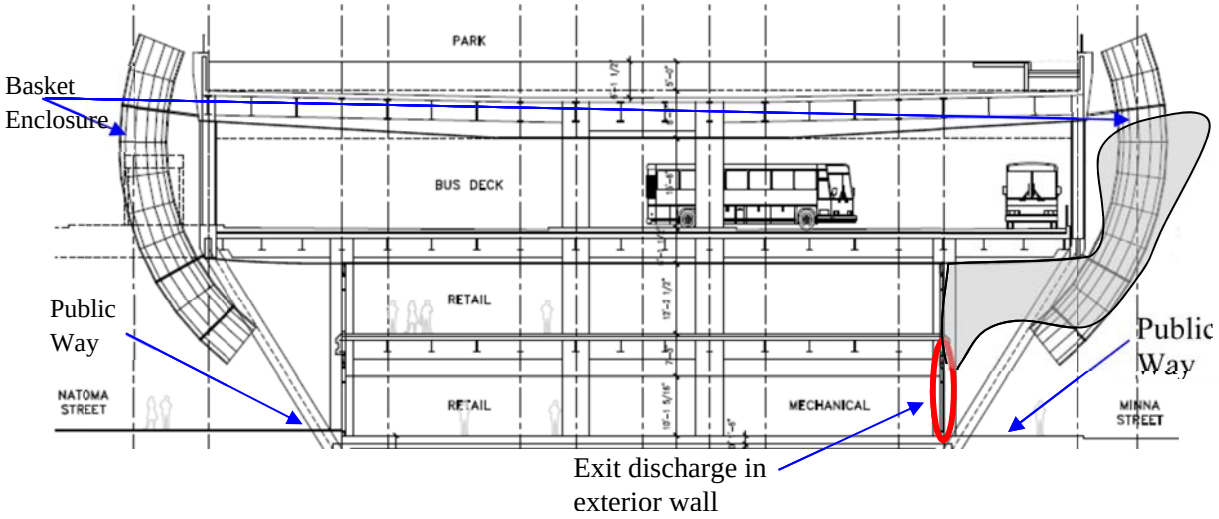


Figure 10: Transverse building section showing areas of discharge

Stair 601 will discharge into the bus plaza between Fremont St and Beale St. This configuration meets the requirements of SFBC Section 1024.1, Exception 1. Three out of four exits from the park (S201, S301, S401) discharge directly to the public way. Stair 601 has direct line of site to the exterior of the building and the public way.

7.18 Egress Courts

1. An egress court will connect Stair 201 to Minna Street and Natoma Street pedestrian ways, respectively. The width of the egress courts is approximately 15 feet.
2. The egress courts will be open to sky and unobstructed.
3. No fire resistance rate construction on the west exterior wall is required because the width of the egress courts is more than 10 feet per SFBC Section 1024.5.

7.19 Accessible Means of Egress

7.19.1 General

1. The number of required accessible means of egress will be provided in accordance with the required means of egress. Refer to Table 7
    a. Ground Level, Second Level, Rooftop Park, and Upper Level of Rooftop Park Restaurant (in abeyance) will comply with the provision for accessible means of egress in accordance with Section 1007 of the 2007 California Building Code as adopted by the City of San Francisco (2007 SFBC)

b. The Platform Level, Lower Concourse Level and Bus Deck Levels are transit levels. Egress is required to comply with NFPA 130 in lieu of the SFBC. In accordance with NFPA 130, accessible means of egress are to be addressed by the requirements of NFPA 101, and the Federal Railroad Administration (FRA), Federal Transit Administration (FTA). The latter two agencies adopt the Americans with Disabilities Act (ADA) requirements for accessible safe egress.

2. The maximum travel distance from an accessible space shall not exceed the travel distance permitted for the occupancy in accordance with Section 7.12 on Page 39 .
3. Signage for accessible means of egress will comply with SFBC Section 1007.7.

7.19.2 Accessible Means of Egress by Level

Accessible means of egress can be served by several different egress components. For TTC, this includes: Areas of refuge (AOR) served by accessible stairs or accessible elevators, Exterior Areas for Assisted Rescue (EAFAR) served by accessible stairs or accessible elevators, Horizontal Exits, and Direct Exits (at grade).

The following sections describe the accessible means of egress from the lowest levels to the highest level in the building.

7.19.2.1 Train Platform and Lower Concourse Levels

- The Train Platform and Lower Concourse Levels will be provided with AORs in accordance with requirements, guidelines and recommendations found in NFPA 101, 2006 Edition and the Americans with Disabilities Act Guidelines and the ADAAG as adopted in 2006. These codes do not require accessible means of egress in facilities protected by sprinkler systems throughout; however, accessible means of egress will be provided in these levels.
- The maximum travel distance to an AOR in these levels will be 496 feet. This is derived on a wheelchair travel speed of 3.5 fpm and an allowable time to exit the platform of 4 minutes. AORs will be provided in all enclosed emergency exits allowing for 2 wheelchair spaces in each enclosed stair. Each space will be not less than 30 by 48 inches each. The AORs will comply with the requirements of two-way communication.

7.19.2.2 Ground Level

The Ground Level is at grade. Accessible means of egress is provided via direct exterior exits designed in accordance with the 2007 SFBC.

7.19.2.3 Second Level

- The Second Level will be provided with accessible means of egress in accordance with the SFBC. The required number of accessible means of egress will be provided by AORs. The AORs will comply with the requirements of two-way communication. The number of AOR spaces for wheelchairs will be provided in the enclosed stairshafts in adequate number to accommodate 1 person per two hundred occupants. A horizontal exit is also provided on this level from Sector B to Sector A, in accordance with CBC 1022 and acts as a supplementary accessible means of egress.

7.19.2.4 Bus Deck

- This Bus Deck egress system is required to comply with NFPA 130. The Bus Deck will be provided with AORs in accordance with requirements, guidelines and recommendations found in NFPA 101, 2006 Edition and the ADAAG as adopted by FRA and FTA in 2006. These codes do not require accessible means of egress in facilities protected by sprinkler systems throughout; however, accessible means of egress will be provided in these levels. AORs will be provided in all enclosed emergency exits allowing for 2 wheelchair spaces. Each space will be not less than 30 by 48 inches each.

7.19.2.5 Roof Park Level Accessible Means of Egress

The Rooftop Park Level will be provided with elevators, as specified in this section, meeting the requirements for accessible elevators which comply with 1007.4.

In order to have adequate space for the number of occupants required to have either AORs or EAFARs, six elevators serving the park area at the Park Level will meet the provisions of SFBC 1007.4. The elevators will be provided with standby power and will be accessed by EAFARs. The six elevators are:

- Elevator PE-201
- Elevator SE-202
- Elevator PE-301
- Elevator PE-403
- Elevator PE-502
- Elevator PE-704

EAFARs will be provided in close proximity to the six elevators. The total number of spaces at the EAFARs will be based on a load factor of 2 wheelchair spaces per 200 occupants. Each space will be designed at 30” by 48” in accordance with SFBC Section 1007.6.1. Because unlimited travel

distance is permitted in an open outdoor assembly space per Exception 2 of SFBC 1025.7, the travel distance is unlimited. Although not normally required by the code, the EAFARs located at accessible elevators which serve the Roof Park Level will be provided with two way communications compliant with SFBC Section 1007.6.3.

7.19.2.6 Roof Park Restaurant Upper Level (in Abeyance)

In the event the rooftop restaurant with mezzanine is provided, the Upper Level of the Restaurant is required to be provided with two accessible means of egress.

- One will be an EAFAR adjacent to the open stair, and the other will be an accessible elevator complying with Section 1007.4. This elevator is also required to be accessible in accordance with SFBC Sections 1007.2.1.
- Occupants using the accessible elevator at the Upper Level Rooftop Restaurant will be required to transfer horizontally at the 1st Level Rooftop Restaurant. The occupants will transfer via an accessible path protected by a two hour smoke barrier in order to maintain continuity of the shaft protection. The elevators used in order to comply with this provision are

  a. PE-204

  b. SE-202
- The elevator shafts will be of construction that meets the requirements for 2-hour smoke barriers.
- Although not required by the code, two way communications, compliant with SFBC Section 1007.6.3 will be provided at the EAFAR associated with the elevator.

7.20 Emergency Lighting and Exit Signage

7.20.1 Emergency Lighting

1. Emergency lighting will comply with the Section 1006.3 of the SFBC and SFFC respectively.
2. The system performance will require “initial illumination” that is at least an average of 1 foot-candle (11 lux) and a minimum at any point of 0.1 foot-candle (1 lux) measured along the path of egress.

7.20.2 Exit Signage

1. Exit signage will be provided in accordance with Section 1011 of the SFBC and SFFC respectively.

8 Fire Protection Systems

8.1 Standpipe Systems

1. Standpipe systems will be installed in accordance with NFPA 14 2003 Edition and SFFD requirements.
2. A combined standpipe will be provided. Refer to Section 8.3 for fire pump requirements.
3. The standpipe will be an automatic wet standpipe system equipped with 3-inch hose connections per SFFD amendments.
4. Standpipes shall be hydraulically sized to provide 500 gallons per minute (gpm), for the most hydraulically remote standpipe, and 250 gpm for each additional standpipe.
5. Standpipe outlet valves will be located not less than three feet or more than five feet above the floor.
6. The valve will be placed to provide a minimum clearance of six inches on all sides of the handle and 18 inches on all sides of the threaded outlet.
7. Class I standpipe hose connections will be provided as follows:
   - In every required stairway at each floor level above or below grade.
   - On each side of the wall adjacent to a horizontal exit, unless the floor areas adjacent to a horizontal exit are reachable from exit staiwary hose connection within 100ft. The 100ft distance is measured along the path of travel.
   - In every exit passageway at the entrance from the exit passageway to other areas of a building.
   - Where the most remote portion of a sprinklered floor or story is more than 200 feet from a hose connection, additional hose connections will be provided to achieve full coverage.
   - Riser of Class I standpipe systems will be located within enclosed stairways.
8. The system will be interconnected.

8.2 Automatic Sprinkler Systems

1. An automatic sprinkler system will be provided throughout the building. SFBC Section 903.2.17 exempts the following:
   - Power substations (Note: a substation is defined as a room that contains equipment that is used to convert power)
   - Machinery rooms, electrical rooms and train control rooms protected by an approved automatic suppression system (refer to Section 8.7)

- Guideways when the closest sprinkler heads to the guideway are within 3 feet of the edge, over the platform, and spaced 6 feet on center parallel to the guideway
- Station agent booths not exceeding 150 square feet in area, when provided with an approved smoke detector connected to the building fire alarm system

2. NFPA 130 requires sprinkler protection in the following specific locations:
   - Areas of stations used for concessions
   - Storage areas
   - Trash rooms
   - Steel truss area of all escalators and other similar areas with combustible loadings
3. All valves controlling the water supply for automatic sprinkler systems, pumps, critical air pressures and water-flow switches on all sprinkler systems will be electrically supervised.
4. Alarm, supervisory and trouble signals will be distinctly different and automatically transmitted to the fire command center.
5. A sprinkler water-flow alarm-initiating device and a control valve with a supervisory signal-initiating device will be provided at the lateral connection to the riser on each floor.
6. Approved audible devices will be connected to every automatic sprinkler system. Alarm devices will be provided on the exterior of the building in an approved location.
7. Actuation of the automatic sprinkler system will actuate the building fire alarm system.
8. Since the commodities in the building are classified as light and ordinary hazard, the maximum floor area will be limited up to 52,000 square feet on any one floor.

All sprinklers will be designed for the Hazard Classifications in Table 9.

Table 9: Sprinkler Hazard Classifications

Location	Light Hazard	Ordinary Group 1	Ordinary Group 2
Train Box			**X**
Bus Deck			**X***
Retail Areas			**X**
Offices	**X**		
Restaurants (seating)	**X**		
Kitchens		**X**	
Storage Rooms			**X**

Conference Rooms	**X**		
Mechanical Rooms			**X**

*Note that Bus Deck Hazard Classification is still under review by the SFFD and is addressed in RFI #3.

9. Commercial Cooking Equipment
    - Commercial kitchen exhaust hood and duct systems required by the SFFC or the SFMC to have a Type I hood shall be protected with an approved automatic fire-extinguishing system.
    - The fire alarm system will monitor the activation of all hood and grease exhaust duct systems, cause automatic fuel shut-off for the area served and sound the alarm system in appropriate area(s).
    - Kitchen hood systems, when protected with fire sprinklers, will be served by independent, separately supplied systems without multiple flow switch arrangements. Grease duct systems will be sprinklered, and may be on the same zone as kitchen hood systems. Otherwise, they will be independent, separately supplied systems.
    - Sprinklers or automatic spray nozzles shall not be required where the entire exhaust duct is connected to a listed exhaust hood incorporating a specific duct collar and sprinkler (or automatic spray nozzle) assembly that has been investigated and been shown to protect an unlimited length of duct in accordance with UL 300.

8.3 Fire Pump

1. A single fire pump will be provided for the site. The pump will serve the above ground transit terminal and the below ground train facility.
2. The pump room will be located at in the North West corner at the Train Platform level adjacent the secondary water supply tank. Direct access to the room will be provided. Signage will be provided at the exterior access door to the Fire Pump Room.
3. The fire pump will be located in a 2-hour fire rated enclosure. No equipment or other uses will be placed within this room.
4. An electric motor driven, horizontal split case centrifugal type fire pump will be provided. The fire pump will minimally be rated for 1,000 gpm and sized to provide 100 psi at the hydraulically most remote standpipe outlet. The fire pump discharge pressure will not exceed 300 psi.
5. A jockey pump will be provided, sized to makeup the allowable leakage rate in ten minutes or 1 gpm, whichever is larger. The fire pump will start at 10 psi below the jockey pump starting pressure.
6. The fire pump will be connected to the emergency power supply, provided by the on-site diesel emergency power generator. The power transfer

switch and fire pump controller will be a single manufactured unit, monitored by the fire alarm system.

7. Minimum fuel supply for the fire pump for a minimum duration of 8 hours will be provided.
8. The fire pump system will be installed in accordance with NFPA 20.
9. The fire pump status and secondary water storage tank status will be monitored at Fire Command Center

8.4 Water Supply

1. On-site water supplies will comply with City and County of San Francisco amendments and NFPA 24.
2. The primary water supply will be provided by the city water system.
3. Secondary water is not required for this facility because it is not a high rise building, it is elective. As part of the overall life safety strategy a secondary water storage tank will be provided. The design will be as a follows:
   - The tank will be a minimum of 25,000 gallons (as required for retail occupancies) capably of supply for 30 minutes.
   - The tank will be located adjacent to the fire pump room that is located in the NW corner at the Train Platform Level adjacent the fire pump room.
   - The on-site secondary water supply and the underground fire service main will be installed to comply with NFPA 22, 2003 edition and NFPA 24, 2002 edition respectively.

8.5 Fire Department Connection

1. Fire department connections (FDC's) will be located on each side of the building that fronts a street. FDC and hydrant locations agreed with SFFD are provided in Appendix A
2. Four inlets will be provided for each connection.
3. Fire department connections will be located not less than 18 inches nor more than 48 inches above the level of the adjoining ground.
4. Fire department connection will be fully visible and recognizable from the street or nearest point of fire department vehicle access.
5. A metal sign with raised letters at least 1 inch size will be mounted on all fire department connections for water-based fire protection systems.
6. The potable water supply to automatic sprinkler and standpipe systems will be protected against backflow.

8.6 Station Guideway Deluge System

A white paper for presentation to the State Fire Marshall outlines why an undercar deluge system may not be appropriate for the proposed HSR and Caltrain vehicles.

Until confirmation that the system is not required, the design criteria will be as follows.

1. A deluge system will be provided along the entire length of track at each platform. Undercar deluge is not required in the tunnels or tracks approaching the platforms.
2. The system will be a manual wet system.
3. Deluge nozzles with caps will be located in the approximate center of track with spacing designed to completely wet the underside of the vehicle. System density will be a minimum of 0.19 gallon per minute per square foot for the design area. Open type deluge heads shall be located along the centerline of each track bed and spaced every 7 feet.
4. Each zone will be 300 feet long. Assuming both a Caltrain and CHSRP vehicle are approximately 85-90 feet long, the length of this deluge zone will cover at least 3 vehicles.
5. Flow rates will be determined by assuming two adjacent zones operating simultaneously on one track only.
6. Zones will be manually controlled by switches located in a protected cabinets wither at the Platform or Lower Concourse Level that are acceptable to the SFFD. Zones will be sequentially numbered and defined by track number. Western zones will be controlled by the east end switches, eastern zones will be controlled by the west end switches. If there is a common zone, in the middle of the track, this zone will be capable of operation from both ends of the platform.
7. Control switches will be located in cabinets at the ends of each platform with secure access for fire department personnel only.
8. Each of the station's under car deluge systems shall be supervised from the Fire Alarm Control Panel by means of flow switches. Each valve will be monitored by a separate circuit.

8.7 Alternate Suppression Systems

1. Alternate, approved automatic suppressions systems are permitted by NFPA 130 where water may not be suitable for the hazard
2. A water mist system (NFPA 750 - 2006 Edition) or a clean agent suppression system (NFPA 2001 - 2004 Edition) will be provided in the train control rooms.

8.8 Manual Fire Suppression

1. Fire extinguishers will be provided in accordance with NFPA 10 and the California Fire Code.

8.9 Firefighters Fresh Air System

1. SFFD Administrative Bulletin 5.07 (effective 10/9/08) requires an air replenishment system installed in underground tunnels or pedestrian tunnels greater than 150 feet in length.

8.10 Automatic Fire Detection

1. Fire alarm and detection systems will be installed in accordance with NFPA 72 2002 Edition.
2. Fire Alarm Control Panel will be provided in the Fire Control Room and annunciator panels will be provided at select locations throughout the building approved by the fire official. These are indicated on the fire alarm drawings.
3. Smoke Detection
    - Where doors on hold-opens are installed, spot- type smoke detectors will be installed.
    - A smoke detector will be installed on any door which will activate the closing devices on all doors in the exit enclosure at all levels.
    - Where a damper is installed within a duct, a smoke detector will be installed in the duct within 5 feet of the damper with no air outlets or inlets between the detector and the damper.
    - In the main return air and exhaust air plenum of each air-conditioning system having a capacity greater than 2,000 cubic feet per minute, smoke detectors will be located in a serviceable area downstream of the last duct inlet.
    - At each connection to a vertical duct or riser serving two or more stories from a return air duct of plenum of an air-conditioning system, smoke detectors will be provided.
    - In elevator machine rooms and in elevator lobbies, smoke detectors will be provided.
4. Heat Detection
    - Automatic heat detectors will not be required but may be used as desired.
5. Zoning
    - Fire alarm system will be divided into zones. Each zone will not exceed 25,000 square feet and the length of any zone will not exceed 300 feet in any direction.

- Each floor of a building will be considered as a separate zone. Multiple zones can be used
- Each section of floor of a building that is separated by horizontal exits will be considered as a separate zone.

8.11 Occupant Notification

The occupant notification and evacuation zones will be coordinated with the building evacuation plan. Notification appliances will be controlled based on 6 zones. Each zone will be established based on site specific needs. Refer to Figure 11 for description of the notification zones. The zones are defined as follows:

- Zone 1 will consist of the train platform level and lower concourse level.
- Zone 2 will consist of retail/restaurant areas in Sectors A and B at Grade and Second level.
- Zone 3 will include the Bus Deck level and the Grand Hall.
- Zone 4 will be the Roof Park.
- Zone 5 will be the Inter City Bus Facility
- Zone 6 will consist of the Bus plaza at Grade and office areas at Second Level in Sector D.

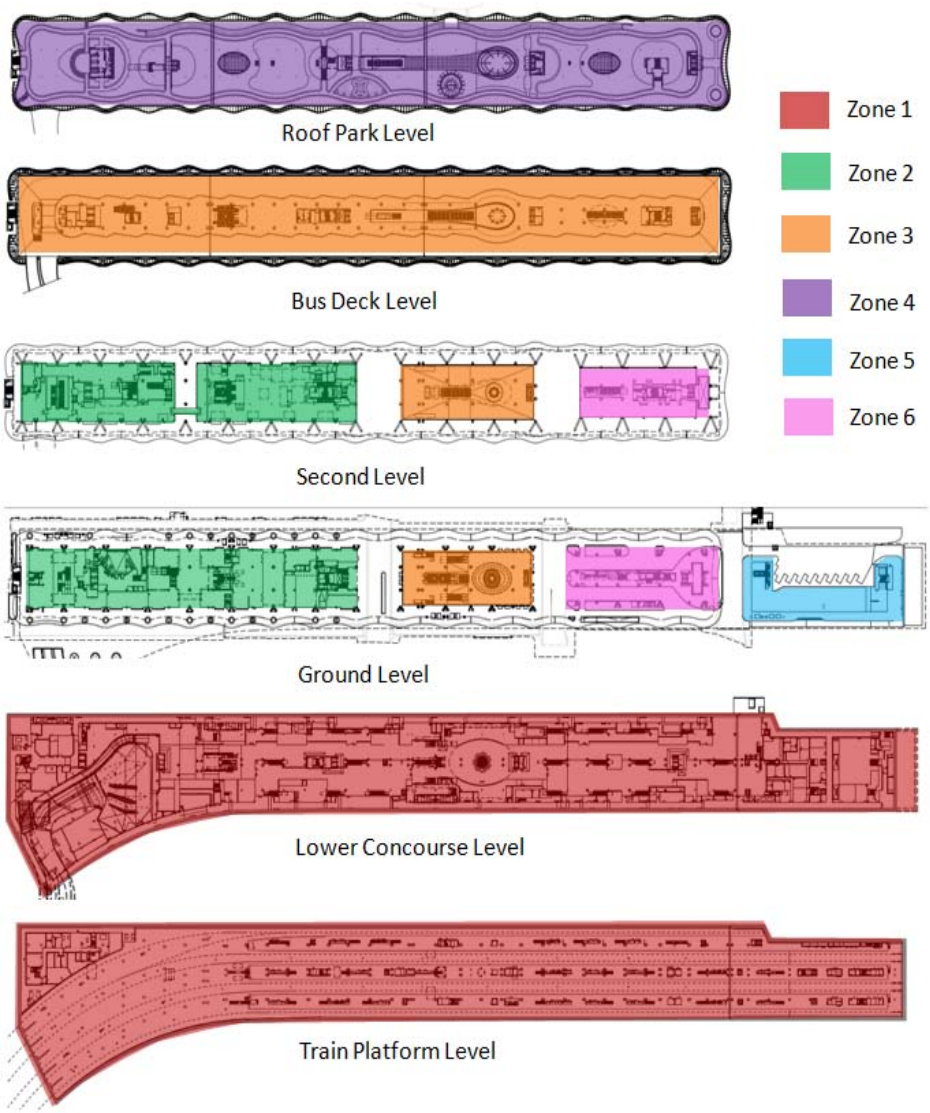


Figure 11: Alarm Notification Zone Diagram

The following zones will be evacuated based on the respective fire locations as recommended in Table 10. There is no specific code requirement for evacuation zoning. It is recommended that the fire alarm contractor review this recommended sequence with the SFFD before finalizing.

Table 10: Notification/evacuation zone activation based on fire location

Fire/Incident Location	Zones Evacuated
Train Platform or Lower Concourse (Zone 1)	Zone 1, Zone 2 (Ground), Zone 3(Ground), Zone 5
Bus Deck (Zone 3)	Zone 3, Zone 4, Zone 2, Zone 6
Zone 3 (Ground)	Zone 3, Zone 1 (Lower Concourse)
Bus Plaza (Zone 6)	Zone 6
Second Level Office (Zone 6)	Zone 6, Zone 3
Roof Park (Zone 4)	Zone 4, Zone 3, Zone 2 (Ground), Zone 6 (Ground)
Zone 2 (Ground)	Zone 2, Zone 1 (Lower Concourse)
Zone 2 (Second Level)	Zone 2, Zone 3

8.11.1 Alarm Notification Appliances

1. Visible alarm notification appliances will be provided in public use area and common use areas including, but not limited to the following:
   - Restrooms, locker rooms, dressing rooms
   - Corridor system
   - Auditoriums, dining rooms, cafeterias
   - Occupied rooms where ambient noise impairs hearing of the fire alarm – kitchens, laundry areas, central sterilization, mechanical equipment rooms
   - Lobbies including elevator lobbies
   - Meeting rooms – conference rooms, waiting rooms, reception rooms/areas, lounges
   - Office rooms/areas
2. Visible notification should be incorporated into the way finding facilities as much as possible. That is, visible notification devices should be located near wayfinding facilities where possible. Mass notification is not currently in the design.

8.11.2 Emergency voice/alarm communication system

1. Emergency voice alarm communication systems will be provided throughout the building. While the code permits the exclusion of voice alarm from the office spaces (i.e. Sector C Level 2), fire speakers will be provided for these areas to simplify the approach as discussed in an email by WSP F+K dated 8/1/11.
2. Emergency voice/alarm communication systems will be installed in accordance with NFPA 72 2002 Edition.

3. The fire alarm occupant notification system will be incorporated with the building PA system for large volume spaces such as the Great Hall, Bus Deck, Lower Concourse, and Train Platforms. Refer to RFLE #5 in Section 3.1.5 for further information.
4. Emergency voice/alarm communication systems will be provided with an emergency power source.
5. The operation of any automatic fire detector or sprinkler water flow device will automatically sound an alert tone followed by voice instructions.
6. Speakers will be provided throughout the building by paging zones which are elevator groups, exit stairways, each floor, and areas of refuge as a minimum. These zones are in addition to the occupant notification zones.
7. A manual override for emergency voice communication will be provided on a selective and all-call basis for all paging zones.
8. Emergency voice/alarm communication system will also have the capability to broadcast live voice messages through paging zones on a selective and all-call basis.
9. Emergency alarm reporting devices (i.e. emergency telephone boxes) will be located on passenger platforms and throughout the stations such that the travel distance from any point in the public area to one of these devices will not exceed 328 feet or 295 feet, respectively.

8.11.3 Park Level Notification

Park Level audible and visual occupant notification is required, however, the Fire Alarm Code provides inadequate design direction for such spaces, leaving the strategy to be worked out between the fire alarm designer and the authority having jurisdiction. The fire alarm design engineer is responsible for coordinating the design strategy with the authorities. This task should be performed before the bidding process.

8.11.4 Public Address System

1. At this stage in the design, a combined PA/FA system will not be provided for the high ceiling, high noise spaces of the TTC (Grand Hall, Bus Deck, Lower Concourse, and Train Platforms). Refer to Section 3.1.5 of this report for more details regarding RFLE #5

9 Emergency Ventilation Systems

An Emergency Ventilation Report will provide details of the systems for the Bus Deck and the Below Grade Train Station that will be provided under separate cover. The following is a summary of the proposed systems.

9.1 Bus Deck

1. An emergency ventilation system will be provided at the Bus Deck Level as required by NFPA 130.
2. The system will be a “mechanically assisted” smoke control system. The system will be designed in accordance with the requirements in the Bus Deck Emergency Ventilation report and installed in accordance with the requirements of NFPA 130 Chapter 7.
3. The system will consider a credible 35MW bus fire at the bus deck and the effect that wind and sprinklers will have on the performance of the system.
4. The emergency ventilation system will provide a tenable environment in accordance with NFPA 130.
5. The emergency ventilation system will be capable of reaching full operation within 180 seconds.
6. The system will be capable of operation for a minimum of 1 hour per NFPA 130 section 7.1.4.

9.2 Below grade Train Station

1. An emergency ventilation system will be provided in the below grade train station. The system will be designed in accordance with the requirements in the Train Station Emergency Ventilation report (still to be reviewed by the SFFD) and installed in accordance with the requirements of NFPA 130 Chapter 7.
2. The emergency ventilation system will provide a tenable environment in accordance with NFPA 130.
3. The emergency ventilation system will be capable of reaching full operation within 180 seconds.
4. The system will be capable of operation for a minimum of 1 hour per NFPA 130 section 7.1.4.
5. The emergency ventilation system will accommodate the maximum number of trains that could be between ventilation shafts during emergency.
6. At Lower Concourse Level, smoke reservoirs will be required as part of the emergency ventilation system. The smoke reservoirs will be created using vertical downstands (automatic drop down) at Gridlines 19 and 25. The downstands will be of non-combustible construction and extend from the ceiling to 12ft above the floor surface.

10 Emergency and Standby Power

10.1 Standby Power

1. A standby power system will be provided in accordance with the California Electrical Code.
2. A fuel supply, sufficient for 8 hours full demand operation, will be provided.
3. The standby power system will pick up its connected loads within 60 seconds of failure of the normal power supply
4. Standby power load will be provided for:
   - Elevators
   - Smoke control system for the train facility emergency ventilation system
   - Accessible means of egress elevators

10.2 Emergency Power

1. An emergency power system will be provided in accordance with SFBC Chapter 27 and the California Electrical Code.
2. The emergency power system will have a capacity and rating sufficient to supply the equipment listed Section 10.2.5.
3. A fuel supply, sufficient for a minimum of 8 hours full demand operation (dictated by the fire pump) will be provided per 2007 California Electrical Code and SFBC Chapter 27.
4. The emergency power system will pick up its connected loads within 10 seconds of failure of the normal power supply.
5. Emergency power load will be provide for the following:
   - Emergency voice/alarm communication systems
   - Fire pump (8 hours supply will be provided)
   - Fire alarm systems
   - Automatic fire detection systems
   - Elevator car lighting
   - Means of egress lighting and exit sign illumination
   - Protective signaling systems
   - Fire Command Center

11 Elevators

11.1 Shaft Protection.

1. All elevator hoistways will be of 2-hour construction.
2. All elevator doors will provide 1½ -hour opening protection.
3. 1 ½-hour rated fire-smoke curtains maybe used to serve as hoistway door opening protection. The fire curtains will be installed in accordance with ICE ES AC 77. Refer to RFI #2

11.2 Venting.

1. Elevator shafts will be vented to the atmosphere. Dampers will be provided over the over the hoistway vent openings. Hoistway vent dampers will open upon activation of any elevator lobby smoke detector serving the associated shaft.
2. Controls and status for the elevator hoistway vents will be provided on the smoke control panel.
3. The vent area will be at least 3.5% of the shaft area with at least three square feet per elevator.
4. Each hoistway will be vented independently of other hoistways.
5. Hoistways will not be vented through the elevator machine rooms.
6. Machine rooms will be zoned separately from the elevator shafts, and conditioned in accordance with Section 3006.2 of the Code.

11.3 Elevator Lobbies.

1. Elevator lobbies will be provided in accordance with Section 707.14.1. Section 707.14.1 requires an enclosed elevator lobby where an elevator shaft enclosure connects more than two stories in Group A occupancies.
2. Elevators will open into a 1-hour rated lobby at all levels, separated from the remainder of the building, including corridors and other means of egress, by walls extending from the floor to the underside of the fire-resistive floor or roof above.
3. In lieu of an enclosed elevator lobby the following are permitted:
   - Smoke Guard or similar will be provided in accordance with Exception 7 of Section 707.14.1.
   - Additional doors will be provided at the hoistway openings in accordance with Exception 3 of Section 707.14.1.
   - Refer to RFI #2 (See Section 3.2.2).

4. Enclosed elevator lobbies are not required at the ground level in accordance with Exception 1 of Section 707.14.1.
5. Elevator lobby doors will be 20-minute fire-rated “S”-labeled assemblies and will be automatic-closing by magnetic release, actuated by smoke detection.
6. Each elevator lobby/landing will have a smoke detector(s) installed within its/their listing(s). Smoke detectors maybe eliminated for elevator landings that open to an exterior space, only if those landings are not provided with a ceiling, roof or other type of overhead shelter. Heat detectors are typically provided, in lieu of, smoke detectors in these types of exterior spaces.
7. Combination fire/smoke dampers will be installed at duct penetrations through the lobby walls.
8. With elevators under normal or standby power, activation of a lobby smoke detector will cause automatic recall of all elevators serving that bank. The cabs will return non-stop to Ground. If detection occurs at Ground, elevators will recall to Second. Once recalled, the elevators will be under manual control only.
9. Manual controls for elevator recall will be provided at the main elevator lobby at Ground Level.

11.4 Manual Overrides

1. A three-position (on/off/bypass), key-operated switch will be provided at the primary recall level for each elevator for emergency override.
2. A three-position (on/off/hold), key-operated switch will be provided inside each elevator cab.
3. Elevator keys will be provided for Fire Department use in case of emergency in a lockable cabinet in the Fire Command Center.
4. The elevator override controls will be provided in the Fire Command Center. The interface must be suitable for responding personnel.

11.5 Accessible Means of Egress Elevator

1. At least one elevator will be provided as an accessible means of egress.
2. The elevator will be accessed from an elevator lobby which is designated as an area of refuge.

For the design of areas of refuge, refer to Section 7.19 of this report.

12 Fire Department Operations

12.1 Fire Apparatus Access

1. A vertical clearance for fire apparatus will be more than 13 feet 6 inches.
2. Fire apparatus access will be more than 20 feet of unobstructed roadway.
3. A turnaround for all dead-end fire access roads will be more than 80 feet and a minimum radius of 40 feet.

12.2 Site Fire Flow

1. SFFC Table B105.1 requires a flow of 5,000 gpm for 4 hours.
2. SFFC Section B105.2 allows a 75% reduction in a sprinklered building or a minimum of 1,500 gpm where approved by the fire department.
3. Resulting fire flow is 1,500 gpm for 4 hours.

12.3 Fire Command Center

1. A fire command center (FCC) will serve as a central staging post for the entire facility. The location of the FCC will be coordinated with the location of the main FDC and will be approved by the fire department. This location is at the corner of Natoma and 1st.
2. The size of the room provided is a minimum of 400 ft^2.
3. The FCC will comply with NFPA 72 and will include, but is not limited to the following:
   - The emergency voice/alarm communication system unit
   - The fire department communications unit
   - Two way FW radio communications
   - Fire detection and alarm system annunciator unit
   - Supervisory Control And Data Acquisition (SCADA) system
   - Annunciator unit visually indicating the location of the elevators and whether they are operational
   - The fire-fighter's control panel for the emergency ventilation system installed in the below grade train station.
   - Controls for unlocking stairway doors simultaneously (if locks are provided)
   - Sprinkler valve and water-flow detector display panels
   - Emergency and standby power status indicators
   - A telephone for fire department use with controlled access to the public telephone system

- Fire pump status indicators
- Schematic building plans indicating the typical floor plan and detailing the building core, means of egress, fire protection systems, fire-fighting equipment and fire department access
- Worktable
- Generator supervision devices, manual start and transfer features
- Public address system LSI unit

4. The ventilation systems at adjacent tunnels and stations shall be permitted to be omitted from the controls of the fire command center.

13 Operation and Maintenance

The following is as summary of the operational and maintenance issues that were conditions as part of the fire life safety strategy and fire engineering analyses. These measures will need to be implemented into a Operation and Maintenance (O&M) manual prior to occupation.

13.1 Roof Park

The proposed operating hours of the Park are between sunrise and sunset; these could change at the discretion of the Transbay Joint Powers Authority (TJPA). It is proposed that the Park will have security monitoring at all times via CCTV and other means such as security guards. It is recognized that a special event, concert, or catered function in the Park will draw large crowds, but not of the magnitude that would result in the maximum occupant load. Additional crowd control could include controlled access at all the entrances during special events via security control and ticket-access-only. It is the intent that the TJPA will develop operational procedures for the Park to address these scenarios and will be incorporated into an overall building management strategy.

13.2 Grand Hall

All retail kiosks in the Grand Hall must be restricted to a 12’ x 12’ plan area and be separated from any adjacent kiosks by 12ft. Also, retail kiosks must be separated from the light column structure as specified in Figure 12 to Figure 14. The retail kiosks must be limited to a fuel load size of 5MW. Typical kiosks examples that satisfy a 5MW limit are sunglass huts, newsstands, coffee stands, sandwich stands, etc. All proposed kiosks must be reviewed by a qualified fire protection engineer prior to use.

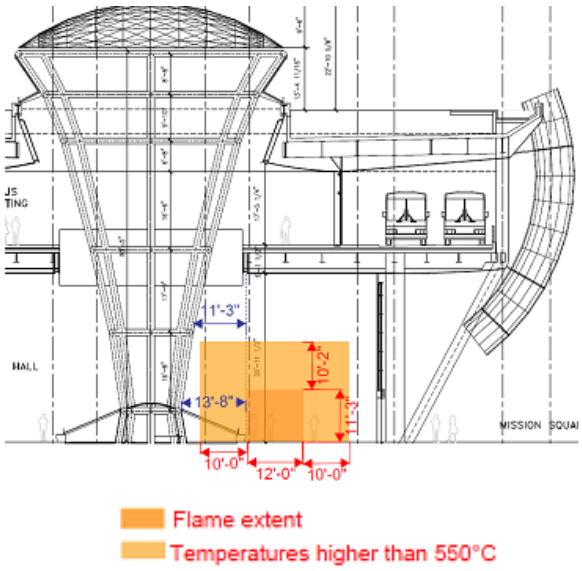


Figure 12: Illustration of kiosk separation distances required at Ground Level to allow light columns to remain unprotected

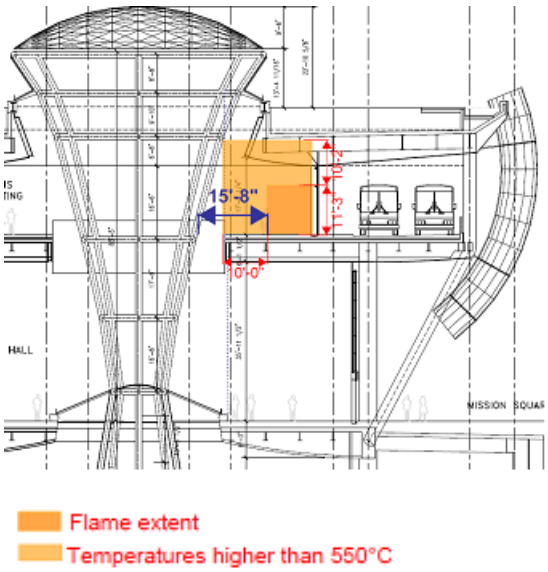


Figure 13: Illustration of kiosk separation distances (transverse direction) required at Bus Deck Level to allow light columns to remain unprotected

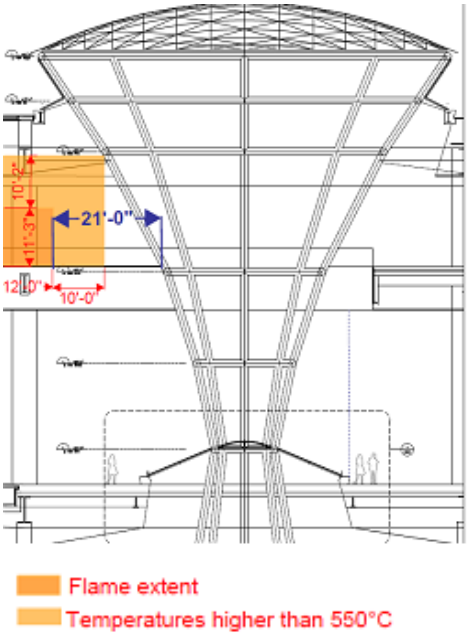


Figure 14: Illustration of kiosk separation distances (longitudinal direction) required at Bus Deck Level to allow light columns to remain unprotected

Appendix A

Reference Material and Reports

A1 List of Reference Material

1	Request for Local Equivalency #1: Application of NPFA 130 for the bus deck
2	Request for Local Equivalency #2: Application of NFPA 130 in lieu of SFBC Section 433 for the below grade train facility
3	Request for Local Equivalency #3: Structural Fire Engineering
4	Request for Local Equivalency #4: Exterior Opening Protection and Fire Spread
5	Request for Local Equivalency #5: Public Address System used for Fire Alarm Paging
6	Request for Local Equivalency #6: Fire Fighter Fresh Air - WITHDRAWN
7	Request for Local Equivalency #7: Park Stair Pressurization
8	Request for Interpretation #1: Roof Park Occupant Load and Egress Facilities
9	Request for Interpretation #2: Elevator Lobbies and Hoistway Openings
10	Request for Interpretation #3: Bus Deck Sprinkler System
11	Request for Interpretation #4: Emergency Stretcher Elevator
12	Request for Interpretation #5: Enclosed Mezzanine 75 feet Above Lowest Level of Fire Department Access

Request for Local Equivalency for Alternate Design of Construction Under Sections 104A.1 and 104A.2.8 of the 2007 San Francisco Building Code and Section 111 of the 2007 California Building Code

Transbay Transit Center, San Francisco
Local Equivalency #1

Application of NFPA 130 for the Bus Deck

Building Description

The Transbay Transit Center (TTC) will have three above-grade levels, a park on the roof of the building, and two below-grade levels. The above-grade portion of the building will serve as the transit hub for Bay Area bus services, such as AC Transit, Muni, Golden Gate Transit, and Greyhound (in Phase 1). The below-grade levels will house the train station that is expected to serve Caltrain and future high-speed rail.

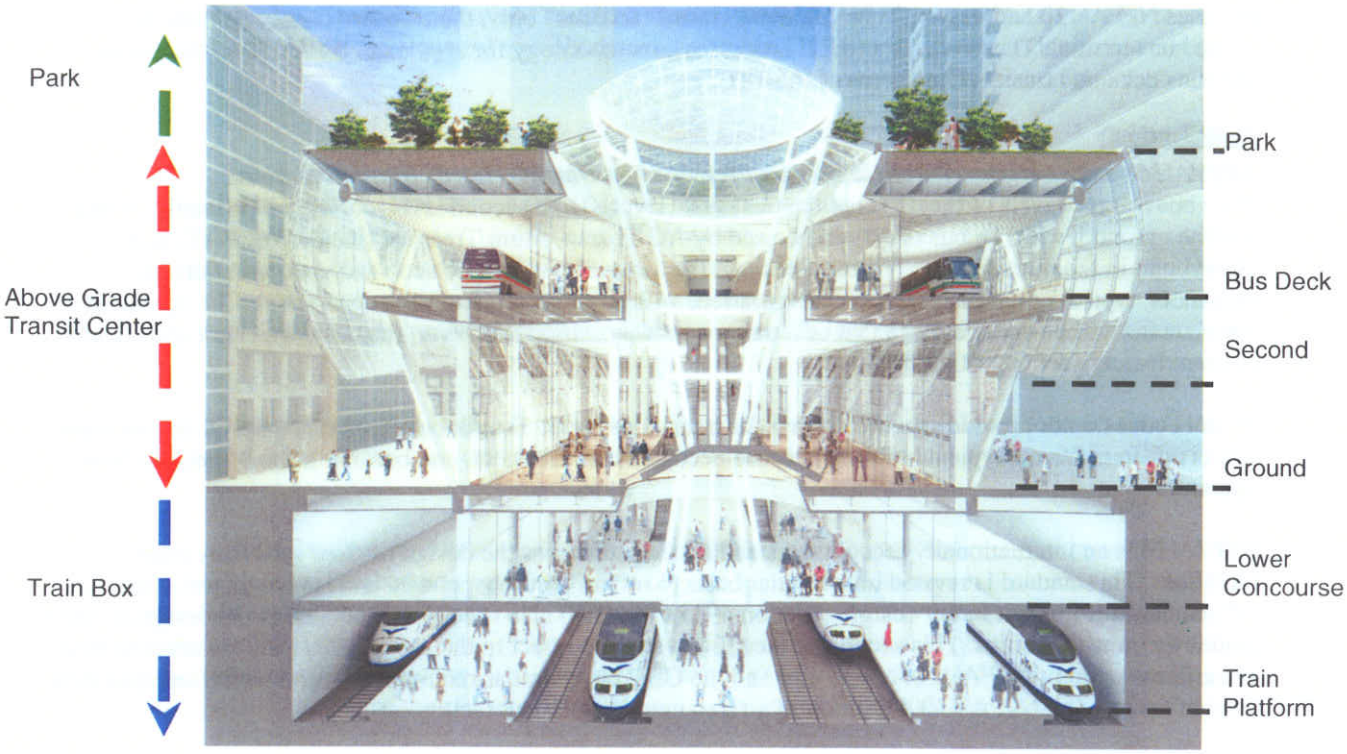


Figure 1: Building Section through the Grand Hall

The building is not a high-rise. The bus deck is primarily open around the perimeter of the building. An enclosed waiting area, which will shelter passengers from the outside, is located in the center of the bus deck and encircles the light column that descends through the lower levels of the building. The enclosed waiting area will be separated from the bus bays so that any residual fumes from bus operations do not filter inside the building. The main concourse areas will be connected via open stairs and escalators.

Code Sections

Chapter 10 of the 2007 San Francisco Building Code (SFBC) addresses exiting requirements for all occupancy classifications. Table 1004.1.1 of the SFBC has occupant load factors for certain uses; however, bus platforms are not specifically addressed. Additionally, exiting from a bus terminal platform is not specifically addressed in SFBC Chapter 10. The 2007 California Building Code (CBC) and SFBC both

include Section 433 for fixed guideway transit systems, which contain requirements for egress and other fire protection systems for such transit areas.

Code Requirement

For reference, detailed code sections are listed in the justification.

Code Intent

The intent of the SFBC is to ensure that the design provides adequate means of protection relative to the hazard so that occupants can evacuate a building in an emergency in a safe and timely manner and life safety is preserved.

Request

This Request for Local Equivalency (RFLE) addresses the application of NFPA 130 (2007) as the design criteria for the above-grade bus deck and the connecting transit-related circulation areas.

Because NFPA 130 addresses "fixed guideway transit facilities" only, the standard cannot be directly applied to the bus terminal. Therefore, this RFLE addresses a methodology for applying NFPA 130 to the design of the bus deck and transit-related areas of the TTC.

Justification

NFPA 130 as the design criteria for the bus deck and bus transit related circulation areas

The above-grade levels of the TTC are the bus deck (level 3), the second level, composed primarily of retail, and the ground level. The bus deck will be used by AC Transit, Muni Treasure Island, WestCAT, and Greyhound in the initial phase. The bus deck and the second level will be accessed via open stairs and escalators, typical of a transit station configuration, with large open circulation concourses. The operation of these areas will be very similar to that of a train or subway station; however, the bus deck is not specifically covered by any section of the SFBC.

Model codes do not provide specific criteria for transit use areas. Transit buildings represent an environment that is different from a typical building because occupants are transient, and because of how such facilities operate.

NFPA 130 is an internationally recognized standard that addresses the design of *fixed guideway* transit facilities. This standard is revised on a regular basis to reflect industry practice and is recognized as the "go to" standard for transit facility design. Section 433 of the CBC also specifically addresses the design of fixed guideway transit facilities. This section of the CBC went into effect in the early 1990s and was adapted from an earlier version of NFPA 130. NFPA 130 and the CBC have similar requirements, and intend an equivalent level of safety. The NFPA 130 definition of a fixed guideway transit facility is:

> *FIXED GUIDEWAY TRANSIT SYSTEM. An electrified transportation system, utilizing a fixed guideway, operating on right-of-way for the mass movement of passengers within a metropolitan area, and consisting of its fixed guideways, transit vehicles, and other rolling stock; power system; buildings; maintenance facilities; stations; transit vehicle yard; and other stationary and movable apparatus, equipment, appurtenances, and structures.*

With buses classified as "transit vehicles," bus operation at the TTC will meet the definition for a fixed guideway transit facility except that buses do not operate on fixed guideways. Strictly speaking, NFPA 130 or SFBC Section 433 cannot be directly applied under this definition. However, the similarities between a fixed guideway transit facility and the bus facility suggest that NFPA 130 would be more appropriate than the general requirements of the SFBC. These similarities include:

- A bus terminal is a transit facility.
- The layout and characteristics of the bus terminal have the same features as a train station, including open stairs and escalators, waiting concourses and mezzanines, and the transient occupants arriving and waiting to depart.
- Compared to a typical Group A occupancy, occupants in the transit areas of the TTC will be in the building only long enough to wait and board a bus or train or exit the building once alighted from a bus or train.
- The bus terminal will have operational peak periods, similar to a train station.
- Occupant awareness and behavior will be similar to that of a train station
- The directional flow and bus stop locations will be specific to the service, so the directionality of the bus is defined, similar to a fixed guideway.

With a fixed guideway train platform, if a train is stopped at the platform, other trains cannot enter the station via that same track; however, if a bus is stopped on the bus deck, service operation is still possible, as buses can drive around the stopped bus. In this scenario, a bus platform has an operational advantage over a train platform. Occupants can continue boarding and alighting even if a bus is out of service.

The application of NFPA 130 to the bus deck and the circulation areas would permit the use of open stairs and escalators as a means of egress; this is one of the primary reasons for using NFPA 130. This application is permitted in previous versions and the current version of NFPA 130 and the CBC (previously Section 414A, now Section 433). Using open escalators as part of the means of egress means that occupants are more likely to exit the building by the path with which they are most familiar. The fact that escalators can be used as part of the means of egress permits much more flexibility in the design of the building.

The proposed layout of each above-grade level is shown in Figure 2. Areas where NFPA 130 requirements would apply are defined as "transit areas." Adjacent areas where SFBC requirements apply are defined as "non-transit areas." It is important to note that if transit and non-transit areas use a common stair or exit passage, a cross check will be conducted to verify that there is sufficient capacity provided to meet both sets of criteria.

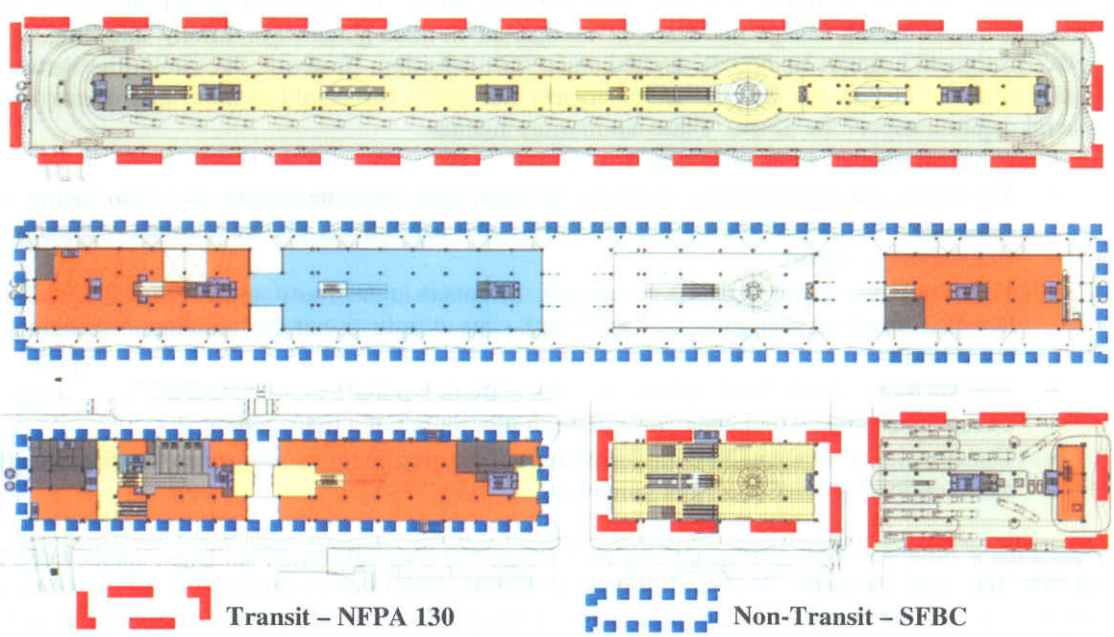


Figure 2: Transit and non-transit areas for the above grade potions of the TTC building

Included in Table 1 is a comparison of the general means of egress requirements between NFPA 130 and SFBC Chapter 10. Table 1 illustrates that the SFBC is more restrictive for non-transit buildings; however, it does recognize that for a transit facility (as addressed in SFBC Section 433), a different set of criteria for this building occupancy is necessary.

Table 1: Means of Egress Comparison of NFPA 130 and SFBC Chapter 10

Issue	2007 SFBC Chapter 10	2007 NFPA 130
Required Exits	Minimum 4 exits required for more than 1,000 occupants* (Table 1019.1)	Provide as necessary to meet 4 and 6 minute rules below.
Exit Locations	Not less than one-third of the length of the maximum overall diagonal dimension (1015.2)	At least two means of egress remote from each other (5.5.3.1)
Exit Enclosure	Enclosed by a 2-hour rated wall (1020.1)	Not required (5.2.3.1)
Escalator	Not permitted for egress	Permitted for egress (5.5.6.3.2.2)
Travel Distance	Group A – 250 feet max (Table 1016.1)	300 feet max (5.5.6.1.1)
Common Path of Egress Travel	Group A – 75 feet max (1014.3)	82 feet max (5.5.1.4)
Egress Time	Not specified	From platform: 4 min. max. (5.5.6.1) To a point of safety: 6 min. max. (5.5.6.2)
Exit Capacity	Stairway: 5 people/in. (0.2 in./occ.) (1005) Door: 6.67 people/in.(0.15 in./occ.) or 5 people/in.(0.2 in./occ.) for A occupancies > 300 (1005 and 1025.3))	Stairway including escalator: 1.41 people/in.-min. (5.5.6.3.2.3) Door: 2.27 people/in.-min. (5.5.6.3.3.2) One escalator assumed out of service (5.5.6.3.2.6)

In summary, the SFBC (Section 433) recognizes that different criteria are necessary for transit stations. Application of NFPA 130 to the bus deck is better suited to the proposed use, and NFPA 130 is more current than the SFBC regarding issues surrounding transit facilities. It would be a better tool than SFBC Section 433.

Bus Deck Occupant Load

Although not a "fixed guideway transit system" by definition, the bus deck is analogous to a train station where the buses arrive at a platform and passengers wait on a common platform. One approach to defining the occupant load for the bus deck is to use the area of the enclosed bus waiting area and apply an occupant load factor to define the number of occupants at this level. However, given the transient nature of passengers and the fact that ridership has peak periods during the day (i.e., the morning and afternoon commutes), this may not be that relevant or applicable.

The alternative approach to defining the design occupant load for the bus deck is to use the peak period concept in NFPA 130. The 2007 version of NFPA 130 criteria for determining the platform occupant load is more performance based compared with SFBC Section 433. NFPA 130 allows the designer to define the peak period; this could range between 10 and 20 minutes, when the highest ridership is expected in the building. If projected peak period data is not available and peak hour data is used, then a surge factor should be applied. The train loads and waiting loads need to consider service disruptions, delays, and system reaction times. A full explanation of the NFPA 130 variables and how these will be applied to the operation of the bus deck are provided in Table 2.

Table 2: Explanation of NFPA 130 variables for determining platform occupant loads and application to the bus deck

Terminology	NFPA 130 Definition	Bus Deck Application
Design Year	The projected year that the system is designed using forecasted ridership. This is typically 15-25 years past the anticipated opening date.	The bus deck analysis will use 2030 as the design year.
Special Event Considerations (5.5.5.3)	If the station is located close to an arena or facility that is likely to host special events, the affect on the calculated occupant load requires consideration.	The anticipated ridership from events at AT&T Park will be considered in the analysis. Additionally, the park on top of the building could have an influence on ridership based on the type of events to be held at the park.
Peak period (5.5.5.2.1)	The time within the peak hour that has the highest ridership flow rate. This is at the discretion of the engineer but typically ranges between 10 and 20 minutes. Periods in both the AM and PM should be considered.	The bus deck calculation will use the peak period approach. Ridership and bus scheduling has indicated that the PM peak will provide the highest occupant load. The peak period is between 5:15 pm and 5:30 pm.
Surge Factor (A5.5.5.1)	When hourly ridership data is used to derive the peak period ridership, a surge factor is applied as a statistical correction. A5.5.5.1 recommends factors between 1.3 and 1.5. Surge factors are not required if peak period information is available.	The more conservative surge factor of 1.5 will be applied. This is the upper bound recommended by NFPA 130.
Headway (3.3.23)	Time between trains coming into the station. Can be track dependent based on direction of the peak period.	The average headway will be defined by the total number of buses during the peak hour per bus bay.
Peak Period Occupant Load (5.5.5.6.1)	Shall be based on the simultaneous evacuation of the entraining load and the train load for that platform in the peak period.	The same approach will be adopted.
Entraining load (5.5.5.6.2)	The entraining load for each platform shall be the sum of the entraining loads for each track serving that platform.	The entraining or "waiting" (i.e. passengers waiting for a bus) load will be determined by passengers entering the station. Instead of "per track" it will be per bus bay.
Train Load (5.5.5.6.3)	Derived from the average headway and the total number of passengers entering the station during the peak period.	The average bus load will be determined based on number of passengers entering the station during the hourly peak.
Maximum Train Load (5.5.5.6.3.1)	The maximum passenger capacity of the train. When calculating train load with consideration to service delays (or missed headways) the train load will be limited to the train passenger capacity if the missed headway load is greater.	Maximum bus capacity is 50, which is representative of AC Transit, which has the highest passenger load.

Terminology	NFPA 130 Definition	Bus Deck Application
Service Delays (A5.5.5.6.2.1)	Service delays in fixed guideways have traditionally been addressed by a missed headway. That is, if a train doesn't arrive at the previous station or service is delayed, the accumulation of passengers on the platform at the previous station will take the next available train. Similarly, boarding passengers will accumulate on the platform.	To account for service delays bus service from the TTC will be stopped during the peak period.

During the initial period of the peak period, bus service will continue to operate. To account for service delays, bus service in and out of the building will be stopped to allow passenger accumulation on the bus deck; the delay has been defined as 10 minutes, as this is close to the average bus headway. This 10-minute delay will capture one headway on each bus bay, and in some cases two headways, depending on bus schedules. Two missed headways are over and above what NFPA 130 would normally require; therefore, the calculation is conservative in that respect. The design occupant load will be that accumulated on the platform at the end of the peak period. The methodology for calculating the bus deck occupant load is defined in Table 3.

Table 3: Bus Deck Occupant load calculation methodology

Step		Comments
1	**Bus Data** 1. Peak Period duration, PP = 15 mins 2. Number of buses in the peak period, $B_{pp} = B_{total} \times PP/60$ 3. Number of bus bay, Bays = 37 4. Bus stops per bay, $B_{stops} = \frac{B_{pp}}{Bays}$ 5. Average Bus Headway (HW) = PP/B_{stops}	Each bus bay will have at least 1 bus that will stop during the peak period. Depending on bus schedules, some bays may have 2 buses stop during the peak period especially if the first stop is at the start of the peak period.
2	**Peak Period Ridership** Apply a surge factor (S) of 1.5 to the hourly peak numbers and determine the peak period ridership loads. 1. Boarding passengers $PL_{Boarding\text{-}PP} = SF \times PL_{Boarding\text{-}Hourly} \times \frac{PP}{60}$ 2. Alighting Passengers $PL_{Alighting\text{-}PP} = SF \times PL_{Alighting\text{-}Hourly} \times \frac{PP}{60}$ 3. Total peak period throughput $PL_{Total} = PL_{Boarding\text{-}PP} + PL_{Alighting\text{-}PP}$	PL_{total} represents the total throughput of passengers at the bus deck during the peak period. It does not represent the design occupant load on the platform post dwell period because bus operation will continue to operate where boarding and alighting will still occur.
3	**Bus Boarding Passengers removed from platform** Determine the number of occupants removed from the bus waiting areas prior to service dwell time by buses still in operation. 1. Service Dwell Period, DP = 10 minutes 2. Operational Period, OP = PP – DT 3. Buses during Operational Period $B_{pp\text{-}OT} = B_{pp}. OP/PP$ 4. Boarding Passengers removed during Operational Period $PL_{Bus\_Boarding} = B_{pp\text{-}OP} \times$ Max Bus Load	This calculation determines the number of passengers that will be removed from the waiting areas by buses still in operation prior to the service dwell period.

Step		Comments
4	**Bus Alighting Passengers not brought into the station** Determine the number of occupants not brought into the station during the dwell period. 1. Service Dwell Period, DP = 10 minutes 2. Alighting passengers not brought into the station $PL_{Bus\_Alighting} = PL_{Alighting\text{-}PP} \times DP/PP$	This calculation determines the number of alighting passengers not brought into the terminal once service is stopped.
5	**Platform Load** $PL_{pp} = PL_{Total} - PL_{Bus\_Boarding} - PL_{Bus\_Alighting}$	

Other Design Criteria

This section outlines other SFBC requirements and the comparative NFPA 130 requirements. Note that this is not an exhaustive summary of all the detailed requirements. The purpose is to illustrate any major differences, if they exist, and the criterion that is the most restrictive.

Table 4: Comparison of other fire life safety criteria between SFBC and NFPA 130

Requirement	SFBC (2007)	NFPA 130 (2007)	Criteria Applied
Construction Type	**Table 503** Minimum Type IB for A-3 building with unlimited floor area and a maximum of 11 stories.	**5.2.1.** Building construction for all new stations shall be not less than Type I – or Type II– or combinations of Type I– and Type II.	Type IB construction type required.
Fire Separation • Power Substations • Trash rooms • Electrical rooms • Train control and battery rooms • Emergency generator rooms • Traction power substations • Public and non-public separation	**433.2.2.2** • 3 hrs • 2 hrs • 2 hrs • 2 hrs • 2 hrs • 3 hrs with no openings to public areas • 2 hrs	**Section 5.2.3** • 3 hrs • 1 hr minimum • 2 hrs • 2 hrs • 2 hrs • 3 hrs • 2 hrs	The only similar requirement to NFPA 130 is SFBC Section 433. NFPA 130 is similar or more restrictive, except for trash rooms. NFPA 130 criteria will be used.
Sprinklers	**903.2.1.3 Group A-3.** An automatic sprinkler system shall be installed in this building in accordance with this code section.	**5.7.3.1** An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and in the steel truss area of all escalators and other similar areas with combustible loadings, except trainways. **5.7.3.2** Installation of sprinkler systems shall comply with NFPA 13 or applicable local codes as required.	The bus deck, including vehicle way, will be fully sprinklered.

Requirement	SFBC (2007)	NFPA 130 (2007)	Criteria Applied
Standpipes and Hose Systems	**905.3.1 Building height** A Class III system in above ground buildings where the floor level of the highest story is more than 30 ft above the lowest level of fire department access. Class I permitted where an automatic sprinkler system is installed.	**5.7.4.1** Class I or Class III standpipes shall be installed in enclosed stations in accordance with NFPA 14.	Class I standpipes will be installed in accordance with local requirements.
Smoke Control System	**403.13** The above grade building is not a high rise; therefore, smoke control is not required. **404.4** The above grade building does not have an atrium; therefore, smoke control is not required. **405.5** The below grade portion of the building will have smoke control. This is a separate fire compartment.	**7.1.2.3** A mechanical emergency ventilation system shall not be required in an open system station.	An analysis will be conducted to define the smoke ventilation requirements at the bus deck from a bus fire.
Fire Command Center	**433.4.4** Emergency management panel room is required.	**5.7.6** Fire command center will be provided per NFPA 72.	A Fire Command Center will be provided.
Train ways	No criteria	Chapter 6 not applicable to the bus deck.	
Emergency Ventilation	Section 433.4.5	Chapter 7	NFPA 130 requirements
Vehicle Design	No criteria	Chapter 8 not applicable to the bus deck.	

Summary

This request addresses the use of NFPA 130 as the design criteria for the bus deck and above-grade transit areas of the TTC. Application of NFPA 130 requires a local equivalency because the bus deck does not meet the strict definition of a fixed guideway transit system. This document outlines an equivalent, sensible methodology for applying NFPA 130. In our professional opinion, NFPA 130 will provide an equivalent level of safety and meet the intent of the SFBC.

Prepared by
Arup Fire

11/12/09
Andrew R Coles, PE Date

REGISTERED PROFESSIONAL ENGINEER
ANDREW R. COLES
FP 1650
EXP 6/30/11
FIRE PROTECTION
STATE OF CALIFORNIA

Approved by Hanson Tom
San Francisco Department of Building Inspection

11/12/09
Date

Approved by Bill Mitchell
San Francisco Fire Department

11/12/09
Date

Approved by Edmond Sum
Transbay Joint Powers Authority

12 NOVEMBER 2009
Date

DEPARTMENT OF BUILDING INSPECTION
City & County of San Francisco
1660 Mission Street, 2nd Floor, San Francisco, California 94103-2414
TEL 415-558-6133 FAX 415-558-6686

NOTICE OF DECISION
BOARD OF EXAMINERS MEETING
March 23, 2009
Case No. 2009-01

Property Address: 425 Mission Street

On March 23, 2009, the Board of Examiners held a duly noticed public hearing to consider the applicant's proposal, per the 2007 San Francisco Building Code (SFBC) Sections 104A.2.8 and 111.2.4, to use an alternative code "2007 NFPA130" (NFPA130) in lieu of the prevailing SFBC Section 433 and SFBC Chapter 10 as local Code Equivalency for its application to the below grade train platform level and the elevated bus deck level within the proposed Transbay Transit Center Building located at 425 Mission Street. Details of these equivalency applications are illustrated in the accompanying equivalence request documents.

Proponent submitted for consideration the following local code equivalency request applications: No.1 – to adopt the application of NFPA 130 for the Bus Deck area of the building; and, No. 2 – to adopt the application of NFPA 130 in lieu of SFBC Section 433 for the below grade train platform and facility area of the building.

The subject proposed Transbay Transit Center Building is the hub of transportation for the San Francisco Bay Area with accommodation of multiple transit agencies including Train services, buses services from various regional public transportation agencies such as MUNI, SamTran, Greyhound, AC Transit, Contra Costa Transit, and Golden Gate Transit, among others, and taxies. Subject proposed building is under the jurisdiction of the Transbay Joint Power Authority **(TJPA)** which is a Quasi-State Entity, and such proposed construction is exempted from acquiring building permits from local jurisdiction of this Department of Building Inspection **(DBI)**; while San Francisco Fire Department **(SFFD)**, representing State Fire Marshal, considers subject project is under SFFD jurisdiction. Thus, TJPA opts to enter a Memorandum of Understanding with DBI to have DBI to perform plan review and field inspection for subject Transit Center building, with DBI on an advisory capacity to TJPA by providing a letter of recommendation for plan approval upon completion of review.

This Board of Examiner has the following considerations: With applicant's presentation to this Board of Examiners (BOE) depicting the major differences and similarities in the compliance of these codes to the areas affected; with the proposed added fire safety installations of fire sprinkler throughout, which is beyond the NFPA130 compliance requirement but would be otherwise be required by the SFBC provision; and with the consideration of a more appropriate and updated NFPA130 code for fixed guided way transit design versus the SFBC Section 433 which was based on the framework of an earlier version of NFPA130; bus deck operates similar to the train platform, thus it is considered appropriate to apply NFPA130 also.

Testimony was given by the applicant's representative and by Staffs of the San Francisco Fire Department and Department of Building Inspection with regard to the understanding of the preliminary uses and layout of the building. Based on the presentation of the oral and written testimony, the Board of Examiners voted 7 to 1 to approve the motion to approve the applicant's proposal as follows:

The Board of Examiner approves the aforementioned Local Code Equivalency requests subject to the following conditions:

(1) this is a one-time approval and does not constitute a precedent;
(2) applicant to continue to work with and comply with the requirements of DBI and SFFD; and,
(3) final drawings and specifications shall incorporate all such DBI and SFFD requirements.

Members present: Mel Cammisa (President), Manuel Flores (Vice President), Dick Glumac, Kevin Mirkovich, Patrick Buscovish, Robert Fuller, Jason Langkammerer, James Reed

City staff present: DBI - Hanson Tom, DBI, Board Secretary, Jeffrey Ma, Willy Yau, Raymond Lui;
San Francisco Fire Department - Capt. Bill Mitchell, Tod Stephenson

Applicant representative: ARUP - Andrew Coles, Jim Quitar, Anthony Bruzzone;
AAI Architects Inc. – Erick Del Angel;
TJPA – Edmond Sum, Alfred Lau, Joyce Oishi, Rebecca Armanta;
AC Transit – Robert Del Rosario

Motion made by Board Member Dick Glumac, and seconded by Vice President Manuel Flores
AYES: Cammisa, Flores, Glumac, Mirkovich, Buscvish, and Langkammerer
NOES: Fuller

Motion adopted by resolution pursuant to the San Francisco Building Code Section 105A.1.11 at the regular scheduled meeting held March 23, 2009.

Per SFBC Sec.105A.1.12, a tape recording of this meeting is maintained in this Board of Examiner in DBI. These tape recordings are available for duplication upon request with all costs of duplication be borne by the party requesting duplication.

By: Hanson W. Tom 4/21/2009
Hanson W. Tom, Secretary
Board of Examiners

Copy to: All members of this Board of Examiners
SFFD Attendees - Captain Bill Mitchell, Tod Stephenson
Applicant Team Representatives
DBI Director – Vivian Day, C.B.O.
DBI Attendees – Hanson Tom, Jeffrey Ma, Raymond Lui, Willy Yau

City and County of San Francisco
Department of Building Inspection

Gavin Newsom, Mayor
Vivian L. Day, C.B.O., Director

BOARD OF EXAMINERS (BOE)

Special Meeting

Monday, March 23, 2009, at 5:30 P.M.
San Francisco Permit Center
1660 Mission Street, 2nd Floor, Room 2001

AGENDA:

POLICY STATEMENT ON PUBLIC COMMENT: Please see attached San Francisco Administrative Code Section 67.17.

1.0 Call to order and roll call

2.0 Selection of Chairperson - Vice-Chair

3.0 Public comment

4.0 Old business

5.0 New business

5.1 Appeal No. 2009-01, Transit Joint Power Authority (TJPA), Transbay Transit Center, 425 Mission Street, Blocks and Lots:

3718/025	3721/031	3719/003	3721/045A	3720/001	3721/046
3721/006	3721/054	3721/015A	3721/053	3721/016	3721/047
3721/019	3721/109-118	3721/020	3721/108	3721/029	

Mr. Edmond Sum, Engineering Manager, requests a variance to Sections 104A.1 and 104A.2.8 of the 2007 San Francisco Building Code and Section 111 of the 2007 California Building Code; a variance to request for approval of Local Equivalency for Alternate Design of Construction for Transbay Transit Center.

6.0 Adjournment

MEMBERS OF THE BOARD
Mr. Manuel Flores, Chairperson
Mr. Mel Cammisa, Member
Mr. Ken Cleaveland, Member
Mr. Robert Fuller, Member
Mr. Dick Glumac, Member
Mr. Jason Langkammerer, Member
Mr. Arnie Lerner, Member
Mr. Kevin Mirkovich, Member
Mr. James Reed, Member
Mr. Armin Wolski, Member
Structural Engineer Seat - Vacant

DEPARTMENT REPRESENTATIVES
Hanson Tom, Board Secretary (415) 558-6157
Jeff Ma, Engineer (415) 558-6150

SF FIRE DEPARTMENT REPRESENTATIVE
Bill Mitchell, Captain (415) 558-6517

CITY ATTORNEY'S REPRESENTATIVE
John Malamut, Deputy City Attorney (415) 554-4757

Structural Safety
1660 Mission Street – San Francisco CA 94103
Office (415) 558-6133 – FAX (415) 558-6436 – www.sfgov.org/dbi

BOARD OF EXAMINERS
REQUEST FOR HEARING
FORM AB-042

Case No.:	Date Filed:	Fee:
Address: 425 MISSION ST.	Block & Lot: SEE ATTACHED	Application No.:
Applicant's Name: EDMOND SUM	Title: ENGINEERING MANAGER	Telephone No.: 415.5974040
Building Occupancy/Use	Signature of Applicant:	

1. Code Section 433 of the San Francisco Building Code cannot be entirely satisfied because:

   PER ATTACHED DOCUMENTATION

2. In lieu of complying exactly with the code, the following alternative is proposed as a means of providing an equivalent degree of safety:

   PER ATTACHED DOCUMENTATION

3. Supporting arguments are: (attach additional information)

   PER ATTACHED DOCUMENTATION

official use only

Recommendation:	Acceptance	Date	Denial	Date
Director of Building Inspection				
Fire Marshal, SFFD				

4. Board of Examiners' action:

BOARD OF EXAMINERS
REQUEST FOR HEARING
FORM AB-042

Case No.:	Date Filed:	Fee:
Address: 425 MISSION ST.	Block & Lot: SEE ATTACHED	Application No.:
Applicant's Name: EDMOND SUM	Title: ENGINEERING MANAGER	Telephone No.: 415.5974040
Building Occupancy/Use	Signature of Applicant:	

1. Code Section UMC 10 of the San Francisco Building Code cannot be entirely satisfied because:

PER ATTACHED DOCUMENTATION

2. In lieu of complying exactly with the code, the following alternative is proposed as a means of providing an equivalent degree of safety:

PER ATTACHED DOCUMENTATION

3. Supporting arguments are: (attach additional information)

PER ATTACHED DOCUMENTATION

official use only

Recommendation:	Acceptance	Date	Denial	Date
Director of Building Inspection				
Fire Marshal, SFFD				

4. Board of Examiners' action:

**Request for Local Equivalency for Alternate Design of Construction
Under Sections 104A.1 and 104A.2.8 of the
2007 San Francisco Building Code and
Section 111 of the 2007 California Building Code**

**Transbay Transit Center, San Francisco
Local Equivalency # 2**

Application of NFPA 130 in lieu of SFBC Section 433 for the below-grade train facility

Building Description

The Transbay Transit Center (TTC) will have three above-grade levels, a park on the roof of the building, and two below-grade levels. The above-grade portion of the building will serve as the transit hub for Bay Area bus services, such as AC Transit, Muni, Golden Gate Transit, and Greyhound (in Phase 1). The below-grade levels will house the train station that is expected to serve Caltrain and future high-speed rail.

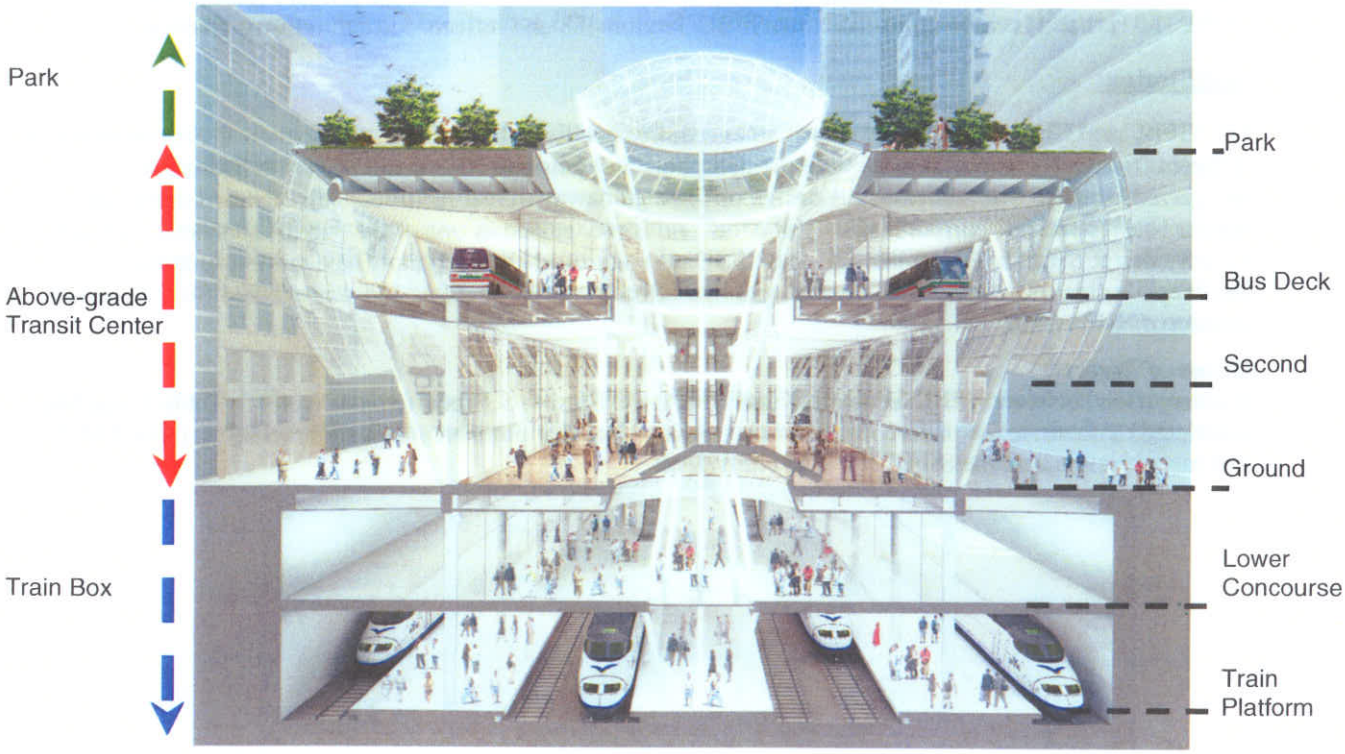


Figure 1: Building Section

The lower concourse and train platform levels are two underground levels that will serve California high-speed rail and Caltrain. The lower concourse will have stair and escalator openings to the Ground level and contain retail shops in addition to waiting rooms for high-speed rail and Caltrain.

Code Section

The 2007 San Francisco Building Code (SFBC), adapted from the 2007 California Building Code (CBC), addresses exiting requirements for all occupancy classifications. Specific requirements for fixed guideway transit facilities are included in Section 433. The section of the SFBC contains requirements for egress from those transit areas.

Code Requirement

SFBC Section 433 identifies requirements for fixed guideway transit facilities. For reference, detailed code sections are listed in the justification.

Code Intent

The intent of SFBC Section 433 is to ensure that the design provides adequate means of protection so that occupants can evacuate a building in an emergency in a safe and timely manner and life safety is preserved.

Both SFBC and CBC provide specific guidelines for the construction of "fixed guideway transit facilities." Because of the transient nature of occupants and how transit stations operate, the intent of both is that the life safety systems are designed according to the hazard.

Request

This Request for Local Equivalency (RFLE) addresses the application of NFPA 130 (2007) as the design criteria for the below-grade train levels in lieu of SFBC Section 433. One of the primary reasons for adopting NFPA 130 is that it is more up-to-date than SFBC Section 433 and reflects current industry practice.

Justification

The SFBC and CBC recognize that transit areas require specific criteria. They represent an environment that is different from a typical building because the occupants are transient. NFPA 130 is an internationally recognized standard that addresses the design of fixed guideway transit facilities. This standard is revised on a regular basis to reflect "current industry practice" and is recognized as one of the "go to" standards for transit facility design. Section 433 of the CBC and SFBC also addresses the design of fixed guideway transit facilities. Section 433 of the CBC was brought into effect in the early 1990s and was adapted from an earlier version of NFPA 130.

Means of Egress

A comparison between SFBC Section 433 and NFPA 130 Section 5.5 requirements (refer to Table 1) has been conducted to illustrate the differences between criteria. Note that numbers in square brackets "[ ]" for NFPA 130 capacities indicate the SFBC exit lane equivalent.

Table 1: Means of Egress Comparison of NFPA 130 and SFBC Section 433

Issue	2007 SFBC Section 433	2007 NFPA 130
General		
Point of Safety	An enclosed fire exit that leads to a public way or safe location outside the structure, or an at-grade point beyond any enclosing structure, or other area that affords adequate protection for passengers. (433.1.2)	An enclosed fire exit that leads to a public way or safe location outside the station, trainway, or vehicle, or to an at-grade point beyond the vehicle, any enclosing station, trainway, or vehicle, or another area that affords adequate protection to passengers. (3.3.33)
		For open stations where the concourse is below or protected from the platform by distance or materials as determined by an appropriate engineering analysis, that concourse shall be permitted to be defined as a point of safety.
Occupant Load Calculation		
Peak Period Occupant Load	The station occupant load shall be the sum of the number of persons in the calculated train load of trains entering a station plus the entraining load of persons awaiting train(s), during a specified time period.(433.3.1)	The peak period occupant load for each platform shall be based on the simultaneous evacuation of the entraining load and the train load for that platform in the peak period. (5.5.5.6.1)
Calculated Train Load	The calculated train load is the number of passengers on trains simultaneously entering the station on all tracks in normal traffic direction during the peak 15-minute period. (433.3.1.1) Shall only consider one train at a track. (433.3.1.1)	The maximum train load for each track shall be based on the train load per train headway factored to account for service disruptions and system reaction time. (5.5.5.6.3) Shall only consider one train at a track. (5.5.5.2)
Entraining Load	The entraining load is equal to the number of passengers that would accumulate on the platform in the time period equivalent to two headways or 12 minutes during the peak 15-minute period, whichever time period is greater. (433.3.1.2)	The entraining load for each platform shall be the sum of the entraining loads for each track serving that platform. (5.5.5.6.2) The entraining load for each track shall be based on the entraining load per train headway factored to account for service disruptions and system reaction time. (5.5.5.6.2.1)
Minimum Platform Load	Not less than the maximum train capacity of a train that would occupy a single track. (433.3.1)	Not required by NFPA 130.
Exit Location		
Distance from either end of platform to an enclosed exit	20 feet (433.3.2.1)	Not required, however, the local AHJ may require enclosed stairs at their discretion for fire department access.
Common path of travel	75 feet (1014.3)	82 feet or one car length (5.5.1.4)
	In enclosed stations with emergency ventilation systems regularly used escalator and stair are not required to be enclosed. (433.3.6.2)	Escalators and stairs regularly used by the public do not need to be enclosed. (5.2.3.1) An emergency ventilation system is required. (7.1.2.2)
Travel Distance	Maximum distance from any part of the station to point of safety is less than 300 ft. (433.3.5)	Maximum distance to an exit route from the platform is less than 300 ft. (5.5.6.1.1)
Horizontal exits	Not more than 50%. (1022)	Up to 100%, but not more than 50% into one building. (5.5.1.5)

Issue	2007 SFBC Section 433	2007 NFPA 130
Arrangement of Exits	Escalators must be paired with stairs. (433.3.4.1)	Escalators not required to be paired with stairs.
	Escalators may not account for more than half of the units of exit from a level. (433.3.4.1)	Escalators may not account for more than half of the means of egress from any level. (5.5.6.3.2.4~7)
		If certain conditions are met, escalators can account for over half of the required means of egress from any level. (5.5.6.3.2.5) (1) The escalators are capable of being remotely brought to stop after a warning announcement from a location having visual surveillance of the full escalator. (2) A portion of the means of egress capacity from each station level is comprised of stairs. (3) For enclosed stations, at least one enclosed exit stair or exit passageway shall provide continuous access from the platforms to the public way.
	The escalator with the most adverse effect on exiting must be assumed out of service. (433.3.4.2)	The escalator with the most adverse effect on exiting must be assumed out of service. (5.5.6.3.2.6)
Enclosed Emergency exits	For enclosed, underground stations enclosed emergency exits are required within 20 ft from the ends of the platform. (433.3.1)	Enclosed exits are required for those that are not used regularly by passengers. (5.2.3.1)
Exit Capacity		
Exit lane width Fractional Lanes	22 inch (433.3.2.2.1) 12 inch (433.3.2.2.1) Escalators of 32 inch can be counted as 1.5 lanes (433.3.2.2.1)	Exit lanes concept not used, calculation based on actual width in inches.
Minimum stair width	44 inch (1009.1)	43 inch (5.5.6.3.2.1)
Minimum platform and corridor clear width (incl. egress width, safety zone, & wall buffer)	For platform & corridor 5'-0" per 433.3.3.1 also needs to discount platform edge & wall buffer	For platform 6'-2" (44"+18"+12") see 5.5.6.3.1.2 For corr., 5'-8", 44"+12"+12"
Minimum door/gate width	36 inch (433.3.3.1.3)	36 inch (5.5.6.3.3.1)
Minimum fare gate width	20 inch (4..3.3.1.4)	18 inch (5.5.6.3.4)
Platform and corridor lane/inches capacity	50 pp/min (433.3.3.1.1)	2.08 pp/inch/min [45.76 pp/min] (5.5.6.3.1.3)
Platform and corridor travel speed	200 ft/min (433.3.3.1.1)	124 ft/min (5.5.6.3.1.4)
Concourse lane/inches capacity	50 pp/min (433.3.3.1.1)	2.08 pp/inch/min [45.76 pp/min] (5.5.6.3.1.3)
Concourse travel speed	200 ft/min (433.3.3.1.1)	200 ft/min (5.5.6.3.1.4)
Upward stairs and stopped escalators lane/inches capacity	35 pp/min (433.3.3.1.2)	1.41 pp/inch/min [31.02 pp/min] (5.5.6.3.2.3)
Upward stairs and stopped escalators travel speed	50 vertical ft/min (433.3.3.1.2)	48 vertical ft/min (5.5.6.3.2.3)
Downward stairs and stopped escalators lane/inches capacity	40 pp/min (433.3.3.1.2)	1.41 pp/inch/min [31.02 pp/min] (5.5.6.3.2.3)

Issue	2007 SFBC Section 433	2007 NFPA 130
Downward stairs and stopped escalators travel speed	60 vertical ft/min (433.3.3.1.2)	48 vertical ft/min (5.5.6.3.2.3)
Door/gate lane/inches capacity	50 pp/min (433.3.3.1.3)	2.27 pp/inch/min [49.94 pp/min] (5.5.6.3.3.2)
Fare gate capacity	50 pp/min (433.3.3.1.4)	50 pp/min (5.5.6.3.4.1)
Fare turnstiles capacity	50 pp/min	25 pp/min
Exiting Time		
Maximum time to clear station platform	4 min (433.3.2.2.2)	4 min (5.5.6.1)
Maximum time to move from the most remote point on platform to point of safety	6 min (433.3.2.2.3)	6 min (5.5.6.2)

There are some apparent differences between SFBC Section 433 and NFPA 130, which are identified as follows:

1. The stair/escalator travel speeds and the walking speeds for NFPA 130 are slower than those of the SFBC. One limitation is that the SFBC uses the "exit lane approach," which does not account for incremental differences between a half and a full exit lane, whereas NFPA 130 has slower speeds but allows the calculation on a per-inch basis.
2. The SFBC requires 300 ft to a point of safety; NFPA 130 requires 300 ft to a means of egress from the platform.
3. The SFBC is more prescriptive in how the occupant load is defined, which is not a true reflection of how the system would operate. NFPA 130 is more tailored to actual transit system use.
4. SFBC requires escalators paired with stairs; NFPA 130 does not. However, both require that the total stair width must be greater than the total number of escalators in the emergency exiting analysis.
5. SFBC requires enclosed emergency exits within 20 ft from the ends of the platforms; NFPA 130 does not.
6. NFPA 130 requires a higher smoke layer height (2.5 m or ~8 ft) than SFBC Section 433 (1.8 m or 6 ft); therefore, the ventilation system requirements are more stringent in NFPA 130.

In summary, NFPA 130 and SFBC Section 433 have similar requirements with some exceptions that have been noted. NFPA 130 is a more current criterion and reflects the current industry approach. Although differences exist, the intent of both NFPA 130 and SFBC 433 is the same, and applying NFPA 130 Section 5.5 for means of egress will not adversely affect the level of safety.

Other Fire Life Safety Requirements

This section outlines other SFBC Section 433 requirements and the comparative NFPA 130 requirements. Note that this is not an exhaustive summary of all the detailed requirements. The purpose is to illustrate any major differences, if they exist, and the criterion that is the most restrictive.

Table 2: Comparison between SFBC Section 433 and NFPA 130 of other fire life safety requirements

Requirement	SFBC Section 433	NFPA 130	Applicable Criteria
Construction Type	**433.2.1** Unless otherwise specified in this section, buildings or portions of buildings classed as stations of fixed guideway transit systems shall be minimum Type I, Type IB, or Type IIA construction. Underground stations shall be a minimum Type I or Type IB construction.	**5.2.1.** Building construction for all new stations shall be not less than Type I – or Type II– or combinations of Type I– and Type II.	The same criterion applies to both. Type IB minimum will be used for an underground building of this nature.
Fire Separation • Power Substations • Trash rooms • Electrical rooms • Train control and battery rooms • Emergency generator rooms • Traction power substations • Public and non-public separation	**433.2.2.2** • 3 hrs • 2 hrs • 2 hrs • 2 hrs • 2 hrs • 3 hrs with no openings to public areas • 2 hrs	**5.2.3** • 3 hrs • 1 hr minimum • 2 hrs • 2 hrs • 2 hrs • 3 hrs • 2 hrs	NFPA 130 is similar or more restrictive, except for trash rooms. NFPA 130 will be used.
Sprinklers	**903.2.17.1** An automatic sprinkler system shall be installed in all stations of fixed guideway transit systems. Exceptions: 1. Guideways when the closest sprinkler heads to the guideway are within 3 feet (914 mm) of the edge, over the platform, and spaced 6 feet (1829 mm) on center parallel to the guideway. 2. Station agent booths not exceeding 150 square feet (13.9 m^2) in area, when provided with an approved smoke detector connected to the building fire alarm system. 3. Power substations. 4. Machinery rooms, electrical rooms and train control rooms protected by an approved automatic fixed fire-extinguishing system. 5. Open stations. 6. Station platform areas open to three or more sides.	**5.7.3.1** An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and in the steel truss area of all escalators and other similar areas with combustible loadings, except trainways. **5.7.3.2** Installation of sprinkler systems shall comply with NFPA 13 or applicable local codes as required.	Stations will be sprinklered in accordance with SFBC requirements.
Standpipes and Hose Systems	**905.3.10** Underground stations shall be provided with a Class III standpipe system.	**5.7.4.1** Class I or Class III standpipes shall be installed in enclosed stations in accordance with NFPA 14.	Class I permitted where sprinklers are installed per SFFD fire code amendments.
Under Car Deluge	**903.2.17.2** requires an under car deluge system.	Not specified. Section 5.7.3.4 would require an under car deluge system if specified by the local authority.	Under car deluge will be provided.
Emergency Ventilation System	**433.4.5** Design layer height of 6 feet.	**Chapter 7** Design layer height of ~8 feet.	NFPA 130 is more comprehensive and will be the governing criteria.

Requirement	SFBC Section 433	NFPA 130	Applicable Criteria
Fire Command Center	**433.4.4** Emergency management panel room is required.	**5.7.6** Fire Command Center will be per NFPA 72.	A Fire Command Center will be provided.
Train ways	No criteria	**Chapter 6**	NFPA 130
Vehicle Design	No criteria	**Chapter 8**	NFPA 130

Table 2 shows that direct adoption of NFPA 130 for other fire life safety issues will meet the intent of SFBC Section 433, as most of the requirements will be equivalent or governed by the San Francisco Fire Department (SFFD) requirements.

Summary

This request addresses the use of NFPA 130 in lieu of SFBC Section 433 as the design criteria of the fixed guideway transit facility in the TTC station. Application of NFPA 130 requires a local equivalency because SFBC Section 433 addresses the design of such a facility. The primary reason for this approach is that NFPA 130 is seen as a more dynamic, current standard than SFBC Section 433 because it is revised on a more frequent basis. Both NFPA 130 and SFBC Section 433 have the same intent. Both are also intended to be applied as a set of criteria, not by specific section. This request provides a comparative assessment of the fire life safety requirements and has shown that NFPA 130 has very similar requirements, and in some cases, it is more detailed that the SFBC. Therefore, it is our professional opinion that direct application of NFPA 130 will provide an equivalent level of safety as SFBC Section 433.

Prepared by:

Arup Fire

11/12/09

Andrew R Coles, PE Date

REGISTERED PROFESSIONAL ENGINEER
ANDREW R. COLES
FP 1650
EXP. 6/30/11
FIRE PROTECTION
STATE OF CALIFORNIA

Approved by Hanson Tom

San Francisco Department of Building Inspection

11/12/09

Date

Approved by Bill Mitchell

San Francisco Fire Department

Capt M J Mitchell 11/12/09

Date

Approved by Edmond Sum

Transbay Joint Powers Authority

12 NOVEMBER 2009

Date

DEPARTMENT OF BUILDING INSPECTION
City & County of San Francisco
1660 Mission Street, 2nd Floor, San Francisco, California 94103-2414
TEL 415-558-6133 FAX 415-558-6686

NOTICE OF DECISION
BOARD OF EXAMINERS MEETING
March 23, 2009
Case No. 2009-01

Property Address: 425 Mission Street

On March 23, 2009, the Board of Examiners held a duly noticed public hearing to consider the applicant's proposal, per the 2007 San Francisco Building Code (SFBC) Sections 104A.2.8 and 111.2.4, to use an alternative code "2007 NFPA130" (NFPA130) in lieu of the prevailing SFBC Section 433 and SFBC Chapter 10 as local Code Equivalency for its application to the below grade train platform level and the elevated bus deck level within the proposed Transbay Transit Center Building located at 425 Mission Street. Details of these equivalency applications are illustrated in the accompanying equivalence request documents.

Proponent submitted for consideration the following local code equivalency request applications: No.1 – to adopt the application of NFPA 130 for the Bus Deck area of the building; and, No. 2 – to adopt the application of NFPA 130 in lieu of SFBC Section 433 for the below grade train platform and facility area of the building.

The subject proposed Transbay Transit Center Building is the hub of transportation for the San Francisco Bay Area with accommodation of multiple transit agencies including Train services, buses services from various regional public transportation agencies such as MUNI, SamTran, Greyhound, AC Transit, Contra Costa Transit, and Golden Gate Transit, among others, and taxies. Subject proposed building is under the jurisdiction of the Transbay Joint Power Authority **(TJPA)** which is a Quasi-State Entity, and such proposed construction is exempted from acquiring building permits from local jurisdiction of this Department of Building Inspection **(DBI)**; while San Francisco Fire Department **(SFFD)**, representing State Fire Marshal, considers subject project is under SFFD jurisdiction. Thus, TJPA opts to enter a Memorandum of Understanding with DBI to have DBI to perform plan review and field inspection for subject Transit Center building, with DBI on an advisory capacity to TJPA by providing a letter of recommendation for plan approval upon completion of review.

This Board of Examiner has the following considerations: With applicant's presentation to this Board of Examiners (BOE) depicting the major differences and similarities in the compliance of these codes to the areas affected; with the proposed added fire safety installations of fire sprinkler throughout, which is beyond the NFPA130 compliance requirement but would be otherwise be required by the SFBC provision; and with the consideration of a more appropriate and updated NFPA130 code for fixed guided way transit design versus the SFBC Section 433 which was based on the framework of an earlier version of NFPA130; bus deck operates similar to the train platform, thus it is considered appropriate to apply NFPA130 also.

Testimony was given by the applicant's representative and by Staffs of the San Francisco Fire Department and Department of Building Inspection with regard to the understanding of the preliminary uses and layout of the building. Based on the presentation of the oral and written testimony, the Board of Examiners voted 7 to 1 to approve the motion to approve the applicant's proposal as follows:

The Board of Examiner approves the aforementioned Local Code Equivalency requests subject to the following conditions:

(1) this is a one-time approval and does not constitute a precedent;
(2) applicant to continue to work with and comply with the requirements of DBI and SFFD; and,
(3) final drawings and specifications shall incorporate all such DBI and SFFD requirements.

Members present: Mel Cammisa (President), Manuel Flores (Vice President), Dick Glumac, Kevin Mirkovich, Patrick Buscovish, Robert Fuller, Jason Langkammerer, James Reed

City staff present: DBI - Hanson Tom, DBI, Board Secretary, Jeffrey Ma, Willy Yau, Raymond Lui;
San Francisco Fire Department - Capt. Bill Mitchell, Tod Stephenson

Applicant representative: ARUP - Andrew Coles, Jim Quitar, Anthony Bruzzone;
AAI Architects Inc. – Erick Del Angel;
TJPA – Edmond Sum, Alfred Lau, Joyce Oishi, Rebecca Armanta;
AC Transit – Robert Del Rosario

Motion made by Board Member Dick Glumac, and seconded by Vice President Manuel Flores
AYES: Cammisa, Flores, Glumac, Mirkovich, Buscvish, and Langkammerer
NOES: Fuller

Motion adopted by resolution pursuant to the San Francisco Building Code Section 105A.1.11 at the regular scheduled meeting held March 23, 2009.

Per SFBC Sec.105A.1.12, a tape recording of this meeting is maintained in this Board of Examiner in DBI. These tape recordings are available for duplication upon request with all costs of duplication be borne by the party requesting duplication.

By: Hanson W. Tom 4/21/2009
Hanson W. Tom, Secretary
Board of Examiners

Copy to: All members of this Board of Examiners
SFFD Attendees - Captain Bill Mitchell, Tod Stephenson
Applicant Team Representatives
DBI Director – Vivian Day, C.B.O.
DBI Attendees – Hanson Tom, Jeffrey Ma, Raymond Lui, Willy Yau

City and County of San Francisco
Department of Building Inspection

Gavin Newsom, Mayor
Vivian L. Day, C.B.O., Director

BOARD OF EXAMINERS (BOE)

Special Meeting

Monday, March 23, 2009, at 5:30 P.M.
San Francisco Permit Center
1660 Mission Street, 2nd Floor, Room 2001

AGENDA:

POLICY STATEMENT ON PUBLIC COMMENT: Please see attached San Francisco Administrative Code Section 67.17.

1.0 Call to order and roll call

2.0 Selection of Chairperson - Vice-Chair

3.0 Public comment

4.0 Old business

5.0 New business

5.1 Appeal No. 2009-01, Transit Joint Power Authority (TJPA), Transbay Transit Center, 425 Mission Street, Blocks and Lots:

3718/025	3721/031	3719/003	3721/045A	3720/001	3721/046
3721/006	3721/054	3721/015A	3721/053	3721/016	3721/047
3721/019	3721/109-118	3721/020	3721/108	3721/029	

Mr. Edmond Sum, Engineering Manager, requests a variance to Sections 104A.1 and 104A.2.8 of the 2007 San Francisco Building Code and Section 111 of the 2007 California Building Code; a variance to request for approval of Local Equivalency for Alternate Design of Construction for Transbay Transit Center.

6.0 Adjournment

MEMBERS OF THE BOARD
Mr. Manuel Flores, Chairperson
Mr. Mel Cammisa, Member
Mr. Ken Cleaveland, Member
Mr. Robert Fuller, Member
Mr. Dick Glumac, Member
Mr. Jason Langkammerer, Member
Mr. Arnie Lerner, Member
Mr. Kevin Mirkovich, Member
Mr. James Reed, Member
Mr. Armin Wolski, Member
Structural Engineer Seat - Vacant

DEPARTMENT REPRESENTATIVES
Hanson Tom, Board Secretary (415) 558-6157
Jeff Ma, Engineer (415) 558-6150

SF FIRE DEPARTMENT REPRESENTATIVE
Bill Mitchell, Captain (415) 558-6517

CITY ATTORNEY'S REPRESENTATIVE
John Malamut, Deputy City Attorney (415) 554-4757

Structural Safety
1660 Mission Street – San Francisco CA 94103
Office (415) 558-6133 – FAX (415) 558-6436 – www.sfgov.org/dbi

BOARD OF EXAMINERS
REQUEST FOR HEARING
FORM AB-042

Case No.:	Date Filed:	Fee:
Address: 425 MISSION ST.	Block & Lot: SEE ATTACHED	Application No.:
Applicant's Name: EDMUND SUM	Title: ENGINEERING MANAGER	Telephone No.: 415.5974040
Building Occupancy/Use	Signature of Applicant:	

1. Code Section 433 of the San Francisco Building Code cannot be entirely satisfied because:

PER ATTACHED DOCUMENTATION

2. In lieu of complying exactly with the code, the following alternative is proposed as a means of providing an equivalent degree of safety:

PER ATTACHED DOCUMENTATION

3. Supporting arguments are: (attach additional information)

PER ATTACHED DOCUMENTATION

official use only

Recommendation:	Acceptance	Date	Denial	Date
Director of Building Inspection				
Fire Marshal, SFFD				

4. Board of Examiners' action:

BOARD OF EXAMINERS
REQUEST FOR HEARING
FORM AB-042

Case No.:	Date Filed:	Fee:
Address: 425 MISSION ST.	Block & Lot: SEE ATTACHED	Application No.:
Applicant's Name: EDMOND SUM	Title: ENGINEERING MANAGER	Telephone No.: 415.5914040
Building Occupancy/Use	Signature of Applicant:	

1. Code Section UMP 10 of the San Francisco Building Code cannot be entirely satisfied because:

   PER ATTACHED DOCUMENTATION

2. In lieu of complying exactly with the code, the following alternative is proposed as a means of providing an equivalent degree of safety:

   PER ATTACHED DOCUMENTATION

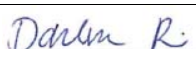
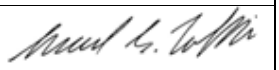
3. Supporting arguments are: (attach additional information)

   PER ATTACHED DOCUMENTATION

official use only

Recommendation:	Acceptance	Date	Denial	Date
Director of Building Inspection				
Fire Marshal, SFFD				

4. Board of Examiners' action:

Project title	Transbay Transit Center, San Francisco			Job number 132241	
Document title Document ref	Local Equivalency # 3 Performance Based Structural Fire Engineering			File reference	
Revision	Date	Filename	TTC RFLE #3 –Structural Fire Engineering – Final Issue.doc		
Final	02-11-11	Description	Final Issue		
			Prepared by	Checked by	Approved by
		Name	Darlene Rini	Andrew Coles	Richard Coffin
		Signature			
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		Name			
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		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ☑

Request for Local Equivalency for Alternate Design of Construction
Under Sections 104A.1 and 104A.2.8 of the
2007 San Francisco Building Code and
Section 111 of the 2007 California Building Code

Transbay Transit Center, San Francisco
Local Equivalency # 3

Performance Based Structural Fire Engineering

Building Description

The Transbay Transit Center (TTC) project replaces the existing Transbay Terminal at First and Mission St. with a modern 3-story (70 foot high), 1 million square foot regional transit hub located in downtown San Francisco. The above-grade levels contain two levels of assembly/retail/office space, a Bus Deck Level and a Roof Park Level of approximately 5.4 acres. The above-grade portion of the building serves as the transit hub for San Francisco Bay Area bus services, such as AC Transit, Muni, Golden Gate Transit, and Greyhound. The building also has two below-grade levels that are expected to serve Caltrain and the future California High Speed Rail network.

Figure 1: Building section through the Grand Hall

The superstructure of the TTC building is primarily a steel-frame with composite floors and a perimeter, external steel braced system that supports both gravity and lateral forces. The structure is comprised of the following main components:

- Framework of steel primary and secondary beams
- Composite concrete and metal deck floors
- Internal vertical steel columns
- Light column structure (Grand Hall only)
- Perimeter, external steel braced frame structures (consisting of V-columns and braces), referred to as “basket columns,” which contain eccentrically braced frames (EBFs)
- Transverse steel special moment frames (SMFs)

Code Requirement

Table 601 of the 2007 San Francisco Building Code (SFBC) defines the structural fire protection requirements for the specific structural elements based on the building type.

As TTC is a Type IB building, the prescriptive fire resistance rating requirements are as follows:

- Structural frame = non-combustible, 2 hours
- Bearing walls = non-combustible, 2 hours
- Floor construction = non-combustible, 2 hours
- Roof construction* = 1 hour
- Grand Hall structure = non-combustible, 2 hours
- External braced structure = 2 hours

*Note: The Park Level is considered a floor as it serves publicly occupied space.

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A[e]	B	A[e]	B	HT	A[e]	B
Structural frame[a]	3[b]	2[b]	1	0	1	0	HT	1	0
Bearing walls Exterior[g] Interior	3 3[b]	2 2[b]	1 1	0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[f]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction Including supporting beams and joists	2	2	1	0	1	0	HT	1	0
Roof construction Including supporting beams and joists	$1^1/_2$[c]	1[c, d]	1[c, d]	0[c, d]	1[c, d]	0[c, d]	HT	1[c, d]	0

Code Intent

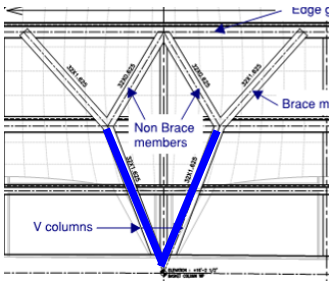
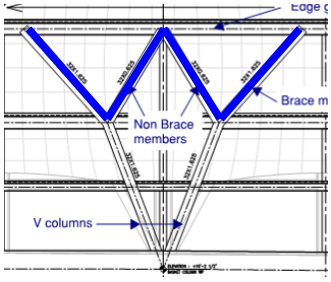
The fire resistance requirement for the structure is intended to provide **stability and fire separation** such that building occupants can evacuate safely and fire fighters can conduct fire fighting activities in a credible fire event.

Equivalency

Under Sections 104A.1 and 104A.2.8 of the 2007 San Francisco Building Code and Section 111 of the 2007 California Building Code a performance-based structural fire engineering assessment, through a Request for Local Equivalency (RFLE), was conducted to determine an engineered level of fire protection for select elements of the TTC superstructure.

The specific elements of the TTC structure that were examined are as summarized in Table 1.

Table 1: Structural elements where structural fire engineering (SFE) is proposed

Element/Location	Description
Basket V-Columns 	• 2-hour fire proofing is required per SFBC. • An SFE analysis is proposed to define an appropriate level of fire protection for the structure based on an assessment of the credible fire scenarios that occur in/around the structure (such as a retail fire, delivery truck fire, etc.) and the actual load level in the fire limit state. The aim is to meet the intent of the code for fire life-safety.
Grand Hall (Light Columns) **Grid 19-25** 	• 2-hour fire proofing is required per SFBC. • The Grand Hall area of the building is a high volume, high ceiling space, circulation area with a limited or definable fire load. • An SFE analysis is proposed to demonstrate that standoff distances from potential fuel loads in the Grand Hall space to the light column structure is sufficiently far, such that fire protection will not be required for the light columns. • Note: Due to the close proximity to a potential 20MW train fire at Platform Level and the difficulties with restricting fuel loads at Lower Concourse, the light column structure at these levels will be protected with either a UL listed product or concrete-infill.
Diagonal Braces - Bus Deck Level 	• 2-hour fire proofing is required per SFBC. • A whole frame thermo-mechanical analysis of the structure is proposed to define an appropriate level of fire protection for the diagonal braces at the Bus Deck Level given the actual load level in the fire limit state and a 35MW bus fire scenario.

In general, the fire protection strategy for the elements identified in Table 1 are proposed to be based on a performance-based analysis of the actual structural elements or systems in real fire scenarios. This involves the evaluation of realistic fire scenarios, heat transfer analysis from the design fires to the structural elements in question, and the quantification of the structure's response for the duration of the fire.

In this way, the fire protection of the structure is specifically engineered for the actual building geometry, structural systems, applied loading conditions and fire exposures. This is in contrast to the prescriptive requirements, where, the actual fire hazards and response of the structure to the fire is not quantified or explicitly understood, and may be potentially unsafe.

The aim of the proposed approach is to deliver a structure that provides an equivalent level of safety for occupants and emergency services in a credible fire event that meets the intent of the SFBC for stability and compartmentation.

Justification

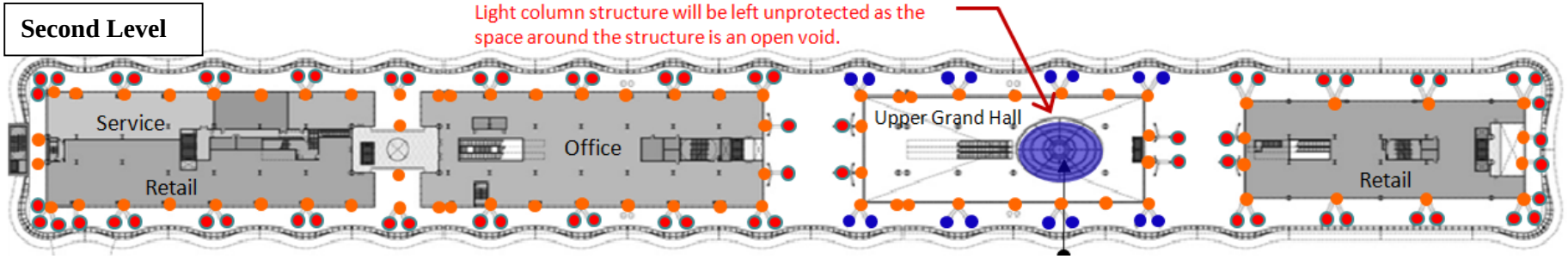
The detailed calculations and justifications are presented in a two volume report:

- Volume #1 – presents a single element structural fire analysis of the external steel braced frames from Ground to the Second Level (i.e. V-columns) and the "light" columns in the Grand Hall of the TTC.
- Volume #2 – presents a whole-frame structural fire analysis of the diagonal braces of the perimeter steel braced frame and the perimeter gravity columns at the west and east ends of the structure at the Bus Deck Level.

Together Volume #1, Volume #2 and the "Design Fire, Input Data, and Modeling Assumptions" report form the RFLE #3. The following figures summarize the proposed engineered fire protection strategy based on these reports.

Enclosed at the end of this request form are amendments to the Volume #1 Final Report dated November 2010, based on the comments received at the meeting dated 01/26/2011.

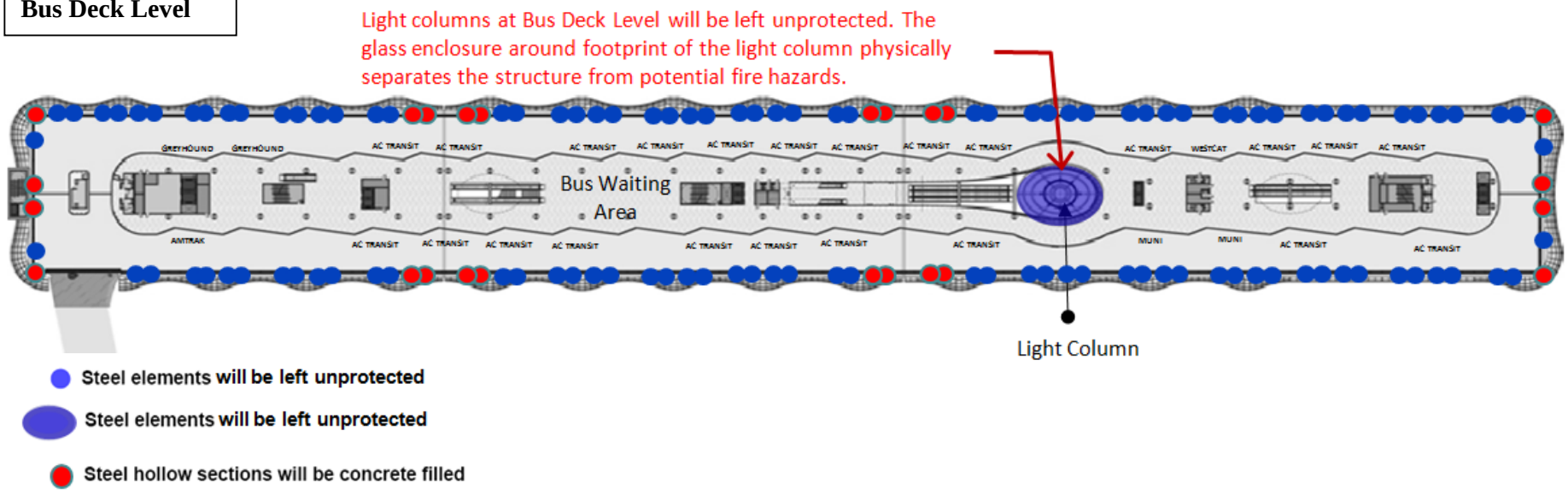
Engineered Fire Protection Strategy of V-columns and Light Columns – Plan View



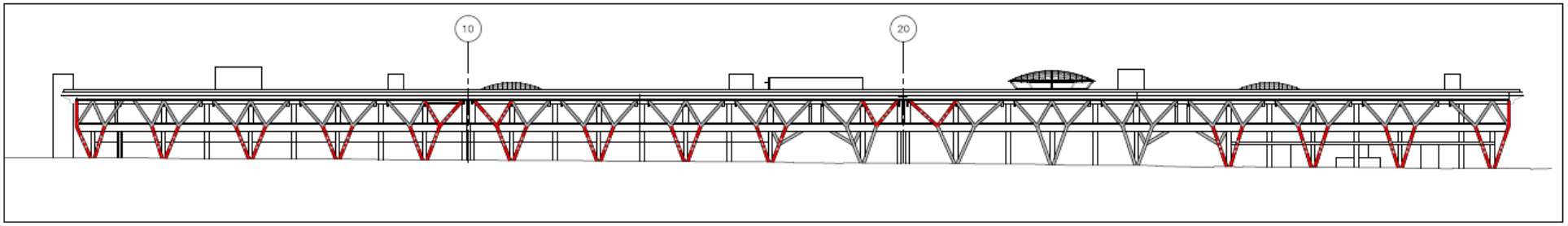
- Steel elements will be left unprotected
- Steel elements will be left unprotected
- Steel elements will be 2-hour protected with spray-applied fire resistive material
- Steel hollow sections will be concrete filled

Engineered Fire Protection Strategy of Diagonal Braces – Plan View

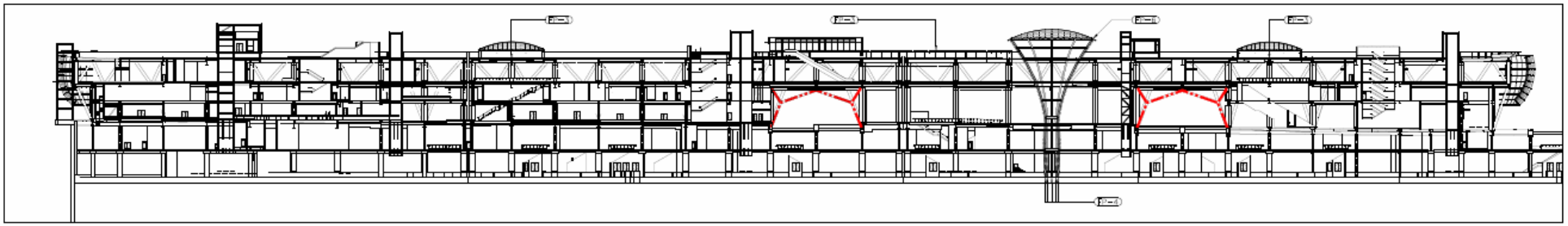
Bus Deck Level



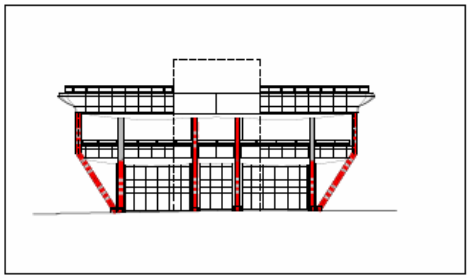
Engineered Fire Protection Strategy of External Steel Braced Frame and Bridge Structures – Elevation View



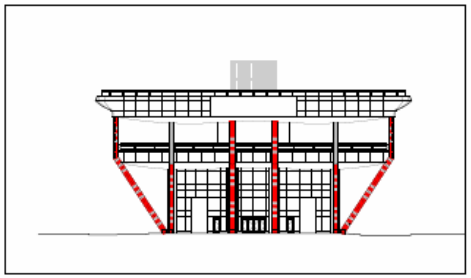
3 SOUTH ELEVATION AESS (NORTH SIMILAR)
SCALE NTS



4 BUILDING SECTION SHOWING FIREPROOFING
SCALE NTS

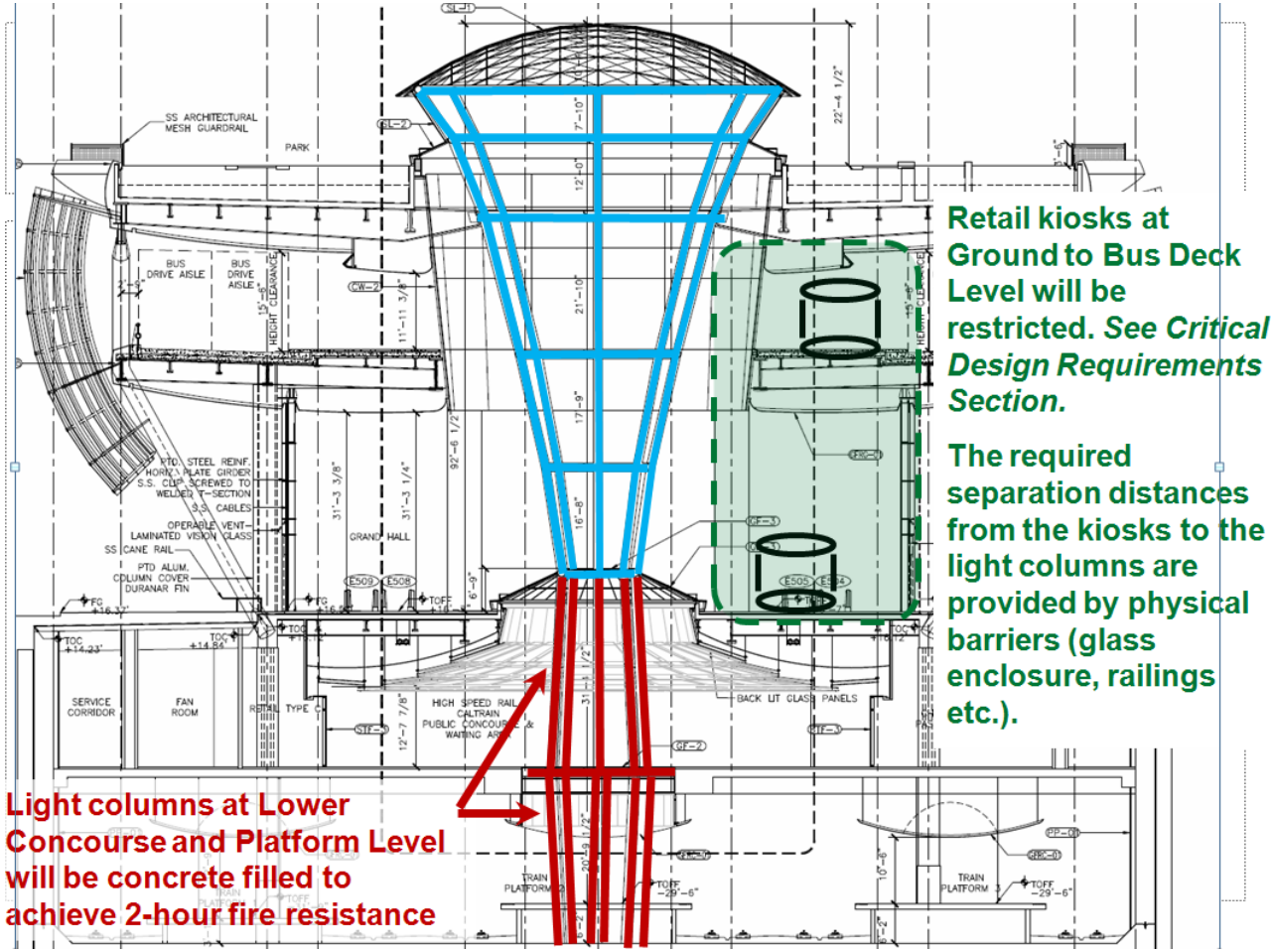


5 WEST ELEVATION AESS
SCALE NTS



6 EAST ELEVATION AESS
SCALE NTS

Engineered Fire Protection Strategy of Light Columns – Elevation View



Summary

In summary, based on the results of the Structural Fire Engineering Report Volumes 1 and 2 dated November 2010, it is our professional judgment that the proposed fire-protection strategy for TTC superstructure meets an equivalent level of safety intended by Table 601 of the 2007 SFBC.

Prepared by:
Arup Fire

Darlene R 2-11-11
Darlene Rini, P.E. Date

REGIS. PROFESSIONAL ENGINEER
DARLENE RINI
No. 1708
EXP. 9/30/12
FIRE PROTECTION
STATE OF CALIFORNIA

Approved by Hanson Tom
San Francisco Building Department

Hanson Tom 5/11/11
Date

Approved by Captain Don Fields
San Francisco Fire Department

Don Fields 5/11/11
Date

Approved by Edmond Sum
Transbay Joint Powers Authority

8 JUNE 2011
Date

Approved by Dr. Nestor Iwankiw, S.E.
Peer Reviewer

See attached letter dated January 12, 2011
Date

Approved by Dr. Venkatesh Kodur
Peer Reviewer

See attached letter dated January 12, 2011
Date

Approved by Albert Chen, P.E., S.E.
Thorton Tomasetti (Structural Engineer)

6/13/2011
Date

Enc:

- Meeting Minutes – January 26, 2011
- Updated pages to RFLE #3 – Structural Fire Engineering Report (Volume #1)
- Updated Structural Fire Engineering Design Objectives memo
- Third Party Peer Review Signoff Letter dated January 12, 2011

Meeting Action Notes

Project	**TRANSBAY TRANSIT CENTER** San Francisco, California, USA	Project Number	Adamson 0803 -00
Location	**Conference Call**	Date Time	**January 26, 2011** 10:00am – 10:30am
Subject	**SFE Final Report – SFDBI/SFFD Comment Review Conference Call**	Meeting Number	**CD-SFE Conf Call-001**

Prepared by	Adamson Associates, Inc.	AAI	Erick del Angel	eda

Present				
	Company		**Attendee**	
	TJPA	TJPA	Ed Sum	
	San Francisco Department of Building Inspection & Fire Department	SFDBI / SFFD	Hanson Tom, Donald Fields, Tod Stephenson	
	Project Management Project Control	PMPC	Alfred Lau, Derrick Cooper	
	Structural Fire Engineering Review Panel	SFE - PR	Nestor Niwankiw, Venkatesh Kodur	
	Arup	Arup	Darlene Rini, Andrew Coles	
	Adamson Associates, Inc.	AAI	Erick del Angel, Carl Keim	

Adamson Associates, Inc. will rely on these notes as the approved record of matters discussed and conclusions reached during this meeting, unless written notice to the contrary is received by Adamson Associates, Inc. within seven calendar days of the issue date of these meeting notes.

Meeting Action Notes

Subject	SFE Final Report – SFDBI/SFFD Comment Review Conference Call	Meeting Number	CD-SFE Conf Call-001

No.	ITEM	DISCUSSION	ACTION	DATE
1.0	**Purpose of Meeting**	The purpose of the meeting was to review SFDBI / SFFD final comments to Final SFE Report. The Peer Review Panel has already issued a letter of approval.	INFO	
1.1	**Street Crossing Braces**	SFDBI / SFFD noted that the color diagram submitted by AAI that summarizes the different fire protection solutions to structural steel (Sheet A1-8651) indicated that the structural braces shown at the street crossings are also in-filled with concrete, same as the basket columns; however the report does not mention them or the need for fire protection. Arup agreed to revise the report to indicate that such structural members will require fire protection.	Arup	Feb. 2, 2011
1.2	**Light Column**	Arup presented and reviewed the fire protection strategy for the light columns. The light column is a structural element that spans six levels of the TTC. According to the report the light columns at the Platform Level are to be fireproof with a 2-HR UL approved system, because of the close proximity of a potential train fire to the light column structure. The remaining levels of the structure are not fire- protected, albeit restrictions were placed at the Lower Concourse through Bus Deck Level. Within a distance of 10' from the steel structure, no combustible materials of any kind or kiosk may be placed. It was also noted that these restrictions would be part of the O&M manual of the facility.	INFO	
1.2.1	Light Column - Report Revision	The SFDBI / SFFD stated that placing a fuel load restriction from the light column structure would not be a robust solution over the life of the building and that a physical barrier (e.g. rail) or architectural separation (e.g. floor separation or void) would provide an acceptable solution. Arup indicated that the light column structure at Ground to Bus Deck level is provided with various physical separations (e.g. hand rail, glass barrier, etc) from any potential fuel loads or kiosks. Arup and AAI agreed to provide drawings highlighting the location of the physical barriers and the separation distances from the barriers to the light column structure that are sufficiently large to permit the light columns to be left unprotected (at these levels). No objection was offered by SFDBI/SFFD/Peer Reviewers. However, at Lower Concourse Level Arup indicated that a permanent physical barrier is not provided from any potential fuel loads to the light column. Arup indicated that at Lower Concourse a permanent physical barrier would not be necessary to keep fuel loads away from the light column structure, as any barrier would impede the flow of passenger traffic and functional use of the space. SFDBI/SFFD were not in agreement and requested a more robust fire protection strategy for the light columns at this level (i.e. Lower Concourse Level) Arup and AAI agreed that the light column steel structure at Lower Concourse could be protected with infill concrete similar to that provided at Train Platform Level. SFDI / SFFD felt that this would be an acceptable solution. Arup/AAI to coordinate with the structural engineer.	Arup / AAI	Feb. 2, 2011

Meeting Action Notes

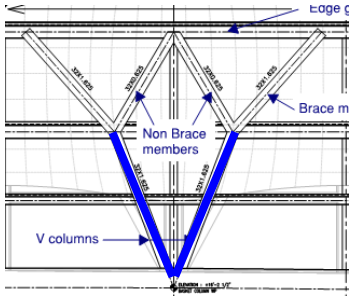
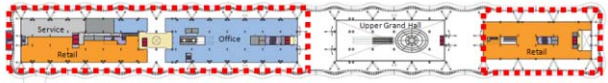
Subject	SFE Final Report – SFDBI/SFFD Comment Review Conference Call	Meeting Number	CD-SFE Conf Call-001

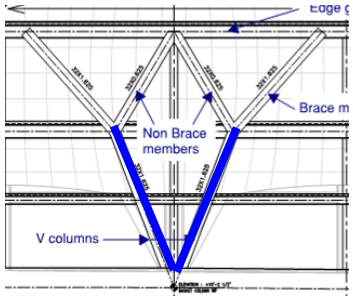
1.3	**Other Comments**	The SFDBI / SFFD stated that there were other miscellaneous paragraphs within report that required clarification	INFO	
1.3.1	Report Page 42 Sec 5.2.3	Arup to add figures that are missing	ARUP	Feb. 2, 2011
1.3.2	Report Page 40 Figure 37	Arup to remove the statement, “5MW or larger” from the fire protection diagrams for the light column structure	ARUP	Feb. 2, 2011
1.3.3	Report Appendix C – Criteria memo	In the background of Section 2: Standard fire resistance in the memo issued Arup issued to AHJ; “Strength of Material…	ARUP	Feb. 2, 2011
1.3.4	Report Page 39	Summary of all results. Make sure it coordinates with sheet A1-8651	ARUP	Feb. 2, 2011
1.4	**Final Documents**	Arup to issue page and cover letter by February 2, 2011	ARUP/AAI	Feb. 2, 2011

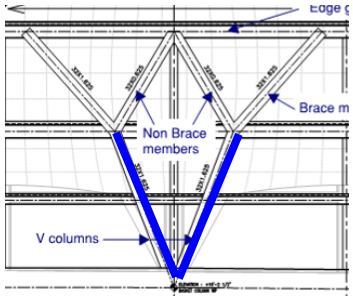
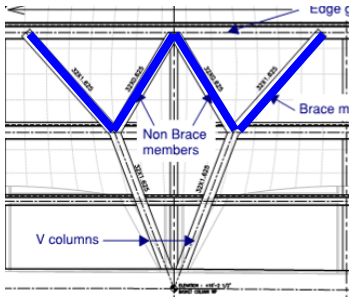
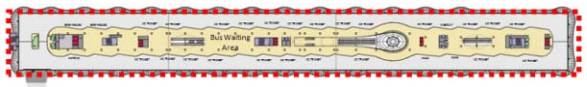
End of Action Notes.

Summary of Results

The findings and recommendations of the study are summarized as follows:

Structural System	Results	Fire Protection Requirements
V Columns  ***Gridlines 1 – 17 (Ground and 2nd Level), and 27– 34 (2nd level only)***  *Ground Level*  *Second Level*	➢ Analysis of a range of fire scenarios that could occur internal and external to the building has shown that external flames projecting from retail and office fires at the Ground and Second Level would likely engulf between 1 – 8 basket column units depending on the size of the retail/office compartment. ➢ The single element analysis showed that if the V-columns were not protected, they would not have sufficient capacity to resist the applied loads when exposed to external flames from a retail fire at the Ground and/or Second Level. Failure is defined as being unable to carry their applied load.	➢ All basket columns between Gridlines 1 – 17 and between Gridlines 27 – 34 (Second Level only) require 2-hour fire protection. This includes the bridge structures over 1st and Fremont Street. See Figure 2. ➢ The 2-hour fire resistance will be achieved by filling the V-columns with plain, light weight concrete with carbonate aggregate. Reinforcement will not be required for the concrete infill due to the inherent robustness of the structure with the loss of 2 V-columns and a vertical column. The structure's robustness in fire has been demonstrated in a progressive collapse analysis. This approach has been agreed with the Peer Review Panel in a meeting dated May 27th, 2010. Details of the progressive collapse analysis are available in the *Design Development Blast Resiliency Assessment Report* dated February 2010. ➢ Refer to Figure 1 for external basket column locations.

Structural System	Results	Fire Protection Requirements
V Columns  **Bus Plaza (Ground Level)** ***Gridlines 27– 34***  *Ground Level*	➢ Due to the close proximity of the basket columns to the single-deck, double-deck, and articulating buses within the Bus Plaza it is likely that several basket V-columns could be engulfed in flames simultaneously. ➢ Based on a structural fire assessment of the load-bearing capacities of the V- columns filled with plain, lightweight, carbonate concrete in the fire limit state, an inherent fire resistance of 2-hours can be achieved without any additional external fire protection.	➢ All basket columns located within the bus plaza between Gridlines 27 – 34 (Ground Level to the underside of the Bus Deck Level slab) will require 2-hour fire protection. This includes the braces supporting the bridge structure over and Fremont Street. See Figure 2. ➢ The hollow steel members will be filled with plain, light-weight, carbonate concrete to achieve an equivalent 2-hour fire resistance. Reinforcement will not be required for the concrete infill due to the inherent robustness of the structure with the loss of 2 V-columns and a vertical column. The structure's robustness in fire has been demonstrated in a progressive collapse analysis. This approach has been agreed with the Peer Review Panel in a meeting dated May 27th, 2010. Details of the progressive collapse analysis are available in the *Design Development Blast Resiliency Assessment Report* dated February 2010.

Structural System	Results	Fire Protection Requirements
V Columns  ***Grand Hall*** *(Ground and 2nd Level)* ***Gridlines 19–25***  *Ground Level*	➢ For the range of fire scenarios that could occur internal and external to the building, the governing fire scenario for the V-columns adjacent to the Grand Hall is a delivery truck fire along the external perimeter of the building, as bus traffic is not permitted along Natoma St. to the south and Mission Square is pedestrian space to the north. ➢ Based on a conservative 25MW delivery truck fire along the longitudinal and lateral façade of the Grand Hall the analysis has shown that the V-columns will have sufficient capacity without any applied fire proofing when exposed to a delivery truck fire.	➢ The V-column members between Gridlines 19 – 25 will not be fire protected (i.e. bare steel). ➢ ***Refer to the Critical Design Requirements Section for other structural details required by this analysis.***
Diagonal Braces  **(Bus Deck Level)** 	➢ For the Bus Deck Level, the single element analysis has shown that if both non-brace and brace elements <u>are not provided with fire protection</u>, they would **<u>NOT</u>** have sufficient capacity to resist the applied loads when exposed to a localized, <u>steady state</u> bus fire (both double-decker and single-deck buses).	➢ Refer to Volume #2 of the RFLE #3 for the fire protection strategy for the diagonal elements at Bus Deck Level

Structural System	Results	Fire Protection Requirements
Light Columns **(Grand Hall)**   *Ground Level*	➢ The most severe fire scenario that could affect the light columns in the Grand Hall and Lower Concourse is a localized retail kiosk fire. ➢ The analyses have shown that if the kiosk is located more than 10' horizontally and 21'-4" vertically from the light column structure, then the light column structure will have sufficient capacity to resist the applied loads. ➢ At Train Platform Level, the light columns could be directly engulfed in flame from a 20MW train fire. Thus, the light columns at this level will require 2-hour fire protection.	**Light Columns at <u>Train Platform and Lower Concourse Level</u>** o Based on the close proximity of the light columns to a potential train fire scenario, 2-hour fire protection is required at the Train Platform Level. This will be achieved by filling the tubes with light-weight, carbonate concrete. o At the request of DBI and SFFD in a meeting dated 1/27/2011, the light columns at Lower Concourse Level will be filled with light-weight carbonate concrete to achieve a 2-hour fire resistance. See meeting notes for details. **Light Columns at <u>Ground to Bus Deck Level</u>** o The light columns from Ground to Bus Deck Level will not be fire protected (i.e. bare steel). o Physical barriers such as a hand rail/parapet wall (Ground Level) and a glass enclosure (Bus Deck Level) will provide the required separation distances from the light column elements to any potential fuel loads at these levels. (See Figure 4 – Figure 6). o The retail kiosks/fuel packages within the Grand Hall will be limited to a plan area of 114 ft² and separated from adjacent kiosks by 12ft. The kiosks will be limited to 500kW/m^2 of fuel load such as newsstands, sunglass huts, sandwich stands, etc. o ***Refer to the Critical Design Requirements Section for other structural details required by this analysis.***

Engineered Fire Protection Strategy

External Steel Braced Structure and Light Columns in Grand Hall

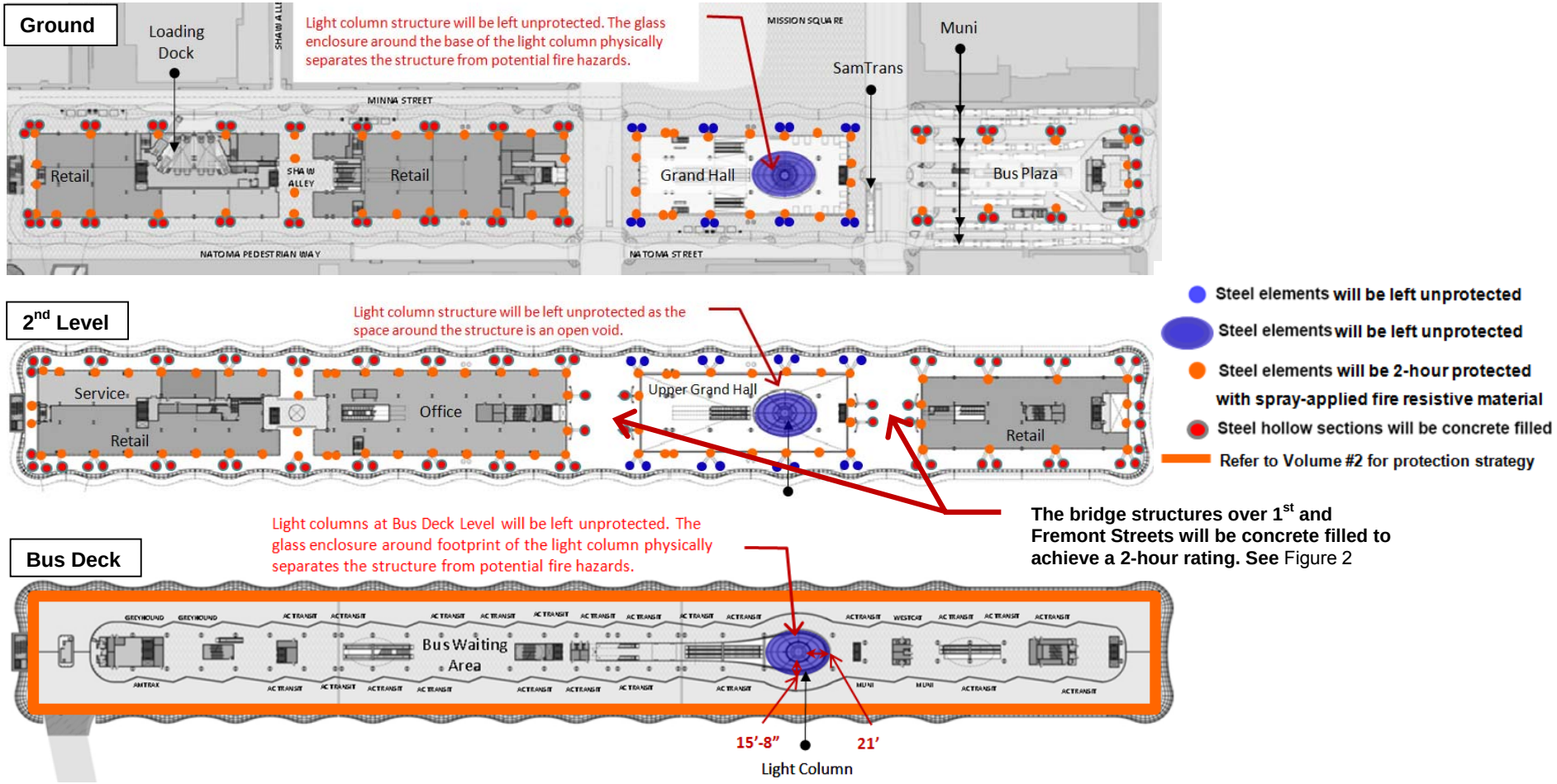
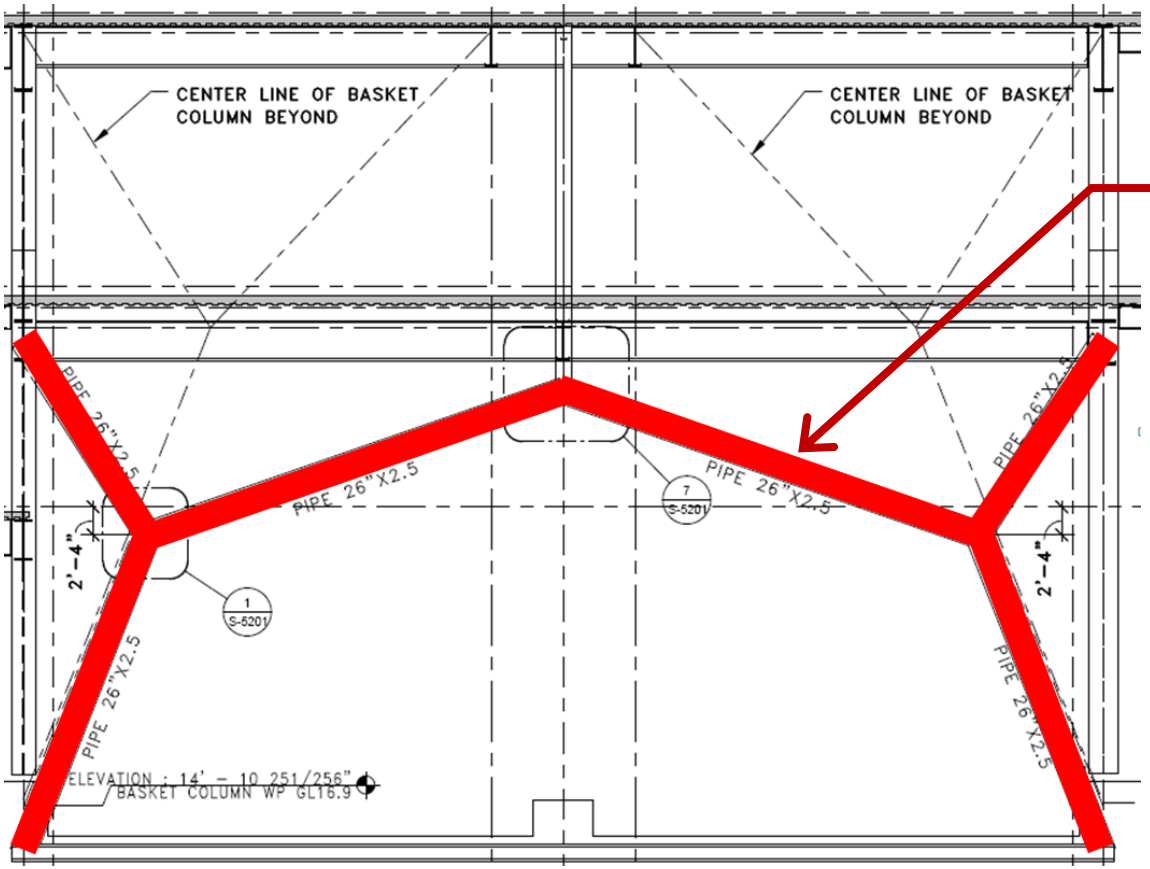


Figure 1: Engineered fire protection strategy per level for the V columns, diagonal braces and columns located in the Grand Hall

Bridge Structures (Elevation View)



The bridge structure over 1st and Fremont Streets will be concrete filled to achieve a 2-hour rating.

Figure 2: Fire protection strategy for the bridge structures located over 1st and Fremont Street

Light Column Structure (Elevation View)

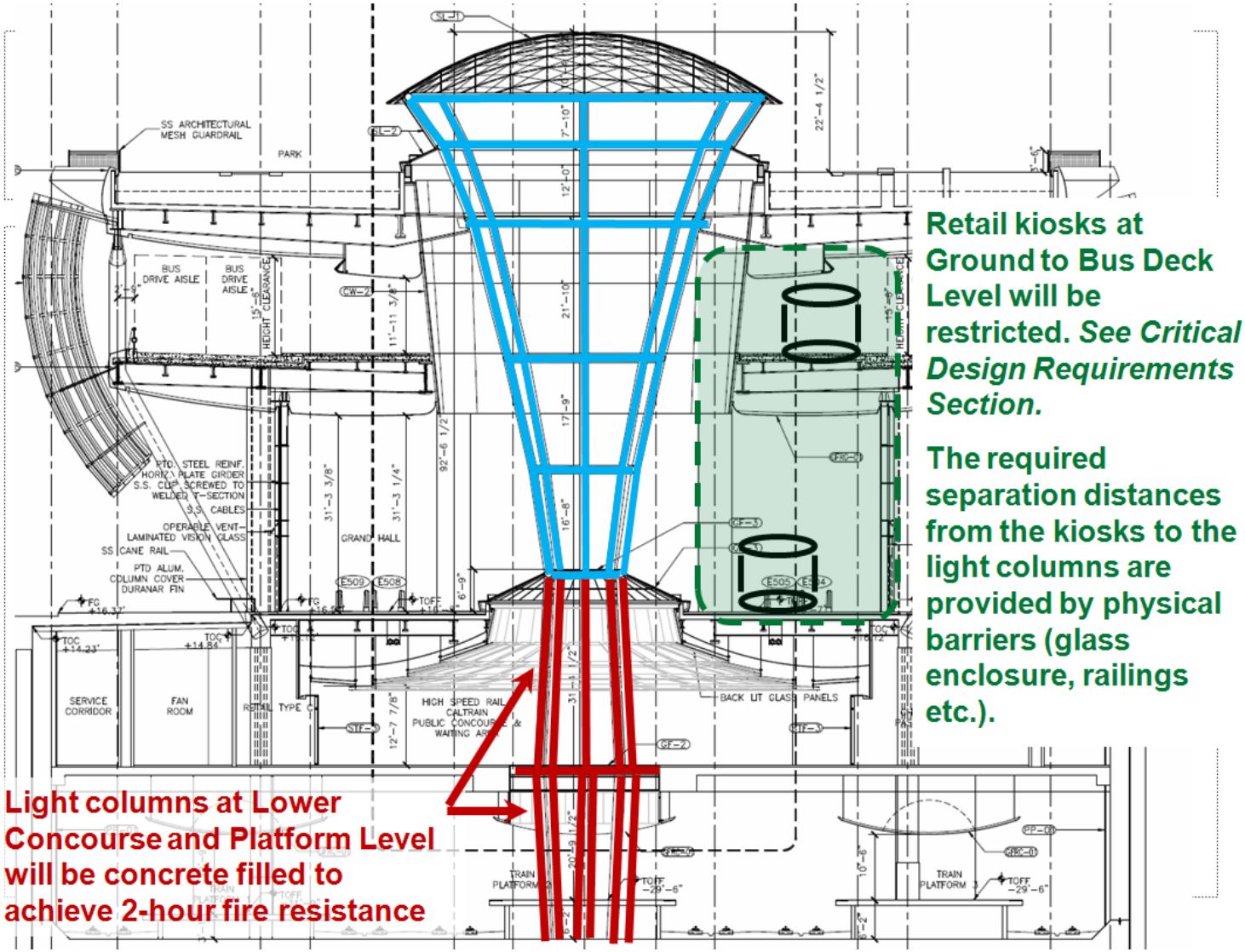


Figure 3: Engineered fire protection strategy for the light columns located in the Grand Hall

Critical Design Requirements

The following requirements form the basis of the engineered fire protection strategy presented in this report. Without the implementation of these requirements the analysis within this report is invalid. These are as follows:

Structural Requirements

- All structural steel pipes (V-columns and diagonal braces) will have a yield strength of 50ksi [345N/mm²] per 50% DD structural drawings, dated 8/31/09.
- All steel basket V-column elements will have section properties based on 100% DD structural drawings, dated 2/6/10. The steel hollow tubes for the V-columns should be no smaller than 32” diameter.

Fire Protection Requirements

- Where concrete infill is used to achieve 2-hour structural fire resistance for the external braced elements, the concrete shall be normal or light weight concrete with carbonate aggregates and a compressive strength of 4ksi [28N/mm²].
- The concrete-filled hollow sections shall be provided with steam vents to minimize the buildup of steam pressures and the effects of concrete spalling. The vents shall be no less than ½ -inch ± 1/12 inch in diameter, and located at the top and bottom of each story placed symmetrically on opposite wall sides (4 per elevation section) [19]. The vertical spacing shall be no more than 10-12ft. These vent holes must remain open and unobstructed (uncovered) during service.
- The steam vents should not be painted, sealed or covered in any way. These requirements should be included in the O&M manual. Note: Prior to the issuance of the Certificate of Occupancy, Arup will conduct an onsite verification of the vents and issue a special inspection report per relevant aspects of Section 1704 of the SFBC.
- Connections throughout the building should be protected to the highest fire rating of any element they are attached to. This will be achieved using best practice in accordance with the SFBC. Bolts need to be protected.
- All beams connected directly to internal columns require 2-hour fire protection. This is based on the assumption that the temperature rise in protected beams will be limited to 593°C over 2-hours of the standard fire per ASTM E119.
- All fire protection thicknesses to structure except as otherwise stated above, should be derived from a UL listed assembly or other tested/approved system.

Any alterations to the protection standard, limiting temperature requirements, structural arrangement, or structural section sizes assumed in this work, would require review to determine if the alteration falls outside the limits of the analysis.

Fuel Load Restrictions in Grand Hall

- All retail kiosks in the Grand Hall must be restricted to a 12’x12’ plan area and be separated from any adjacent kiosks by 12’.
- The retail kiosks must be limited to a fuel load size of 5MW. Typical kiosks examples that satisfy a 5MW limit include sunglass huts, newsstands, coffee stands, sandwich stands. All proposed kiosks must be reviewed by a qualified fire protection engineer prior to use.

- Retail kiosks must be separated from the light columns as specified in Figure 4 to Figure 6. These separation distances are currently provided by physical barriers (e.g. hand rail/parapet wall at Ground Level and a glass enclosure at Bus Deck Level) in the current architectural design.
- The fuel load restrictions specified herein will be included in the Operations and Maintenance Manual for the facility.

Other Requirements

- The distance from the base of the basket columns to the curb can be no less than 32’ along the longitudinal façade; and no less than 21’ along the transverse façade of the Grand Hall block.

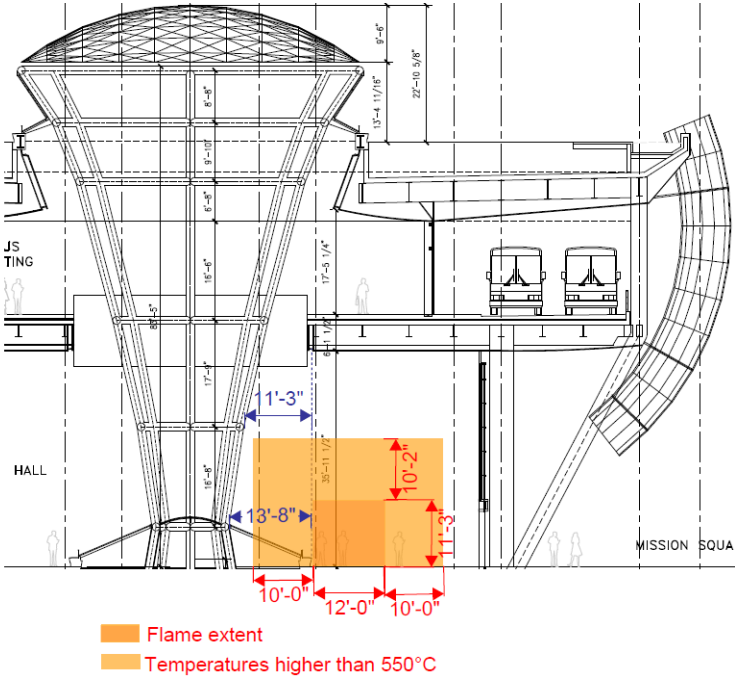


Figure 4: Illustration of kiosk separation distances required at Ground Level to allow <u>light columns</u> to remain unprotected

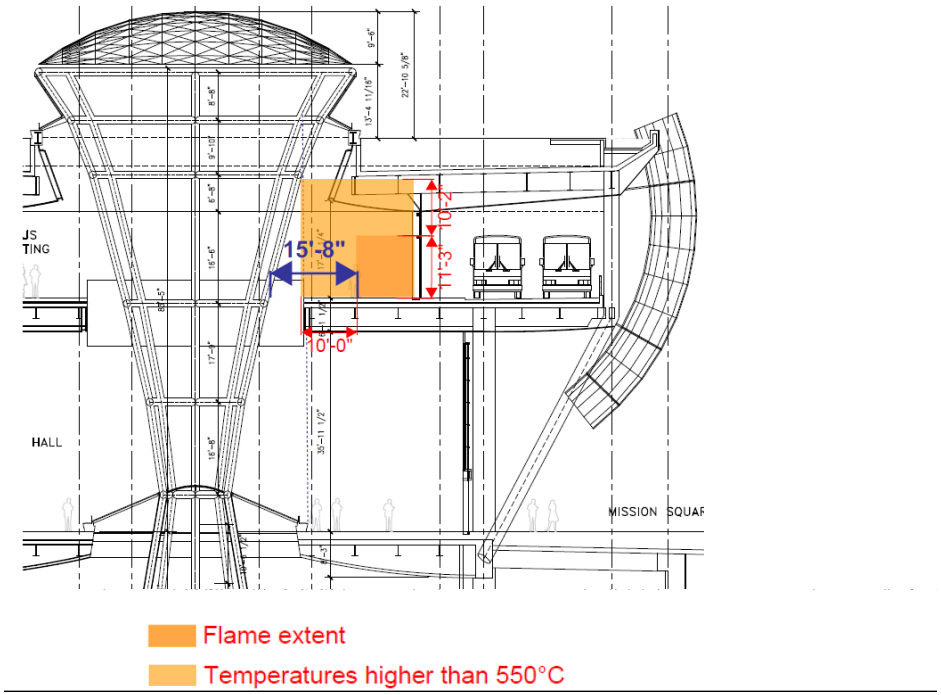


Figure 5: Illustration of kiosk separation distances (transverse direction) required at Bus Deck Level to allow <u>light columns</u> to remain unprotected

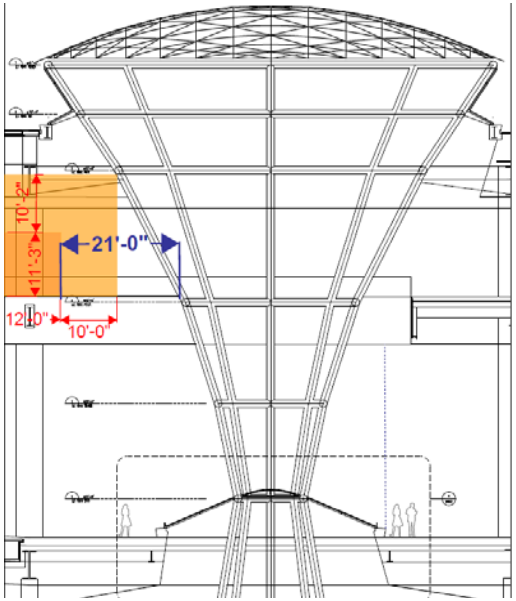


Figure 6: Illustration of kiosk separation distances (longitudinal direction) required at Bus Deck Level to allow light columns to remain unprotected

5 Conclusions

A performance-based structural fire engineering assessment has been carried out on the above ground steelwork of the Transbay Transit Center building.

As part of this assessment, several credible fire scenarios that could potentially expose the steel superstructure of the building have been identified. Thermal and mechanical analyses were undertaken to assess the impact of the fires on the structural elements. The results of these analyses are summarized as follows.

Table 20: Summary of all results

Critical elements of structure	Location in the building		Most onerous fire scenario	Can Structural Elements Be Left Unprotected ?	Fire Protection Strategy
External Braced Structure (V-Columns and Diagonals)	Ground and 2nd Level	Between Gridlines 1-17, and 27-34 (2nd Level only)	External flames projecting from retail and office fires at Ground and 2nd level	**NO**	Fill hollow steel members (V columns) with light-weight concrete with carbonate aggregate to achieve a 2-hour fire rating
		Between Gridlines 27-34 (Bus Plaza grade level only)	Localized bus fire	**NO**	Fill hollow steel members (V columns) with light-weight concrete with carbonate aggregate to achieve a 2-hour fire rating
		Between Gridlines 19-25	Delivery Truck fire	**YES**	Protection not required
	Bus Deck	Entire Level	Localized bus fire	**YES**	See Volume #2 of the RFLE#3
Light column structure	Train Platform level		Train fire	**NO**	Provide 2-hour fire protection. Concrete infill will not provide the required fire resistance.
	Lower Concourse		Localized kiosk fire	**NO**	At the request of DBI and SFFD in a meeting dated 1/27/2011, light-weight carbonate concrete infill will be provided to achieve a 2-hour fire resistance. See meeting notes for details.

Critical elements of structure	Location in the building	Most onerous fire scenario	Can Structural Elements Be Left Unprotected ?	Fire Protection Strategy
	Ground, 2nd and Bus Deck Level	Localized kiosk fire	YES	Protection not required. See Critical Design Requirements

5.1 Proposed Fire Protection Strategy

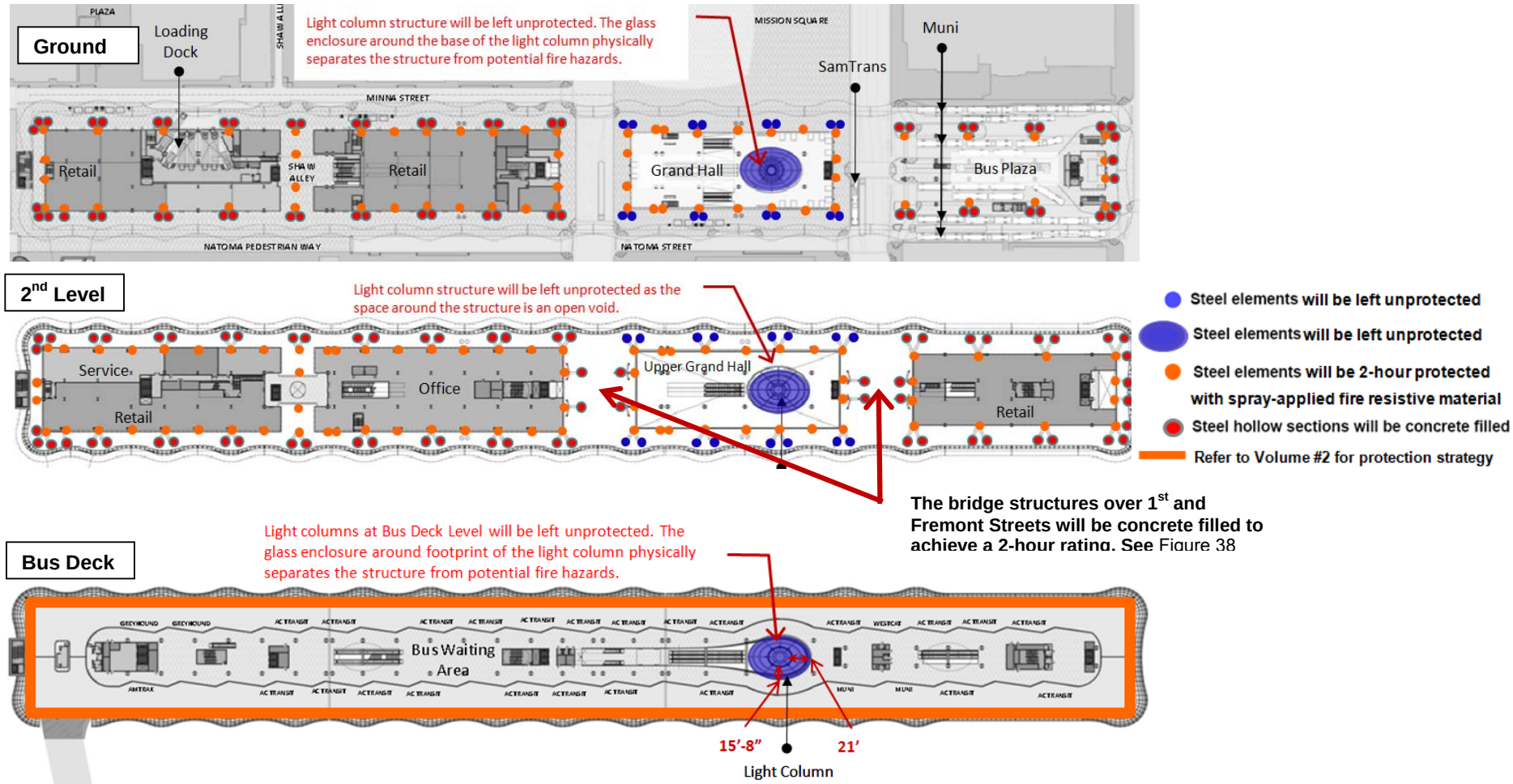
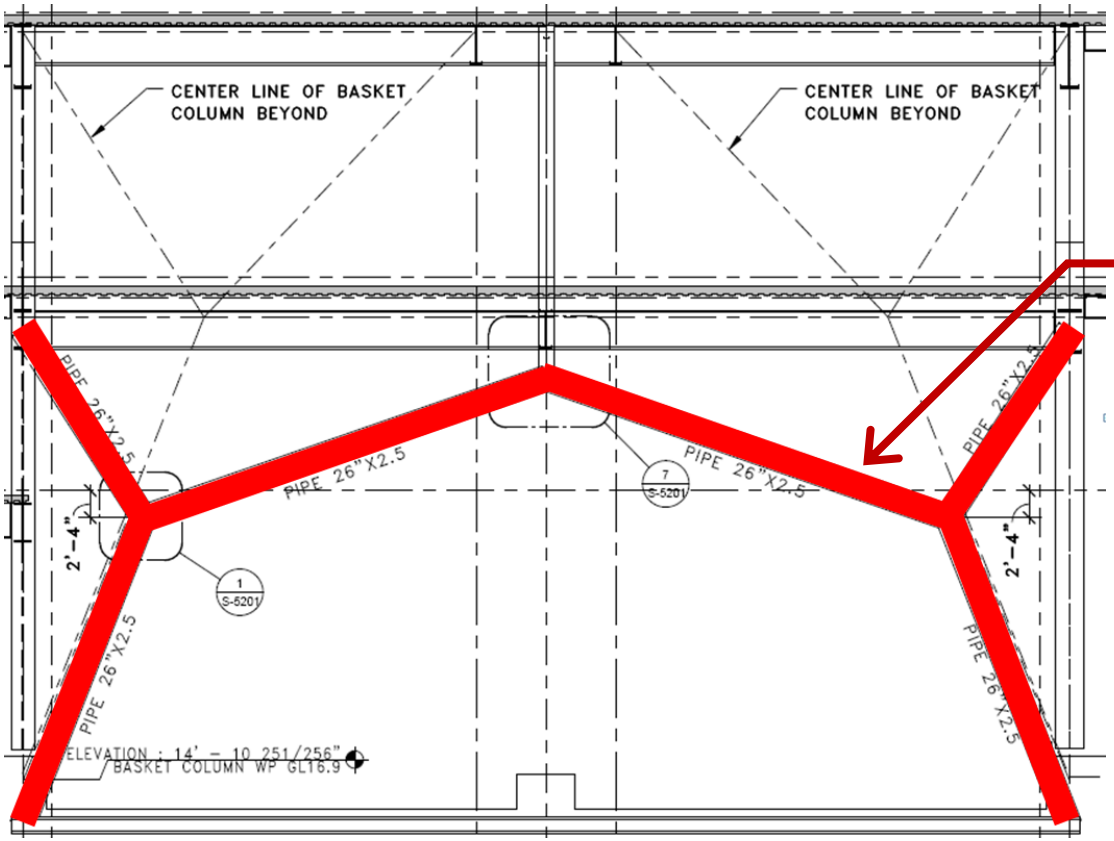


Figure 37: Proposed, engineered fire protection for external braced structure (basket columns + diagonals) and Light columns in Grand Hall



The bridge structure over 1st and Fremont Streets will be concrete filled to achieve a 2-hour rating.

Figure 38: Fire protection strategy for the bridge structures located over 1st and Fremont Street

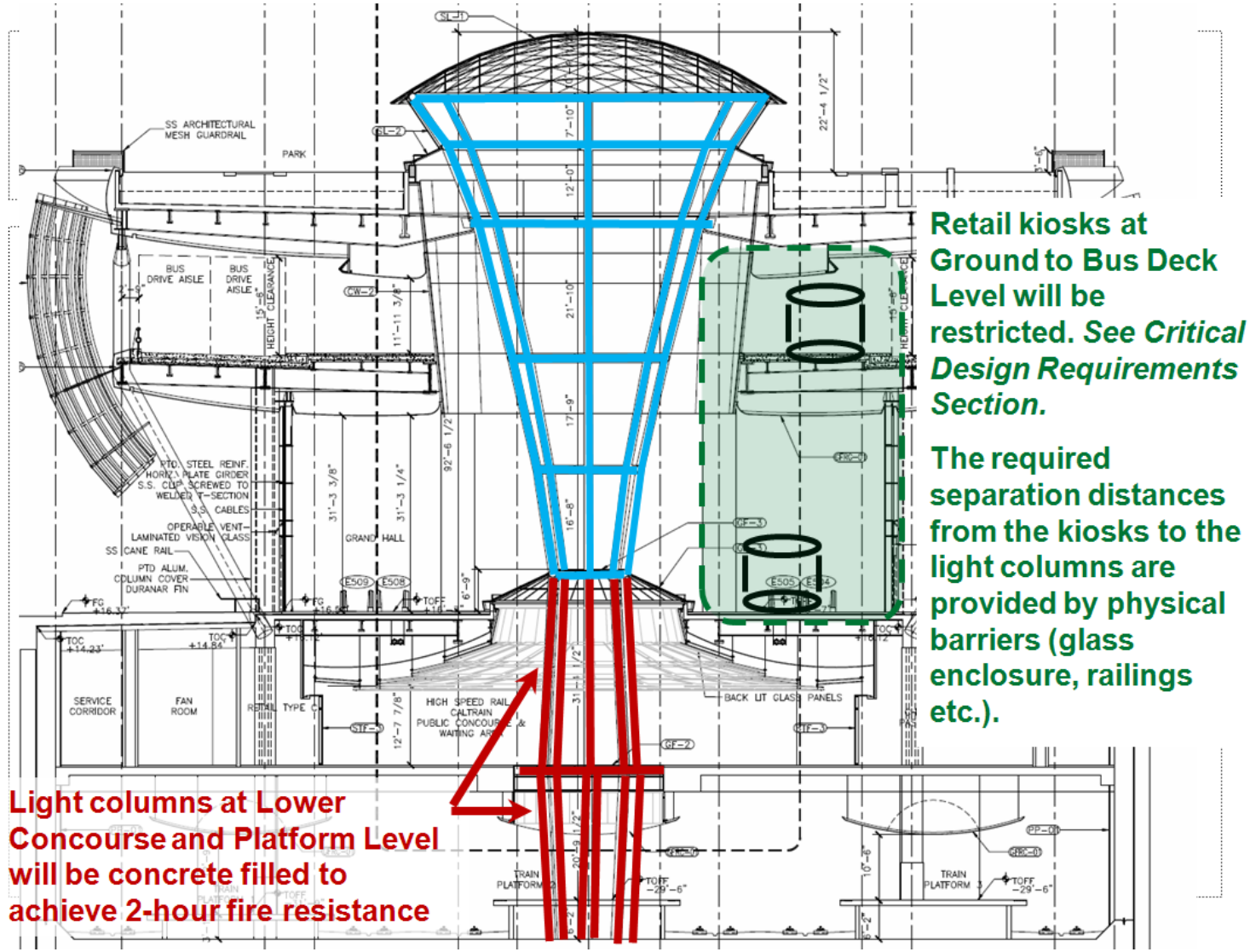


Figure 39: Engineered fire protection strategy for the light columns located in the Grand Hall

5.2 Critical Design Requirements

The following requirements form the basis of the engineered fire protection strategy presented in this report. Without the implementation of these requirements the analysis within this report is invalid. These are as follows:

5.2.1 Structural Requirements

- All structural steel pipes (V-columns and diagonal braces) will have a yield strength of 50ksi [345N/mm²] per 50% DD structural drawings, dated 8/31/09.
- All steel basket V-column elements will have section properties based on 100% DD structural drawings, dated 2/6/10. The steel hollow tubes for the V-columns should be no smaller than 32" diameter.

5.2.2 Fire Protection Requirements

- Where concrete infill is used to achieve 2-hour structural fire resistance for the external braced elements, the concrete shall be normal or light weight concrete with carbonate aggregates and a compressive strength of 4ksi [28N/mm²].
- The concrete-filled hollow sections shall be provided with steam vents to minimize the buildup of steam pressures and the effects of concrete spalling. The vents shall be no less than ½ -inch ± 1/12 inch in diameter, and located at the top and bottom of each story placed symmetrically on opposite wall sides (4 per elevation section) [19]. The vertical spacing shall be no more than 10-12ft. These vent holes must remain open and unobstructed (uncovered) during service.
- The steam vents should not be painted, sealed or covered in any way. These requirements should be included in the O&M manual. Note: Prior to the issuance of the Certificate of Occupancy Arup will conduct on onsite verification of the vents and issue a special inspection report per relevant aspects of Section 1704 of the SFBC.
- Connections throughout the building should be protected to the highest fire rating of any element they are attached to. This will be achieved using best practice in accordance with the SFBC. Bolts need to be protected.
- All beams connected directly to internal columns require 2-hour fire protection. This is based on the assumption that the temperature rise in protected beams will be limited to 593°C over 2-hours of the standard fire per ASTM E119.
- All fire protection thicknesses to structure except as otherwise stated above, should be derived from a UL listed assembly or other tested/approved system.

Any alterations to the protection standard, limiting temperature requirements, structural arrangement, or structural section sizes assumed in this work, would require review to determine if the alteration falls outside the limits of the analysis.

5.2.3 Fuel Load Restrictions in Grand Hall (i.e. adjacent to Light Columns)

- All retail kiosks in the Grand Hall must be restricted to a 12'x12' plan area and be separated from any adjacent kiosks by 12'.
- The retail kiosks must be limited to a fuel load size of 5MW. Typical kiosks examples that satisfy a 5MW limit are sunglass huts, newsstands, coffee stands, sandwich stands. All proposed kiosks must be reviewed by a qualified fire protection engineer prior to use.
- The fuel load restrictions specified herein will be included in the Operations and Maintenance Manual for the facility.

5.2.4 Other Requirements

- The distance from the base of the basket columns to the curb can be no less than 32' along the longitudinal façade; and no less than 21' along the transverse façade of the Grand Hall block.

5.3 Retail Kiosk Location Restrictions in Grand Hall

Retail kiosks must be separated from the light columns as specified in Figure 40 to Figure 42. These separation distances are currently provided by physical barriers (e.g. hand rail/parapet wall at Ground Level and a glass enclosure at Bus Deck Level) in the current architectural design.

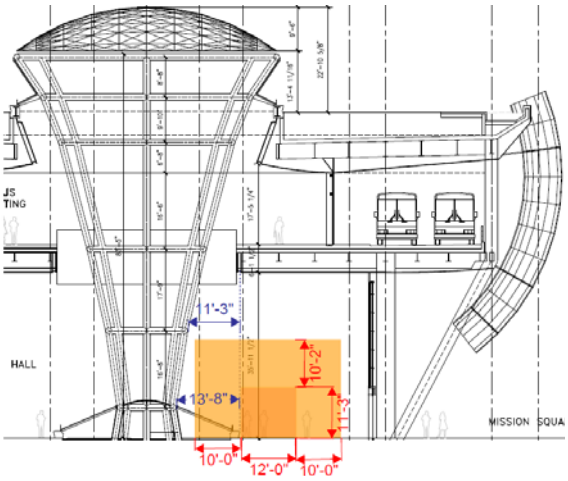


Figure 40: Illustration of kiosk separation distances required at Ground Level to allow light columns to remain unprotected

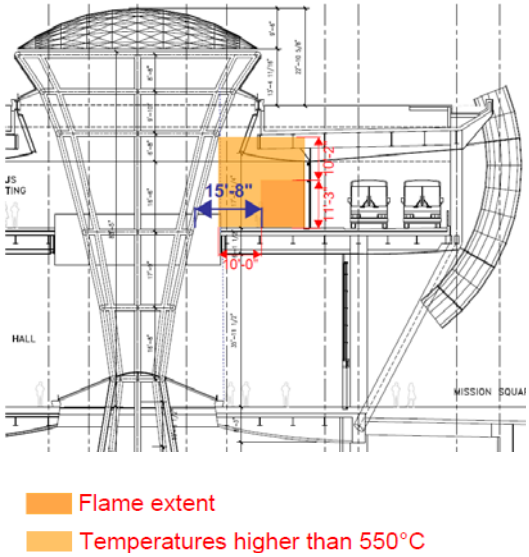


Figure 41: Illustration of kiosk separation distances (transverse direction) required at Bus Deck Level to allow light columns to remain unprotected

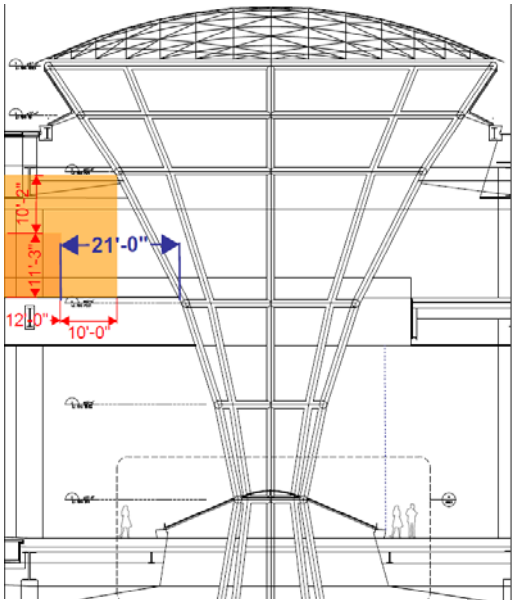


Figure 42: Illustration of kiosk separation distances (longitudinal direction) required at Bus Deck Level to allow light columns to remain unprotected

1 Introduction

At the request of the Structural Fire Engineering Peer Reviewer Panel, this memorandum is intended to highlight the performance criteria of the "engineered" fire protection for select steel elements of the Transbay Transit Center (TTC) project. This applies to the V-columns from Ground to Second Level, diagonal braces at Bus Deck Level and light columns in the Grand Hall. Figure 1 highlights the structural elements where a performance-based fire protection strategy is proposed.

All other structural elements will be protected according to the prescriptive requirements of the code (i.e. provided with a listed 2-hour fire rated assembly or as prescribed in Chapter 7 of the San Francisco Building Code 2007 edition (SFBC))

Figure 1 - Select structural steel elements assessed in Structural Fire Analysis

Specifically, the aim of this memo is to provide the Transbay Joint Powers Authority (TJPA) with an understanding of the anticipated performance of the structure in a "severe fire" event given a:

- Code-based or Prescriptive approach (i.e. 2-hour fully protected)
- Proposed Performance-Based approach (i.e. select bare steel)

A "severe fire" event is only anticipated if several fire safety features for the TTC fail (i.e. sprinkler system, fuel load control, etc.) and fire department response is inhibited or severely delayed. In the event that any one of these features is functional or in-place a severe fire event is unlikely.

Both approaches (code-based and performance-based) are designed to satisfy the life-safety intent of the SFBC. While both strategies are not specifically aimed at limiting damage, the combined life-safety features of TTC (not just the structural fire protection) will contribute to transit operational continuity and property protection. That is, the fire safety features of the TTC (automatic sprinkler system, smoke detection system, first aid fire fighting, fire fighting services, fuel load control etc) while designed to enable safe egress and limit the spread of fire and smoke throughout the building, will also contribute to limiting severe fire events which could impact the structure. Regardless of the structural fire protection strategy, these features are important and play a significant role to limit any potential transit interruption due to fire. Designing the structure beyond life-safety, specifically to limit all property damage and/or transit disruption due to fire would significantly alter the architectural design approach.

However, in the unlikely event that several of these features fail, it is possible that some amount of structural or smoke damage could occur in either a code-based approach or the proposed performance-based approach.

2 Standard Fire Resistance

The fire resistance of a structural element or assembly is the ability to withstand exposure to fire without the loss of load bearing function and/or to act as a barrier against spread of fire. In the U.S., this is expressed in terms of a length of time that the structural element can withstand exposure to a standard "laboratory" fire that is termed the "standard fire resistance" of the element or system.

While all structural elements have an inherent fire resistance (i.e. without protection), it is common practice to use fire protection materials or "fire-proofing" to prevent or delay the temperature rise in the structural elements. These passive fire protection materials are designed and tested to keep the temperature of a structural steel element below a limiting ("failure") temperature.

Historically, the limiting temperature of a steel element is assumed by the Code to be around 550°C, when the strength of the material is at 50% of its ambient capacity (Figure 2). Below this limiting temperature the element is assumed to be able to maintain stability, and satisfy the **life safety** objectives of the code that are:

- Provide safe means of egress, or refuge, for building occupants in the event of a fire
- Allow for emergency service activities by the fire department

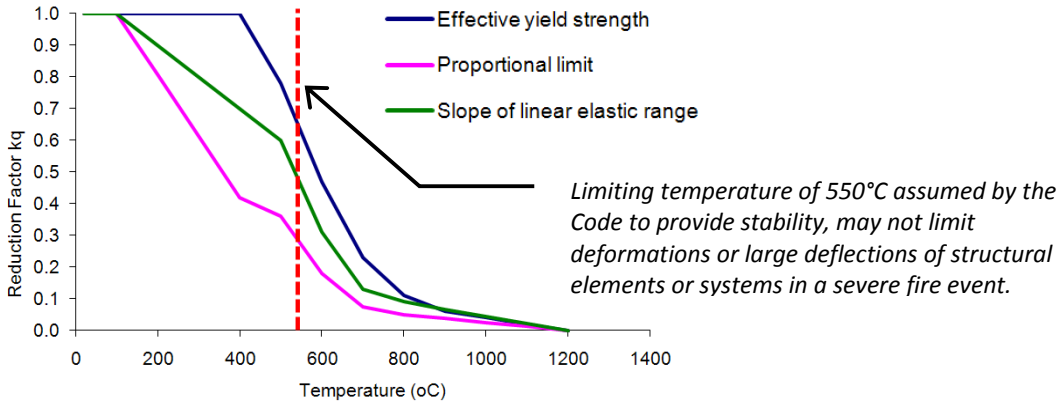


Figure 2 – Steel properties at elevated temperature per Eurocode 3 Part 1-2

While the 550°C temperature limit may satisfy life safety, it may **not** meet property protection and/or operational continuity objectives. This is because at 550°C steel has not only reached 50% of its ambient yield strength, but it is also at 45% of its ambient stiffness and 27% of its ambient elasticity. This means that an element even when fire protected to "code" can experience large deformation and displacements in a severe fire event. A "severe fire" event is only anticipated if several fire safety features for TTC fail (i.e. sprinkler system, fuel load control, etc.) and fire department response is inhibited or severely delayed. In the event that any one of these features is functional or in-place a severe fire event is unlikely.

3 Code Requirements

As a Type IB non-combustible building, the TTC is required to satisfy the standard fire resistance requirements of Table 601 of the SFBC for the various structural elements of the building. See Table 1:

Table 1 – Prescriptive requirements for TTC superstructure

Building Element	Fire Resistance Rating Requirement (Type IB)	Description
Structural frame	2 hours	Includes columns, girders/beams/ trusses/spandrels having direct connection to columns, members of floor/roof construction with direct connection to columns, bracing members essential to vertical stability of primary structural frame under gravity loading (e.g. external braced frame structure)
Floor construction	2 hours	Includes slabs, any structural member not having direct connection to columns (e.g. secondary beams), bracing members not required to maintain stability under gravity loading

In addition to the code required structural fire resistance levels, the TTC facility is required to, and is expected to, have the following key fire life-safety features as detailed in the Fire Life Safety Strategy Report:

- Automatic sprinkler system
- Class I Standpipe system
- Automatic fire detection system
- Emergency ventilation system (Bus Deck Level and Train Box)
- Fire department operations facilities (Control Center)
- Fuel load control and housekeeping
- Operations and maintenance procedures and emergency response protocol

The combination of all these features provides a holistic approach to fire protection and fire life-safety. This means that even fire safety features that are designed to enable safe egress and limit the spread of fire and smoke throughout the building (such as the sprinkler system, smoke control system, etc.), will also contribute to limiting the likelihood of a fire event that could impact the structure.

4 Anticipated Structural Fire Performance

This section presents the anticipated structural fire performance of the TTC structure in a "**severe fire"** event given a code-based approach vs. a performance-based approach. A "severe fire" event is only anticipated if several fire safety features in the TTC fail (i.e. sprinkler system, fire department intervention, smoke detection, etc.). In the event that any one of these features is operational, a severe fire event affecting the structure is unlikely.

The intent of this section is to inform TJPA on the likely performance of the structure such that expectations on structural fire resistance are met given the proposed performance-based structural fire protection solution.

The two types of fire protection strategies compared in this section are as follows:

- ***Code-Based Approach*** – consists of a fully-protected TTC building where all the structural elements are protected to achieve a 2-hour standard fire resistance in accordance with the prescriptive requirements of the SFBC. In this solution, the structural elements are provided with fire protection materials such that their temperature does not exceed 550°C under a 2-hour standard fire exposure. The aim is to provide stability and fire separation such that **life safety** is preserved for building occupants, fire fighters, and the general public in the vicinity of the building.

- ***Proposed Performance-Based Approach*** – consists of a TTC building where an engineered level of fire protection has been provided for the structure such that only a select number of steel elements are left bare. This fire protection strategy is based on the actual performance of the structure under realistic fire conditions. The effects of thermal expansion, load redistribution, secondary load paths, structural redundancies, material degradation, applied load level, continuity, connection performance, etc are quantified and used to inform the design. Like a code-based approach, the aim of this approach is to provide fire **life safety** with respect to stability and fire separation.

Table 2 compares the key performance metrics of the two different approaches to structural fire protection of the TTC.

Table 2 – Anticipated Fire Performance for 2 Different Fire Protection Strategies for TTC

Fire Protection Strategy	Exposed Steel Basket Columns, Light Columns?	Maximum Possible Steel Temperature**	Anticipated Performance in **Severe Fire Event***							
			Life-Safety Preserved ?	Stability maintained ?	Fire separation maintained ?	Deformation ?	Large displacements ?	Area of Damage?	Will structural elements need to be replaced?	Smoke damage?
Code-Based (i.e. fully protected)	N	550°C	Y	Y	Y	Medium-High	Medium-High	Localised	Y	Medium-high
Performance-Based (i.e. bare steel basket columns and light/vertical columns in Grand Hall)	Y	550°C (1200°C for bare steel diagonal braces)	Y	Y	Y	Medium-High High (for diagonal braces)	Medium-High	Localised	Y	Medium-high

** Several fire safety features (i.e. sprinkler system, fire department intervention, smoke detection, first aid fire fighting, fuel load control, etc.) would have to fail in TTC in order to have a structurally severe fire event. In the event that any one of these features is operational, a severe fire event affecting the structure is unlikely.*

***In the performance-based approach, select steel braces at the Bus Deck level could reach temperatures as high as 1200°C. While the temperature of bare steel in fire can be significantly higher than "code protected" steel (i.e. 550°C), the resulting deformation or distortion to the steel element at 550°C vs. 1200°C will not be markedly different. Steel elements can deform at temperatures as low as 150°C in certain design conditions. Thus, in the event a steel element reaches temperatures of 550°C, let alone 1200°C, it is likely that the element will need replacement.*

5 Conclusions

Based on a review of the overall fire life-safety design philosophy for TTC and a comparison of anticipated fire performance for a code-based approach vs. the proposed performance-based approach, the following comments can be made:

- The overall fire strategy of TTC incorporates a holistic approach to life-safety. Thus, the fire safety features that are designed to enable safe egress and limit the spread of fire and smoke throughout the building provide a beneficial effect of limiting the likelihood of fire events which could cause structural damage.
- Standard fire resistance of structural elements is primarily aimed at satisfying life safety objectives, and not explicitly designed to address property loss or transit operation objectives. However, life-safety features of the TTC will still provide some level of damage loss prevention.
- A "severe fire" event is only anticipated if several of the TTC fire safety features (i.e. sprinkler system, fire department intervention, smoke detection, first aid fire fighting, fuel load control, etc.) fail. In the event that any one of these features is operational, a severe fire event affecting the structure is unlikely.
- In the unlikely event that a "severe fire" develops, deformation, large displacements and smoke damage can reasonably be expected for either a code protected building or an engineered fire protected building (i.e. where select elements are left unprotected). In either scenario, some structural elements will likely need to be replaced due to permanent deformations and/or material damage.

In summary, this memo intends to inform the TJPA of the criteria used in the performance-based design of the structural fire protection. This memo also summarizes how the criteria compare to a "code approach."

We respectfully request acknowledgement that the criteria used and the predicted response is acceptable to the TJPA.

Prepared by:

Arup Fire

Darlene R. 10-20-10

Darlene Rini, P.E. Date

Accepted by:

Transbay Joint Powers Authority

20 OCT 2010

Edmond Sum, P.E. Date

REGISTERED PROFESSIONAL ENGINEER
DARLENE RINI
FP1708
EXP. 9/30/11
FIRE PROTECTION
STATE OF CALIFORNIA

January 12, 2011

Mr. Alfred Lau, AIA
Transit Center Project Manager
Transbay Transit Center Program
Transbay Joint Powers Authority (TJPA)
201 Mission Street
Suite 2750
San Francisco, CA 94105

Subject: Final Peer Review Letter – Engineered Fire Protection for TJPA Transit Center, San Francisco, CA

Dear Alfred:

Per your request, this short joint letter is intended to confirm Dr. Venkatesh Kodur's and my Peer Review acceptance of the design team's Final Reports (transmitted in November, 2010) and proposed code equivalency request dated Oct. 1, 2010.

Both of us were retained by the Transbay Joint Powers Authority (TJPA) in the late spring of 2010 to independently serve as Peer Review consultants for the new Transit Center Project in San Francisco, CA. The focus of these reviews were several design alternatives developed by Arup Fire and the Project team for specific unprotected structural steel elements within the structure in lieu of the prescriptive building code requirements (based on minimum fire resistance ratings) for:

- Exterior steel braced frame – basket V-columns and diagonal braces
- Interior light columns of the Grand Hall

It was understood that all other structural elements not covered by these Reports will be passively fire protected in accordance with the usual prescriptive code requirements.

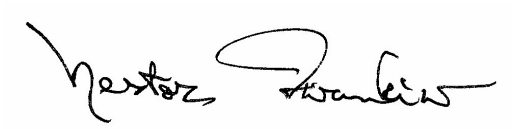
Our peer reviews were performed from a limited conceptual/theoretical perspective only for the referenced structural fire engineering aspects of the Project. These reviews did not include any rigorous calculations to independently verify the given analytical/design results. We also did not vet the numerical accuracy of the various design details and modeling assumptions, input properties, structural layouts, etc. or participate in any of the pending conformance/quality assurance of the actual construction relative to the design and building code provisions.

Dr. Kodur and I participated in two meetings in San Francisco with the design team and local Building and Fire Department officials, and in a couple additional web teleconferences, to review/discuss the proposed (alternative) fire resistive designs, to answer questions and recommend changes. The topics of discussion included the proposed design fire scenarios, various analytical model assumptions and inputs, structural load combinations and factors, connections, potential failure mechanisms and the expected "worst-case" fire damage. Besides a number of editorial revisions/corrections in the Reports, the more substantive changes included addition of vent holes in all the concrete-filled basket columns, clarification of which member connections may be left unprotected, explicit acknowledgment of expected "worst-case" fire damage (permanent large deflections), and confirmation of several key structural fire design principles. All this is documented in detail within the Project files and is not repeated here.

In our opinion, all issues raised during this Peer Review process were satisfactorily resolved by the design team and are reflected in the relevant final documents presented in the 4th Quarter of 2010. Accordingly, we endorse the Building and Fire Department's acceptance of the Oct. 1, 2010 code equivalency request in this regard.

This joint letter concludes our Peer Review process on this TJPA Transit Center Project.

Respectfully submitted,



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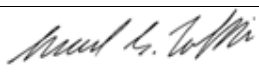
Project title	Transbay Transit Center, San Francisco			Job number	132241
Document title	Local Equivalency # 4 Exterior Opening Protection and Fire Spread			File reference	
Document ref					

Revision	Date				
Draft 1	2/25/09	Filename	TTC RFLE #4 – Exterior wall opening protection - Draft 1.doc		
		Description	Internal draft		
			Prepared by	Checked by	Approved by
		Name	Yong Lim	Armin Wolski	Richard Coffin
		Signature			
Draft 2	1/15/10	Filename	TTC RFLE #4 – Exterior wall opening protection - Draft 2F 1-19-10.doc		
		Description	Reviewed draft for issue to DBI/SFFD		
			Prepared by	Checked by	Approved by
		Name	Andrew Coles/Yong Lim	Armin Wolski	Richard Coffin
		Signature			
Draft 3	4/1/10	Filename	TTC RFLE #4 – Exterior wall opening protection - Draft 3_4-1-10.docm		
		Description	Incorporate comments from DBI/SFFD related to the design of the basket enclosure and providing sprinklers on the north side of the bus deck between grids 27-33.5.		
			Prepared by	Checked by	Approved by
		Name	Andrew Coles/Yong Lim	Armin Wolski	Richard Coffin
		Signature			
Issue	6-24-10	Filename	TTC RFLE #4 – Exterior wall opening protection – Issue 6-7-10.docm		
		Description	Address SFFD/DBI concerns regarding the basket enclosure fire rating. Issue for approval.		
			Prepared by	Checked by	Approved by
		Name	Andrew Coles/Yong Lim	Armin Wolski	Richard Coffin
		Signature			

Issue Document Verification with Document ☑

Request for Approval of Local Equivalency for Alternate Design of Construction Under Sections 104A.1 and 104A.2.8 of the 2007 San Francisco Building Code and Section 111 of the 2007 California Building Code

Transbay Transit Center, San Francisco
Local Equivalency # 4

Exterior Opening Protection and Fire Spread

Building Description

The Transbay Transit Center (TTC) has three above-grade levels, a park on the roof of the building, and two below-grade levels. The above-grade portion of the building serves as the transit hub for Bay Area bus services, such as AC Transit, Muni, Golden Gate Transit, and Greyhound. The below-grade levels include the train station portion that is expected to serve Caltrain and the future high-speed rail.

Figure 1: Building Section

The TTC will be located between existing buildings along Minna Street to the north and Natoma Street to the south. The property line will vary depending on the elevation. The attached drawings define the property line of the TTC building, the public right-of-way locations, and the common property lines with adjacent buildings in detail. Along the building exterior there is a glass basket enclosure. The distance between the basket enclosure and the face of the TTC building (which is defined as the edge of slab on the bus deck level) is 16 feet in most locations; toward the east end of the TTC, the distance reduces to 6 feet. The space between the basket enclosure and the building face is vacant and will have no fire load.

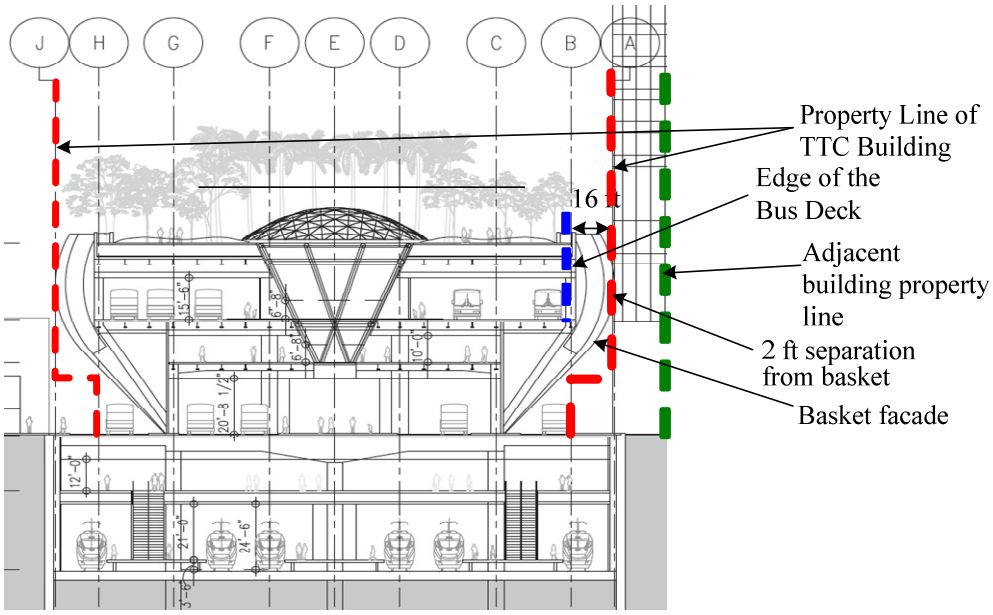


Figure 2: Building location relative to the public way and proposed property lines

Code Sections

The 2007 San Francisco Building Code (SFBC) Table 602, Table 704.8, and Section 3202.3.1 and Section 3202.3.3.

Code Requirements

TABLE 602
FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE[a,e]

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H, L	OCCUPANCY GROUP F-1, M, S-1	OCCUPANCY GROUP A, B, E, F-2, I, R[f], S-2, U[b,f]
$x < 5^{c}$	All	3	2	1
$5 \le x < 10$	IA Others	3 2	2 1	1 1
$10 \le x < 30$	IA, IB IIB, VB Others	2 1 1	1 0 1	1[d] 0 1[d]
$X \ge 30$	All	0	0	0

Table 602 requires a one-hour wall where exterior walls are less than 30 feet from the properly line.

TABLE 704.8
MAXIMUM AREA OF EXTERIOR WALL OPENINGS[a]

CLASSIFICATION OF OPENING	FIRE SEPARATION DISTANCE (feet)							
	0 to 3[d,j]	Greater than 3 to 5[c,g]	Greater than 5 to 10[c,e,g,h]	Greater than 10 to 15[c,e,g]	Greater than 15 to 20[c,g]	Greater than 20 to 25[c,g]	Greater than 25 to 30[c,g]	Greater than 30
Unprotected	Not Permitted	Not Permitted[c]	10%[i]	15%[i]	25%[i]	45%[i]	70%[i]	No Limit[b]
Protected	Not Permitted	15%	25%	45%	75%	No Limit[b]	No Limit[b]	No Limit[b]

Where automatic sprinklers are installed, SFBC Section 704.8.1 permits the use of the tabulated limitations for protected openings.

Other requirements for awnings are found in Chapter 32:

> **3202.3.1 Awnings, canopies, marquees and signs.** Awnings, canopies, marquees and signs shall be constructed so as to support applicable loads as specified in Chapter 16. Canopies

shall be allowed only over entrance doorways and only for Occupancy Groups A, B, F-1, M, S-1, S-2 and R. Canopies may be constructed as awnings and with the same limitations except that:

1. The maximum width shall be 10 feet (3.048 m); and
2. The maximum extension over public sidewalk may be to a point 2 feet (0.61 m) from the curb; and
3. The outer column support shall be located in the outer one-third of the sidewalk.

3202.3.3 Encroachments 15 feet or more above grade. Encroachments 15 feet (4572 mm) or more above grade shall not be limited.

Code Intent

The intent of Table 602 and 704.8 is to provide adequate means of protection, relative to the hazard, so that both the TTC building and the adjacent property are protected from fire spread between buildings.

The intent of Section 3202.3 is to prohibit projections near the level of the public right-of-way up to 15 feet in height so that the free passage of pedestrians along the sidewalk or other walking surface will not be inhibited. However, Section 3202.3.1 and 3202.3.3 permit projections at the 8-foot height and above because encroachments into the public right-of-way do not interfere with or impede pedestrian or vehicle traffic.

Request

The request is to define the opening protection requirements relative to the property line or the centerline of the street, whichever is applicable. Where portions of the TTC building are close to the property line, alternative methods of opening protection will be used. Alternative methods of protection are intended to mitigate flame spread between buildings and to allow closer-than-normal setback distances, as defined by Table 704.8, while maintaining the architectural theme. As part of this strategy, the basket enclosure will be defined as an awning and will meet all the requirements of the SFBC.

Justification

1. Datum for the Face of the Building

The SFBC requires the fire separation distance to be measured from the point where the fire load is located. For the Ground and Second Level, the exterior walls will be used as the datum point. At the Bus Deck level, the basket enclosure is a non-combustible structure and is considered as an "awning" (refer to Section 2 for justification) therefore the datum used as the "face of the building" will be the edge of the bus deck slab. This location has been selected because a bus could be parked within 2-3 feet from the edge of the bus deck and a bus fire is considered the worse-case fire hazard.

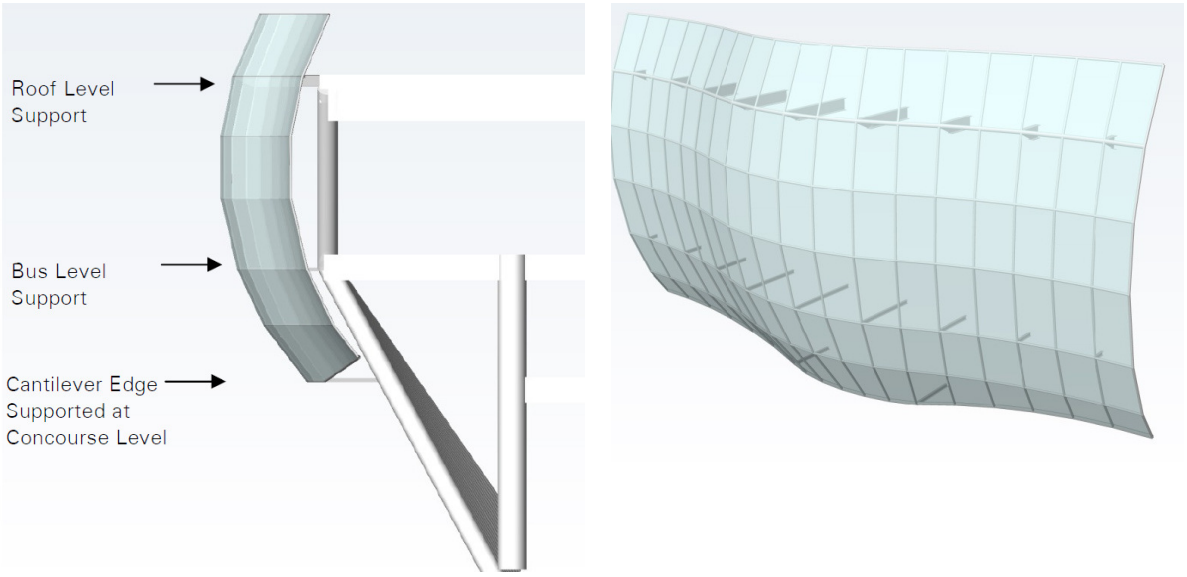
2. Justification of the Basket Enclosure as an "awning"

The basket enclosure is attached to the main body of the TTC and will project over the sidewalk and over the public street. It will be constructed of steel and glass and therefore has no fire load because these materials are non-combustible. The basket enclosure is intended to visually obstruct the bus deck level from below; there will be no signage mounted on this element of the building; therefore, the basket enclosure can be considered equivalent to a non-combustible, fixed awning. The following discussion is of the basket enclosure sub-structure and how this will meet the requirements of an "awning" and other aspects of the design to address specific hazards.

2.1. Design of the basket enclosure

SFBC Table 601.1 requires any members of the structural frame carrying gravity loads to be provided with fire protection. The basket enclosure is not part of the main structural frame, and it does not carry any gravity loads of the building; therefore, there is no code requirement for this sub-structure to be fire rated. This system is analogous to curtain wall glazing systems used in typical high-rise buildings. The code does not require these systems to be fire rated, except that the supporting structure is non-combustible and designed in accordance with Chapter 16 of the CBC; these are the identical requirements for awnings. Although the fire hazards of a high-rise building and the TTC Station are different (i.e., office vs. assembly, high rise vs. low rise), the similar attribute is that in the event of a fire, glass is likely to fracture and fall out of the supporting structure onto the street below. The code does not require special treatment for curtain wall systems in high-rise buildings; therefore, this is applicable for the basket enclosure of the TTC Station. The fact that the TTC building protrudes over the street does not increase the hazard if glass falls from the supporting structure.

The basket enclosure will be designed and constructed in accordance with SFBC Chapter 16, Section 3105 and Section 3202. The enclosure is composed of flat glass panels supported by a steel structure. For seismic performance reasons, the basket enclosure is divided into segments approximately 80 feet long. The supporting structural system consists of a grid of rigidly connected tubes that form a quadrangular mesh. The enclosure is tied back to the main structure with struts at each level. Lateral support for the enclosure is provided at the roof and at bus levels; the lower edge of the enclosure is tied back to the basket columns at the concourse level. The geometry of the enclosure and its supporting system are shown in Figure 3.

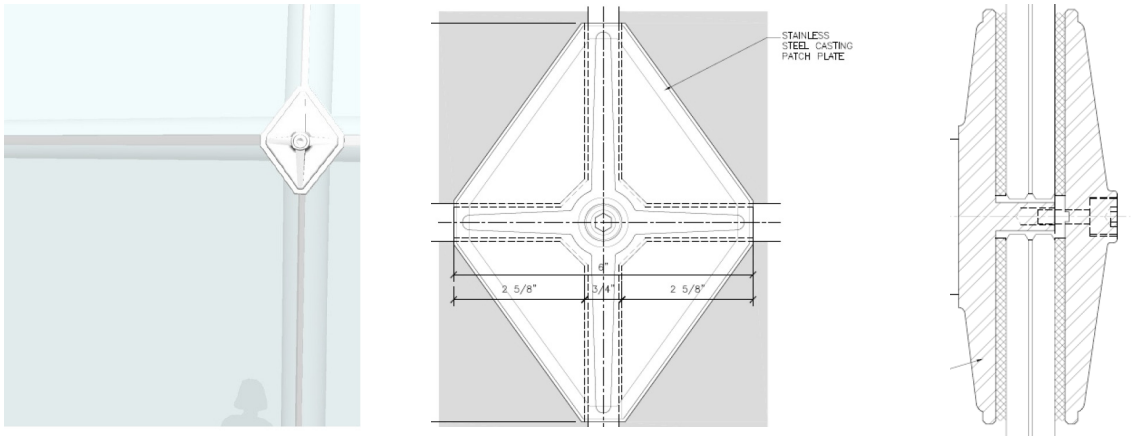


a) Attachment to the main structure **b) Isometric view of a basket enclosure segment**

Figure 3: Basket enclosure attachment to the main structure

The laminated glass panels are made up of two 10-millimeter-thick sections and a 1.52-millimeter-thick plastic interlayer. The glass and the design of the structure make the basket enclosure capable of resisting blast loads. Laminated glass also performs well under fire conditions where temperatures of 300°C (572°F) are reported for glass fracture; however, the interlayer will keep the glass panel integral so that the panel will remain in place.

The glass panels are held in place by corner patch plate attachments. These are diamond-shaped, cast stainless steel attachment plates. The glass panels are elastically supported at the corners on neoprene support pads. This type of connection allows absorption of the in-plane deformation of the panels through deformation in the neoprene pads. The design of this system is governed by the blast loads that have been determined for the project. Figure 4 provides details of the patch plate mounting system.



a) Isometric of patch plate and glass panels **b) Patch plate** **c) Patch plate section**

Figure 4: Patch plate details

The basket enclosure will be a non-combustible structure so, from a fire spread perspective, it does not represent an additional fire load between buildings. Other evident hazards are that the basket enclosure projects over the public way and over the street, so the concern is that the glass panels could fall onto the sidewalk or onto vehicles. The design of the supporting structure and attachment system are in accordance with SFBC Chapter 16 and ASCE 7-05 Chapter 13. As previously stated, the design of the system is governed by the blast loads and thus the system is overdesigned for the required design seismic events. In the event of a fire beneath the basket enclosure, the fire would have to be severe enough for the flame temperatures to cause fracture and subsequent failure of the laminate glass panels for them to fall out. In this scenario pedestrians would not be using the sidewalk as emergency services would be on site to address a severe scenario. The overall risk to the public of a glass panel falling onto a pedestrian or a motorist during a fire is remote. In summary, the basket enclosure does not represent an adverse risk to overall safety.

2.2. Vertical Clearance less than 15 feet

Section 3202.3.1 allows projections up to two-thirds the width of sidewalk, measured from the building, for awnings that are 8-15 feet above the sidewalk. The lowest point of the basket enclosure is approximately 13 feet above the sidewalk. The projected height of the façade from the lowest point of the basket enclosure to the outer extent is approximately 10 feetThe sidewalk is approximately 22 feet wide; two-thirds the width of the sidewalk is 14 feet. Therefore, for portions below 15 feet, the projected basket enclosure distance is 2 feet, which is less than 14 feet and is therefore in compliance with the SFBC.

2.3. Vertical Clearance greater than 15 feet

At a vertical height of greater than 15 feet, the maximum projected distance of the basket enclosure is 10 feet beyond the edge of the bus deck and is within the limits of the property line, as shown in Figure 5. Therefore, the design is in compliance with SFBC Section 3202.3.3.

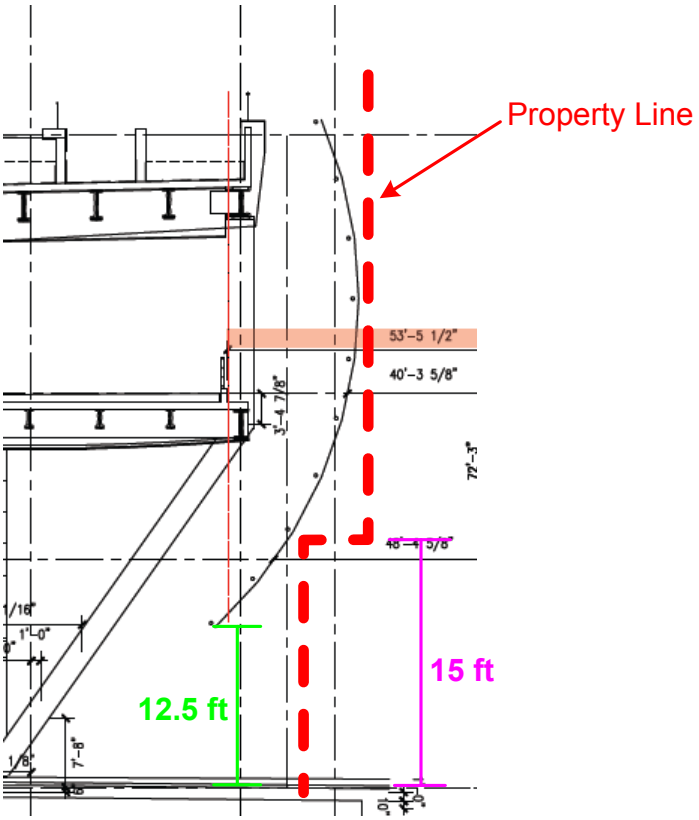


Figure 5: Basket enclosure clearance above the public way or street

3. Property Line or Centerline of the Street

The fire separation distance can be determined by measuring from the "face of the building" to the property line, centerline of a street, or public right of way (ROW) under SFBC Section 702.1. Where there is a legitimate street or right of way, the fire separation distances can be measured to the centerline of the street or ROW if this is located further from the building than the property line. For the purpose of this assessment, the building has been separated into three conditions that are described as follows (refer to Figure 6):

- Condition 1 (Green): At the west end and the south side between grid 1-10.5, there will be a court at Ground Level. The property line between the TTC building and the adjacent lot is used to define the fire separation distances for the exterior walls and the court requirements.
- Condition 2 (Pink): The TTC building is bound by Minna Street to the north (between grids 1-26.5) and Natoma Street to the South (between grids 10.5-26.5). The centerline of the street will be used to define the fire separation distances.
- Condition 3 (Blue): The TTC building is located adjacent to the existing 301 Mission to the north, and 181 and 199 Fremont to the south between gridlines 26.5-34. The property line between the TTC building and the adjacent Fremont Street buildings are used to define the separation distances for this portion of the building.

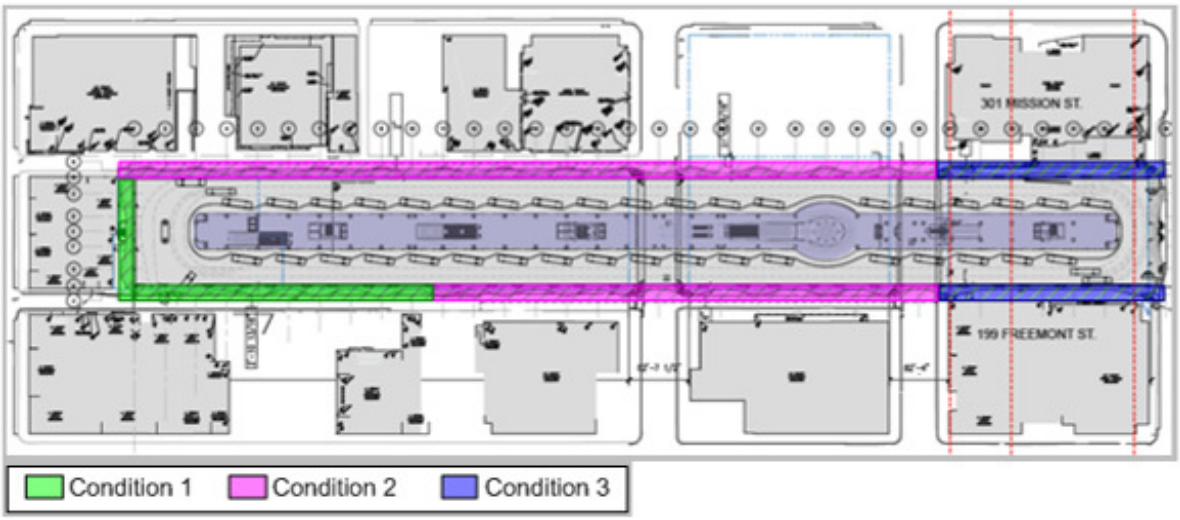


Figure 6: Center Line of the Streets/Imaginary Property Line

4. Fire Separation Distances and Exterior Wall Ratings

SFBC Table 602 requires a 1-hour exterior wall rating when the fire separation distance is less than 30 feet. However, this must also be considered with the opening protection requirements discussed in Section 5.

Because of the three dimensional property line of this building, there are different conditions at different locations and elevations along the length of the building. The minimum separation distances are summarized in Table 1 for the respective conditions defined in Section 3.

Table 1: Fire separation distances to respective property lines (Feet)

	Condition 1	Condition 2	Condition 3
North Side	**West End B-J**	**Grid 1 – 26.5**	**Grid 26.5 - 34**
Ground	36	37	44 (See note 3)
Second	36	37	44
Bus Deck	23	30	14 (See note 4)
South Side	**Grid 1 - 10.5**	**Grid 10.5 - 26.5**	**Grid 26.5 - 34**
Ground	34	44	47 (See note 3)
Second	34	44	45
Bus Deck	35	25	16 (See note 1 and 2)

The following are in reference to Table 1:

1. 181 Fremont is a 3-story brick building located between Grids 27-30 on the south side of the TTC (refer to SKA-474R). At the bus deck level, the face of the building is about 17 feet from the property line.
2. 199 Fremont is located between Grids 30-33. A survey indicates that this building has an existing 3-hour wall with no openings that extends the full height of the TTC building, and the separation distance to the adjacent property line is approximately 16 feet at the Bus Deck Level. Therefore, it is proposed that no treatment to the exterior wall openings at this location is required because the adjacent building provides sufficient protection for spread between buildings.
3. The Muni bus plaza is located at grade level between Grids 26.5-34. At this location there are stairs and mechanical rooms that are located in the center of the building. The separation distance for these elements is approximately 60 feet to the property line. Additionally, the Muni bus plaza is considered

as part of the public right of way. Under this condition the need for additional external fire wall separation at the property line is not required.

4. On the north side of the bus deck level, the face of the TTC building is 14 feet from the property line (refer to SKA-453R). However, at this elevation, the building facing the TTC (a recently built high-rise tower at 301 Mission) is approximately 40 feet from the common property line. Therefore, the actual separation at the bus deck level to the adjacent building is 54 feet.

In summary, the entire perimeter of the Ground Level and Second Level is greater than 30 feet from the adjacent property line or public right-of-way, and thus the exterior walls of the TTC do not need to be fire-resistance rated. At the bus deck level above, there are some sections of the exterior wall that require a 1-hour rating. These locations are defined in Figure 7, with the 1-hour fire resistance rating for exterior walls shown for Condition 3 in Figure 8 and shown in Attachment 2.

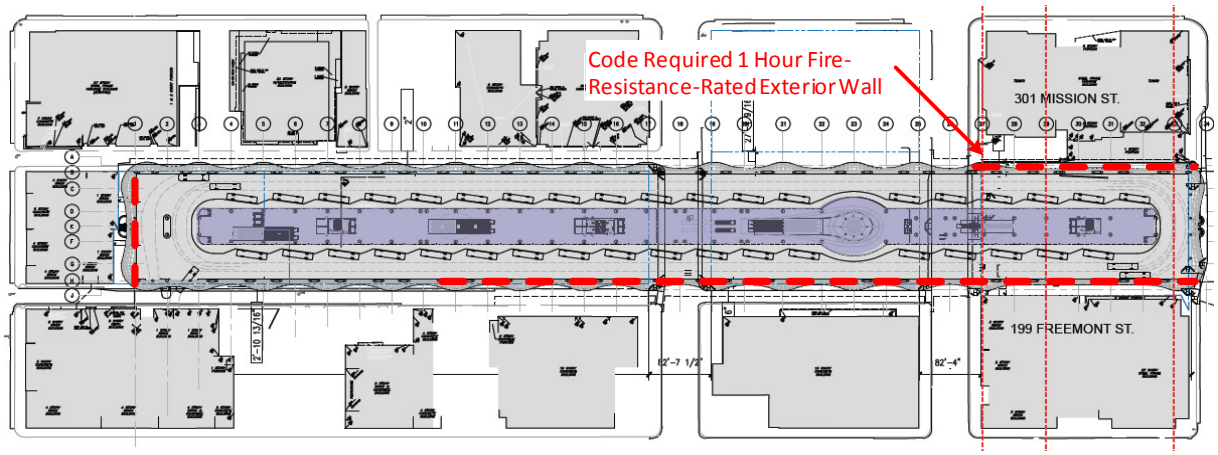


Figure 7: Required 1-Hour exterior walls at the bus deck level per SFBC Table 602

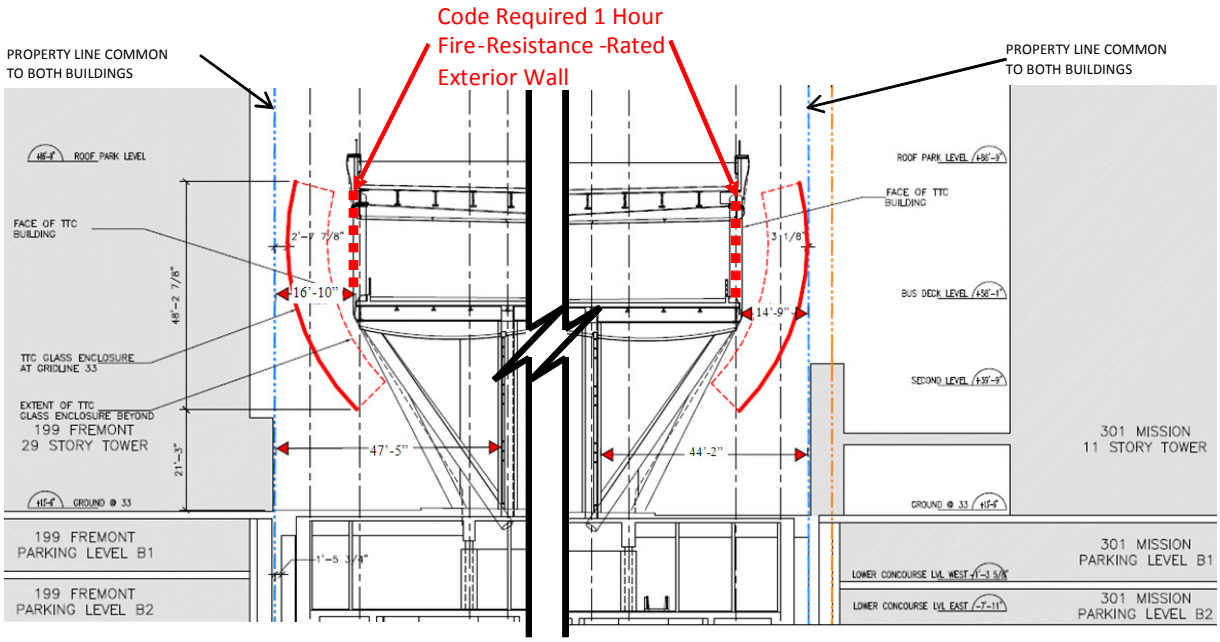


Figure 8: Section showing Condition 3, Grid 26.5 - 34 (refer to SKA-0453R)

5. *Opening Protection Requirements*

The maximum area of exterior wall openings will be determined by the separation distances in Table 1 and by the requirements of SFBC Table 704.8. The opening protection limits can be divided into three fire separation areas specific to the TTC building: 1) greater than 20 feet; 2) 15-20 feet; and 3) 10-15 feet. As previously noted, there are sections of the perimeter walls at the bus deck level only that requires a 1-hour fire resistance rating. These are discussed as follows.

5.1. Separation Distance greater than 20 feet

Where the fire separation distance in Table 1 is more than 20 feet, unlimited and unprotected openings are permitted. That is, the exterior wall is permitted to have unlimited unprotected openings. This occurs at the following locations at the bus deck:

1. West End between Grids B-J
2. South side between Grids 10.5-26.5

5.2. Separation Distances between 15-20 feet

Where the separation distance is between 15-20 feet, the exterior wall surface can be 75% unprotected. The south exterior wall of the bus deck level between Grids 26 - 34 facing the shared property line has a fire separation distance of 16 feet. The height of the exterior wall at the bus deck level is 32 feet (blue shade); the height of the opening is 17 feet (red shade); thus, the opening area is 53%, which is less that the permitted 75%. This meets the SFBC requirements and no further treatment is required. This is depicted in Figure 9.

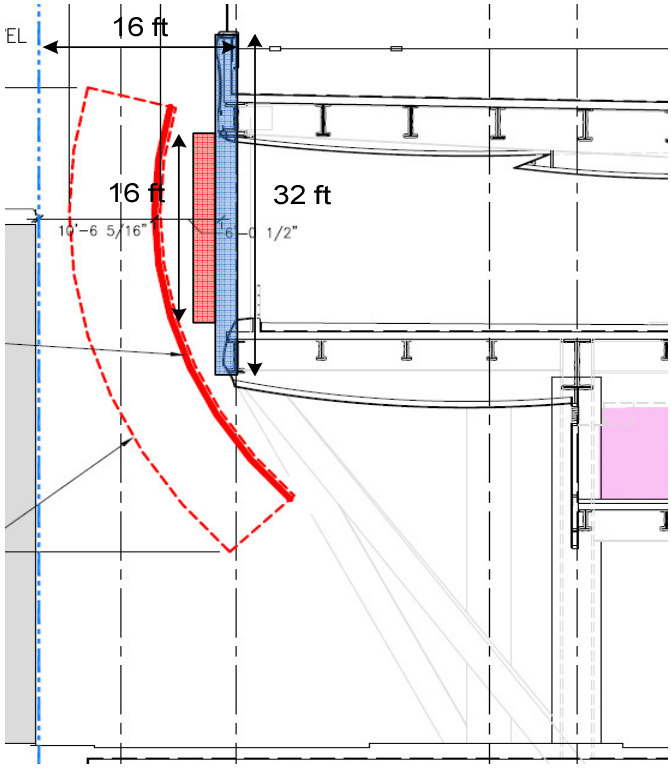


Figure 9: South bus deck opening areas between Grids 26.5 – 34 (refer to SKA-0474R)

5.3. Separation Distances between 10-15 feet

Where the separation distance is between 10-15 feet, the building is permitted to have up to 45% of its exterior wall as unprotected openings. The north exterior wall of the bus deck level between Grids 27-33.5 is a minimum of 14 feet from the shared property line (refer to Figure 10). As discussed in Section 5.2, the open area along the perimeter of the bus deck is approximately 53%. In this area the openings are required to be less than 45%. Because of the 8% opening discrepancy, the following analysis is conducted to verify that, due to the expected combustible loading, the additional opening area creates no credible flame spread concerns.

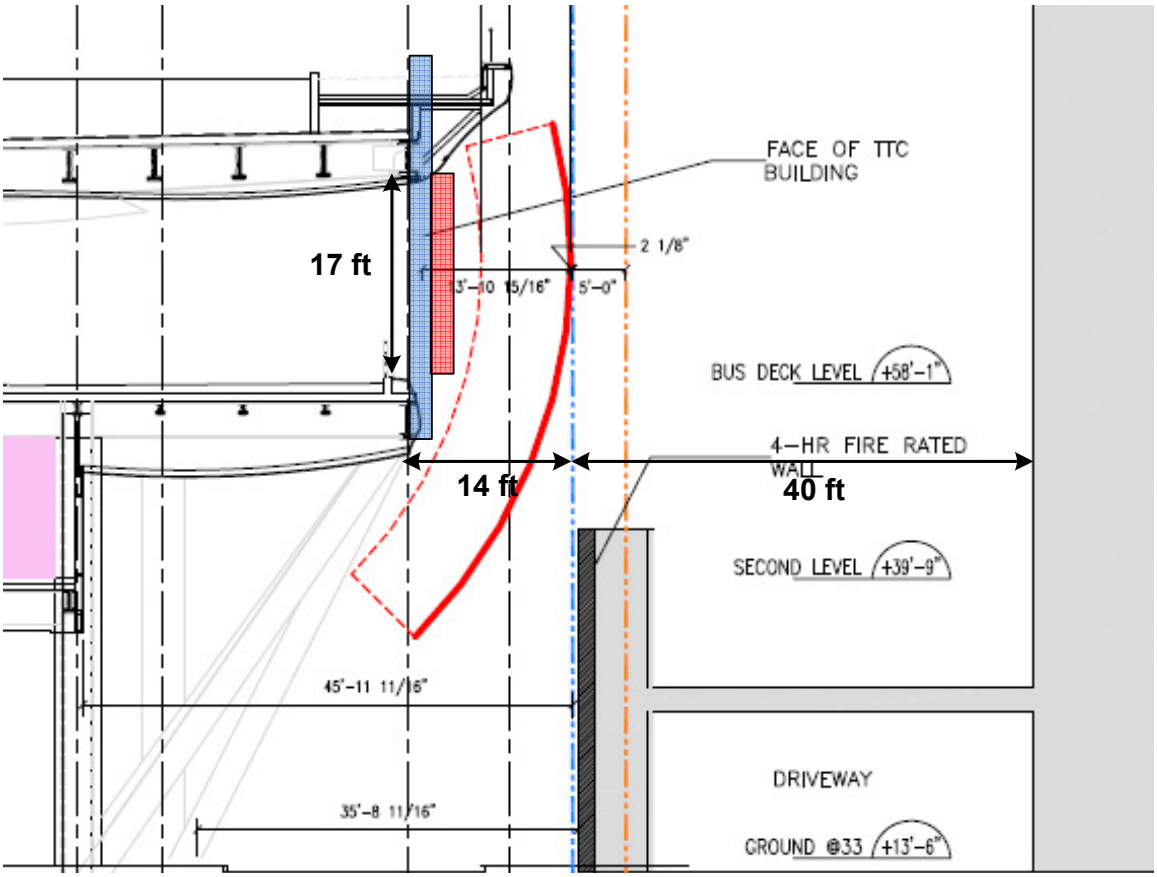


Figure 10: North bus deck opening areas between Grids 27 – 33.5 (refer to SKA-0474R)

Methodology:

A deck bus fire at the bus deck level, identified as the worst case design fire, is analyzed using a calculation method by Law.[1] An exposure analysis using conservative flame temperature and configuration factors is used to evaluate the heat flux from a potential bus fire on the bus deck. A critical horizontal distance of 14'-0" between the edge of slab and the adjacent property line was identified. Conservative building conditions were assumed with no exterior opening protection and no sprinkler protection.

Performance Criteria:

The calculated critical heat flux is compared with the maximum tolerable incident radiant heat energy per SFBC Table 1406.2.1.2. The intent of Table 1406.2.1.2 is to establish a maximum heat flux for a given fire separation distance between buildings, to prevent sustained flaming and fire spread to adjacent properties.

[1] *Law, Margaret, "Fire Safety of Bare External Structural Steel,", 1989*

TABLE 1406.2.1.2
MINIMUM FIRE SEPARATION FOR COMBUSTIBLE VENEERS

FIRE SEPARATION DISTANCE (feet)	TOLERABLE LEVEL INCIDENT RADIANT HEAT ENERGY (kW/m^2)	FIRE SEPARATION DISTANCE (feet)	TOLERABLE LEVEL INCIDENT RADIANT HEAT ENERGY (kW/m^2)
5	12.5	16	5.9
6	11.8	17	5.5
7	11.0	18	5.2
8	10.3	19	4.9
9	9.6	20	4.6
10	8.9	21	4.4
11	8.3	22	4.1
12	7.7	23	3.9
13	7.2	24	3.7
14	6.7	25	3.5
15	6.3		

Assumptions:

The assumptions used in the analysis are as follows:

- A bus fire on the bus deck[2]
- Worst-case design fire location
- Horizontal separation distance measured as the distance from the edge of slab to the adjacent property line
- Conservative building details with no exterior opening protection and no sprinkler protection
- The benefit of sprinkler activation and radiation attenuation through the basket enclosure facade was not considered
- Fire separation distance measured to the property line instead of the façade of the adjacent building, located an additional 40 feet from the property line
- Radiating panel dimensions based on conservative bus fire dimensions
- Fire analysis and flame temperature by Law

Results:

Attachment 1 includes the detailed analysis that is used to determine the critical heat flux to the adjacent property line from the bus deck level of the TTC building. The results show incident radiant heat energy of 4.2 kW/m^2, which is below the tolerable incident radiant heat energy of 6.7 kW/m^2. This suggests that a potential bus fire does not present a significant flame spread hazard to adjacent properties under these specific conditions.

Further, a qualitative analysis suggests that the actual incident radiant heat energy will be less than the calculated value because of the conservative assumptions used in the analysis. A combination of an active fire sprinkler system within the bus dock area and a glass façade at the building exterior will provide radiation attenuation to further reduce the heat flux at the adjacent property line. The literature notes that the presence of heat-treated or tempered glass can attenuate radiation levels between 40-60% while the glass is still in place[3]. These active and passive features provide an additional level of conservatism and safety for the design.

[2] SFPE Figure 3-1.86
[3] Law, Margaret, "Safe Distances from Wired Glass Screening a Fire," Institution of Fire Engineers Quarterly, London, 1969.

To provide an equivalent level of protection, sprinklers spaced 6 feet on center will be provided between Grids 27-33.5 along the northern wall at the bus deck level to mitigate fire spread concerns.

Conclusion:

The analysis suggests that the proposed design will not exceed the tolerable limit for flame radiation to the assumed property line. Further, active and passive fire protection features provide an added level of redundancy that is not taken into consideration in the analysis. The opening area of 53% will meet the intent of the code as demonstrated in the previous analysis. To provide an equivalent level of protection, sprinklers 6 feet on center will mitigate any fire spread concerns in this area of the bus deck.

Summary

In summary, the basket enclosure is considered as an awning and complies with SFBC Section 3202. The exterior wall at the Ground and Second Levels are set back from the property line or public ROW such that these walls can be non-rated. At the bus deck level, the analysis has shown that the design meets the performance requirements of the SFBC while maintaining the proposed opening requirements. It is the opinion that the proposed design provides an equivalent level of safety required by the SFBC.

This RFLE is used as a basis of design; final approval will be obtained during the plan check process where all of the dimensions and requirements included in this report will be verified by SFFD and DBI.

Prepared by:
Arup Fire

6.24.10
Andrew R Coles, PE Date

REGISTERED PROFESSIONAL ENGINEER
ANDREW R. COLES
FP 1650
EXP. 6/30/11
FIRE PROTECTION
STATE OF CALIFORNIA

Approved by Hanson Tom
San Francisco Department of Building Inspection

Hanson Tom 6/28/2010
Date

Approved by Captain Don Fields
San Francisco Fire Department

Capt. Don Fields 6/28/
Date

Approved by Edmond Sum
Transbay Joint Powers Authority

6 JULY 2010
Date

Attachment 1

DIMENSIONS OF BUS

Width =	2.65	m
Height =	3.0	m
Length =	12.5	m
% opening =	50%	
Weight =	11,340	kg

[1]Area Calculation

Area windows, A_w =	45.5	m^2
*Area total, A_T =	111.7	m^2
Window weight, h =	1.5	m
Floor Area, F_A =	33.1	m^2
Fire Load Density, L =	11340	$kg\text{-}m^2$
*excluding windows		

$\eta = (A_T)/(A_W h^{1/2}) =$ 2.01

$\psi = (L)/((A_w A_T)^{1/2}) =$ 159

[1]*Reference Fire Safety of Bare External Structural Steel*, Law, 1989

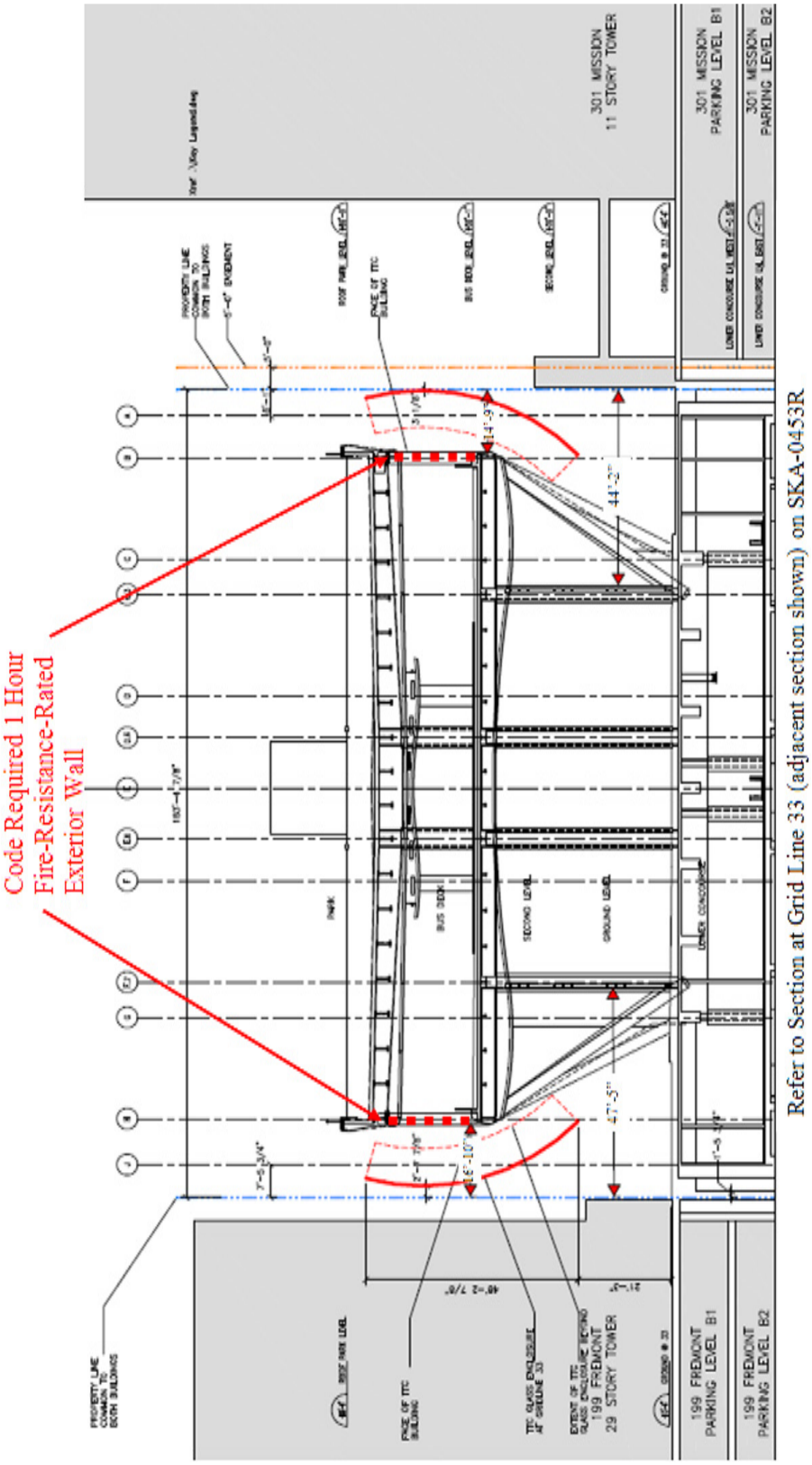
[1]Geometry of the radiating panel

Height =	1.91	m	
Width =	6.7	m	width cube
Radiating Panel Temp, T_R=	1063	K	Equation 3

[1]*Reference Fire Safety of Bare External Structural Steel*, Law, 1989

Distance from radiating panel (ft)	**[2]Flame** configuration factor, ϕ	**[3]Flame** radiation, Iz (kW/m^2)	**Heat received,** Iz+αTa (kW/m^2)	**[4]Surface Temp**, T_s (K)	**Steel temperature (°C)**	**[4]Heat Flux on Adjacent Surface**
14.0	0.108	7.64	11.37	533	**260**	4.18 kw/m^2
[2]Reference 2008 SFPE, Table 104.1						
[3]Reference 2008 SFPE, Section 1-4, Equation 47						
[4]Reference 2008 SFPE, Section 1-4, Equation 53						

Attachment 2



Request for Local Equivalency for Alternate Design of Construction
Under Sections 104A.1 and 104A.2.8 of the
2007 San Francisco Building Code and
Section 111 of the 2007 California Building Code

Transbay Transit Center, San Francisco
Local Equivalency # 5

Public Address System used for Fire Alarm Voice Notification

Code Section

San Francisco Building Code (SFBC) Section 907.2 requires a fire alarm system installed in accordance with the provisions of the SFBC and 2010 NFPA 72.

Code Requirement

NFPA 72, commonly known as the National Fire Alarm Code, defines the requirements for Fire Alarm systems including listing requirements, signal monitoring, survivability, minimum sound levels, and other specific requirements. Speech intelligibility is an issue discussed in the Appendix. To achieve the signal monitoring requirements of NFPA 72 a UL listed system is required.

Code Intent

The intent of NFPA 72 is to set the performance levels and reliability of various types of fire alarm systems. Per NFPA 72 Section 1.2.3 "The Code establishes minimum required levels of performance, extent of redundancy, and quality of installation *but does not establish the only methods by which these requirements are to be achieved*"

Request

This Request for Local Equivalency (RFLE) requests the use of the Public Address (PA) system as the method for Fire Alarm Voice Notification, with a system that is designed and installed to meet the intent of NFPA 72, with some components such as speakers, not UL or CSFM listed.

Justification

A Fire Alarm Voice Communication system, using UL and CSFM listed amplifiers and speaker appliances will not provide the required speech intelligibility in high ambient noise, large volume spaces such as the Grand Hall, Bus Deck, Lower Concourse, and Train Platforms. It would not be prudent to attempt to utilize this type of equipment for that purpose, as it would likely fail a field test for intelligibility during final inspection.

The PA system will utilize high fidelity audio performance equipment, notably loudspeaker systems and amplification equipment. This will ensure that voice messages in high noise, large volume areas will be intelligible to commuters and operating personnel who will rely on being able to hear voice pages to enable the operation of normal Transit Center functions.

System monitoring will be included that will allow operating staff to monitor system functionality. At a minimum the monitoring will inform operators when loudspeakers, amplifiers, or paging zones malfunction. This addresses the intent of NFPA 72 requirements for the Fire Alarm voice paging system. Because of the regular, daily use of the PA system any malfunctions would be diagnosed faster than what is normally required for regular fire alarm testing.

Other aspects of the design that will address the intent of NFPA 72 are noted as follows:

1. All PA system speakers (approximately 1,500) will be UL 1480 listed with the exception of the speakers located in the Grand Hall (approximately 14 – 20). The Grand Hall speakers are self-powered (120V) and selected to meet the acoustical challenges of the Grand Hall; these speakers are not available with UL 1480 listing.
2. All FA speakers (approximately 375) will be UL and CSFM listed and comply fully with NFPA 72.
3. PA system speaker wiring will be supervised using market available technology and will to the extent possible meet the intent of 2010 NFPA 72. Related supervisory signals will be input to the FA system as trouble indications.
4. The PA system will be connected to the emergency power system and provided with battery backup to meet the related requirements of 2010 NFPA 72.
5. Speaker wiring will be configured to meet the survivability requirements of 2010 NFPA 72 (i.e., attack by fire on one zone to not affect operation of another zone).
6. The combined system will be zoned for selective paging including partial evacuation based on code and SFFD requirements, and as documented in the Fire Life Safety Strategy Report.
7. Fire Alarm system speakers in non-public areas (such as offices or mechanical spaces etc) of the Transit Center
8. Visual alarm strobes throughout all areas of the building
9. Wiring will be run in non-combustible, metallic conduit
10. Test procedures will be per NFPA 72 Annex D. SFFD will require testing by an approved 3rd party testing agency to be hired by TJPA.
11. The Public Address and Fire Alarm systems will to the extent possible be designed and specified to allow (and not preclude) the future addition of a Mass Notification system to the project. The PA system vendors are committed to the extent possible to pursuing and obtaining UL 2572 listings for their equipment based on the UL 2572 consensus standard published on October 7, 2011.
12. Fire Alarm and Public Address system equipment will be installed in rooms protected for Fire Alarm equipment in accordance with NFPA 72. Smoke detection protection is required for any FA system control equipment and any PA system control equipment used for emergency messaging.
13. Acoustically Distinguishable Spaces (ADS) assignments shall be submitted to SFFD for review and approval in accordance with 2010 NFPA 72 18.4.10.3. It is noted that this requirement is apart and separate from the RFLE request and that this submittal will be made at a later phase of the design and will not be subject to or delay the approval of the RFLE.

Voice intelligibility MW Fire 12/20/11

2010 - MW Fire 12/20/11

The following documents are attached to this RFLE:

1. PA/FA system diagram prepared by WSP Flack + Kurtz dated 12/19/11.
2. The FA signaling zoning diagram prepared by ARUP dated 12/19/11.
3. Speaker type diagram prepared by Shen, Milsom & Wilke dated 12/19/11.

Summary

This local equivalency addresses the use of the PA system for Fire Alarm paging in the large volume spaces such as the Grand Hall, Bus Deck, Lower Concourse, and Train Platforms. Using the PA system will provide an equivalent level of performance that is required by NFPA 72 for system supervision and monitoring. Therefore, it is our opinion that this approach meets the intent of the SFBC and NFPA 72.

2010 MW Fire 12/20/11

2010 MW Fire 12/20/11

Prepared by:
WSP Flack + Kurtz

REGISTERED PROFESSIONAL ENGINEER
RANDY MEYERS
No. E10673
exp 6/30/13
ELECTRICAL
STATE OF CALIFORNIA

Randy J. Meyers, PE — Date 12/15/11

Approved by:
San Francisco Department of Building Inspection

12/20/11
Date

(FOR RECORD ONLY!)

Prepared by:
Arup

12/15/11

Armin Wolski, PE — Date

Approved by:

San Francisco Fire Department

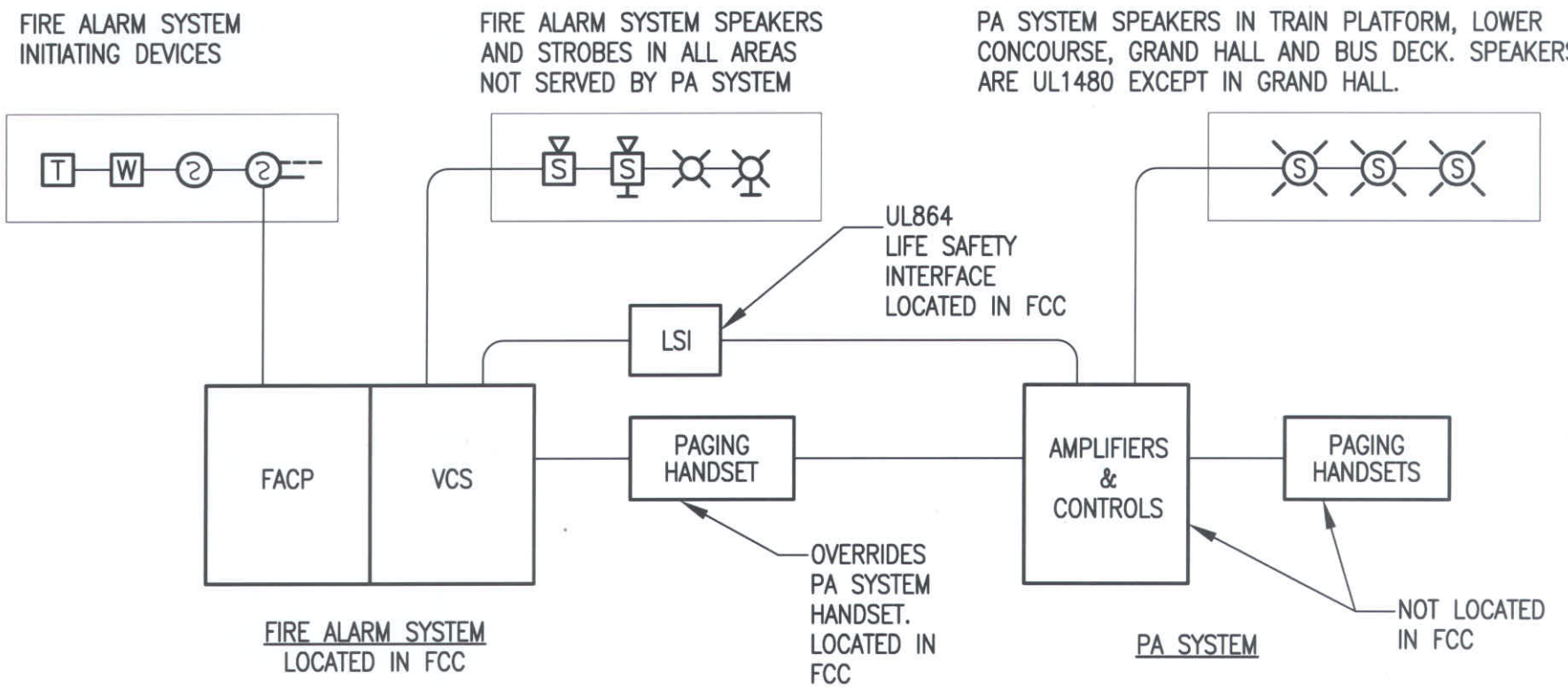
12/20/11
Date

REGISTERED PROFESSIONAL ENGINEER
ARMIN G. WOLSKI
FP1436
exp 6/30/12
FIRE PROTECTION
STATE OF CALIFORNIA

Approved by:

Transbay Joint Powers Authority

19 DEC 2011
Date



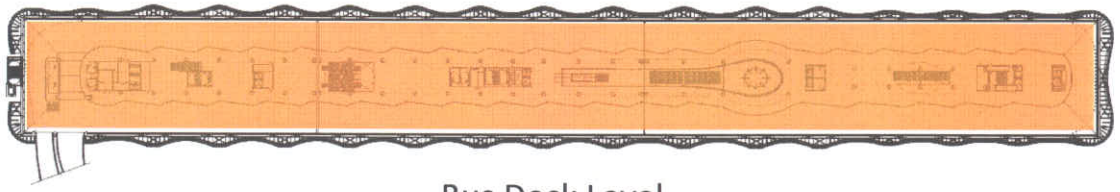
FIRE ALARM LEGEND

	AREA SMOKE DETECTOR, CEILING MOUNTED (SMOKE DETECTOR, SEMI-FLUSH MOUNTED IN CEILING)		VISUAL ALARM; CEILING MOUNTED	FACP	FIRE ALARM CONTROL PANEL
	DUCT TYPE SMOKE DETECTOR		VISUAL ALARM; WALL MOUNTED	VCS	VOICE COMMUNICATION SYSTEM
T	SPRINKLER TAMPER SWITCH	S	FIRE ALARM SPEAKER; CEILING MOUNTED	S	PA SPEAKERS
W	SPRINKLER WATER FLOW SWITCH	S	FIRE ALARM SPEAKER; WALL MOUNTED		

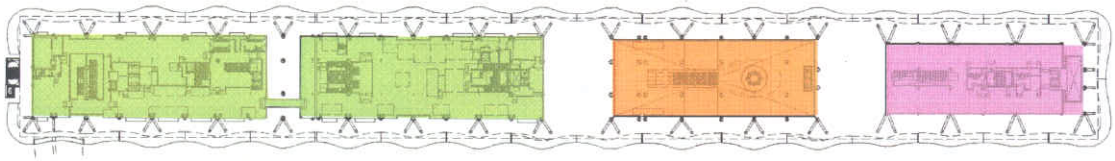
WSP · FLACK+KURTZ
405 Howard St.,Suite 500
San Francisco, CA 94105
Tel. (415) 398-3833
www.wspfk.com

Project	Revision Description/Sketch Name	Project No.	Date:	Reference Drawing No.
TRANSBAY TRANSIT CENTER	COMBINED FIRE ALARM/ PUBLIC ADDRESS SYSTEM	S08.14200.00	12/19/2011	
		By: RJM	Scale: NTS	Detail Drawing No. SKE-010

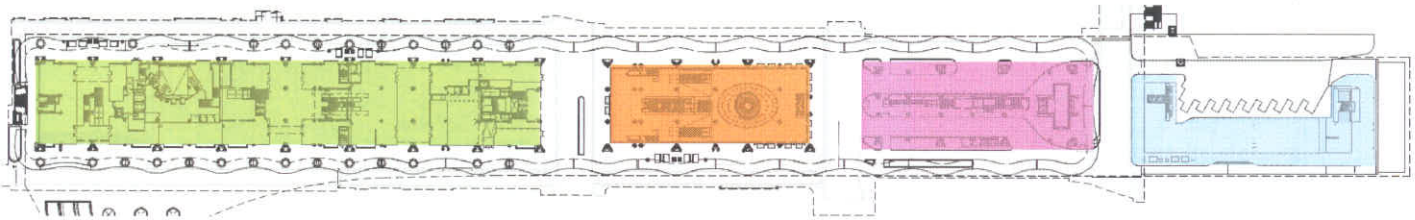
Roof Park Level



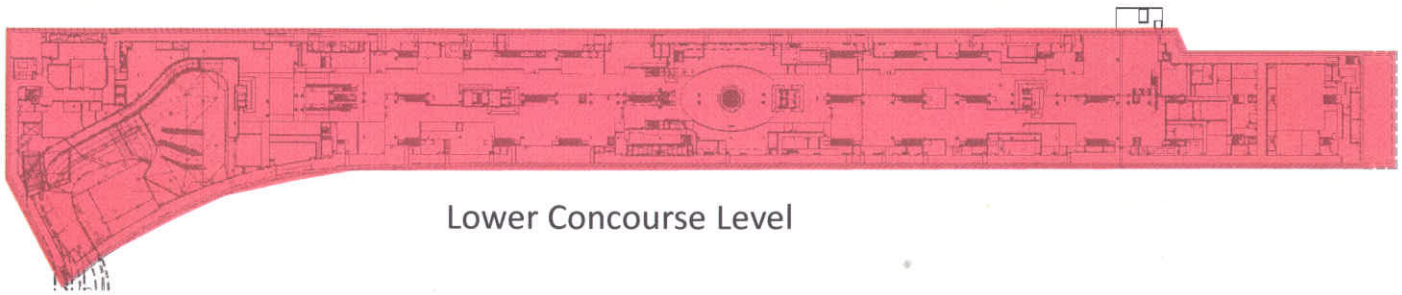
Bus Deck Level



Second Level



Ground Level



Lower Concourse Level

Train Platform Level

Zone 1

Zone 2

Zone 3

Zone 4

Zone 5

Zone 6

NON-UL 1480 SPEAKERS

UL 1480 SPEAKERS

ALL NON-PUBLIC AREAS WILL BE COVERED BY UL LISTED FIRE ALARM SPEAKERS AND STROBES

GROUND LEVEL

12/19/11

ALL NON-PUBLIC AREAS WILL BE COVERED BY UL LISTED FIRE ALARM SPEAKERS AND STROBES

SECOND LEVEL

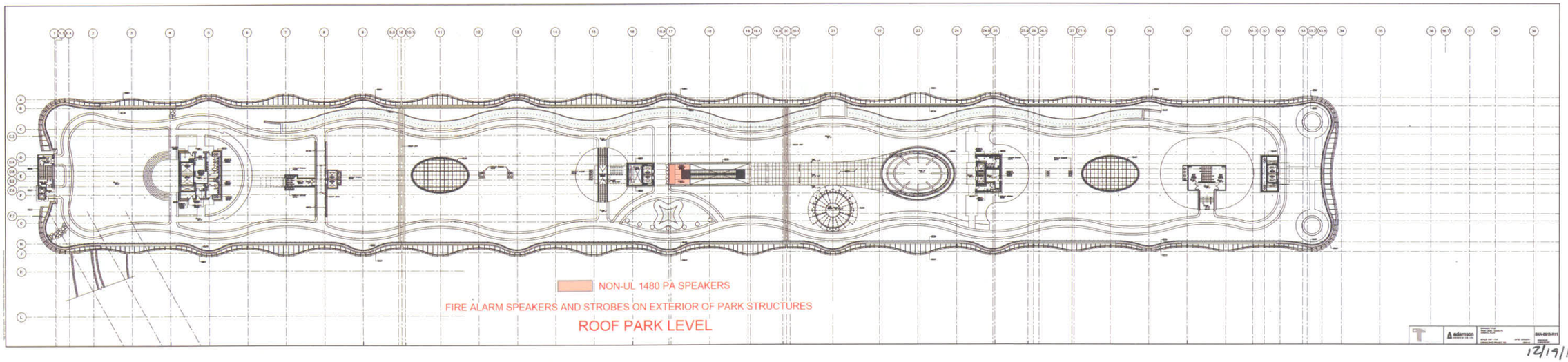
12/19/11

UL 1480 PA SPEAKERS

ALL NON-PUBLIC AREAS WILL BE COVERED BY UL LISTED FIRE ALARM SPEAKERS AND STROBES

BUS DECK LEVEL

12/19/11

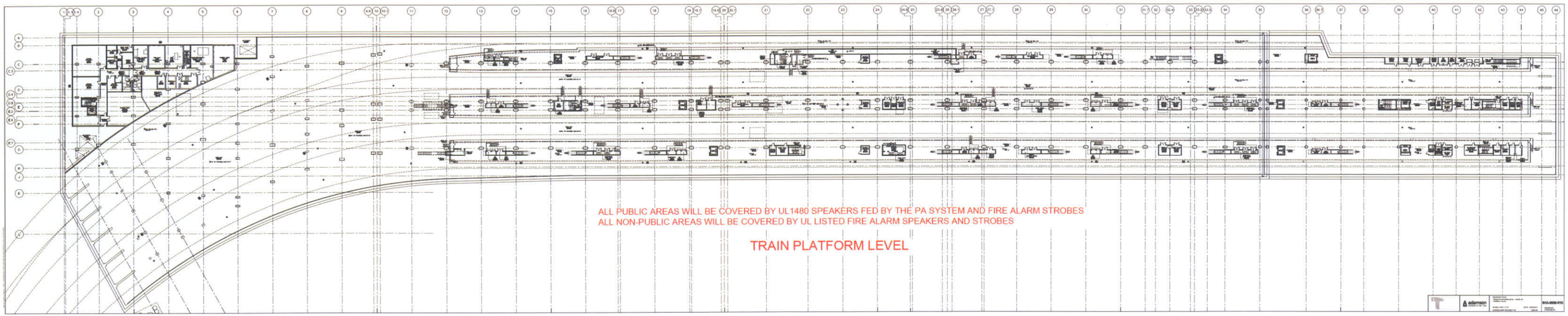


NON-UL 1480 PA SPEAKERS

FIRE ALARM SPEAKERS AND STROBES ON EXTERIOR OF PARK STRUCTURES

ROOF PARK LEVEL

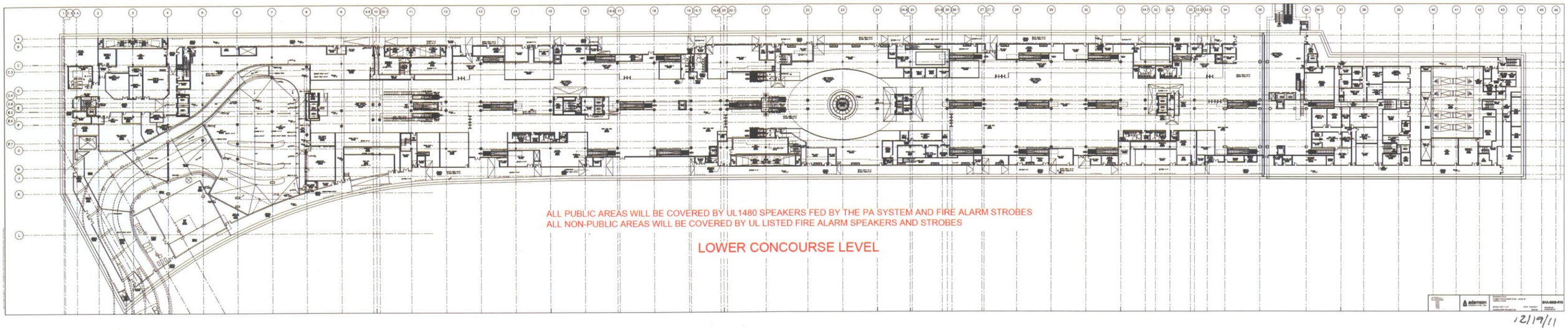
12/19/11



ALL PUBLIC AREAS WILL BE COVERED BY UL1480 SPEAKERS FED BY THE PA SYSTEM AND FIRE ALARM STROBES
ALL NON-PUBLIC AREAS WILL BE COVERED BY UL LISTED FIRE ALARM SPEAKERS AND STROBES

TRAIN PLATFORM LEVEL

12/19/11



ALL PUBLIC AREAS WILL BE COVERED BY UL1480 SPEAKERS FED BY THE PA SYSTEM AND FIRE ALARM STROBES
ALL NON-PUBLIC AREAS WILL BE COVERED BY UL LISTED FIRE ALARM SPEAKERS AND STROBES

LOWER CONCOURSE LEVEL

12/19/11

ArupFire WSP · FLACK+KURTZ

Document Verification

Local Equivalency # 5
Public Address System used for Fire Alarm **Voice**

Project title		Transbay Transit Center, San **Francisco**			Job number 132241
Document title		Local Equivalency # 5 Public Address System used for Fire Alarm Voice Communication			File reference
Document ref					
Revision	Date	Filename	TTC RFAM #5 - PA used for Fire Alarm Draft 1.doc		
Draft 1	10/9/09	Description	First Draft		
			Prepared by	Checked by	Approved by
		Name	Andrew Coles/Randy Meyers	Armin Wolski	Richard Coffin
		Signature			
Draft 2	9/2/11	Filename	TTC RFAM #5 - PA used for Fire Alarm Draft 2.doc		
		Description	Second Draft		
			Prepared by	Checked by	Approved by
		Name	Randy Meyers/Armin Wolski	Armin Wolski	Armin Wolski
		Signature			
Draft 3	12/19/11	Filename	TTC RFAM #5 - PA used for Fire Alarm Draft 3.doc		
		Description	Third Draft		
			Prepared by	Checked by	Approved by
		Name	Randy Meyers/Armin Wolski	Armin Wolski	Armin Wolski
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ☑

ATTACHMENT A

DEPARTMENT OF BUILDING INSPECTION
City & County of San Francisco
1660 Mission Street, San Francisco, California 94103-2414

REQUEST FOR APPROVAL OF LOCAL EQUIVALENCY FOR MODIFICATION OR ALTERNATE MATERIALS, DESIGN OR METHODS OF CONSTRUCTION

DATE SUBMITTED May 24, 2012

[Note: This form shall be recorded as part of the permanent construction records of the property]

If no permit application has been filed, a Preapplication Review Fee is required for review of a request for local equivalency or modification, per SFBC Table 1A-B, Item 5. Additional fees may be required by Fire Department and other City review agencies.

If a permit application has been filed, no additional fees are required for this review.

Permit Application # _____

Property Address: 425 MISSION STREET

Block and Lot: ____/____ Occupancy Group: A Type of Construction: I-B No. of Stories: 4

Describe Use of Building Transit Facility with Park

Under the authority of the 2010 San Francisco Building Code, Sections 104A.2.7 and 104A.2.8; the 2010 San Francisco Mechanical Code, Section 105.0; the 2010 San Francisco Electrical Code, Section 89.117; and the 2010 San Francisco Plumbing Code, Section 301.2; the undersigned requests modifications of the provisions of these codes and/or approval of alternate materials, designs or methods of construction. Two copies of supporting documents, including plans showing the proposed modifications or alternate materials, design or methods of construction, are attached.

Regular Code Requirement (specify Code and Sections)
SFBC/CBC Sections 1025.6.2.1 and 1025.6.3

Proposed Modification or Alternate

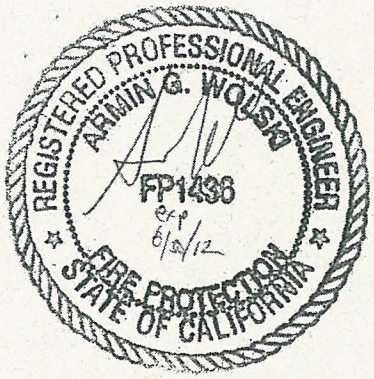
See attached.

Case-by-Case Basis of Request - Describe the practical difficulties presented in meeting the specific conditions of the code and how the proposed modification or alternate meets the intent of the code. A separate form should be filled for each requested modification or alternate. Attach copies of any Administrative Bulletin, Code Ruling, reference, test reports, expert opinions, etc., which support this request. The Department may require that an approved consultant be hired by the applicant to perform tests or analysis and to submit an evaluation report to the Department for consideration.

See attached.

Requested by:	PROJECT SPONSOR	ARCHITECT/ENGINEER
Print Name:	EDMOND SUM	Armin Wolski
Signature:		
Telephone:	(415) 597-4040	(415) 957-9445

[PROFESSIONAL STAMP HERE]



PLAN REVIEWER COMMENTS:

RECOMMENDATIONS: [signed off/dated by:]	Approve	Approve with conditions	Disapprove
Plan Reviewer:			
Division Manager:			
for Director of Bldg. Inspection			
for Fire Marshal:			

6/13/2012

6/13/2012

CONDITIONS OF APPROVAL or OTHER COMMENTS

Project title	Transbay Transit Center, San Francisco		Job number
Document title	Local Equivalency # 7 Rooftop Park Stair Enclosure Protection		File reference
Document ref			

Revision	Date				
Draft	05-04-12	Filename	TTC RFLE #7 – Rooftop Park Stair Enclosure Protection – Draft Rev1.doc		
		Description	Issue to Design Team for review		
			Prepared by	Checked by	Approved by
		Name	Craig R. Studer, P.E.	Armin Wolski, P.E. Darlene Rini, P.E.	Kevin Clinch, P.E.
		Signature			
Issue	05-24-12	Filename	TTC RFLE #7 - Rooftop Park Stair Pressurization - F		
		Description	Added reference to barometric relief damper and associated 2,500 cfm safety factor.		
			Prepared by	Checked by	Approved by
		Name	Craig R. Studer, P.E.	Armin Wolski, P.E. Darlene Rini, P.E.	Kevin Clinch, P.E.
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ☑

Request for Local Equivalency for Alternate Design of Construction Under Sections 104A.1 and 104A.2.8 of the 2007 San Francisco Building Code and Section 111 of the 2007 California Building Code

Transbay Transit Center, San Francisco
Local Equivalency # 7

Rooftop Park Egress – Stair Enclosure Protection

Introduction

An earlier Request for Interpretation (RFI) of the building code (Interpretation #1, dated 11/12/2009) was submitted to formalize the approach and egress strategy from the rooftop park. This document stated that the Transbay rooftop park is an outdoor assembly, open to the sky, and as such, meets the definition of an outdoor smoke protected assembly. Under this arrangement, the application of the exit width factors permitted in Section 1025.6.3 would be appropriate. Although the RFI was deemed acceptable, the City of San Francisco interpreted that Section 1025.6.3 requires that the egress from the rooftop park should remain smoke free through the exit stair shafts meeting the requirements of 1025.6.2.1. This equivalency has been prepared to justify a design that meets the intent of Section 1025.6.2.1 for this given application.

Code Section and Requirement

CBC Section 1025.6.2.1 – Smoke Control: "Means of egress serving a smoke-protected assembly seating area shall be provided with a smoke control system complying with Section 909 or natural ventilation designed to maintain the smoke level at least 6 feet (1829 mm) above the floor of the means of egress."

Code Intent

The code intent is to maintain a smoke free environment from the smoke protected assembly seating to the protected means of egress. This has been interpreted to require the stairs which serve the park to be provided with smoke control.

Request

To fulfill the intent of Section 1025.6.2.1 by using a positive pressure differential for the stair enclosure.

Proposed Design and Justification

For the stair shafts, in an effort to mitigate a remotely possible abnormal fire condition, interior stairs S301, S401 and S601 will be positively pressurized to a minimum of 0.15 inches water gage differential between the stair and the "fire floor." The pressurization system is intended to augment the natural or mechanical smoke control systems, thereby protecting the entire paths of egress in accordance with CBC Section 1025.6.2.1. This arrangement would be similar to the stair pressurization alternative allowed by section 909.20.5 of the 2006 edition of the International Building Code.

Each pressurized stair will include a barometric relief damper which is capable of relieving at least 2,500 cfm. The pressurization system in each stair will be designed/sized to accomplish the target pressure differential plus an additional "safety factor" of 2,500 cfm. Each stair will be tested to meet the minimum pressure differential, while maintaining a minimum of 2,500 cfm discharge through the barometric relief damper, with all doors closed,

Stair S201 does not serve any other levels, is not threatened by smoke intrusion because of fires on other levels and will therefore not be pressurized.

With the rooftop park being outside the building and open to the sky above, the arrangement would naturally meet the requirement of maintaining the smoke level at least 6 feet above the rooftop park deck under any normal fire condition. Therefore, the stairs will not be provided with a vestibule at the rooftop park deck as they would not provide any additional level of protection. In addition, other levels of the building that may be of particular concern (with the potential for high fuel loads or high heat release rates such as the Bus Deck Level, Lower Concourse and Train Platform Level) are currently provided with their own smoke control systems designed to maintain tenability during evacuation. Therefore, vestibules on these other levels are also not necessary as the smoke layer will be maintained above 6 feet during the course of evacuation.

The stair pressurization fans will be included on the smoke control panel and will meet the operational requirements of Section 909.16, "Fire-fighter's smoke control panel".

Stair pressurization fan characteristics and installation will meet the requirements of Section 909, including:

909.10.5 Fans. "In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty, with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices in accordance with the requirements of Chapter 16. Motors driving fans shall not be operated beyond their nameplate horsepower (kilowatts), as determined from measurement of actual current draw, and shall have a minimum service factor of 1.15."

909.11 Power Systems. "The smoke control system shall be supplied with two sources of power. Primary power shall be from the normal building power system. Secondary power shall be from an approved standby source complying with the *California Electrical Code.*"

909.12 Detection and Control Systems. "Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Section 907."

Stair pressurization fans will start on any system fire alarm signal. CBC Section 909.20.4 requires the ventilation system to be activated by smoke detectors at each floor at the entrance to the smokeproof enclosure. However, smoke detectors at the rooftop park, bus deck, and train platform level may not be effective or create a nuisance alarm (e.g. exhaust gases). Therefore the proposed stair pressurization system will not include any fire or smoke detection outside the entrance to the stair except for spaces that are conditioned by the HVAC system.

Conclusion

The proposed arrangement will meet the intent of Section 1025.6.2.1 and address the San Francisco Fire Department's concerns for maintaining a smoke free path of egress.

We respectfully request your concurrence and approval of this Local Equivalency with the understanding that the proposed assembly will meet the level of safety intended by the code.

Prepared by:
Arup Fire

Craig Studer Date

Approved by:
San Francisco Building Department

Hanson Tom 6/13/2012
Hanson Tom Date

Reviewed by:
Arup Fire

5/24/12
Armin Wolski, P.E. Date

REGISTERED PROFESSIONAL ENGINEER
ARMIN G. WOLSKI
FP1436
6/13/12
FIRE PROTECTION
STATE OF CALIFORNIA

Approved by:
San Francisco Fire Department

6/13/2012
Date

Approved by:
Transbay Joint Powers Authority

4 JUNE 2012
Edmond Sum Date

Request for Interpretation of the
2007 San Francisco Building Code

Transbay Transit Center, San Francisco
Interpretation # 1

Roof Park Occupant Load and Egress Facilities

Introduction

The Transbay Transit Center (TTC) will serve as the transit hub for Bay Area bus services, Muni and California High Speed Rail. The building will have has three above -grade levels, a park on the roof of the building, and two below-grade levels.

This letter is intended to formalize the approach and egress strategy from the rooftop park (hereafter, "the Park") with the San Francisco Department of Building Inspection (DBI) and the San Francisco Fire Department (SFFD) based on discussions with DBI and SFFD. This will be used as a basis of design through the design process and final approval will be obtained during the plan check process.

Interpretations

Smoke Protected Assembly

The Park is an outdoor assembly to which we propose applying the outdoor smoke protected assembly provisions of the San Francisco Building Code (SFBC). The egress width is adjusted in the SFBC for inherently safe areas, and this is recognized under "smoke protected assembly areas." In Section 1025.6.3, *Width of means of egress for outdoor smoke-protected assembly*, the SFBC identifies different exit widths for large assembly spaces with smoke protection. The SFBC recognizes the inherent fire safety of large spaces equipped with smoke exhaust systems.

Since the smoke hazard is greatly minimized, the SFBC acknowledges that occupants will have more time to evacuate the area. The longer available safe-egress time permits the use of a different egress width factor. The larger the space, the more time occupants have to safely evacuate, and therefore the smaller the egress width factor that is required. However, even the largest *indoor* smoke-protected assembly seating space relies on the reliability of mechanical systems for smoke control.

The code commentary to the 2006 International Building Code states, "Generally, an outdoor assembly area meets the smoke control requirements of SFBC Section 1025.6.1 by natural ventilation and does not require an automatic sprinkler system."

The Park is an outdoor assembly and is open to the sky. Based on the code commentary, the argument that outdoor spaces provide an equivalent level of smoke control as a mechanical smoke control system is valid. More importantly, because they do not rely upon a mechanical exhaust system, outdoor spaces provide a significantly higher level of reliability and redundancy for smoke venting.

Based on the above, it is reasonable to propose that the Park be defined as an "outdoor smoke protected assembly" and that the exit width factors permitted in Section 1025.6.3 of 0.06 inch per person for corridors and ramps and 0.08 inch per person for stairs are appropriate for calculating stair widths. Table 1 defines the stair width and capacities and assumes that sufficient door width will be provided so that the stair tread width governs the flow.

Request for Interpretation of the
2007 San Francisco Building Code

Transbay Transit Center, San Francisco
Interpretation # 2

Elevator hoistway opening protection and elevator lobbies

Introduction

We are writing to request your concurrence with our interpretation of Section 707.14.1 of the 2007 California Building Code as adopted and enforced by the City and County of San Francisco (SFBC). Section 707.14.1 addresses the requirements for elevator lobbies. This request for interpretation addresses the following issues:

- opening protection of the elevator hoistways,
- alternatives for elevator lobbies, and
- omission of lobbies and hoistway opening protection at exterior, open-to-sky landings

The Transbay Transit Center (TTC) has 4 sets of public elevators with non-fire rated, glass hoistway doors located at Gridlines 8, 16, 24.9, and 32 that connect the Lower Concourse Level through to the Roof Park Level. An additional single public elevator is also provided at Gridline 1 connecting Ground to Park Level.

Because all the public and service elevator hoistways pass through a 2-hour fire rated floor assembly, all elevator hoistways are required to be 2-hour fire rated in accordance with Section 707.4 with 1-½ hour hoistway opening protection per Section 715.4. In addition to an elevator shaft enclosure, the State Fire Marshal (SFM) amendments require elevators in Group A occupancies serving more than 2 floors to be provided with lobbies at each level (with the exception of the ground level per Exception 1) per Section 707.14.1. Note: Elevators connecting only two levels (e.g. elevators connecting the Platforms to the Lower Concourse) are not required to have lobbies.

In the TTC, where a physical lobby is not provided, a 2-hour fire rated smoke curtain across the non-fire rated glass hoistway doors is proposed to satisfy the hoistway door opening protection requirement (per shaft opening requirements of Section 715.4) while also providing the smoke containment requirements for elevator lobbies (Exception 7 of Section 707.14.1).

While the 2-hour fire rated smoke curtain with non-fire rated hoistway doors (in lieu of a non-fire rated smoke curtain with 1-½ hour fire rated hoistway door) does not strictly meet the letter of code, the intent of the code is deemed to be satisfied. That is, the proposed fire-rated smoke curtain will limit the spread of fire and smoke via the elevator hoistway door opening. The testing and performance requirements for the proposed fire/smoke curtain are provided herein.

At the Roof Park Level, elevator lobbies are proposed to be omitted because this level is open to sky. Any fire or smoke that may spread vertically via the elevator shaft will vent direct to outside. A fire at the roof will not impact the levels below via the shaft.

Generic configurations of these arrangements are provided in Figure 1. The specific approach for each elevator at each level will be addressed in the architectural drawings.

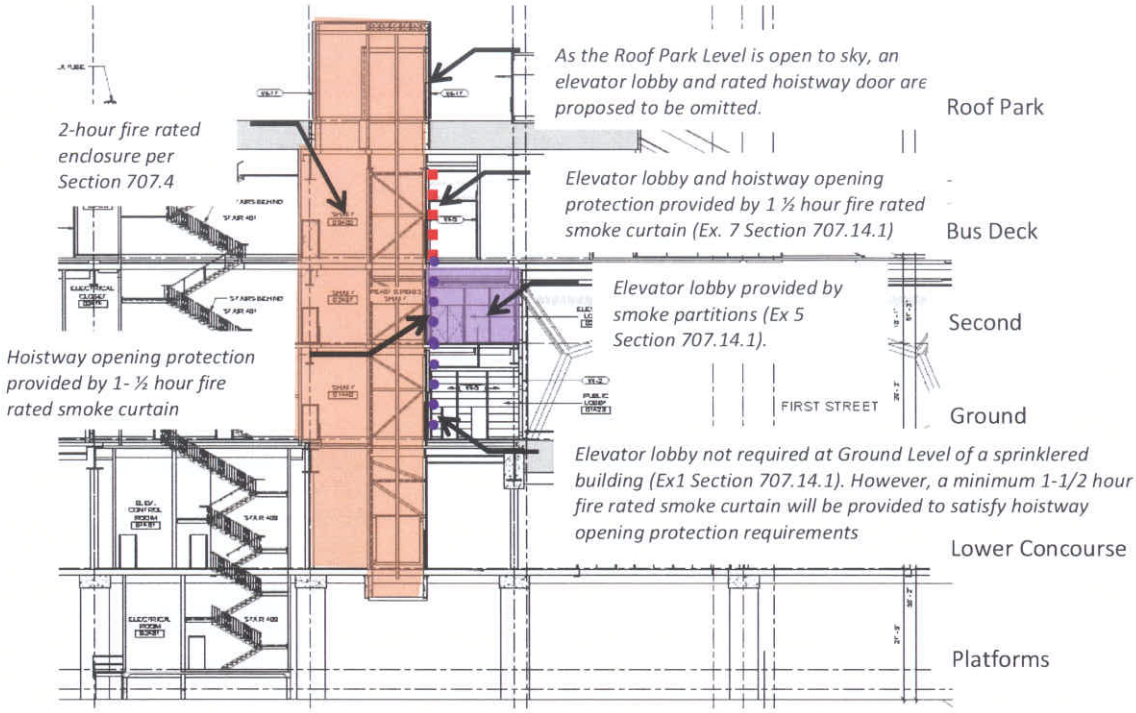


Figure 1: Proposed public elevator lobby strategy for TTC

Interpretations

Elevator Hoistway Opening Protection and Lobby

Section 707.14.1 of the 2007 SFBC with SFM amendments requires a lobby to separate the elevator shaft from each floor by smoke partitions in a sprinklered building. Section 707.4 requires a 2-hour fire rated shaft with 1-½ hour hoistway opening protection per Section 715.4

There are four sets of public elevators with non-rated glass hoistway doors. The glass doors are provided for transit security reasons. These elevators are located at Gridlines 8, 16, 24.9, and 32 that connect the Lower Concourse through to the Roof Park, and at Gridline 1 that connects Ground to the Roof Park. The public elevator shafts are enclosed in 2-hour fire rated construction in accordance with Section 707.4. Per Table 715.4, the hoistway doors are required to be protected with a 1 ½ hour fire rated opening protection. A lobby enclosure is also required to satisfy the SFM amendments per Section 707.14.1, which can be satisfied via a smoke containment system (Exception 7) where a fire rated hoistway door is provided.

To meet the hoistway door fire rating and lobby requirements for the elevator shaft, a minimum 1 ½ hour fire rated smoke curtain (such as Elevator Shield from BLE, McKeon Fire fighter series product, or equivalent) is proposed. This satisfies both the 1 ½-hour fire rating for hoistway door opening protection (Section 715.4) and the smoke containment requirement for elevator lobbies (Exception 7 of Section 707.14.1). While the proposed 2-hour fire rated smoke curtain meets the intent of the code, by limiting fire and smoke spread via the elevator hoistway door, it does not strictly meet Exception 7 of Section 707.14.1. That is, Exception 7 specifies a *rated* hoistway door coupled with a smoke containment system (i.e. smoke curtain) in compliance with ICC ES AC 77 (see attached). The ICC ES AC 77 acceptance criteria do not address the scenario where the smoke containment system also achieves the hoistway door opening fire protection.

To meet the intent of Exception 7 of Section 707.14.1 for elevator lobbies and Section 715.4 for hoistway opening protection, the proposed fire and smoke containment system must meet the following criteria:

- Comply with ICC ES AC 77 testing and performance criteria (i.e. materials, air leakage, expansion characteristics, installation, cycling, motor, release mechanism, smoke detection, opening force, quality control, etc.)
- Be provided with an egress switch on both sides of the fire/smoke curtain that complies with ANSI A117.1 for operation of a powered door
- Achieve a minimum fire rating of 1 ½ hours in accordance with UL10b (Fire test for door assemblies) and UL 10d (Fire test for protective curtains)
- Satisfy the UL "S" Label (UL 1784) for this specific application
- Be CSFM listed as a fire rated smoke curtain for a minimum of 1-½ hours
- Be readily openable through manual operation from the elevator car side without a key, tool, special knowledge or effort (per SFBC Section 3002.6).
- Does not disrupt firefighter operations for the elevator per 2007 CFC 607.1 (2007 ASME 17.1a 2.27.3.2 Phase I Emergency Recall Operation by Fire Alarm Initiating Devices and 2.27.3.3 Phase II Emergency In-Car Operation

For an elevator that only accesses two levels (where lobbies are not required) and utilizes glass hoistway doors the fire rated smoke curtain will be used to provide the hoistway opening protection. Other permissible methods are rated doors that close on alarm.

Where the proposed fire/smoke curtain is not adopted, the elevators will be provided with 1-½ hour hoistway doors and lobbies constructed of smoke partitions per Section 707.14.1 (Ex. 5) for sprinklered buildings.

In our opinion the proposed methods of protection of the hoistway openings and the provisions for lobbies meet the intent of the code.

Roof Park hoistway opening protection and lobbies

At the Roof Park Level, the fire and smoke separation required for the hoistway door and elevator lobby is proposed to be omitted for the public elevators. Because the Roof Park Level is not enclosed and open to sky, any vertical transmission of fire and smoke via the elevator shaft will vent to outside and will have minimal effect on occupant egress or fire fighting activities. Because the lower levels are provided with rated hoistway openings and lobbies (or equivalent) the actual risk of fire or smoke entering the hoistway from the lower floors is negligible. In the event of a fire at the Roof Park Level, it is unlikely that smoke and fire will travel down the elevator shaft to the floors below. Aesthetically, this would provide greater flexibility as the need for a lobby or fire partition does not serve a purpose under this arrangement.

In our interpretation, based on the argument that the Roof Park Level is open to sky, a fire-rated hoistway door and elevator lobby at the Roof Park Level is not required for the elevators terminating at the Roof Park. This configuration is considered to meet the intent of the code.

Conclusion

In conclusion, it is our contention that the proposed design of the public elevator hoistway fire rating and smoke containment system meets the requirements of the San Francisco Building Code and SFM Amendments.

Prepared by:

Arup Fire

Darlene Kim, PE — Date 12/08/11

REGISTERED PROFESSIONAL ENGINEER
DARLENE KIM
FP 1708
EXP. 9/30/13
FIRE PROTECTION
STATE OF CALIFORNIA

Approved by:

San Francisco Department of Building Inspection

Acting Deputy Director — Date 2/7/2012

Approved by:

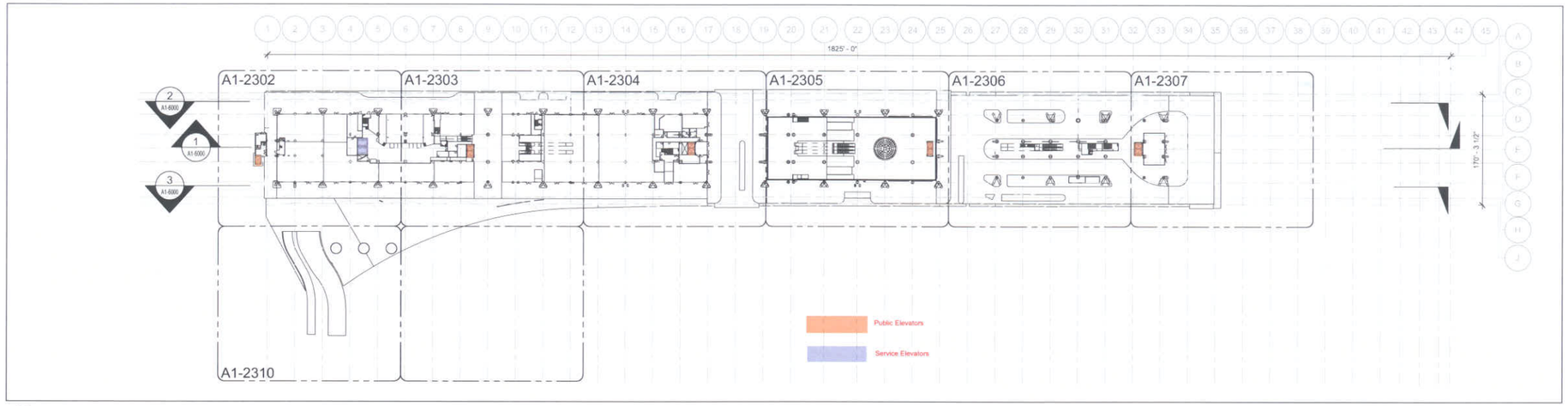
San Francisco Fire Department

Date 1/31/12

Approved by:

Transbay Joint Power Authority

30 JAN 2012
Date



1 A1-2001 GROUND LEVEL ORIENTATION PLAN
SCALE: 1/64" = 1'-0"

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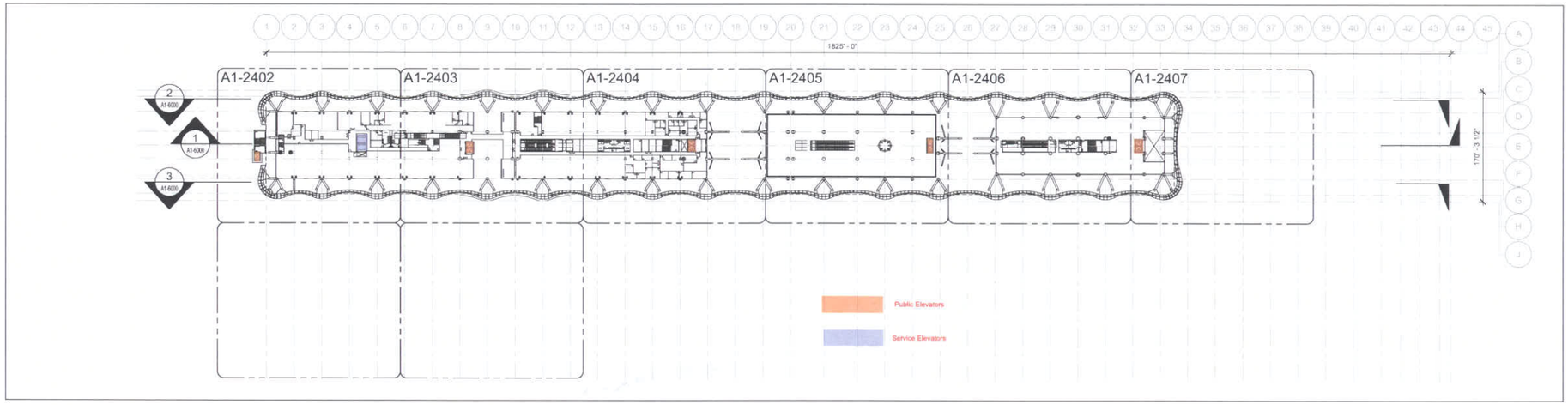
SCALE IN FEET



2 A1-2001 SECOND LEVEL ORIENTATION PLAN
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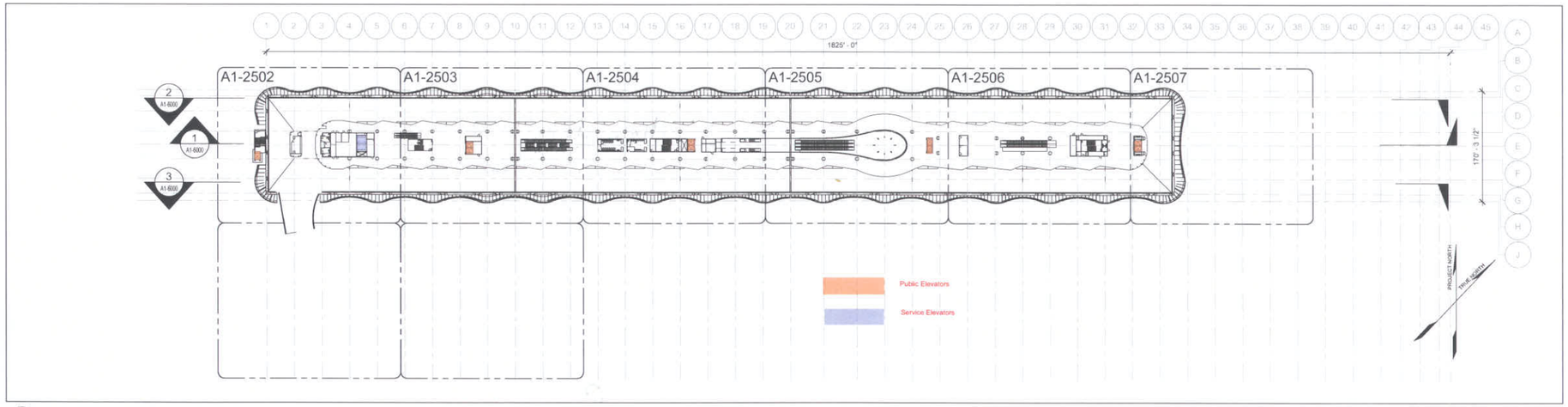

3 A1-2001 BUS DECK LEVEL ORIENTATION PLAN
SCALE: 1/64" = 1'-0"

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SCALE IN FEET

Transbay Transit Center
TRANSBAY JOINT POWERS AUTHORITY

Polli Clarke Polli Architects
adamson ASSOCIATES INC

01 02 03 04 05 06 07 08
09 10 11 12 13 14 15 16
Key Map

REVISIONS

NO	DATE	DESCRIPTION	BY
1	12/10/10	ISSUED FOR CONSTRUCTION - BUTTRESS/SHORING/EXCAVATION	GM
2	12/20/10	50% CONSTRUCTION DOCUMENTS	GM

CONTRACT NO. 08-04-CMGC-000

PROJECT TITLE
TRANSBAY TRANSIT CENTER PROGRAM
TRANSBAY TRANSIT CENTER
SAN FRANCISCO, CA

SHEET TITLE
GROUND, SECOND, & BUS DECK LEVELS

ARCHITECT / ENGINEER SEAL

NOT FOR REGULATORY APPROVAL, PERMITTING, OR CONSTRUCTION

APPROVED PRINCIPAL ARCHITECT	G. METZGER
APPROVED PROJECT MANAGER	S. ROTT
APPROVED PROJECT MANAGER	E. DEL ANGEL
DESIGNED BY: S. ROTT	CHECKED BY: W.R. BRADLEY
DRAWN BY: J. LYSKOVA	DATE: 12/20/2010
SCALE: 1/64" = 1'-0"	SIZE: E
FACILITY NO: 140	REVISION: 0
SHEET NUMBER: A1-2001	SEQUENCE NUMBER: 317 of 1880

Note:
If this sheet is not 44" x 34", it has been revised from its original size. Scales noted on drawings/details are no longer applicable.

50% CONSTRUCTION DOCUMENTS

NOT USED

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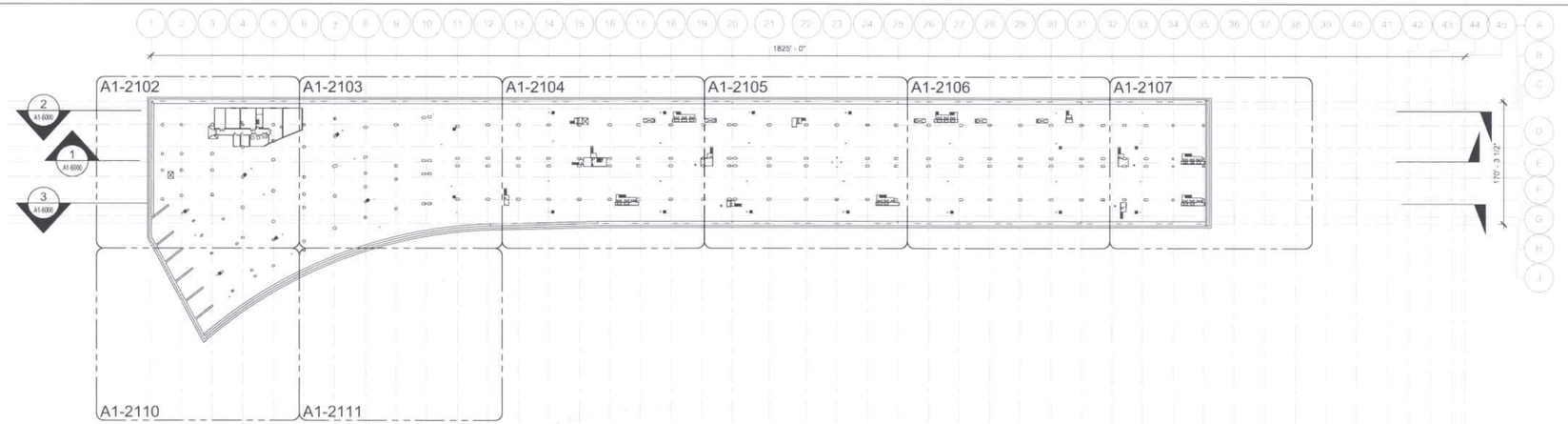

2 A1-2000 TRAIN PLATFORM LEVEL ORIENTATION PLAN
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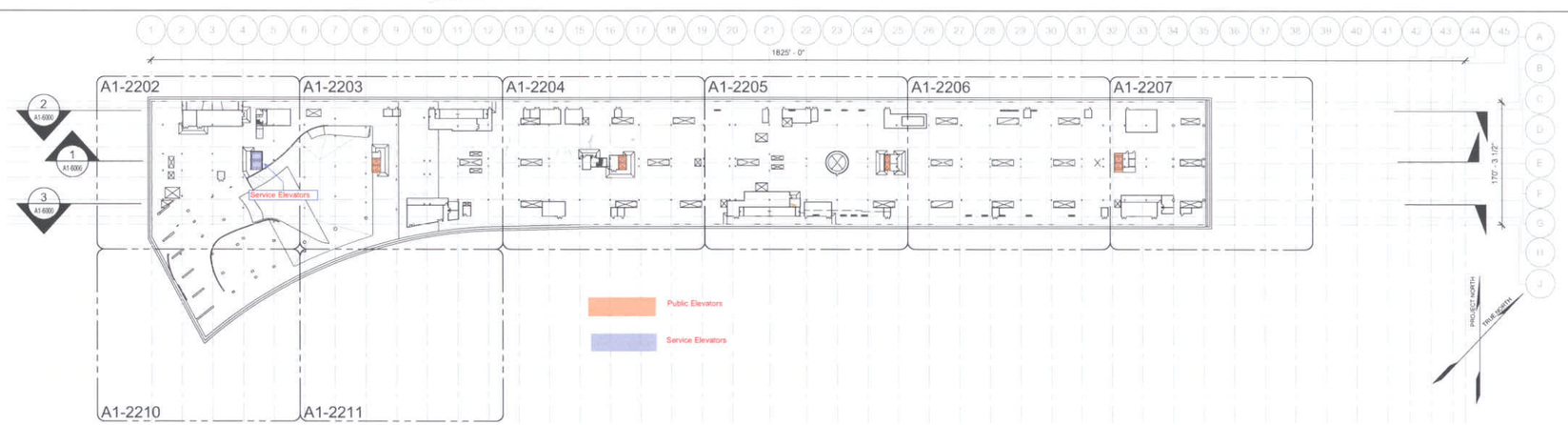

3 A1-2000 LOWER CONCOURSE LEVEL ORIENTATION PLAN
SCALE: 1/64" = 1'-0"

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SCALE IN FEET

Transbay Transit Center
TRANSBAY JOINT POWERS AUTHORITY

CONSULTANT
Pelli Clarke Pelli Architects
adamson ASSOCIATES, INC

01 02 03 04 05 06 07 08
09 10 11 12 13 14 15 16
Key Map N

REVISIONS

NO	DATE	DESCRIPTION	BY
1	12/13/10	ISSUED FOR CONSTRUCTION - BUTTRESS/SHORING/EXCAVATION	GM
2	12/20/10	50% CONSTRUCTION DOCUMENTS	GM

CONTRACT NO: 08-04-CMGC-000
PROJECT TITLE: TRANSBAY TRANSIT CENTER PROGRAM
TRANSBAY TRANSIT CENTER
SAN FRANCISCO, CA
SHEET TITLE: FOUNDATION, TRAIN PLATFORM, & LOWER CONCOURSE LEVELS

ARCHITECT / ENGINEER SEAL

NOT FOR REGULATORY APPROVAL, PERMITTING, OR CONSTRUCTION

APPROVED PRINCIPAL ARCHITECT	G. METZGER
APPROVED PROJECT MANAGER	S. ROTT
APPROVED PROJECT MANAGER	E. DEL ANGEL
DESIGNED BY: P. MACPHAIL	CHECKED BY: W.R. BRADLEY
DRAWN BY: K. WROBLEWSKI	DATE: 12/20/2010
SCALE: 1/64" = 1'-0"	SUB: E; FACILITY NO: 140; REVISION: 0
SHEET NUMBER: A1-2000	SEQUENCE NUMBER: 316 of 1880

Note:
If this sheet is not 44" x 34", it has been revised from its original size. Scales noted on drawings/details are no longer applicable

50% CONSTRUCTION DOCUMENTS

Meeting Action Notes

Project	**TRANSBAY TRANSIT CENTER** San Francisco, California, USA	Project Number	Adamson 0803 -00
Location	**TJPA - Conference Room** 201 Mission Street, Suite 2100, San Francisco, CA	Date Time	**5 April 2011** 10:30am – 1:00pm
Subject	**CD Bus Deck Ventilation and RFI 2**	Meeting Number	**CD-DBI/SFFD-020**

Prepared by	Adamson Associates, Inc.	AAI	Carl Keim	CK

Invited / cc:				
	Company		**Attendee**	
	San Francisco Fire Department	SFFD	Janice Hayes, Jon Corbett Don Fields, Tod Stephenson	JH, JC DF, TS
	San Francisco Department of Building Inspections	SFDBI	Hanson Tom, James Zahn	HT, JZ
	Transbay Joint Powers Authority	TJPA	Alfred Lau, Ed Sum Rebecca Armenta, Joyce Oishi	AL, ES RA, JO
	ARUP	ARUP	Andrew Coles, Robert Gerard	AC, RG
Via Phone				
	Adamson Associates, Inc.	AAI	Erick del Angel	eda
/ cc:	George Metzger, Randy Volenec, Doug Dron, Bill Bradley, Sandor Rott, Peter Buffington, Jana Lyskova, Rose Martin			
	Material Reviewed:	• Arup - Transbay Transit Center / Bus Deck CFD Comments Design Team Response 3-23-11 • Preliminary Design Criteria for the Bus Deck and Train Facility Emergency Ventilation CFD Analyses • Request for Interpretation # 2 of the 2007 San Francisco Building Code | Transbay Transit Center, San Francisco *Elevator hoistway opening protection and elevator lobbies*		

Meeting Action Notes

Subject	CD Bus Deck Ventilation and RFI 2	Meeting Number	CD-DBI/SFFD-020

No.	ITEM	DISCUSSION	ACTION	DATE
20.1	**Request for Interpretation #2**			
20.1.1	Elevator Rating Requirements	AC introduced the topic - the intent of document RFI # 2 is to obtain concurrence to three issues: 1. Opening protection of the elevator hoistways. 2. Alternatives for elevator lobbies and omission of lobbies 3. Hoistway opening protection at exterior, open-to-sky landings	INFO	
20.1.2	Atrium Shield	Provides UL ratings for smoke and fire protection. Provides compliance for CBC 707.14.1. Under normal conditions, the assembly is retracted in a steel head box in the ceiling. Upon receipt of a signal from the fire alarm system, or the complete loss of power or communication, the system descends by gravity. Deployment is gravity fail-safe and does not require battery-backup to descend.		
20.1.3	Questions	SFFD asked if this proposal meets the requirements of Exception 7. Arup to follow up and revise the letter to indicate compliance with ICC ES AC 77. SFFD stated that the service elevator will require a lobby or equivalent.		
20.1.4	Roof Park Level	SFFD/DBI agreed that the atrium shield assembly is not required at roof Park level because this level is open to the sky. Any fire or smoke that may spread vertically via the elevator shaft will vent direct to outside.		
		The service elevator requires a vestibule at the Park level, the service building should suffice; ratings will be required for partitions and doors. The SFFD wants there to be a way to operate the fire curtains from inside the elevator side of the curtain and suggested a manual button to be provided.		
20.1.5	Approval	SFFD/DBI agree on the proposal. Arup to revise the letter with the suggested modifications and clarification prior to approval.	ARUP	
20.2	**CFD Bus Deck Comment Review**			
20.2.1	Verification and Validation	AC stated that RWDI will provide software validation. Copy of the revised report will be sent to DBI/SFFD.	RWDI/ARUP	
20.2.2	Ventilation Controls	In the previous meeting, it was requested that the design team provide a mechanical controls description, since there are some ceiling fans that would need to be off on emergency mode. eda stated that the mechanical engineers would provide a description for DBI review.		
20.2.3	Worst Case Scenario Data	Wind study source data requested by SFFD. Studies done in 35mw steady state in the report. A revised report to be issued and will include all data driving the analysis. Summer and winter extremes will have little effect on the fire analysis and are not typically considered. The team does not intend to include these.	ARUP/RWDI	
20.2.4	Natural Ventilation	Since natural ventilation plays a role in smoke evacuation, SFFD would like to see guidelines used in calculations.	RWDI	

20.2.6	Tenability Requirements	The A/E team questions the tenability requirements once the public is evacuated. SFFD interprets NFPA 130 to require passenger and fire fighter protection for a minimum of 1 hour. The A/E team agrees that there is a minimal operational requirement, but the tenability criteria for fire fighter intervention should not be the same as passenger evacuation. SFFD states that operations access needs protection. The evacuation is expected to be complete within 6 minutes of alarm; this is faster than SFFD can arrive due to distance from facility. The 10 meter visibility at 2.5m above the floor is in question by the A/E team for fire fighter intervention. This is overly onerous and is not the intent of a smoke control system (as stated in the literature). The system is there to assist fire fighter intervention, not provide a tenable environment. The intent of the analysis is to show that for post evacuation fire fighters are still able to reach the incident level and assess the situation and then conduct operations. The consensus was that the report should show how the time factors of NFPA 130 Annex B2.3 are considered and how the results show compliance for each stage of an emergency event.	ARUP/RWDI	
20.2.7	Exiting Report	ARUP to provide exiting report for SFFD review	ARUP	
20.3	**Next Steps**			
20.3.1	SFFD/DBI Conclusion	SFFD/DBI has concerns that the approach has numerous uncertainties that they are not familiar with. Additionally, because a natural ventilation system in lieu of a mechanical system is proposed that a peer review should be conducted. SFFD/DBI stated that they require 2 reviewers (one academic and one from industry) that are qualified to conduct a CFD peer review. The requirements are as follows: • Must have a US PE license • Are familiar with the CFD packages Star CCM+ and OpenFoam (possibly with the FireFoam add-on software) • Are familiar with the application of these packages for justifying natural ventilation as a means of smoke control The design team will provide names that they are familiar with for review and approval.	TJPA/Design Team	
20.3.2	Logistics and Schedule	It was discussed that this peer review process could take more than two months. TJPA and the design team will prepare a list and schedule to be reviewed with SFFD/ DBI prior to engaging the peer review team.		
20.3.3	Alternate Plan	It was also noted that given the current construction document schedule, it would be advisable for the design team to consider an alternate prescriptive mechanical ventilation solution in addition to	Design team/TJPA	

		the peer review process for the current natural ventilation scheme. Eda stated that the design team will review these options with the TJPA and respond to the SFFD and DBI with the proposed work plan.		

End of Meeting Action Notes.

First issue date: *Comments must be submitted within 5 business days. After 10 business days, the meeting minutes will serve as record.*
Final Issue Date:

ACCEPTANCE CRITERIA FOR SMOKE-CONTAINMENT SYSTEMS USED WITH FIRE-RESISTANCE-RATED ELEVATOR HOISTWAY DOORS AND FRAMES

AC77

Approved October 2008

Effective November 1, 2008

Previously approved October 2007, October 2003, January 2001, September 1992

PREFACE

Evaluation reports issued by ICC Evaluation Service, Inc. (ICC-ES), are based upon performance features of the International family of codes and other widely adopted code families, including the Uniform Codes, the BOCA National Codes, and the SBCCI Standard Codes. Section 104.11 of the *International Building Code*® reads as follows:

> The provisions of this code are not intended to prevent the installation of any materials or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

Similar provisions are contained in the Uniform Codes, the National Codes, and the Standard Codes.

This acceptance criteria has been issued to provide all interested parties with guidelines for demonstrating compliance with performance features of the applicable code(s) referenced in the acceptance criteria. The criteria was developed and adopted following public hearings conducted by the ICC-ES Evaluation Committee, and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from the previous edition, a solid vertical line (**|**) in the margin within the criteria indicates a technical change, addition, or deletion from the previous edition. A deletion indicator (→) is provided in the margin where a paragraph has been deleted if the deletion involved a technical change. This criteria may be further revised as the need dictates.

ICC-ES may consider alternate criteria, provided the report applicant submits valid data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. Notwithstanding that a product, material, or type or method of construction meets the requirements of the criteria set forth in this document, or that it can be demonstrated that valid alternate criteria are equivalent to the criteria in this document and otherwise demonstrate compliance with the performance features of the codes, ICC-ES retains the right to refuse to issue or renew an evaluation report, if the product, material, or type or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use of the product, material, or type or method of construction.

Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports.

ACCEPTANCE CRITERIA FOR SMOKE-CONTAINMENT SYSTEMS USED WITH FIRE-RESISTANCE-RATED ELEVATOR HOISTWAY DOORS AND FRAMES (AC77)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this criteria is to establish the basis for recognition in ICC Evaluation Service, Inc. (ICC-ES), evaluation reports of smoke-containment systems as tight-fitting, smoke and draft control assemblies under Section 715.4.3 of the 2006 *International Building Code*® (IBC), Section 1004.3.4.3.2.1 of the 1997 *Uniform Building Code*™ (UBC), or Section 705.1.3.2 of the 1999 *Standard Building Code*© (SBC). The reason for this criteria is the absence of referenced standards within the IBC upon which to determine code compliance, therefore this subject is an alternative material to what is prescribed in the codes. Bases of recognition are IBC Section 104.11.

1.2 Scope: The systems are used with fire-resistance-rated elevator hoistway doors and frames or as smoke curtain systems installed remotely from the hoistway door at the intersection of the elevator lobby and corridor. Use of either type of system would permit deletion of the separated elevator lobby required under IBC Section 707.14.1, UBC Section 1004.3.4.5, or SBC Section 412.6.1. Recognition under the SBC is applicable to Group B and R high-rise buildings.

Smoke-protected elevator lobbies are not specifically required by the BOCA® *National Building Code*/1999 (BNBC). However, where smoke-protected elevator lobbies are proposed to be provided as part of a building design, the smoke-containment system described in the ICC-ES evaluation report is permitted under the BNBC, when installation is in accordance with the evaluation report.

Systems tested in accordance with UL 10C (see exception to Section 3.9) are recognized for use as alternatives to a 20-minute fire door assembly complying with the requirements of IBC Sections 715.4.3 and 715.4.3.1.

1.3 Reference Standards: Where standards are referenced in this criteria, these standards shall be applied consistently with the code (IBC, UBC or SBC) upon which compliance is based. Standard editions applicable to each code are summarized in Table 1.

1.3.1 2006 *International Building Code*®, International Code Council.

1.3.2 1997 *Uniform Building Code*™.

1.3.3 1999 *Standard Building Code*©.

1.3.4 BOCA® *National Building Code*/1999.

1.3.5 ASTM D 412, Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers—Tension, ASTM International.

1.3.6 ASTM D 1434, Determining Gas Permeability Characteristics of Plastic Film and Sheeting, ASTM International.

1.3.7 ASTM D 1876, Peel Resistance of Adhesives (T-Peel Test), ASTM International.

1.3.8 ASTM E 84, Surface Burning Characteristics of Building Materials, ASTM International.

1.3.9 UL 10B, Fire Tests of Door Assemblies, Underwriters Laboratories Inc.

1.3.10 UL10C, Standard for Positive Pressure Fire Tests of Door Assemblies, Underwriters Laboratories Inc.

1.3.11 UL 1784, Air Leakage Tests of Door assemblies, Underwriters Laboratories Inc.

1.3.12 UL 228, Door Closers With and Without Integral Smoke Detectors, Underwriters Laboratories Inc.

1.3.13 UL 268, Smoke Detectors for Fire Alarm Signaling Systems, Underwriters Laboratories Inc.

1.3.14 UL 864, Standards for Control Units and Accessories for Fire Alarm Signaling Systems, Underwriters Laboratories Inc.

1.3.15 NFPA 105, Installation of Smoke-Control Door Assemblies, National Fire Protection Association.

1.3.16 NFPA 258, Determining Smoke Generation of Solid Materials, National Fire Protection Association.

1.3.17 NFPA 70, National Electrical Code, National Fire Protection Association.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted:

2.1.1 General information on the manufacturing process.

2.1.2 Dimensioned drawings and details noting size, component material types and materials, configuration and installation instructions.

2.1.3 Method of field adjustment.

2.1.4 Inspection and maintenance schedule.

2.1.5 Maximum temperature exposure necessitating replacement.

2.1.6 Installation instructions and details. The instructions shall address the need to field test the system for proper operation after installation.

2.2 Product Identification: Each smoke-containment system shall be identified as follows:

2.2.1 The manufacturer's or private labeler's name.

2.2.2 Reference to installation instructions.

2.2.3 Maximum leakage rating at the specified pressure and temperature conditions (cfm/square foot of door opening).

Exception: Where information specified in Section 2.2.3 is in installation instructions attached to, or packaged with, the product, the above information need not be on the smoke-containment system.

2.2.4 Type of door assembly for which smoke-containment system is intended.

Exception: If each product includes the information specified in Section 2.2.4 with installation instructions that

are attached to, or packaged with, the product, the information need not be on the smoke-containment system.

2.2.5 If a product is manufactured at several locations, each piece shall be distinctively marked to identify origin.

2.2.6 Label of the approved inspection agency.

2.2.7 Evaluation report number.

2.3 Testing Laboratories, Test Reports and Product Sampling:

2.3.1 Testing Laboratories: Testing laboratories shall comply with Section 2.0 of the ICC-ES Acceptance Criteria for Test Reports (AC85), and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

2.3.2 Test Reports: Test reports shall comply with AC85.

2.3.3 Product Sampling: Sampling of the smoke-containment system components for tests under this criteria shall comply with Section 3.1 of AC85.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 Materials: The smoke-containment system shall comply with the requirements of either Section 3.1.1, 3.1.2, 3.1.3 or 3.1.4:

3.1.1 The smoke-containment film shall be a minimum 1-mil-thick [0.001 inch (0.025 mm)] transparent polyamide meeting the following requirements:

3.1.1.1 The film shall be reinforced with 100 denier nomex yarn spaced $^1/_4$ inch (6.4 mm) each way. The reinforcing fill yarn shall be attached to the film and overlap the unadhered reinforcing warp yarn. The bond between the yarn and the film shall be at least 2 pounds per inch (0.35 N/mm) when tested according to ASTM D 1876.

3.1.1.2 The film shall be connected along its length to a $2^1/_2$-inch-wide-by-0.125-inch-thick (63.5 mm by 3.2 mm) PM14 multi-pole flexible magnet of energized ferrite in a nitrile rubber binder exerting minimum 1.4 MGOe of force. The multipoles shall be oriented along the length, perpendicular to the magnet width.

3.1.1.3 The film and magnets shall be connected with a 0.5-inch-wide-by-0.125-inch-thick (12.7 mm by 3.2 mm) continuous joint of low-modulus silicone.

3.1.1.4 The smoke-containment film shall have a flame-spread index of 25 or less and a smoke-developed rating of 50 or less when tested in accordance with ASTM E 84 (IBC and SBC) or UBC Standard 8-1 (UBC).

3.1.1.5 The film shall maintain its physical properties after exposure to accelerated aging and certain chemicals. The test methods shall be approved by ICC-ES before the tests are conducted.

3.1.1.6 The smoke-containment system shall be tested and comply with the requirements set forth in Sections 3.2, 3.3, 3.4.1 and 3.5 through 3.8.

3.1.2 The smoke-containment curtain shall be a minimum 2.5-mil-thick [0.0025 inch (0.64 mm)] silica cloth curtain coated with urethane-based resin on one side and complying with the following requirements:

3.1.2.1 The curtain shall be comprised of silica fabric panels stitched together horizontally with twisted stainless steel threads. The stitched seams shall be able to withstand a minimum pressure of 3.1 pounds per square foot (150 Pa).

3.1.2.2 The curtain shall have a flame-spread index of 25 or less and a smoke-developed rating of 50 or less when tested in accordance with ASTM E 84 (IBC and SBC) or UBC Standard 8-1 (UBC).

3.1.2.3 The curtain shall be attached to a horizontal steel winding shaft at the top and set in a frame assembly consisting of a horizontal steel bottom bar assembly and vertical steel guide rails that capture the edge of the curtain. Steel mounting plates attached at the tops of the guide rails support the winding shaft and provide a structure for the attachment of a sheet metal hood. A woven glass-fiber cloth smoke seal is provided on both sides of the head. Secondary components of the assembly include steel locking bolts at the edge of the curtain to retain it in the guides, steel bracket anchors and steel guide rail anchors.

3.1.2.4 The smoke-containment system shall be tested and comply with the requirements set forth in Sections 3.2, 3.4.2 and 3.6 through 3.9.

3.1.3 The smoke curtain system shall consist of a smoke-containment film that is a minimum 3-mil-thick [0.003 inch (0.076 mm)] PTFE-coated glass-fiber or para-aramid meeting the following requirements:

3.1.3.1 The film shall consist of separate PTFE-coated glass-fiber or para-aramid sheets, joined horizontally by heat sealing.

3.1.3.2 The smoke-containment film shall be connected to the drive system utilizing vertical edge containment loops on either side of the curtain. The loops slide over vertical guide rods contained within the side rails. A narrow vertical slot in each side rail prevents the screen/guide rod assembly from disengaging the side rail.

3.1.3.3 The side rails attach from floor to ceiling on both sides of the opening to be protected. The top portion of the rails also attach to the units housing for the purpose of aligning drive components.

3.1.3.4 The curtain is mechanically operated up and down by an electric drive motor that turns a bearing supported axle running the length of the housing, and pulleys engaging toothed drive belts and contained within the side rails adjacent to the screen guide rods. The toothed drive belt and pulleys at the end of the axle actuate loops in the drive belt. When the belt is activated, the bottom bar of the smoke curtain lowers from the housing as a screen roller tube feeds out the smoke curtain.

3.1.3.5 An egress switch that complies with ANSI A 117.1 for operation of a powered door shall be located on both sides of the smoke curtain.

3.1.3.6 The smoke-containment film shall have a flame-spread index of 25 or less and a smoke-developed rating of 50 or less when tested in accordance with ASTM E 84 (IBC and SBC) or UBC Standard 8-1 (UBC).

3.1.3.7 The smoke-containment system shall be tested and comply with the requirements set forth in Sections 3.2, 3.4.1 and 3.5 through 3.8.

3.1.4 The smoke containment curtain shall be a minimum 2.5-mil-thick [0.0025 inch (0.65 mm)] silica cloth, coated on one side with acrylic resin and complying with the following requirements:

3.1.4.1 The curtain shall be comprised of silica cloth panels stitched together vertically with twisted stainless steel threads. The acrylic resin coating shall have a minimum coverage of 2.36 ounces per square foot (80 g/m^2). The stitched seams shall be able to withstand a minimum pressure of 3.1 pounds per square foot (150 Pa).

3.1.4.2 The curtain material shall be connected along its length to a $3^1/_2$- inch-wide-by-0.124-inch-thick (83 mm by 3.2 mm) multi-pole magnet of energized ferrite in an nitrile rubber binder exerting a minimum 1.4 MGOe force. The multipoles shall be oriented along the length perpendicular to the magnet width.

3.1.4.3 The curtain material shall completely cover the magnets and shall be joined by stitching (2X) along the full length of the magnet.

3.1.4.4 Between the magnet and the curtain material a $4^3/_4$-inch-wide-by-$^5/_{64}$-inch-thick heat expansion material consisting of intumescent graphite encapsulated in a butyl rubber sheet shall be enclosed along the full length of the magnet. The edges of the magnet shall be protected by $^3/_4$-inch-wide-by-$^5/_{64}$-inch-thick (20 mm x 2 mm) of the same material. The heat expansion material shall have the capability of expanding a minimum of 10 times the original material thickness.

3.1.4.5 At variable positions along the magnet length bi-metallic shape memory alloy strips consisting of Nickel – titanium and measuring $2^3/_4$-inch-wide-by-$^3/_{16}$-inch-high-by-$^1/_{64}$-inch-thick (70mm by 5mm by 0.5mm) shall be riveted horizontally on the elevator side of the curtain. The bi-metallic strips shall activate at a maximum temperature of 212°F (100 °C). When heated, the bi-metallic strips shall expand differentially into a concave shape and grasp specially shaped auxiliary rails after which the intumescent material expands to protect the magnet and bimetallic strips.

3.1.4.6 The curtain shall have a flame spread index of 25 or less and a smoke-developed index of 50 or less when tested in accordance with ASTM E 84 (IBC or SBC) or UBC Standard 8-1 (UBC).

3.1.4.7 The smoke containment system shall be tested and comply with the requirements set forth in Sections 3.2, 3.4.1 (excluding Sections 3.4.1.6.1.3 through 3.4.1.6.1.6) and 3.6 through 3.9.

3.2 Air Leakage: The rate of air leakage through the smoke-containment system shall be determined at 0.1 inch (25 Pa), 0.2 inch (50 Pa) and 0.3 inch (75 Pa) water pressure differential when tested to the performance requirements of UL 1784 (IBC and SBC) or UBC Standard 7-2, Part II (UBC). Tests include cycling and air leakage at ambient and elevated [400˚F (204˚C)] temperatures.

Conditions of Acceptance: The air leakage rating at both ambient and elevated [400˚F (204˚C)] temperatures shall not exceed 3.0 cfm (14.16×10^{-4}) per square foot of opening at 0.1 inch water pressure (25 Pa) difference.

3.3 Expansion Characteristics: The total expansion of the smoke-containment system shall be determined at 0.3 inch water pressure (75 Pa) differential at both ambient and elevated [400˚F (204˚C)] temperatures.

Conditions of Acceptance: The smoke-containment system cannot expand more than 6 inches (152 mm) at this pressure difference at ambient or elevated [400˚F (204˚C)] temperatures.

3.4 Cycling: The smoke-containment system shall be cycled according to one of the following methods.

3.4.1 Standard Test Method for Cyclic Movement of Rolling Magnetic Gasket Systems:

3.4.1.1 Purpose: To determine the cyclic movement of the rolling magnetic gasket system.

3.4.1.1.1 This test method is applicable to rolling magnetic gasket systems used to prevent the infiltration of air and smoke through an entrance or exit way.

3.4.1.2 Apparatus:

3.4.1.2.1 Any arrangement of equipment capable of performing the test procedure within the allowable tolerances is permitted.

3.4.1.2.2 Mounting Frames: No. 14 gage ferrous metal frames shall have a 2-inch-wide (51 mm) profile. Frame shall be blind attached to the wall.

3.4.1.3 Test Specimens: Three full size samples shall be used. The temperatures within the laboratory shall be 73.4˚F ± 3.6˚F (23˚C ± 2˚C).

3.4.1.4 Mounting: The system is mounted above test frame according to the manufacturer's written installation instructions. The resulting installation shall be plumb and square.

3.4.1.5 Procedure: Emergency alarm contacts are first energized, allowing the curtain to drop, completely covering the opening. The rewind contacts are next energized, allowing the curtain to roll into container, completely unseating the gasket material.

The door is closed. The curtain is visually inspected after each set of 50 full cycles. The container and frame are visually inspected after each set of 100 full cycles.

3.4.1.6 Visual Inspection:

3.4.1.6.1 Immediately following each set of 50 full cycles, the curtain is visually inspected for the following signs of fatigue:

3.4.1.6.1.1 Visual metal fatigue.

3.4.1.6.1.2 Cracks or creases in film.

3.4.1.6.1.3 Loss of reinforcing yarn adhesion.

3.4.1.6.1.4 Loss of sealant joint adhesion.

3.4.1.6.1.5 Stretching of sealant joint.

3.4.1.6.1.6 Loss of laminating adhesive.

3.4.1.6.1.7 Misalignment of curtain reel at threshold.

3.4.1.6.1.8 Misaligned rolling relative to the test frame.

3.4.1.6.2 Immediately following each set of 100 full cycles, the curtain is visually inspected for the following signs of fatigue:

3.4.1.6.2.1 Visual metal fatigue.

3.4.1.6.2.2 Warpage of door.

3.4.1.6.2.3 Visual damage to hinge, latch or door stay.

3.4.1.6.3 Immediately following each set of 100 full cycles, the test frame is visually inspected for visual wear.

3.4.1.7 Conditions of Acceptance: The smoke-containment system shall demonstrate no fatigue after completing 100 cycles. The system shall continue to function without impairment.

3.4.2 Standard Test Method for Cyclic Movement of Coiling Curtain Systems:

3.4.2.1 Purpose: To determine the cyclic movement of the coiling curtain system.

3.4.2.1.1 This test method is applicable to coiling curtain systems described in Section 3.1.2 used to prevent the infiltration of air and smoke through an entrance or exit.

3.4.2.2 Apparatus:

3.4.2.2.1 Any arrangement of equipment capable of performing the test procedure within the allowable tolerances is permitted.

3.4.2.2.2 Guide Rails: Minimum No. 16 gage steel plate, of the manufacturer's standard profile and size. Frame shall be attached to the wall in accordance with the manufacturer's standard installation instructions.

3.4.2.3 Test Specimens: Three full-size samples shall be used. The temperature within the laboratory shall be 73.4˚F ± 3.6˚F (23˚C ± 2˚C).

3.4.2.4 Mounting: The system is mounted above the test frame according to the manufacturer's written installation instructions. The resulting installation shall be plumb and square.

3.4.2.5 Procedure: Emergency alarm contacts are first energized, allowing the curtain to drop, completely covering the opening. The alarm contacts are de-energized and the release mechanism is reset and the curtain is rolled back into the initial open position.

The door is closed. The curtain is visually inspected after each set of 50 full cycles. The container and frame are visually inspected after each set of 100 full cycles.

3.4.2.6 Visual Inspection:

3.4.2.6.1 Immediately following each set of 50 full cycles, the curtain is visually inspected for the following signs of fatigue:

3.4.2.6.1.1 Cracks or creases in the fabric.

3.4.2.6.1.2 Curtain edge retention in the vertical guiderails.

3.4.2.6.1.3 Misalignment of the bottom bar at threshold.

3.4.2.6.1.4 Misaligned rolling relative to the test frame.

3.4.2.6.2 Immediately following each set of 100 full cycles, the curtain is visually inspected for the following signs of fatigue:

3.4.2.6.2.1 Cracks or creases in the fabric.

3.4.2.6.2.2 Warpage of curtain or frame.

3.4.2.6.2.3 Visual damage to entire assembly.

3.4.2.6.3 Immediately following each set of 100 full cycles, the test frame is visually inspected for visual wear.

3.4.2.7 Conditions of Acceptance: The smoke-containment system shall demonstrate no fatigue after completing 100 cycles. The system shall continue to function without impairment.

3.4.3 Standard Test Method for Cyclic Movement of Smoke Curtain Systems:

3.4.3.1 Purpose: To determine the cyclic movement of the smoke-containment system.

3.4.3.1.1 This test method is applicable to smoke-containment systems described in Section 3.1.3 used to prevent the infiltration of air and smoke through an entrance or exit.

3.4.3.2 Apparatus:

3.4.3.2.1 Any arrangement of equipment capable of performing the test procedure within the allowable tolerances is permitted.

3.4.3.2.2 Mounting Frames: For systems described in Section 3.1.1, the frame shall consist of No. 14 gage ferrous metal frames having a 2-inch-wide (51 mm) profile. The frame shall be blind-attached to the wall. For the systems described in Sections 3.1.2 and 3.1.3, the system shall be mounted in accordance with the system manufacturer's instructions.

3.4.3.3 Test Specimens: Three full-size samples shall be used. The temperature within the laboratory shall be 73.4˚F ± 3.6˚F (23˚C ± 2˚C).

3.4.3.4 Mounting: The system is mounted above the test frame according to the manufacturer's written installation instructions. The resulting installation shall be plumb and square.

3.4.3.5 Procedure: Emergency alarm contacts are first energized, allowing the curtain to drop, completely covering the opening. The rewind contacts are next energized, allowing the curtain to roll into container, completely unseating the gasket material.

The curtain is visually inspected, with the curtain in the closed position, after each set of 50 full cycles. The container and frame are visually inspected after each set of 100 full cycles.

3.4.3.6 Visual Inspection:

3.4.3.6.1 Immediately following each set of 50 full cycles, the curtain is visually inspected for the following signs of fatigue:

3.4.3.6.1.1 Visual metal fatigue.

3.4.3.6.1.2 Cracks or creases in film.

3.4.3.6.1.3 Loss of fabric adhesion.

3.4.3.6.1.4 Misalignment of curtain reel at threshold.

3.4.3.6.1.5 Misaligned rolling relative to the test frame.

3.4.3.6.2 Immediately following each set of 100 full cycles, the curtain is visually inspected for the following signs of fatigue:

3.4.3.6.2.1 Visual metal fatigue.

3.4.3.6.2.2 Warpage of door.

3.4.3.6.2.3 Visual damage to operable components.

3.4.3.6.3 Immediately following each set of 100 full cycles, the test frame is visually inspected for visual wear.

3.4.3.7 Conditions of Acceptance: The smoke-containment system shall demonstrate no fatigue after completing 100 cycles. The system shall continue to function without impairment.

3.5 Motor: The motor shall be evaluated and listed as required by NFPA70, the National Electrical Code.

3.6 Release Mechanisms: Components of release mechanisms shall be recognized by an independent testing agency accredited by the International Accreditation Service, Inc. (IAS). For the system described in Section 3.1.3, the integral battery backup system that is part of the releasing drive shall be tested and listed to UL 864.

3.7 Smoke Detector: The smoke detector to which the smoke-containment system is connected shall be tested and listed according to UL 228 or UL 268.

3.8 Opening Force: The maximum force to disengage the gasketing system described in Section 3.1.1 is 15 lbf (67 N), and shall be verified by using a spring scale applied perpendicular to the plane of the film at the boundary. The maximum force to lift the curtain described in Section 3.1.2 is 15 lbf (67 N), and shall be verified by using a spring scale applied perpendicular to lower horizontal edge of the curtain assembly.

3.9 Fire Test: The smoke-containment system shall have a minimum 20-minute rating without hose stream when tested in accordance with UL 10B and IBC Section 715.4.2.

Exception: When recognition of the system is for use as an alternative to a 20-minute fire door assembly complying with the requirements of the IBC Section 715.4.3, the smoke-containment system shall have a minimum 20-minute rating without hose stream when tested in accordance with UL 10C.

4.0 QUALITY CONTROL

4.1 The products shall be manufactured under an approved quality control program with inspections by an inspection agency accredited by International Accreditation Service.

4.2 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted. ■

TABLE 1—CROSS REFERENCE OF STANDARD EDITIONS

STANDARD	1997 *UNIFORM BUILDING CODE*™	2006 *INTERNATIONAL BUILDING CODE*®	1999 *STANDARD BUILDING CODE*©
ASTM D 412	1988	1988	1988
ASTM D 1434	1988	1988	1988
ASTM D 1876	1983	1983	1983
ASTM E 84	UBC Standard 8-1	2004	1995
NFPA 70	1996	2005	1996
NFPA 105	1989	2003	1989
NFPA 228	1986	1986	1986
NFPA 258	1987	1987	1987
UL 10B	UBC Standard 7-2, Part I	1997 with revisions through October 2001	N/A
UL 10C	N/A	1998 with revisions through November 2001	N/A
UL 228	1986	1986	1986
UL 268	N/A	1996 with revisions through January 1999	1989
UL 864	N/A	2003 with revisions through October 2003	N/A
UL 1784	UBC Standard 7-2, Part II	1995	1995

OFFICE OF THE STATE FIRE MARSHAL
FIRE ENGINEERING DIVISION
BUILDING MATERIALS LISTING PROGRAM

APPLICATION FOR LISTING SERVICE

PRINT OR TYPE. Incomplete applications will be RETURNED.

Company Name: BLE Smoke & Fire Curtain CSFM Assigned Co. Number: _____

Address: 12310 Pinecrest Road Suite 201

Reston, VA 20191

Contact Person: Dr. Steven Sadeghian Email: steven@cysadevelopment.com

Telephone: (888) 917-5612 Fax: (888) 917-8777

APPLICATION IS HEREBY MADE FOR THE FOLLOWING (***CHECK ONE***):

[X] **New listing**: Specify Category No. from CSFM Category List: **4076**
Provide check/money order for $320.00 (per each listing), copy of **complete test report**, copy of manufacturer's data sheet/specifications and a completed application.

[ ] **Technical Revision** to existing Listing No. _____
Provide check/money order for $200.00 (per each listing), copy of **revised test report pages corroborating revision**, copy of manufacturer's data sheet/specifications, description of exact revision (please edit copy of current existing listing), and a completed application.

[ ] **Cross listing** from existing Listing No. _____
Provide check/money order for $320.00 (per each listing), copy of the testing laboratory correlation sheet, copy of the manufacturer's data sheet/specifications and a completed application.

[ ] **Non-technical Revision** for Listing No. _____
For **Listee's name** ( ) and/or **address** ( ) change only (Please check appropriate box). For others, see Technical Revision. Provide check/money order for $25.00 (per each listing), description of requested changes and a completed application. Name changes require notification on listing company letterhead (both new and former company) and verification letter from testing laboratory.

Description of product (make/model, etc) and explanation of action needed **(MUST BE COMPLETED)**:
BLE FC240 Fire-protective Curtain: 2-hour rated smoke and fire curtain with UL 1784 "S" Label
CSFM Category Listing for 4076 Smoke and Draft Control for Fire Door
See UL Reports: R21493 (Oct. 28, 2003); R26410 (June 15, 2009); R26410 (Sept. 5, 2009)

CERTIFICATION: As company owner, responsible company officer or authorized agent, I certify that I have read and understand the information on the reverse side of this form and that the facts I present to the California State Fire Marshal for review and evaluation are true and accurate.

Signature _____ Printed Name of Signee Dr. Steven Sadeghian

Date November 9th, 2011 Title of Signee CEO

SUBMISSION: A completed application (on an original application form) and all required supplemental data should be submitted to the address listed next page. Evaluations will be reviewed in the order in which they are received at CSFM. ***Failure to supply all needed information (including signature) will result in REJECTION of the application package.***

FOR CSFM USE ONLY: **Source Code 125700-11** **Box Number:**

Date received: **Date Confirm:**
Date Draft: **Date Final:**

OFFICE OF THE STATE FIRE MARSHAL
FIRE ENGINEERING DIVISION
BUILDING MATERIALS LISTING PROGRAM

APPLICATION FOR LISTING SERVICE

PRINT OR TYPE. Incomplete applications will be RETURNED.

Company Name: BLE Smoke & Fire Curtain CSFM Assigned Co. Number:

Address: 12310 Pinecrest Road Suite 201

Reston, VA 20191

Contact Person: Dr. Steven Sadeghian Email: steven@cysadevelopment.com

Telephone: (888) 917-5612 Fax: (888) 917-8777

APPLICATION IS HEREBY MADE FOR THE FOLLOWING (***CHECK ONE***):

[X] **New listing**: Specify Category No. from CSFM Category List: **4076**
Provide check/money order for $320.00 (per each listing), copy of **complete test report**, copy of manufacturer's data sheet/specifications and a completed application.

[ ] **Technical Revision** to existing Listing No.
Provide check/money order for $200.00 (per each listing), copy of **revised test report pages corroborating revision**, copy of manufacturer's data sheet/specifications, description of exact revision (please edit copy of current existing listing), and a completed application.

[ ] **Cross listing** from existing Listing No.
Provide check/money order for $320.00 (per each listing), copy of the testing laboratory correlation sheet, copy of the manufacturer's data sheet/specifications and a completed application.

[ ] **Non-technical Revision** for Listing No.
For **Listee's name** ( ) and/or **address** ( ) change only (Please check appropriate box). For others, see Technical Revision. Provide check/money order for $25.00 (per each listing), description of requested changes and a completed application. Name changes require notification on listing company letterhead (both new and former company) and verification letter from testing laboratory.

Description of product (make/model, etc) and explanation of action needed **(MUST BE COMPLETED)**:
BLE FC60 Fire-protective Curtain: 1-hour rated smoke and fire curtain with UL 1784 "S" Label
CSFM Category Listing for 4076 Smoke and Draft Control for Fire Door
See UL Reports: R21493 (Oct. 28, 2003); R26410 (June 15, 2009); R26410 (Sept. 5, 2009)

CERTIFICATION: As company owner, responsible company officer or authorized agent, I certify that I have read and understand the information on the reverse side of this form and that the facts I present to the California State Fire Marshal for review and evaluation are true and accurate.

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FOR CSFM USE ONLY: **Source Code 125700-11** **Box Number:**

Date received: **Date Confirm:**
Date Draft: **Date Final:**

Table 1: Egress Width Calculation

Egress Component	Width (in)	Width Factor	Capacity
S201 Stair –Double scissor stair	168	0.08	2100
S301 Stair	100	0.08	1,250
S401 Stair	110	0.08	1,375
S601 Stair - Double scissor stair	200	0.08	2,500
Total	**600**		**7,225**

Occupant Load

Traditionally, parks are not assigned occupant loads as they are outdoor, at-grade areas that are not normally located inside or on top of a building. Entrance into a traditional park can be via multiple locations. Because the Park is located on top of the TTC, during an emergency, occupants at the Park level should be provided with suitable means of notification and exits to safely evacuate from this level. The strictest approach to determining the occupant load for the Park would be to use occupant load factors (as defined in Chapter 10 of the CBC). In meetings with DBI and SFFD, the occupant load factors defined in Table 2 were reviewed and agreed to based on comparisons to other uses and their similarities to the proposed use.

Table 2: Park Occupant Load Factors

Area Description	Description of Use	Occupant Load Factor (ft^2/Occupant)
Assembly	Daytime and after-hours concerts, theatrical performances, *Opera in the Park*, and symphony performances	7
Child Area	Lawn and structurally permanent landscape; dynamic play, artistic element; casual outdoor cafe with seating, serving light "to-go" fare	15
Circulation	Hard walking surfaces similar to airport concourse	100
Landscape	Permanent landscape, planting features and mounds that create the Park topography that cannot be moved, as this is integrated into the base structure of the Park	100
Lawn	Mounded and flat lawn areas; garden, picnics, passive play, frisbee toss, etc.	15
Retail Kiosk	Small kiosks for food, souvenirs, and newspapers	200
Stage	Stage for concerts, theatrical performances, opera, and symphony performances	15
Storage	General storage area behind the stage	300
Restroom	Public restroom	200
Fixed Elements	Light wells, stairs, escalators, etc. – Non occupiable	0
Planting	Densely planted areas around the perimeter of the Park – Non occupiable	0
Water features	Fixed water feature around the perimeter of the Park – Non occupiable	0

The intent is that the Park will be divided into areas with specific uses. One area will have the ability to host staged concerts, another will be designated as communal space, and the other areas will be paved paths or landscaped areas. The Park will consist of 12 sections: assembly, child area, circulation, landscape, lawn, retail kiosk, stage, storage, restroom, planting, fixed elements, and water features, as depicted in Figure 1.

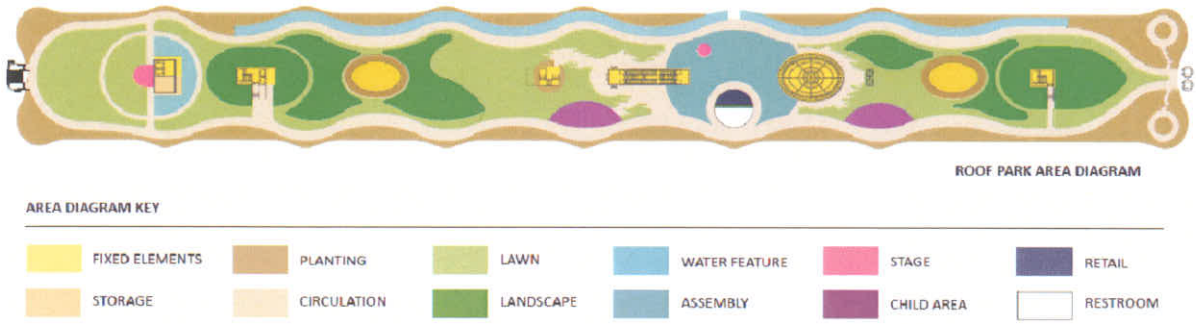


Figure 1: Specific uses of the Park

Applying the occupant load factors in Table 2 to the specific use gives the following occupant loads in Table 3:

Table 3: Occupant Load Calculation

Area	Load Factor	Net Area (ft^2)	Occupant Load
Assembly	7	13,324	1904
Child Area	15	3,806	254
Circulation	100	50,014	501
Landscape	100	28,947	290
Lawn	15	61,146	4077
Retail Kiosk	200	696	4
Stage	15	357	24
Storage	300	277	1
Restroom	200	1,534	8
Planting for the perimeter	0	33,885	0
Fixed Elements	0	17,069	0
Water Features	0	9,922	0
Total		**220,977**	**7063**

Note that the total stair capacity in Table 1 is 7,225, which is in excess of the total occupant load indicted in Table 3. The occupant loads indicated in Table 3 are used as examples; the final occupant loads and load factors will be confirmed during the plan check process.

Required Exits and Assembly Main Exit

Because the total occupant load is more than 1,000, four means of egress are required, in accordance with SFBC Table 1019. The exception of SFBC Section 1025.2 permits exits to be distributed around the perimeter of the building instead of providing a main exit. However, at least one exit should discharge on to a street or unoccupied space of not less than 20 feet in width. The four exits are distributed so that high occupant load areas of the Park are provided with suitable exit capacity. All four exits (refer to Exit Discharge) discharge at grade.

The requirement that Group A occupancies with occupant loads greater than 300 will be provided with an exit width factor of 0.2 inch per person is exempt if a smoke protected assembly is provided. The code exemptions specifically state "smoke protected assembly seating," which implies a mechanical smoke control system. However, the intention of Section 1025.6.3 is to ensure that the same level of protection as a mechanical smoke control system is provided. It is our contention that the outdoor smoke protected assembly meets the intent and level of safety required by the SFBC and is therefore exempt from providing a main exit.

Exit Discharge

Exits are required to discharge to the exterior of the building in accordance with SFBC Section 1024.1. SFBC Section 1024.4 requires that the exit discharge "be sufficiently open to the exterior so as to minimize the accumulation of smoke and toxic gases." Also, SFBC Section 1024.6 requires that "the exit discharge shall provide a direct and unobstructed access to a public way." The definition of a public way is as follows:

> *PUBLIC WAY: A street, alley or other parcel of land open to the outside air leading to a street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and which has a clear width and height of not less than 10 feet (3048 mm).*

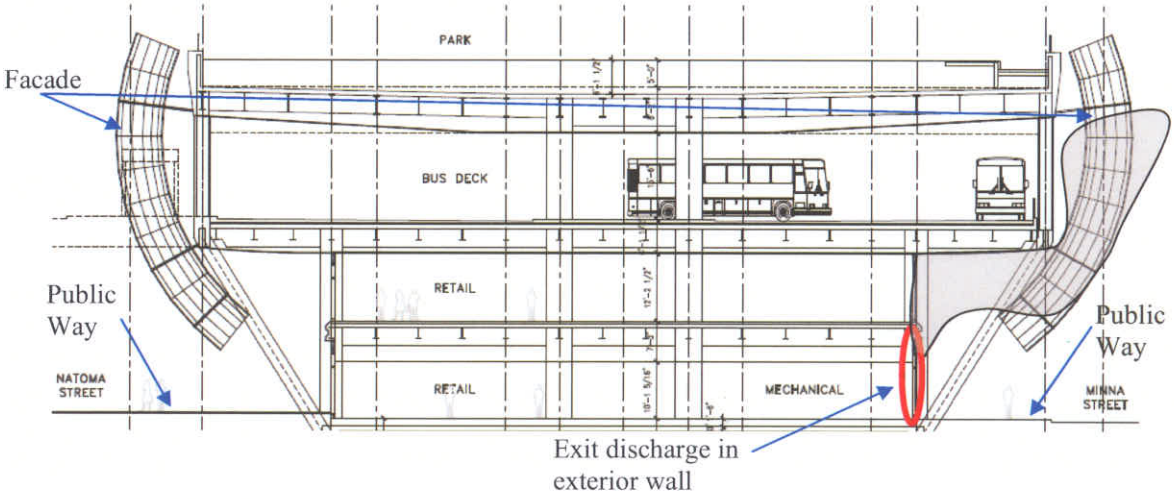


Figure 2: Transverse building section showing areas of discharge

Figure 2 shows that the exit discharge for the four means of egress will have direct access to a public way, except for Stair S601 as described herein. The exits discharge at the exterior of the building at grade; however, the bus deck slab cantilevers over the sidewalk approximately 35 feet above grade. The exterior façade, is a curtain wall made of glass that cantilevers over the sidewalk. Smoke from a fire at ground or the second level would spill and deflect at the slab above. This area is sufficiently open that smoke would not accumulate above the exit and affect the exit discharge. Because occupants have direct access to the public way and the area is sufficiently open this configuration meets the requirements of SFBC Section 1024.

Four emergency stairs are provided from the Park. Stair S201, a double scissor stair located at the west end of the building discharges to an egress court that is open to the sky and provides access to the Minna Street sidewalk. Stair S301 will discharge onto the Minna Street sidewalk to the north. Stair S401 will discharge to

the north onto Minna Street sidewalk. Stair S601 will discharge into the bus plaza between Fremont Street and Beale Street. This configuration meets the requirements of SFBC Section1024.1\, Exception 1 where three out of four exits (S201, S301, S401) discharge directly to the public way; the fourth (S601) discharges below the building into the bus plaza. Stair S601 discharge will meet all of the requirements under SFBC Section 1024.1, Exception 1.1–1.3. That is, there is a direct line of site to the exterior of the building and the public way, there is fire-rated construction between the level of discharge and the train box, and there will be sprinklers over the bus plaza. The attached drawings show plan views of the Park and ground level and detailed plans of the exit discharge.

Path of Egress

For the concept of the "egress path," certain sections of the circulation path around the perimeter of the Park have been considered analogous to a corridor (refer to Figure 3) where multiple "imaginary" exits from adjoining space will enter the corridor. Areas adjoining the path (such as lawns and large assembly areas) are considered rooms. Occupants in a room can reach an exit access through several intervening rooms such as planting areas, lawn, and circulation areas. The west and east ends of the egress path will form a loop. This has been done to avoid "dead-end corridors" and to address "common paths of travel" for areas of the Park that are behind large mounds where a direct line of sight to exits is obstructed. Since the travel distance is not limited for outdoor smoke-protected assemblies, all occupants will have at least two means of egress at any location on the Park. Refer to the attached preliminary exiting plan for distribution of occupant loads. This is included as an example; the final exiting plan will be reviewed during the plan check process.

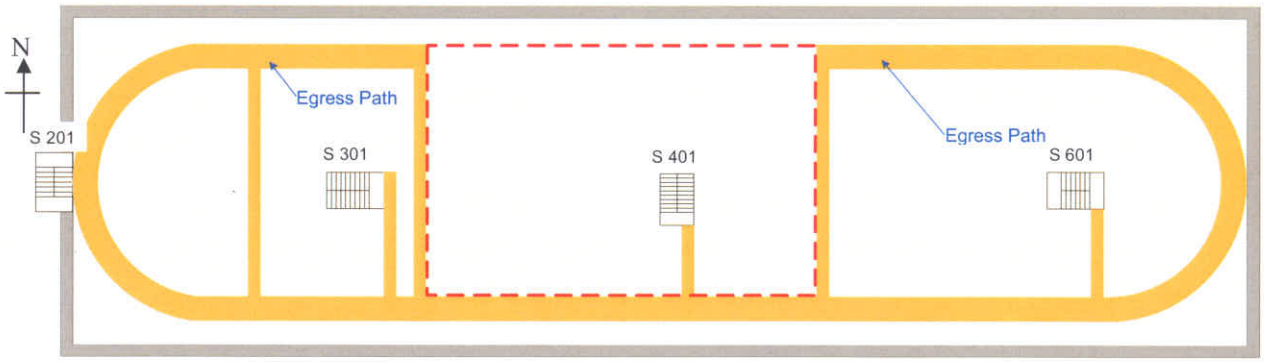


Figure 3: Analogous corridor concept

Emergency Lighting and Exit Signage

Emergency lighting and exit signage will be provided along the defined "egress path" identified in the previous section. Emergency lighting will comply with Section 1006.3 of the SFBC and the SFFC respectively . These require an "initial illumination that is at least an average of 1 foot-candle (11 lux) and a minimum at any point of 0.1 foot-candle (1 lux) measured along the path of egress." Exit signage will be provided in accordance with Section 1011 of the SFBC and the SFFC respectively.

Park Operational Procedures

The proposed operating hours of the Park are between sunrise and sunset; these could change at the discretion of the Transbay Joint Powers Authority (TJPA). It is proposed that the Park will have security monitoring at all times via CCTV and other means such as security guards. It is recognized that a special event, concert, or catered function in the Park will draw large crowds, but not of the magnitude that would result in the maximum occupant load. Additional crowd control could include controlled access at all the entrances during special events via security control and ticket-access-only. It is the intent that the TJPA will develop operational procedures for the Park to address these scenarios and will be incorporated into an overall building management strategy.

Conclusion

In our opinion, the proposed design of the Park meets the requirements of the San Francisco Building Code.

Prepared by:

Arup Fire

11/18/09

Andrew R Coles, PE Date

Approved by Hanson Tom

San Francisco Department of Building Inspection

Hanson Tom 11/24/09

Date

Approved by Bill Mitchell

San Francisco Fire Department

Capt WJ Mitchell 11/24/09

Date

Approved by Edmond Sum

Transbay Joint Powers Authority

19 NOV 2009

Date

Request for Interpretation #3

Transbay Transit Center, San Francisco

Bus Deck Automatic Fire Sprinkler System Design Criteria

Introduction

The 3rd level of the Transbay Transit Center (TTC) is an elevated, fully covered, bus terminal for passenger pick up and drop off. Above the bus terminal is the Rooftop Park. Because the Bus Deck is part of a fully sprinklered building and is covered, the Bus Deck is required to be provided with a sprinkler system in conformance with the applicable codes, the 2007 California Building and Fire Codes (CBC and CFC) as adopted by the City of San Francisco Department of Building Inspection (DBI) and the San Francisco Fire Department (SFFD). DBI and SFFD have acknowledged and accepted that the Bus Deck is permitted to be designed in accordance with NFPA 130, Standard for Fixed Guideway Transit Systems. (See Local Equivalency #1)

In order to design the sprinkler system, the CBC and CFC refer to NFPA 13, Standard for the Installation of Sprinkler Systems, 2002 edition. As part of the design process, it is necessary to classify the hazard in accordance with NFPA 13, as approved by the SFFD. Because a bus fire can be shielded, the SFFD have indicated that the hazard of the bus deck could be beyond the capabilities of Ordinary Hazard (OH) Group II sprinkler systems and that the design should consider a superior system such as Extra Hazard (EH). The SFFD has indicated that the system may need to be Extra Hazard Group II. The following is a request for interpretation using a Extra Hazard Group I Classification.

Code Section and Requirement

CBC and CFC Chapter 9 identify when sprinklers are required.

CFC Chapter 45, identifies the referenced standard to be used for sprinkler system design. The reference has been excerpted as follows:

NFPA

Standard Reference Number	Title
13-02	Installation of Sprinkler Systems, as amended[1]

Code Intent

This section of the code is intended to refer the designer to NFPA 13 in order to design a sprinkler system to protect the building from fire. The scope of NFPA 13 covers the design and installation of a building's sprinkler systems that discharge water in order to control a fire. The system is intended to control the

[1] There are no relevant amendments in the CBC that would alter the NFPA 13 hazard classification process of a bus deck. The CBC defers to the base NFPA 13 language for classification.

spread of fire such that occupants remote from the fire can evacuate safely, the structure is protected from failure, flashover is mitigated, and the fire is either extinguished or maintained at a size that can be extinguished by the responding fire department.

It is not the scope for the system to extinguish a fire, even though in many cases historically, this has and can occur. The purpose of NFPA 13 is to "provide a reasonable degree of protection for life and property from fire."

Requested Interpretation

The current design provides a EH Group I sprinkler system design for the bus deck using a 14 foot by 9.2 foot coverage (129 square feet) (based on Table 8.6.2.2.1(c)) with high temperature (212 degree Fahrenheit), larger orifice (K=8.0) sprinklers. Higher temperature sprinklers are better suited for this application since the fire is not expected to be extinguished and, as a shielded fire, is expected to grow to a substantial size. The application of higher temperature sprinklers thereby increases the effectiveness of the system because their higher temperature helps prevent sprinkler activation remote from the fire. Preventing sprinkler activation remote from the fire ensures more water delivery directly above and near the fire. Using a larger (K=8.0) than standard (K=5.6) orifice sprinkler helps as they tend to produce larger droplets which are more effective to better penetrate through a larger plume for both heat absorption and pre-wetting adjacent unburnt areas near the seat of the fire.

Heat Release Rate

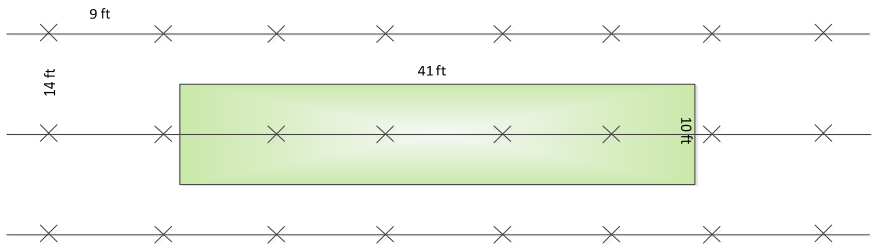
As part of our assessment, we have considered the challenge relating to the potential fire size a bus can present.

The bus design fire size used previously for the TTC structural fire engineering calculations (RFLE 3) was established for the project at 35MW. This is based on older bus test taken from the SFPE Handbook. More recent bus fire tests in Sweden on modern coaches and buses reveal a peak heat release rate in the range of 20-30 MW, however it was agreed to utilized the more conservative value. Notably both fire tests assumed no sprinklers present. Even though the older bus fire test, with the resulting peak heat release was performed without sprinklers present, it was agreed that this peak fire size would also be used for application to the bus deck smoke control analysis.

The same fire size would not be expected with the presence of activated sprinklers. Studies (*Fire Spread in Car Parks*, Department for Communities and Local Government, 2010) show that shielded vehicle fires produce a smaller peak heat release rate when protected by fire sprinklers. The peak heat release rate for larger cars is reduced to more than half when tested under sprinklered conditions, a fact recognized as an acceptable assumption in building design standards in the United Kingdom. (BS 7346-7:2006**)** This is in large part due to some spray intruding into the vehicle's interior via broken windows pre-wetting some of the combustibles, and in part due to the absorption of heat by the sprinkler spray itself. If an inadequate amount of water is supplied to the sprinklers around/above the fire, less than or equal to the amount needed to absorb the heat being released, it is unlikely they will control or provide any suppression of the peak heat release rate. It is only when the amount of water supplied is in of excess of the expected peak heat release rate that one could theoretical expect the sprinklers to offer any benefit.

In order to investigate whether the proposed system would be capable of at least supplying enough water to absorb the extreme peak heat release rate, we have performed the following calculation:

Extra Hazard I



HRR: 35 MW = 35,000 KW = 33,196 Btu/s

Sprinkler Density = 0.24 gpm/ft^2 = 0.033 lb/s-ft^2

(0.24 gal/m-ft^2 ×(1ft^3/7.48gal) × (1min/60s) × 62.43 lb/ft^3)

Δh_{fg} = 970 Btu/lb (latent heat of vaporization of water)

Based on the geometry of the bus, it is assumed that 24 sprinkler heads would be activated and the area of sprinkler activation is assumed 4,000 square feet.

Therefore, the delivered water from the sprinkler system is 132 lb/s to the bus and flames.

0.033 lb/s-ft^2 × 4,000 ft^2 = 132 lb/s

Water falling on the bus can theoretically absorb 128,040 But/s heat.

(132 lb/s × 970 Btu/lb = 128,040 Btu/s)

In conclusion, approximately 26 % of the delivered water can be adequate to absorb 35 MW, the design fire. (33,196 Btu/s ÷ 128,040 = 0.26)

* Additional Consideration (Conservative Assumptions)

A) The sprinklers are expected to discharge the minimum design density.

B) The heat absorbed by the sprinkler water to heat the droplets from 70F to 212F is not included.

C) Automatic sprinkler designed to operate at 4,000 ft^2.

The calculation shows that the amount of heat that the EH-1 system can theoretically absorb is greater than the prescribed 35MW. Although this calculation cannot be used to predict with certainty that all the sprinklers will spray water in such a manner that all droplets will absorb each kW of heat produced, it does give an indication that there is sufficient water supply provided. Furthermore, this calculation has some elements of conservatism as

1. It is not likely that, under operating sprinklers, the bus will actually reach 35 MW and
2. It has not included the additional energy absorbed by the droplets as they heat to vaporization state (from ambient to 212 degrees Fahrenheit (100 degrees C)).

Conclusion

The classification of the NFPA hazard of a given occupancy is an interpretive exercise. It is largely based on expert judgment by using information in NFPA 13 and comparing the various examples to the

proposed occupancies. We have utilized our best engineering judgment to develop an appropriate hazard classification for the bus deck bus area protection system based on the guidance and information given in NFPA 13. This is outlined in detail in this request for interpretation. We have concluded that the amount of water designed to be supplied by the sprinkler system provides heat absorption capacity an order of magnitude greater than the heat expected at sprinkler operation, and multiple times what would be required if the bus fire were to continue growing to its unsprinklered heat release rate.

We are attaching the floor plans with the proposed sprinkler head and piping layout and the supporting hydraulic calculations.

We conclude that the sprinkler hazard classification of Extra Hazard Group 1 with higher temperature, larger orifice (K=8.0) sprinklers is appropriate for the Bus Deck at the TTC, and is expected to provide a level of safety equal to or greater than that intended by the code. We respectfully request your concurrence with the understanding that the proposed hazard, with high temperature and large orifice sprinklers will meet the level of safety intended by the code.

Prepared by:
Arup Fire

Armin Wolski, P.E. Date

Approved by:
San Francisco Building Department

Hanson Tom Date

Prepared by:
Mechanical Design Studio, Inc.

Minola Anghel 4/29/2013

Minola Anghel, F.P.E. Date

Approved by:
San Francisco Fire Department

Date

Approved by:
Transbay Joint Powers Authority

Edmond Sum Date

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January 18, 2013

Request for Interpretation #4 Emergency Stretcher Elevator, Transbay Terminal Center

Dear Sir or Madam

We are writing for confirmation of our interpretation of the application of Section 3002.4a of the applicable 2007 California Building Code (CBC) as it applies to the Transbay Transit Center (TTC).

Section 3002.4a reads:

> 3002.4a General stretcher requirements. All buildings and structures with one or more passenger service elevators shall be provided with not less than one medical emergency service to all landings meeting the provisions of Section 3002.4a.
>
> Exceptions:
> 1. Elevators in structures used only by maintenance and operating personnel.
> 2. Elevators in jails and penal institutions.
> 3. Elevators in buildings or structures where each landing is at ground level or is accessible at grade level or by a ramp.
> 4. Elevator(s) in two-story buildings or structures equipped with stairs of a configuration that will accommodate the carrying of the gurney or stretcher as permitted by the local jurisdictional authority.
> 5. Elevators in buildings or structures less than four stories in height for which the local jurisdictional authority has granted an exception in the form of a written document.

The remainder of Section 3002.4a.1 through 7 further describes the necessary elevator(s) as follows:

3002.4a.l Gurney size. The medical emergency service elevator shall accommodate the loading and transport of an ambulance gurney or stretcher [maximum size 24 inches by 84 inches (610 mm by 2134 mm)) in the horizontal position.

3002.4a.2 Hoistway doors. The hoistway landing openings shall be provided with power-operated doors.

3002.4a.3 Elevator entrance openings and car size. The elevator car shall be of such a size and arrangement to accommodate a 24-inch by 84-inch (610 mm by 2134 mm) ambulance gurney or stretcher in the horizontal, open position, shall be provided with a minimum clear distance between walls or between walls and door excluding return panels not less than 80 inches by 54 inches (2032 mm by 1372 mm), and a minim**um** distance from wall to return Panel not less than 51 inches (1295 mm) with a 42-inch (1067 mm) side slide door.

Exception: The elevator car dimensions and/or the clear entrance opening dimensions may be altered where it can be demonstrated to the local jurisdictional authority's satisfaction that the proposed configuration will handle the designated gurney or stretcher with equivalent ease. Documentation from the local authority shall be provided to the Occupational Safety and Health Standards Board.

3002.4a.4 Elevator recall. The elevator(s) designated the medical emergency elevator shall be equipped with a key switch to recall the elevator nonstop to the main floor. For the purpose of this section, elevators in compliance with Section 3003.2.1.1 shall be acceptable.

3002.4a.5 Designation. Medical emergency elevators shall be identified by the international symbol (Star of Life) for emergency medical services.

3002.4a.6 Symbol size. The symbol shall not be less than 3 inches (76 mm) in size.

3002.4a.7 Symbol location. A symbol shall be permanently attached to each side of the hoistway doorframe on the portion of the frame at right angles to the hallway or landing area. Each symbol shall be not less than 78 inches (1981 mm) and not more than 84 inches (2134 mm) above the floor level at the threshold.

It is the intent of Section 3002.4a to provide elevators for emergency personnel such that they can effectively address emergency conditions that require transport of injured or non-ambulatory occupants from an upper level to another level (typically at grade) where they can access emergency vehicles, personnel and supplies. This intent is evident from the reading of the Exceptions, particularly Exception 4. Exception 4 suggests that if the stairs of a 2-story building are such that rescue personnel can easily evacuate non ambulatory occupants (by virtue of design) then such an elevator is not required. This suggests that the elevator is meant to ensure a certain minimum effectiveness or efficiency or ease necessary for evacuations by stretcher.

The code does not require that a single elevator fulfills this requirement in a building.

The TTC is a 3 story building with a rooftop park and two basement levels. Except for the rooftop, the building is primarily a transit occupancy with train platforms at the lower basement, a passenger concourse at the upper basement, a grand hall for transit patrons at grade, offices and retail at the 2nd level and a bus deck at the 3rd level. The rooftop park is available for general public use, including assembly uses. A restaurant structure occupies a small portion of the park rooftop. The restaurant includes an elevated 2nd Level which overlooks the rooftop park.

The TTC proposes to design *ALL* the elevators in the project to comply with the requirements of 3002.4a. This permits the emergency responders to use any elevator of their choice. However, there are limited situations where the emergency responders may need to either transfer from one elevator to another before reaching grade, or alternatively utilize stairs or escalators to ascend or descend one flight before reaching an elevator with a destination to grade. Figure 1-Section A and Figure 2-Ground Level Plan illustrate the location of emergency stretcher elevators in the project.

As seen on the diagram, the 2nd Level of the restaurant (effectively a mezzanine to the park level), includes an elevator that is designed in accordance with 3002.4a. However emergency response personnel, if needing to transport a non-ambulatory occupant, would either need to descend via the 2 level elevator to the park level, where they can enter an adjacent elevator extending to grade, or descend via one of the two open stairs to the park level where they can chose from several elevators to reach grade. Figure 3.0-Roof Park Plan shows the additional emergency stretcher elevators available to the rooftop occupants. Figure 3.1-Rooftop Restaurant Plan and Figure 3.2-Rooftop Restaurant Section illustrate the transfer geometry.

Also, because of the practicality of designing elevators for a train platform, the platform level has a similar arrangement. The platform elevators on the lower basement level all conform with 3002.4a. However they ascend only to the Concourse Level, the upper basement level. From the Concourse Level, emergency personnel carrying stretchers need to move (laterally) to another elevator in order to reach an elevator that brings them to the grade level. Figure 4-Train Platform Plan and Figure 5-Lower Concourse Plan clarify the transfer.

In addition to the elevators, emergency personnel at the Platform Level can also elect to utilize either the stairs or the escalators, which are effectively “straight” stairs, effective for stretcher transport and a maximum of two stories.

It is our interpretation that the preceding approach meets the requirements of 3002.4a of the 2007 CBC.

We request that you review our approach and if in agreement please counter sign and return to our office.

Yours sincerely

Armin Wolski
Associate Principal

Approved by

San Francisco Fire Department