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**The Fire Protection and  
Life Safety Experts**

- Code Consultation
- Alarm Systems Design
- Fire Sprinkler Design

April 1, 2011  
**Revised April 6, 2011**

Mr. Saroj Bhol  
Port Authority of NY & NJ  
3 Gateway Center, 3<sup>rd</sup> Floor  
Newark, NJ 07102

**RE: NATIONAL SEPTEMBER 11<sup>TH</sup> MUSEUM & MEMORIAL  
DAY 2 OCCUPANCY  
PROJECT NO. 100398.50.000**

Dear Saroj Bhol:

As previously discussed, the National September 11 Memorial & Museum (NS11MM) is currently under construction at the World Trade Center site in New York, New York. The Memorial Plaza is scheduled to be completed and occupied by September 11, 2011, while the remaining portions of the project are scheduled for completion at a future date.

CCI has developed a code compliance strategy report that outlines the overall fire protection and life safety concepts that are intended to comply with the Building Code requirements during the temporary occupancy. This report has been updated based on your comments from the design team's April 1, 2011 submission. One (1) set of the revised Fire Protection and Life Safety Concept Report and one (1) set of the Egress Report is contained herein. Also, three (3) sets of the revised architectural documents that are intended to reflect compliance with the strategies outlined in the report will be mailed to your office. Only the drawings that have incorporated revisions will be included in the mailing.

We appreciate your time in reviewing this revised conceptual submission package. Please contact us at your earliest convenience if you have any comments or questions.

Very truly yours,

Kevin Morin, PE  
Principal

Alex Mear, EI  
Project Consultant

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**National September 11 Memorial & Museum  
Temporary Occupancy of the Memorial Plaza**

**Fire Protection and Life Safety Concept Report**

Prepared for:

National September 11<sup>th</sup> Memorial and Museum  
One Liberty Plaza  
20<sup>th</sup> Floor  
New York, NY 10006

Prepared by:

**CODE CONSULTANTS PROFESSIONAL ENGINEERS, PC**  
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New York, NY 10018  
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Project No. 100398.50.000

April 1, 2011  
Revised April 6, 2011

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**The Fire Protection and Life Safety Experts**



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## Introduction

The National September 11 Memorial & Museum (NS11MM) is currently under construction in Lower Manhattan of New York, New York. The Memorial Plaza is scheduled to be completed by September 11, 2011, while the remaining portions of the project are scheduled for completion at a future date. The Memorial Plaza has an approximate footprint of 249,000 sq ft. that contains green space, two reflecting pools measuring approximately 194 ft by 194 ft in size (37,636 sq ft), trees, paver stones, benches and other permanent fixtures.

### Project Description

Upon the completion of the project, it is intended for the Memorial Plaza to be open to the public such that occupants can move freely to and from the plaza. However, the above grade Memorial Plaza will be open to the public starting on September 11, 2011 (before the completion of the entire project). Because the memorial plaza will be open to the public while the below grade Museum and other projects on the WTC site are still under construction, the Memorial Plaza will be surrounded by construction fences. The construction fences will limit the number of ingress and egress locations for the Plaza. The time between the completion of the Memorial Plaza (September 11, 2011) and the completion of adjacent projects (such that a construction fence is not required) is viewed as a temporary occupancy of the Memorial Plaza.

This report is intended to outline a code compliance approach for the fire protection and life safety requirements for the temporary occupancy of the Memorial Plaza during construction on and around the site of the NS11MM. The occupancy prior to the final Certificate of Occupancy is temporary and will incorporate a phased construction plan for egress.

The proposed temporary occupancy of the Memorial Plaza has been reviewed with the PANYNJ and the New York City Department of Buildings and it has been determined that the 2008 New York City Building Code will be applied to the plaza. Upon completion of the Museum and Memorial Plaza and adjacent projects, compliance with the New York City Building Code for the Plaza will not be necessary because the temporary construction fences will be removed and occupants can move freely to and from the Memorial Plaza.

It is important to note that the below grade museum will not be open as part of the temporary occupancy of the Plaza. Therefore, occupancy of the museum has not been included as part of this analysis.



### Temporary Occupancy Design and Logistics

During the temporary occupancy of the Memorial Plaza, the Museum and Memorial Plaza site will be surrounded by a construction fence. The construction fence will limit the number of public ingress and egress points for the Plaza and restrict access to the Museum to only construction workers and other essential personnel.

It is anticipated that visitors to the temporary Memorial Plaza will only be permitted access to the Plaza through a single arrival area located at the corner of Albany and Greenwich Streets. Access will be monitored by means of a timed reservation and an automatic counting systems administered by the National September 11 Memorial & Museum organization. Visitors will be screened (for security purposes) as they move from the arrival area to the Memorial Plaza. Please see the egress section of this report for additional details on how the occupant load will be limited during this initial period to 1,500 persons on the Memorial Plaza (including staff) at any given time.

Four emergency exits will be provided from the Memorial Plaza that leads to three distinct discharge locations at the public way. The main exit (also the main entrance) is located on the southwest corner of the Memorial Plaza and discharges at the intersection of West Street (Route 9A) and Cedar Street. Another exit is located at the southeast corner of the Memorial site and discharges at the intersection of Liberty Street and Greenwich Street. The remaining two exits are located near the Northwest corner of the Memorial Plaza and discharge at the intersection of Vesey Street and West Street (Route 9A). Please see the egress section of this report for additional details of the egress design.

The attached diagram Appendix A (Memorial Interim Access and Egress And Emergency Egress - Option 2 dated 3-11-11) illustrates the layout of the Memorial Plaza and the surrounding structures. In addition, the diagram shows the standard route taken for public access to the space and the location of the emergency exits.

### **Applicable Codes**

The City of New York has adopted the 2008 New York City Construction codes based on the 2003 editions of the ICC Codes with amendments. In addition, the project will be designed in accordance with the codes and standards adopted by the PANYNJ. The following is a list of the applicable codes for the project:

- 2008 New York City Building Code
- 2008 New York City Fire Code



- PANYNJ Tenant Construction Review Manual

Note: The code references provided throughout this report are for the 2008 New York City Building Code, unless stated otherwise.

## Occupancy Classifications

The temporary Memorial Plaza occupancy will contain the following occupancies (303.1):

- A-5, Assembly  
Outdoor public assembly space

Note: The visitor check-in area, security screening space, and retail space leased by the National September 11 Memorial & Museum is not located within the Memorial Plaza and is not addressed as part of this report.

## Egress

The means of egress for the Temporary Plaza Occupancy will be designed in accordance with Chapter 10 of the Building Code.

### Occupant Load

The total number of occupants on the Memorial Plaza (1,500 person maximum at any single time including the NS11MM staff members) during the temporary occupancy has been established and agreed upon by the National September 11 Memorial and Museum. The established occupant load will be controlled through visitor management and security measures by the National September 11 Memorial and Museum. It is anticipated that the number of occupants permitted onto the plaza will be limited by the real-time count of occupants entering and leaving the plaza.

The operational approach to limit the total number of occupants to 1,500 occupants will be established as the design progresses and will likely include turnstiles or other occupant counting techniques. The final operational approach will be submitted to the PANYNJ for approval in accordance with Section 1004.1.4.

### Number of Exits and Exit Discharge

Exits from the Memorial Plaza discharge directly to the exterior of the construction fence and to the public way via exterior walkways. The exterior walkways will be defined as egress courts as

part of the exit discharge. Egress courts are defined as courts or yards which provides access to a public way for one or more exits (1002.1).

Per Section 1023.2 through 1023.4, exits are permitted to discharge to egress courts provided that the exit courts are open to the exterior so as to minimize the accumulation of smoke and toxic gases, provide sufficient egress capacity, and lead to a public way. By classification as egress courts, the egress provisions such as travel distance limitations are evaluated using the location of the exit (at the construction fence).

The proposed design uses three separate egress courts to serve the four exits from the Memorial Plaza. However, the number of exits provided is not affected by the convergence of the two northwest egress courts because the sufficient egress width is provided for occupants discharging to the public way.

Note: The paths located outside the Memorial Plaza construction fences are classified as egress courts and the exit access gates (located at the construction fences) are classified as exits.

#### Exit Capacity

The exit capacity for the Plaza will be sufficient to accommodate the proposed occupant load of 1,500 persons. The exit capacity for movement through horizontal egress elements such as doors is determined using 0.2 inches per person (1005.1). Therefore, at least 25 feet of egress width must be provided from the Memorial Plaza. Approximately 56.5 feet of egress width is provided from the Memorial Plaza via the four exits.

It is important to note that due to the convergence of the egress courts from the two northwest exits, the total egress width is reduced to 44.5 feet when considering the most restrictive egress path. However, this is still greater than the minimum required 25 feet. The following table outlines the egress clear width provided for the Memorial Plaza:

Exit Location	Egress Width (feet)	Exit Capacity
Northwest	12	720
Southwest (Main)	12.5	750
Southeast	20	1200
Total	44.5	2670 <sup>1</sup>
West	12	720 <sup>2</sup>



- <sup>1</sup> The actual occupant load is limited to 1,500 persons (which includes the NS11MM staff members) by the time ticketing system administered by the NS11MM. Although the occupant load is currently limited by the time ticketing system at 1,500 persons, the total exit capacity of the facility is 2,670 persons.
- <sup>2</sup> West Exit is not included in the total available egress width due to the convergence with Northwest within the egress court.

### Main Exit

Per Section 1024.2, the main exit from the Memorial Plaza will be sized to accommodate one-half of the anticipated occupant load. The Southwest exit will provide 12.5 feet of clear width to accommodate half (750) of the anticipated 1,500 person occupant load.

### Egress Gates & Doors

As outlined in Section 1008.1.1.1, the maximum width of swinging door leafs is 48 inches. However, because the Memorial Plaza is enclosed by construction fences and each exit is at least 12 feet in width, typical side swinging door leafs/gates are not feasible in certain locations. Therefore, it is proposed to provide gates similar to those found in other large assembly areas (such as stadiums) where standard 48 inch leaf doors cannot be used. Using these types of gates will be the most effective means for allowing emergency egress during the evacuation of the plaza.

Per Section 1008.2, gates are permitted to be used in the means of egress provided that they comply with the provisions of Section 1008. Also, horizontal sliding or swinging doors leafs are permitted to exceed 4-feet when they are located in fences surrounding a stadium. Similar to a stadium, the Memorial Plaza is classified as an A-5 occupancy and is surrounded by a fence.

Furthermore, the gates will be monitored by personnel when the plaza is occupied and sufficient means will be provided such that the gates will be secured in the open position (during occupancy). It is proposed to provide a mechanism similar to a cane bolt that can be used to secure the emergency egress doors in the open position when the Memorial Plaza is occupied.

A detailed plan for the monitoring of the emergency gates will be developed and monitored by the NS11MM. When the plaza is closed to the public, the emergency egress gates will be secured/locked in the closed position.



#### Exit Access Hardware

Panic hardware must be provided at exit access doors that serve assembly occupancies where the occupant load exceeds 75 persons (1008.1.9). However, providing panic hardware for the gates where 48-inch door leafs are not used is not feasible due to their planned size and for security reasons (after hours). Therefore, it is proposed to omit panic hardware from the exit access doors where gates larger than 48-inches are being used.

Although panic devices will not be provided at some emergency exit gates, the gates will be unlocked and monitored at all times when the Memorial Plaza is occupied. As outlined in the Egress Gates section (above), a mechanism similar to a cane bolt is proposed to ensure the gates can be secured in the open position.

Where 48-inch leaf doors are used at the Memorial Plaza exits, panic hardware designed in accordance with Section 1008.1.9 will be provided.

#### Walking Surface

All walking surfaces of the means of egress will consist of a slip-resistant surface (1003.4). A definition for a "slip-resistant surface" is not provided in the Building Code and additional guidelines are not provided to determine which surfaces are classified as slip-resistant. Therefore, standard industry standards must be applied when determining what materials should be used for all egress walking surfaces.

#### Changes in Elevation

Where changes in elevation of less than 12 inches exist in the means of egress, sloped surfaces will be used within the egress courts. In addition, where the sloped surfaces exceed one unit vertical change in elevation in 20 units horizontal, a ramp decided in accordance with Section 1003.5 will be provided.

#### Travel Distance

The travel distance from the most remote point of the Memorial Plaza to the entrance of an exit must not exceed the maximum allowable for A-5 occupancies which is 200 feet (Table 1024.7). In addition, occupants must be able to reach a secondary exit within 300 feet.

However, due to the overall area of the Plaza, the travel distance from the most remote location of the Plaza to an exit is approximately 400 feet. The travel distance from the most remote

location to a secondary exit is 395 feet. It is proposed for the travel distance for the plaza to exceed the maximum permitted per Table 1024.7 for the following reasons:

- Occupants will not be subjected to the accumulation of hot smoke and gases (from combustion) because the Memorial Plaza is open to the exterior environment.
- This natural ventilation permits an increase in the time necessary for occupants to exit the plaza (due to the increase in travel distance) without exposing them to the dangers of accumulating hot smoke and other gases. Visibility can also remain constant because smoke and other gases is not accumulating.
- The Memorial Plaza is staffed by trained NS11MM personnel that can provide occupants with direction during an emergency which aids in reducing the time necessary for evacuation.
- An emergency evacuation system with live voice capabilities will be provided to deliver messages to occupants when necessary.
- Additional way finding measures will be provided to illustrate the location of the emergency exits within the Memorial Plaza.

Providing exits from the Memorial Plaza within the maximum allowable travel distances outlined in Table 1024.7 is not feasible due to the size of the site. However, the exterior conditions and life safety measures outlined above provide equivalent protection to an occupant that offsets the increase in travel distance necessary for occupants to reach an exit.

#### Exit Remoteness

A minimum of four exits will be provided from the Memorial Plaza because the occupant load exceeds 1,000 persons (Table 1018.1). Not less than two of those four exits will be remotely located (1014.2.1). To be classified as remote, at least two exits must be separated by a distance not less than one-half the length of the maximum overall diagonal dimension of the area. In addition, the remaining exits will be located as remote from the other exits as practically possible.

The exits located at the northwest corner of the plaza and the southeast corner of the plaza is separated by approximately 816 feet while the length of the maximum overall diagonal of the space is approximately 831 feet. Therefore, the Memorial plaza contains at least two remotely located exits.

### Exit Signs

Per Section 1011.1, exit signs will be provided at all exits and exit access doors and the signs will be readily visible from any direction of travel. Additional exit signs may be beneficial within the Memorial Plaza due to the size of the space. Additional way finding measures will be provided throughout the plaza using temporary exit signs/lighting and through operational protocols (employees will assist the general public in locating exits).

### Emergency Lighting

Emergency lighting will be provided throughout the major circulation paths of the Memorial Plaza in the event of a power failure. The emergency lighting will be provided for duration of not less than 90 minutes after the power failure occurs (1006.3). Per Section 1006.3, the means of egress illumination must be an average of 2 foot-candles and a minimum of 0.2 foot-candles at any one point. However, because the Memorial Plaza is a 249,000 square-foot outdoor space, providing an average of 2 foot-candles throughout the entire space is not practical.

Therefore, the following proposed emergency lighting design will provide equivalent means of illumination for the plaza:

- The main paths of travel throughout at the perimeter of the plaza will be provided with an average of 2-foot candles to help identify main walking paths (aisles) to the exits.
- An average of 5-foot candles will be provided at all four Memorial Plaza exits. The increase in the illumination levels at these locations will allow occupants to easily identify the exits throughout the plaza due to the contrast in lighting.
- The remaining portions of the plaza will be provided with at least 1 foot-candle of illumination. This illumination level is consistent with the International Building Code requirements for emergency lighting.

It is important to note that emergency lighting will also be provided for the egress courts used as a portion of the exit discharge (1006.3.2).



## **Fire Protection Systems**

### Automatic Sprinklers

An automatic sprinkler system is required for A-5 occupancies for any enclosed space that is greater than 1,000 square feet in area (903.2.1.5). However, because the Memorial Plaza does not contain any enclosed spaces, automatic sprinklers will not be provided.

### Standpipes

Class I automatic standpipe systems must be provided for A-5 occupancies where the occupant load exceeds 1,000 persons, except for open-air areas without enclosed spaces. Because the Memorial Plaza is an open-air assembly space that does not contain enclosed spaces, a standpipe system will not be provided (905.3.2).

### Portable Fire Extinguishers

Portable fire extinguishers will be provided for the Memorial Plaza as an A-5 occupancy and should be installed in accordance with Section 906 of the 2008 New York City Fire Code (Fire Code – 906).

However, it is recommended to only provide portable fire extinguishers at constantly supervised locations to protect them from possible abuse and/or damage. Per Exception 1 of Section 906 of the Fire Code, portable fire extinguishers that are subject to theft, malicious use or damage may be located in locations approved by the FDNY Commissioner.

### Fire Alarm System

An automatic and manual fire alarm system is required for group A occupancies with an occupant load greater than 300 persons (907.2.1). This includes the activation (upon initiation of fire alarm system) of a pre-signal system at a constantly attended location from which the Fire Department is notified and live voice evacuation instructions can be initiated using the emergency voice/alarm communication system.

However, because the Memorial Plaza does not contain enclosed spaces and has a footprint of approximately 249,000 square feet, providing a fire alarm system designed using typical audible and visual fire alarm devices may not be feasible.

In lieu of a typical fire alarm system, it is proposed to provide an emergency notification system for the Memorial Plaza with live voice evacuation capabilities using NFPA 72 – National Fire

Alarm and Signaling Code 2010 Edition as a design guide. The system should consist of a series of high power speaker arrays (24.4.3.4.2 NFPA 72 – 2010 Edition) that allows for coverage of the plaza using live voice evacuation instructions to be given by emergency personnel. A high power speaker array is defined as a system that provides capability for voice and tone communication to large outdoor areas (3.3.116 NFPA 72 – 2010).

It is proposed to use the high power speaker array as a public address system to provide alarm notification within the Memorial Plaza. The system will be provided with microphone capabilities for the purposes of live voice announcements. Control of the system will permit the security personnel and/or the Fire Department to communicate to the plaza occupants and initiate evacuation, if necessary. It is important to note that the system will not be designed in accordance with NFPA 72 – 2002 Edition as adopted and amended by Appendix Q. In addition, UL listed devices that are supervised will not be provided as part of the emergency notification system.

#### Emergency Power

Emergency power will be provided (for a duration of 90 minutes) for the following systems:

- Emergency communication system (2702.2.1)
- Exit signs (2702.2.3)
- Means of egress illumination, including the exit discharge (2702.2.4)

#### **Safeguards During Construction**

The following section outlines of the general safeguards and protective measures in accordance with Chapter 33 that will be undertaken around the Memorial Plaza site while the remainder of the NS11MM is under construction.

#### General Protective Measures

All areas used by the public shall be maintained free from ice, snow, grease, debris, equipment, materials, projections, tools, or other items, substances, or conditions that may constitute a slipping, tripping, or other hazard (3303.4.1).

In addition, hose lines, wires, ropes, pipes, chains and conduits will be located so that they will not constitute a tripping hazard as outlined in Section 3303.1.2. Where such lines cross sidewalks or any public way, they will be suspended at least 8 feet (2438 mm) above the walks.



However, a suitable pedestrian bridge can be provided to cross any possible tripping hazard in lieu of suspending the wires.

Contractor's sheds and offices located within 30 feet (9144 mm) of new construction, existing buildings, or the Memorial Plaza will be made of metal or other noncombustible materials. Fire retardant treated wood may be used when protected from the weather (3303.1.3).

#### Vehicular traffic

Per Section 3307.4.3, whenever any work is being performed over, on, or in close proximity to a highway, street, or similar public way, control and protection of traffic will be provided by using barricades, signals, signs, flagperson, or other devices, equipment, and personnel in accordance with the requirements of the Department of Transportation.

#### Construction Fences

The Memorial Plaza will be enclosed with a fence that meets the requirements of Section 3307.7 (3307.3.2). Per Section 3307.7, fences will be at least 8 feet (2438 mm) high, and constructed of wood or other suitable material. Fences will be built solid for their entire length, except for openings with solid sliding or in swinging gates as are required for the proper prosecution of the work, and except for viewing panels. The fence will be constructed along the inside edge of the sidewalk, walkway or temporary walkway and extended to ensure the site is effectively separated from adjacent spaces.

#### Sidewalk Sheds

A sidewalk shed will be provided where material or debris is to be moved by a hoist, crane, derrick, or chute over a sidewalk, walkway, or temporary walkway that is not closed to the public (3307.3.1). Where required, sidewalk sheds will be designed in accordance with Section 3307.6.

#### **Summary**

The National September 11 Memorial & Museum project is currently under construction in New York, New York. The above grade Memorial Plaza will be completed and open to the public before the other portions of the project are completed. However, the plaza will be surrounded by construction fences until the entire project is completed.



Therefore, the Memorial Plaza was evaluated as an A-5 occupancy space (as defined by the 2008 New York City Building Code) and the following fire protection and life safety features will be used during the Temporary Memorial Plaza Occupancy:

- A total of 56.5 feet of egress width (25 feet required) from 4 exits to accommodate the 1,500 occupants.
- A total of 44.5 feet of egress width (25 feet required) within the egress courts to accommodate the 1,500 occupants.
- A main exit of 12.5 feet of egress clear width to accommodate half (750) of the 1,500 occupants.
- Exit signs at each exit and additional way finding measures supported by emergency power.
- Emergency lighting throughout the major circulation paths of the Memorial Plaza
- Portable fire extinguishers at permanently supervised locations.

The design of the Memorial Plaza was not intended to comply with the 2008 New York City Building Code after the completion of the entire National September 11 Museum & Memorial. Therefore, plaza has several inherently non-compliant conditions that will need approval by the New York City DOB. The conditions include the following:

1. Exit access doors consisting of gates will be used that are larger than 4-feet in width and do not contain panic hardware. These gates will be constantly monitored and secured in the open position using a mechanism similar to a cane bolt to ensure sufficient egress is available during an emergency evacuation.
2. An emergency notification system that uses high power speaker arrays supported by emergency power with live voice capabilities for occupant notification. The emergency notification system will allow for live audible instructions to be provided by using a system that functions similar to a public address system which is more suitable than a standard fire alarm system designed in accordance with NFPA 72 – 2002.
3. Travel distances will exceed the maximum allowable for A-5 occupancy use groups. However, equivalent life safety protection will be provided because the plaza will contain trained staff members that can direct occupants in the event of an emergency in addition to live instructions provided by the emergency notification system. Also, occupants will not be

exposed to the accumulation of hot smoke and gases because the plaza is open to the environment.

4. Emergency illumination levels along the perimeter walking paths of an average of 2 foot-candles while all four exits will be illuminated to at least 5 foot-candles. The remaining portions of the plaza will be illuminated to a minimum level of 1 foot-candle. This approach provides occupants with sufficient illumination levels during an emergency while providing a practical solution for providing emergency lighting for the 249,000 square foot Memorial Plaza.

# A P P E N D I X A

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The Fire Protection and Life Safety Experts



CODE CONSULTANTS  
PROFESSIONAL ENGINEERS, PC



REVISION No: 255  
REVISION DATE: 3-11-11



**Memorial Plaza Egress Simulation Report  
Fire Protection and Life Safety**

**National September 11 Memorial & Museum  
Temporary Occupancy of the Memorial Plaza**

Prepared for:

National September 11<sup>th</sup> Memorial and Museum  
One Liberty Plaza  
New York, NY 10006

Prepared by:

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Project No. 100398.50.000

April 1, 2011  
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## Introduction

A computer egress simulation study is currently ongoing to provide the Memorial design team information on the performance of the egress system for the Memorial Plaza during the temporary occupancy. The computer egress model Simulex is being used to calculate an evacuation time for the Memorial Plaza. Revisions have been made to the design of the plaza egress system and several model simulations have been conducted. The intent of the computer egress simulation is to establish a repeatable simulation where specific variables can be changed to evaluate the efficiency of the egress design.

Changes were made to the initial design to establish a “baseline” scenario. The final studies will evaluate the evacuation time of the Memorial Plaza for several scenarios to investigate the impact of egress width and the number of available exits.

Establishing the repeatable simulations will provide information to the design team to further develop the Memorial Plaza design and to develop operational protocols for staff and security. It is not the intent of the study to identify the evacuation time needed to achieve code compliant strategies for the Memorial Plaza.

## Project Description

The Memorial is currently under construction at the World Trade Center site. The Memorial Plaza is scheduled to be completed by September 11, 2011, while the remaining portions of the project are scheduled for completion at a future date. The Memorial Plaza has an approximate footprint of 249,000 sq ft that contains green space, two reflecting pools measuring approximately 194 ft by 194 ft in size (37,636 sq ft), trees, paver stones, benches and other permanent fixtures.

Upon the completion of the project, the above grade Memorial Plaza is intended to be open to the public such that visitors can move freely to and from the Memorial. The Memorial Plaza will be open to the public starting on September 11, 2011, before the completion of the entire project. During the time between the opening of the Memorial Plaza and the completion construction at the site, the Memorial Plaza will be surrounded by construction fences. The construction fences will limit the number of ingress and egress routes for visitors to the Memorial Plaza. The time between the completion of the Memorial Plaza on September 11, 2011 and the completion of adjacent projects is considered to be a temporary occupancy of the Memorial Plaza.



Details of Memorial Plaza layout, including access and exits, proposed life safety systems, and general operational details, are provided in the revised Fire Protection and Life Safety Concept Report developed by Code Consultants Professional Engineers, PC dated April 6, 2011.

### **Applicable Code**

The proposed temporary occupancy of the Memorial Plaza has been reviewed with the PANYNJ and the New York City Department of Buildings and it has been determined that the 2008 New York City Building Code will be applied to the plaza. Therefore, the egress elements of the Memorial Plaza have been evaluated for compliance with the requirements of the 2008 New York City Building Code.

However, upon completion of the Museum, Memorial Plaza, and adjacent projects, compliance with the New York City Building Code for the Plaza will not be necessary because the temporary construction fences will be removed and occupants can move freely to and from the Memorial Plaza.

### **Egress Model**

Simulex is a computer model that calculates the egress movement of individual occupants and accounts for the interaction of occupants during egress. Simulex was originally developed by the Fire Safety Engineering Group at the University of Edinburgh (Scotland) in collaboration with staff at Lund University (Sweden) to simulate the escape movement of people from large, geometrically complex spaces. Simulex uses the actual AutoCAD plans for the project to provide a graphical representation of the egress system within the model.

Occupant movement in the model is governed by walking speed, body size, turning rate, interpersonal distance, and distance to walls or other obstructions. Occupants are not subjected to changes in level using stairs, thus occupant walking speeds down stairs was not provided in the table below. Populations were modeled that account for a range of occupant types and movement speeds.

## Project Assumptions

The following assumptions were used in developing the computer egress simulation:

- The layout of the Memorial Plaza including the location of the construction fences, exit locations, and access to the public way were established using the document "Memorial Interim Access and Egress and Emergency Egress – Option 2" which is dated 3-1-11. (See Attached Appendix A)
- The total available egress is as follows:
  - Northwest Exit – 12 feet wide which provides an exit capacity of 720 persons
  - West Exit – 12 feet wide which provides an exit capacity of 720 persons
  - Southwest Exit – 12.5 feet wide which provides an exit capacity of 750 persons
  - Southeast Exit – 20 feet wide which provides an exit capacity of 720 persons
- A total of 1,500 occupants on the Memorial Plaza begin moving toward an exit at the same time.
- A total of 400 construction workers originating below grade and reaching grade at approximately 1 minute after the simulation as initiated:
  - 100 persons discharging through stair B
  - 100 persons discharging from the west vent structure
  - 100 persons discharging from the east side of the Pavilion
  - 100 persons discharging from the HUB stair to the east of the Pavilion
- A total of 2,000 PATH riders have been included in the model that originate below grade and reach grade at approximately 8 minutes after the simulation is initiated
- Five (5) feet of egress width is blocked at the Southeast exit to account for incoming emergency responders.

- A separate entrance located in the Southwest corner of the project has been provided for emergency responders.

The following tables illustrate the characteristics used for the various groups of occupants simulated for the project.

Memorial Plaza Occupants (1500 Persons)				
Occupant Type	Walking Speed (Feet Per Minute)		Body Width (Feet)	Percentage Of Population (%)
	Mean	Range		
Adult Male	266	226-305	1.71	40
Adult Female	226	187-266	1.51	40
Senior (over 55)	158	99-217	1.57	10
Child (under 12)	177	118-236	1.25	5
Mobility Impaired	158	85-230	1.64	5
Path Riders (2000 Persons)				
Occupant Type	Walking Speed (Feet Per Minute)		Body Width (Feet)	Percentage Of Population (%)
	Mean	Range		
Adult Male	266	226-305	1.71	40
Adult Female	226	187-266	1.51	40
Senior (over 55)	158	99-217	1.57	10
Child (under 12)	177	118-236	1.25	5
Mobility Impaired	158	85-230	1.64	5



Construction Workers (Memorial & Hub) (400 Persons)				
Occupant Type	Walking Speed (Feet Per Minute)		Body Width (Feet)	Percentage Of Population (%)
	Mean	Range		
Construction Workers (Memorial & HUB)	266	226-305	1.71	100

## Egress Scenarios

The Baseline Scenario includes the following assumptions:

- A total of 1,500 occupants on the Memorial Plaza.
  - 500 visitors are located around each reflecting pool at the start of the simulation
  - The remaining 500 visitors are distributed throughout the Memorial Plaza.
- The occupants egress through an exit that is close in proximity while balancing the overall egress time to evacuate the plaza. The number of occupants exiting through each location as follows:
  - Northwest - 371 persons
  - West - 308 persons
  - Southwest - 510 persons
  - Southeast - 311 persons

Additional scenarios will be simulated as the analysis continues based on input from the various entities involved with the reviewing temporary occupancy of the Memorial Plaza. Potential scenarios include, but are not limited to the following:

- Blocking one or more of the exits
- Half of the plaza occupants exit through the main exit while the remaining occupants exit through the exit closest in proximity

## Egress Modeling Results

The egress model has been used to calculate the time from the start of egress until visitors have exited from the Memorial Plaza and also when the visitors reach a public way. Results of the baseline analysis are presented in the following table:

Plaza Occupants		
Scenario	Time for Evacuation of Memorial Plaza (MM:SS)	Total Egress Time to Reach Public Way (MM:SS)
Baseline Scenario	4:09	10:29

The egress times outlined above are based on all occupants beginning to exit at the same time and do not include a delay for occupants to recognize the need to exit or any other safety factors. In addition, the time to reach the public way does not incorporate the final time for all PATH riders to reach the public way.

The attached graph (Appendix B) titled "Population Exited Versus Time" illustrates the number of occupants that have exited the plaza and the public way versus time. The graph shows that approximately 95% of the occupants exit the plaza in 3 minute 15 seconds and 95% of the occupants have reach the public way in 7 minutes 30 seconds.

As a comparison, the following table outlines the approximate egress time for several buildings that contain large assembly occupancies:

Location	Egress Time
Yankee Stadium	≈ 30 min
Mets Stadium	≈ 24 min
High Line	≈ 16 min

## Summary

Computer egress simulations are being prepared for the temporary occupancy of the Memorial Plaza. Results of the baseline scenario indicates calculated egress times of approximately 4 minutes for visitors to exit from the Memorial Plaza and approximately 10 minutes 30 seconds for the plaza occupants to reach a public way. Additional computer scenarios will be conducted to provide additional information to the design team to increase the efficiency of the egress system.



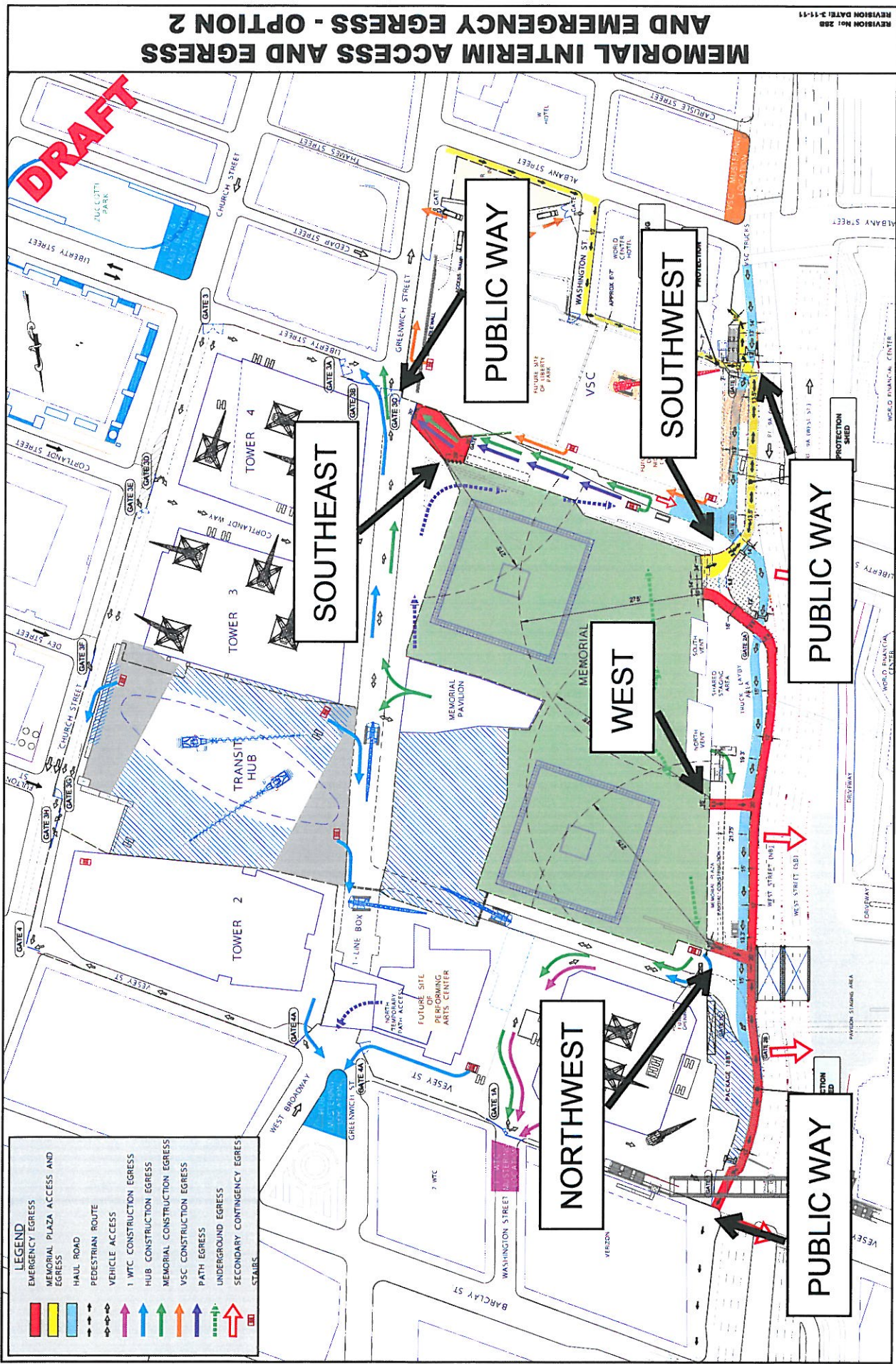
# APPENDIX A

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The Fire Protection and Life Safety Experts



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MEMORIAL INTERIM ACCESS AND EGRESS  
AND EMERGENCY EGRESS - OPTION 2

REVISION NO. 208  
REVISION DATE: 3-11-11



# APPENDIX B

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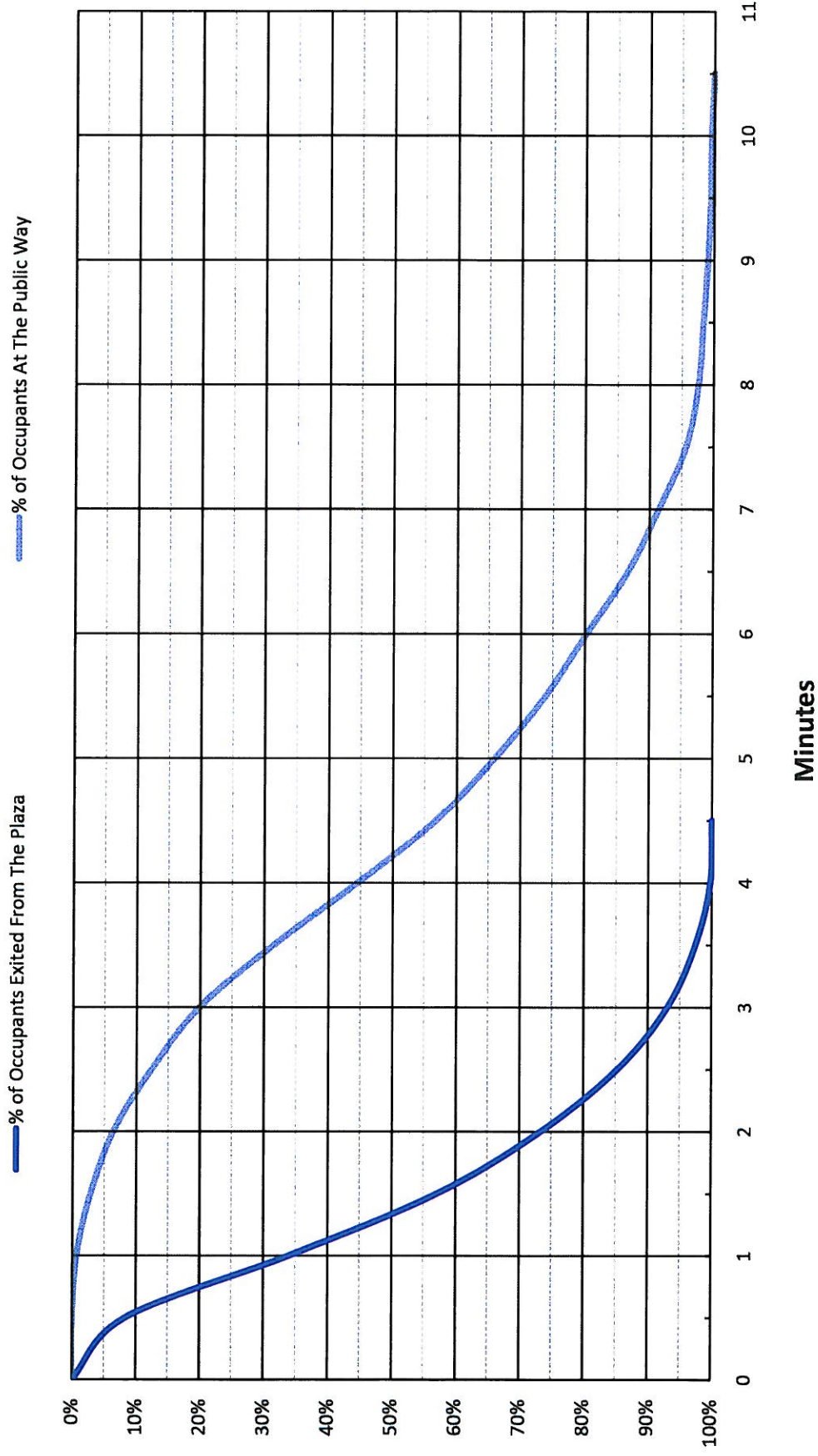
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# Population Exited Versus Time



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