April 3, 2013

Mr. Michael Johanning
WBRC Architects & Engineers
30 Danforth Street, Suite 306
Portland, Maine 04101

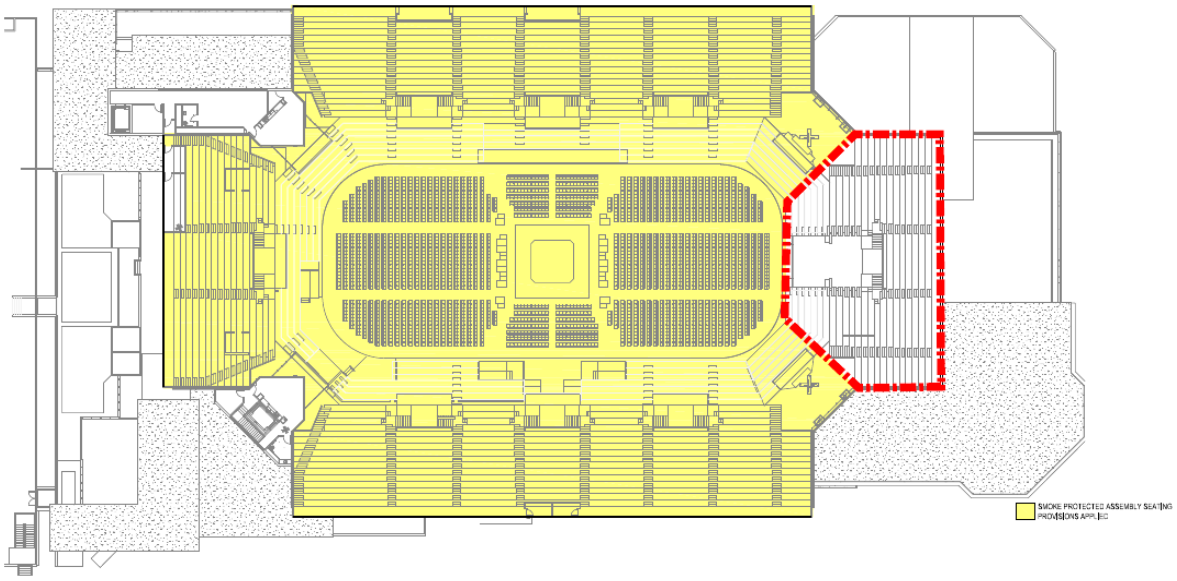
CUMBERLAND COUNTY CIVIC CENTER
PORTLAND, MAINE
NON-SMOKE-PROTECTED SEATING BOWL ANALYSIS

Dear Mike:

The purpose of this letter is to demonstrate that the non-smoke-protected exit factors used on the east Seating Bowl seats in the Cumberland County Civic Center will allow occupants to exit with tenable conditions similar to those provided for occupants in the areas that use smoke-protected exit factors permitted in Section 1028.6 of the 2009 Maine Uniform Building and Energy Code (MUBEC) and Section 12.4.2.1 (2) (a) of the 2009 Edition *Life Safety Code* (NFPA 101).

The figure below illustrates the area of the Seating Bowl using smoke-protected exit factors (highlighted in yellow) and the east Seating Bowl area that uses the non-smoke-protected, or standard, exit factors (outlined in red).

Figure 1
Smoke-Protected Areas in the Cumberland County Civic Center



KANSAS CITY
FP&C Consultants, Inc.
3770 Broadway
Kansas City, MO 64111
T • 816.931.3377 / F • 816.931.3378
www.fpc-consultants.com

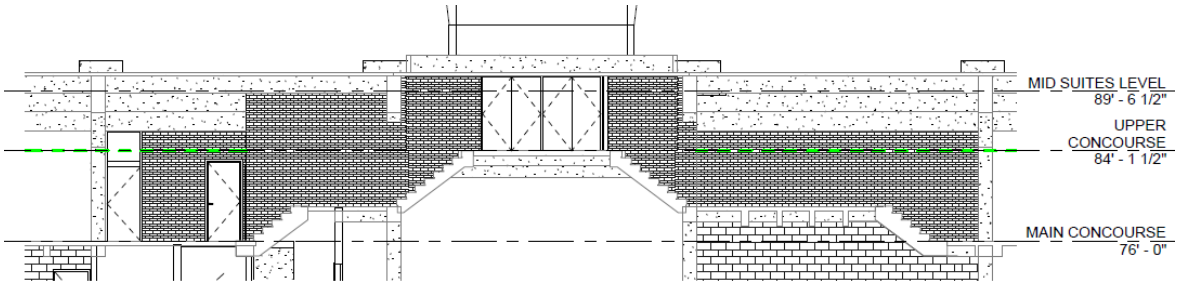
Smoke-protected exit factors permit the use of less exit width for a given population than required by standard exit factors. This reduced exit width will result in longer exit times compared to the same population provided with exits sized using the standard exit factors in the building code.

ISSUE

This letter will demonstrate that the occupants of the east Seating Bowl will have sufficient time to exit through the Main Concourse with at least the same tenable conditions as the occupants using smoke-protected exit factors. The fire scenarios this letter will address will be those referenced from the *Smoke Control Report* dated October 16, 2012.

The fire scenarios of greatest concern are those that occur on the Main Concourse Level (Design Fire Scenario 2) or in the Mechanical Level (Design Fire Scenario 4). Fires in these areas will directly affect egress for occupants exiting from the east Seating Bowl. In particular, this letter will demonstrate that the vomitory that allows the occupants to exit from the east Seating Bowl and the stairs directly outside will remain tenable during the design fire scenarios mentioned above. This vomitory is of concern since occupants from the east Seating Bowl exit into an area that is above the Main Concourse Level (approximately eight feet). The figure below illustrates this area of concern.

Figure 2
West Elevation of East Concourse from East Seating Bowl Vomitory



A fire in the Seating Bowl was not considered the worst case scenario for this analysis as occupants from the east Seating Bowl will be able to exit in less time than the smoke-protected seats of the Seating Bowl.

JUSTIFICATION

Three design fire scenarios were considered for this analysis. As mentioned above, the worst case design fire scenarios were from fires in the vicinity of the east Seating Bowl vomitory on or near the Main Concourse. A fire in the Seating Bowl was also evaluated but was not the worst case scenario. All design fire scenarios are referenced from the *Smoke Control Report* dated October 16, 2012.

1. Main Concourse Fire Scenario [Design Fire Scenario 2]

   A fire on the southeast end of the Main Concourse will generate smoke and hot gases that could affect exiting on the Concourse. The smoke control system in this area was designed to maintain smoke at least six feet above the Main Concourse in order to meet the criteria for smoke-protected exiting. The vomitory from the east Seating Bowl is approximately eight feet higher than the Main Concourse. A timed egress from the east Seating Bowl demonstrates that it takes seven minutes for all occupants to arrive on the Main Concourse level where the rest of the Seating Bowl population is exiting. This egress time (which includes a safety factor) is less than the time when conditions become untenable on the Main Concourse for exiting. Please see Section E.1 of Enclosure 1 (attached) that provides the calculations for this analysis.

2. Mechanical Level Fire Scenario [Design Fire Scenario 4]

   A fire on the Mechanical Level will generate smoke and hot gases that could affect exiting on the Main Concourse. The smoke control system in this area was designed to maintain smoke at least six feet above the Main Concourse in order to meet the criteria for smoke protected exiting. The vomitory from the east Seating Bowl is approximately eight feet higher than the Main Concourse. A timed egress from the east Seating Bowl demonstrates that it takes 4.6 minutes for all occupants to arrive on the Main Concourse level where the rest of the Seating Bowl population is exiting. This egress time (which includes a safety factor) is less than the time when conditions become untenable on the Main Concourse for exiting. Please see Section E.2 of Enclosure 1 (attached) that provides the calculations for this analysis.

3. Seating Bowl Fire Scenario [Design Fire Scenario 1]

   The evaluation of a fire scenario in the Seating Bowl was a comparison between the maximum required egress time from the non-smoke-protected east Seating Bowl and the maximum required egress time from the smoke-protected Seating Bowl. The maximum required egress time for a fire in the Seating Bowl for the smoke-protected seating areas was 4.5 minutes (*Smoke Control Report* dated October 16, 2012, page B-4). This time exceeds the maximum required egress time from the east Seating Bowl (3.4 minutes). Since the referenced Report demonstrated that occupants in the smoke-protected areas of the Seating Bowl had sufficient time to egress in the event of a Seating Bowl fire, the occupants of the east Seating Bowl will also have sufficient time. Please see Section E.3 of Enclosure 1 (attached) that provides the calculations for this analysis.

CONCLUSION

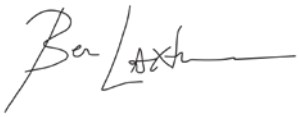
Smoke-protected exit factors permit the use of less exit width for a given population than required by standard exit factors. This reduced exit width will result in longer exit times compared to the same population provided with exits sized using the standard exit factors in the building code. This letter has demonstrated that the occupants of the east Seating Bowl will have sufficient time to exit through the Main Concourse using standard exit factors with at least the same tenable conditions as the occupants using smoke-protected exit factors.

FP&C CONSULTANTS, INC.

If you have any questions or concerns, please feel free to contact me.

Sincerely,

FP&C CONSULTANTS, INC.



Ben Laxton

BAL/adm

Attachments

E.1 TIMED EGRESS ANALYSIS [Design Fire Scenario 2 – Main Concourse Level Fire]

A timed egress analysis is presented to demonstrate that the occupants of the east Seating Bowl of the Cumberland County Civic Center can exit from the Seating Bowl and onto the Main Concourse Level before the visibility on the Main Concourse Level drops below 30 feet as referenced by Appendix A of the *Smoke Control Report* dated October 16, 2012 (the tenability limit for visibility based on data from studies referenced in the Society of Fire Protection Engineers Handbook). The following timed egress calculations evaluate a fire scenario that occurs on the southeast Main Concourse Level.

1. Methodology

The exit rate calculations used in this analysis are similar to the flow rates found in Dr. John Fruin's work, Pedestrian Planning and Design as a Level of Service "E" referenced in Chapter 14, Section 3 of the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 3rd Edition. The flow rates and travel speeds used in this study are conservative and are consistent with emergency exiting considerations. During non-emergency conditions, many persons exit at their leisure and exit times longer than those reported in this study are expected. Studies indicate the human behavior known as panic is rare and does not occur if adequate exits are provided.

The flow rate used for persons traveling through doors or on level accessways is on the lower end of the range provided by Fruin.

The following flow rates and travel speeds have been used:

Table E.1.1
Travel Speeds and Flow Rates

ELEMENT	TRAVEL SPEED IN FEET/MINUTE (ft/m)	FLOW RATE IN PEOPLE/FEET/MINUTE (pfm)
Stairs & stepped aisles (7 inch risers)	60.0 (slow); 100.0 (fast)*	17.0
Stairs & stepped aisles (8 inch risers)	35.0 (slow); 80.0 (fast)*	15.3
Doors	-----	21.0
Seating Rows	35.0 (slow); 80.0 (fast)*	-----
Level exit components	150 (slow); 200 (fast) *	21.0

** The faster speed is used to consider the time for the first person to reach an exit (i.e., the lead person in a crowd). The slower speed is used to address the movement expected by the elderly, persons with disabilities and the last person in a crowd.*

2. Definitions

The following terms are defined to provide clarity:

Queue (Queuing) - Pedestrian waiting condition where forward movement essentially stops and people become stationary for a period of time.

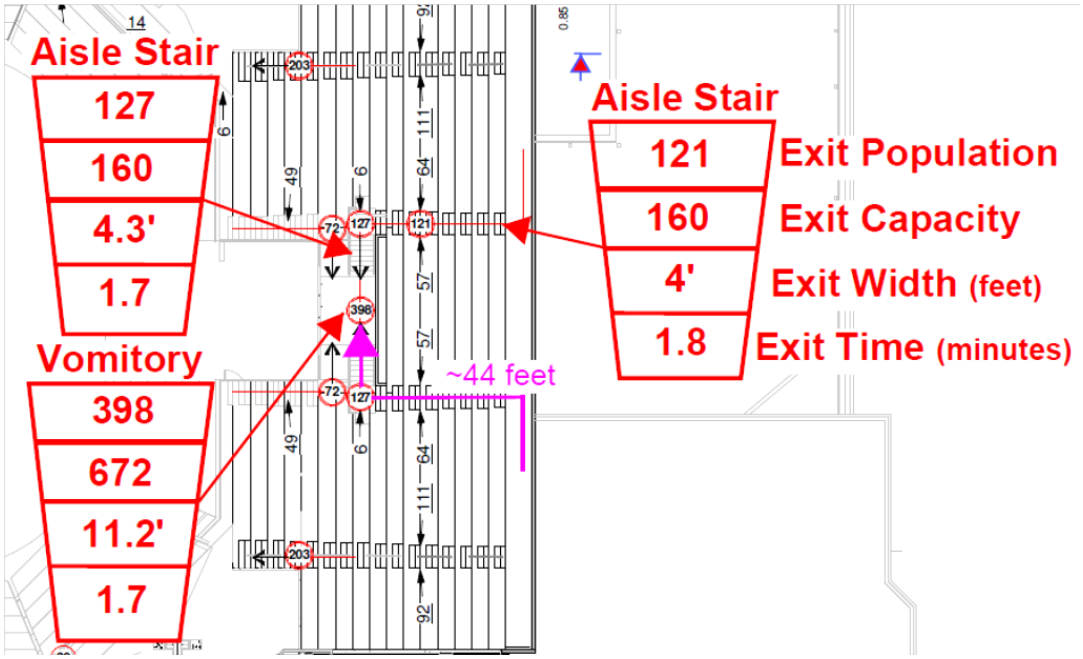
Flow Time - This is the amount of time for a population to pass a particular point.

Egress Time - This is the total time for a population to traverse across a space and includes both the flow time through a point and the travel time to an exit element.

3. Population

The exit analysis uses the populations calculated from the east Seating Bowl seating section manifests (see Figure E.1.1 and Figure E.1.2 below). The Seating Bowl opens into the Main Concourse through the vomitory located midway up the Seating Bowl from the Event Level.

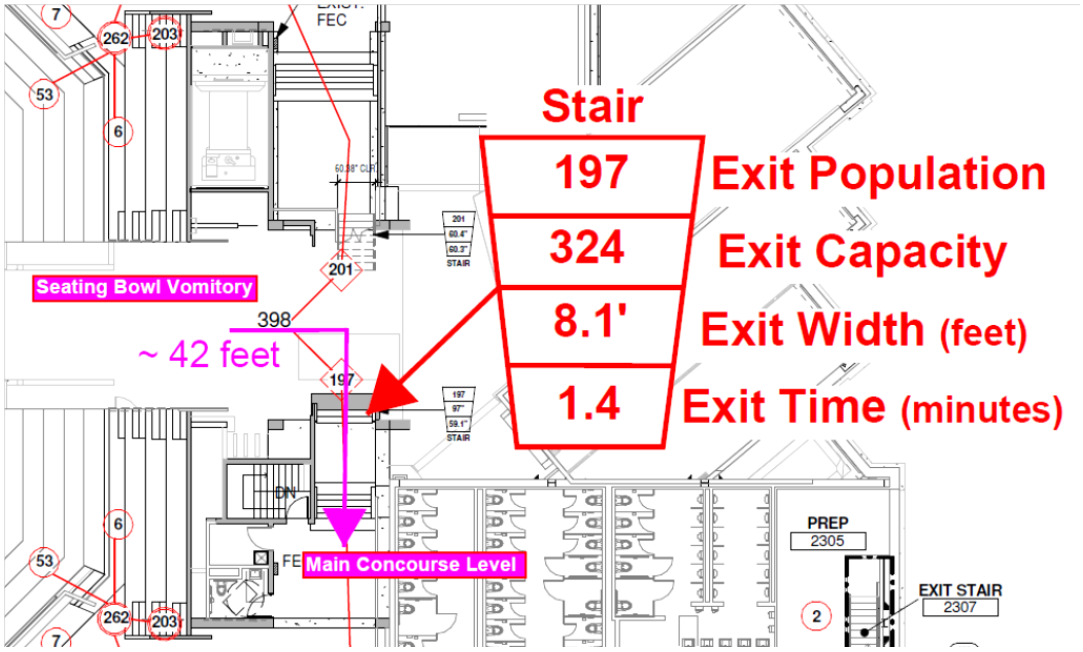
Figure E.1.1
Exiting in the East Seating Bowl



The vomitory provides 11.2 feet of clear egress width. The vomitory can accommodate 672 people. This was calculated using the non-smoke-protected exit factors in Section 1005.1 of the 2009 MUBEC and Table 7.3.3.1 of the 2009 Edition NFPA 101 for level exit components (0.2 inches per occupant).

$$W_{Vomitory} = \left(0.2\ \frac{inches}{occupant} \times \frac{1\ foot}{12\ inches} \times \frac{Vomitory\ width}{11.2\ feet}\right)^{-1} = 672\ occupants$$

Figure E.1.2
Exiting in the East Seating Bowl



The exit stair from the vomitory to the Main Concourse provides 8.1 feet of clear egress width. The stair can accommodate 324 people. This was calculated using the non-smoke-protected exit factors in Section 1005.1 of the 2009 MUBEC and Table 7.3.3.1 of the 2009 Edition NFPA 101 for level exit components (0.3 inches per occupant).

$$W_{Stair} = \left(0.3\ \frac{inches}{occupant} \times \frac{1\ foot}{12\ inches} \times \frac{Vomitory\ width}{8.1\ feet}\right)^{-1} = 324\ occupants$$

4. System Activation and Alarm Notification

The time required for the building systems to detect a fire on the Main Concourse Level was determined based upon the simulation results from the FDS software. The worst case scenario modeled automatic sprinkler activation at 133 seconds. By adding 10 seconds for transmission time of the sprinkler activation to the alarm panel a total time of 143 seconds or 0.8 minutes was estimated for system activation and alarm notification.

5. Egress Initiation

For a fire on the Main Concourse Level, the time for occupants to recognize there was a fire and start to move is estimated to be 0.5 minutes. This number includes time required for both alarm pre-action and alarm recognition. This time accounts for people to realize there is an emergency and begin their egress from the Seating Bowl.

6. Timed Egress Calculations

The following section calculates the time required for the last person to exit the east Seating Bowl onto the Main Concourse Level after egress initiation.

The time required for the last person to exit through the vomitory in the east Seating Bowl and onto the Main Concourse is calculated by dividing the longest travel distance to the vomitory by the slow travel speed(s), in Table E.1.1 above, and comparing these times to the times required for queues to flow through the various egress elements encountered. The maximum travel distance was calculated from the center seat of the highest row of the Seating Bowl to the vomitory.

Time to travel the maximum travel distance of 86 feet (a summation of different egress conditions including seating rows and stairs with 7 inch risers) was calculated using the slow travel speed (60 feet/minute) from Table E.1.1 above. The following equations illustrate the methodology for determining the total required egress time based on travel distance (based on the calculated travel distance shown in Figure E.1.1 and Figure E.1.2 above):

Travel Time at 60 Feet per Minute:

$$86\ feet\ \times \frac{1\ minute}{60\ feet} = 1.4\ minutes$$

The flow time for the aisle stairs, the flow time through the vomitory, and the flow time down the stairs to the Main Concourse was calculated using the flow rate down stairs with 7 inch risers (17 people/feet/minute) and the flow rate through doors (21 people/feet/minute) from Table E.1.1 above. The following equations illustrate the methodology for determining the total required flow time (based on the calculated flow width and population shown in Figure E.1.1 and Figure E.1.2 above):

Time to flow down the narrowest aisle stair in the east Seating Bowl (4-feet wide):

$$\frac{17\ people}{feet \cdot minute} \times (4\ foot\ wide\ aisle\ stair\ width) = \frac{68\ people}{minute}$$

$$121\ people\ (population) \times \frac{1\ minute}{68\ people} = 1.8\ \ minutes$$

Time to flow through the vomitory:

$$\frac{21\ people}{feet \cdot minute} \times (11.2\ foot\ wide\ vomitory\ width) = \frac{235.2\ people}{minute}$$

$$398\ people\ (population) \times \frac{1\ minute}{235.2\ people} = 1.7\ \ minutes$$

Time to flow down the stair from the vomitory to the Main Concourse Level:

$$\frac{17\ people}{feet \cdot minute} \times (8.1\ foot\ wide\ stair\ width) = \frac{137.7\ people}{minute}$$

$$197\ people\ (population) \times \frac{1\ minute}{137.7\ people} = 1.4\ \ minutes$$

The greatest flow time is 1.8 minutes down the narrow aisle stairs.

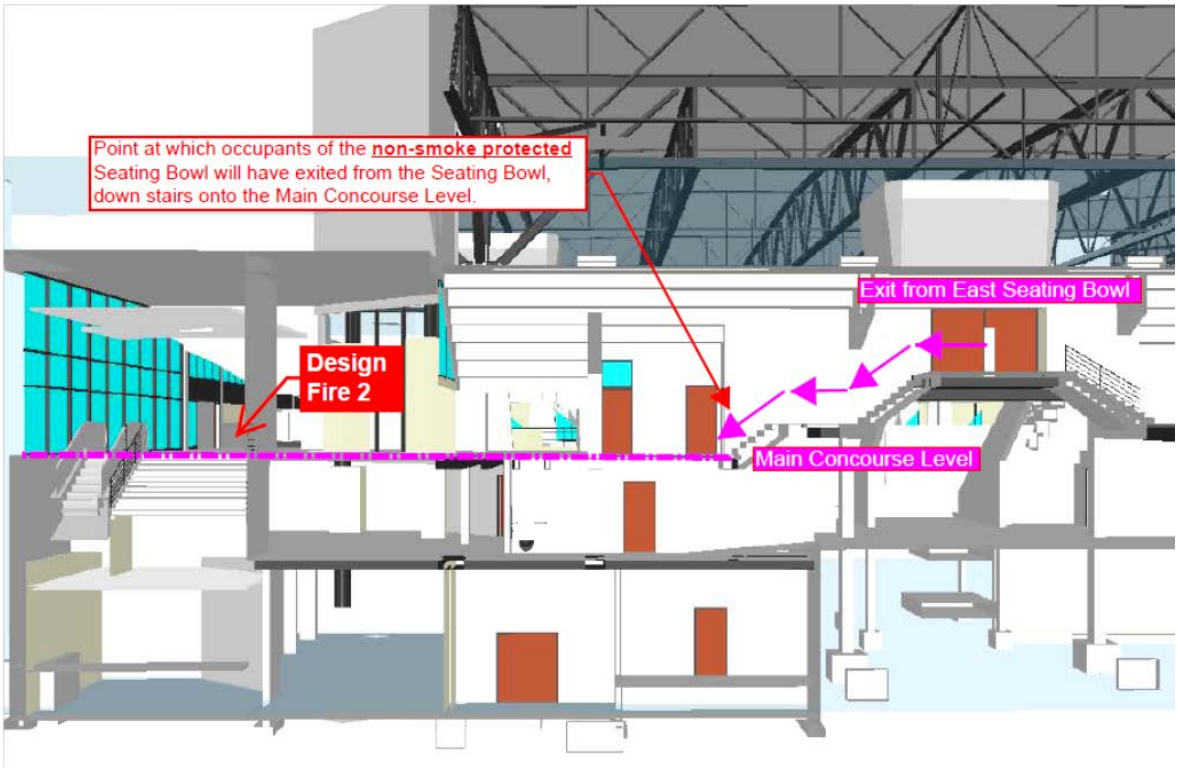
Since the exit flow time (1.8 minutes) is greater than the travel time (1.4 minutes), the exit flow time of 1.8 minutes will be used for the total egress time calculations. The total egress time is summed up in Table E.1.2 below:

Table E.1.2
Seating Bowl Total Egress Time

PHASE	TIME
Fire Alarm activation (automatic sprinklers)	2.4 minutes
Time to initiate egress	0.5 minutes
Vomitory flow from Seating Bowl (greater than travel time)	1.8 minutes
Seating Bowl Total Egress Time:	**4.7 minutes**
Total Egress Time with 2009 MUBEC Safety Factor (1.5):	**7.0 minutes**

The visibility for the occupants to exit the east Seating Bowl to the Main Concourse Level is sufficient before the visibility six feet above the Main Concourse Level drops below 30 feet as referenced by Appendix A of the *Smoke Control Report* dated October 16, 2012 (the tenability limit for visibility based on data from studies referenced in the Society of Fire Protection Engineers Handbook). See Figure E.1.3 below for an illustration of the east end of the Main Concourse Level where the occupants of the east Seating Bowl egress through the vomitory. This illustration shows that the visibility is still tenable on the Main Concourse Level. Note in the illustration that no untenable smoke conditions are present in the east end of the Main Concourse at 7 minutes 48 seconds (the time this image was taken from the simulation).

Figure E.1.3
West Elevation of East Main Concourse
at 7 Minutes 48 Seconds of Simulation Time



E.2 TIMED EGRESS ANALYSIS [Design Fire Scenario 4 – Mechanical Level Fire]

A timed egress analysis is presented to demonstrate that the occupants of the east Seating Bowl of the Cumberland County Civic Center can exit from the Seating Bowl and onto the Main Concourse Level before the visibility on the Main Concourse Level drops below 30 feet as referenced by Appendix A of the *Smoke Control Report* dated October 16, 2012 (the tenability limit for visibility based on data from studies referenced in the Society of Fire Protection Engineers Handbook). The following timed egress calculations evaluate a fire scenario that occurs on the Mechanical Level.

1. Methodology

The exit rate calculations used in this analysis are similar to the flow rates found in Dr. John Fruin's work, Pedestrian Planning and Design as a Level of Service "E" referenced in Chapter 14, Section 3 of the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 3rd Edition. The flow rates and travel speeds used in this study are conservative and are consistent with emergency exiting considerations. During non-emergency conditions, many persons exit at their leisure and exit times longer than those reported in this study are expected. Studies indicate the human behavior known as panic is rare and does not occur if adequate exits are provided.

The flow rate used for persons traveling through doors or on level accessways is on the lower end of the range provided by Fruin.

The following flow rates and travel speeds have been used:

Table E.2.1
Travel Speeds and Flow Rates

ELEMENT	TRAVEL SPEED IN FEET/MINUTE (ft/m)	FLOW RATE IN PEOPLE/FEET/MINUTE (pfm)
Stairs & stepped aisles (7 inch risers)	60.0 (slow); 100.0 (fast)*	17.0
Stairs & stepped aisles (8 inch risers)	35.0 (slow); 80.0 (fast)*	15.3
Doors	-----	21.0
Seating Rows	35.0 (slow); 80.0 (fast)*	-----
Level exit components	150 (slow); 200 (fast) *	21.0

** The faster speed is used to consider the time for the first person to reach an exit (i.e., the lead person in a crowd). The slower speed is used to address the movement expected by the elderly, persons with disabilities and the last person in a crowd.*

2. Definitions

The following terms are defined to provide clarity:

Queue (Queuing) - Pedestrian waiting condition where forward movement essentially stops and people become stationary for a period of time.

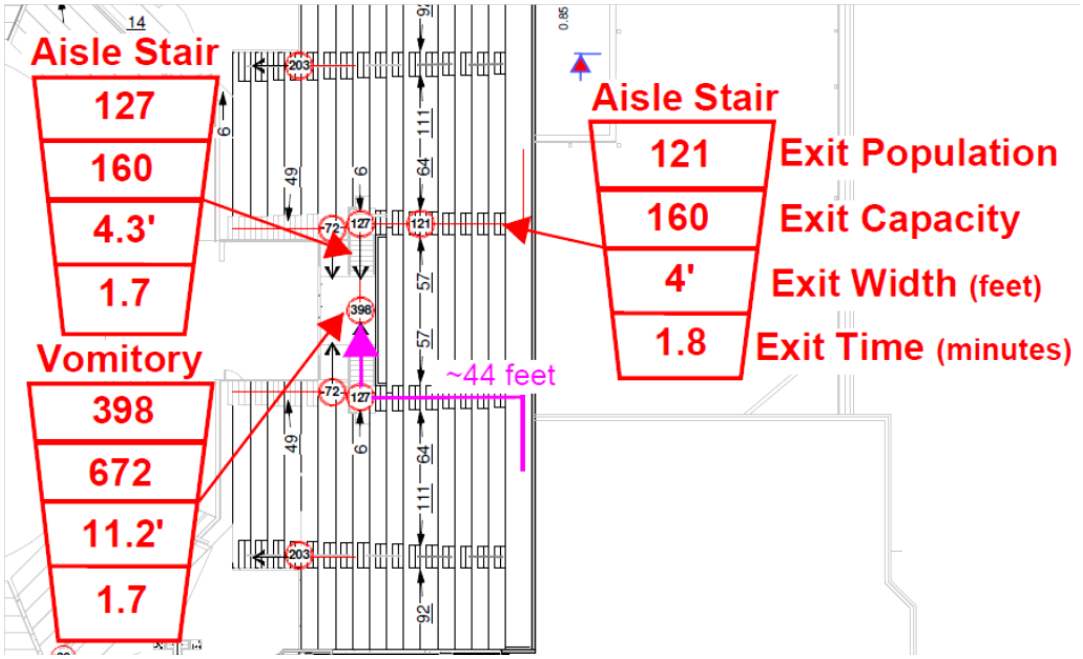
Flow Time - This is the amount of time for a population to pass a particular point.

Egress Time - This is the total time for a population to traverse across a space and includes both the flow time through a point and the travel time to an exit element.

3. Population

The exit analysis uses the populations calculated from the east Seating Bowl seating section manifests (see Figure E.2.1 and Figure E.2.2 below). The Seating Bowl opens into the Main Concourse through the vomitory located midway up the Seating Bowl from the Event Level.

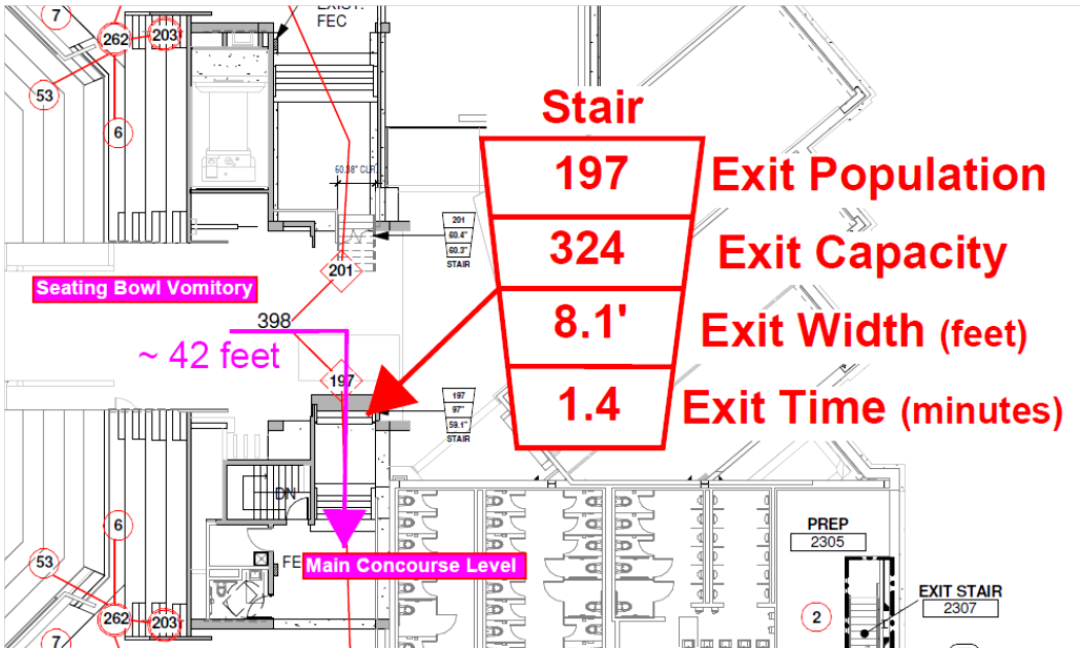
Figure E.2.1
Exiting in the East Seating Bowl



The vomitory provides 11.2 feet of clear egress width. The vomitory can accommodate 672 people. This was calculated using the non-smoke-protected exit factors in Section 1005.1 of the 2009 MUBEC and Table 7.3.3.1 of the 2009 Edition NFPA 101 for level exit components (0.2 inches per occupant).

$$W_{Vomitory} = \left(0.2\ \frac{inches}{occupant} \times \frac{1\ foot}{12\ inches} \times \frac{Vomitory\ width}{11.2\ feet}\right)^{-1} = 672\ occupants$$

Figure E.2.2
Exiting in the East Seating Bowl



The exit stair from the vomitory to the Main Concourse provides 8.1 feet of clear egress width. The stair can accommodate 324 people. This was calculated using the non-smoke-protected exit factors in Section 1005.1 of the 2009 MUBEC and Table 7.3.3.1 of the 2009 Edition of NFPA 101 for level exit components (0.3 inches per occupant).

$$W_{Stair} = \left(0.3\ \frac{inches}{occupant} \times \frac{1\ foot}{12\ inches} \times \frac{Vomitory\ width}{8.1\ feet}\right)^{-1} = 324\ occupants$$

4. System Activation and Alarm Notification

The time required for the building systems to detect a fire on the Mechanical Level was determined based upon the simulation results from the FDS software. The worst case scenario modeled area smoke detector activation at 38.4 seconds. By adding 10 seconds for transmission time of the detector activation to the alarm panel a total time of 48.4 seconds or 0.8 minutes was estimated for system activation and alarm notification.

5. Egress Initiation

For a fire on the Mechanical Level, the time for occupants to recognize there was a fire and start to move is estimated to be 0.5 minutes. This number includes time required for both alarm pre-action and alarm recognition. This time accounts for people to realize there is an emergency and begin their egress from the Seating Bowl.

6. Timed Egress Calculations

The following section calculates the time required for the last person to exit the east Seating Bowl onto the Main Concourse Level after egress initiation.

The time required for the last person to exit through the vomitory in the east Seating Bowl and onto the Main Concourse is calculated by dividing the longest travel distance to the vomitory by the slow travel speed(s), in Table E.2.1 above, and comparing these times to the times required for queues to flow through the various egress elements encountered. The maximum travel distance was calculated from the center seat of the highest row of the Seating Bowl to the vomitory.

Time to travel the maximum travel distance of 86 feet (a summation of different egress conditions including seating rows and stairs with 7 inch risers) was calculated using the slow travel speed (60 feet/minute) from Table E.2.1 above. The following equations illustrate the methodology for determining the total required egress time based on travel distance (based on the calculated travel distance shown in Figure E.2.1 and Figure E.2.2 above):

Travel Time at 60 Feet per Minute:

$$86\ feet\ \times \frac{1\ minute}{60\ feet} = 1.4\ minutes$$

The flow time for the aisle stairs, the flow time through the vomitory, and the flow time down the stairs to the Main Concourse was calculated using the flow rate down stairs with 7 inch risers (17 people/feet/minute) and the flow rate through doors (21 people/feet/minute) from Table E.2.1 above. The following equations illustrate the methodology for determining the total required flow time (based on the calculated flow width and population shown in Figure E.2.1 and Figure E.2.2 above):

Time to flow down the narrowest aisle stair in the east Seating Bowl (4-feet wide):

$$\frac{17\ people}{feet \cdot minute} \times (4\ foot\ wide\ aisle\ stair\ width) = \frac{68\ people}{minute}$$

$$121\ people\ (population) \times \frac{1\ minute}{68\ people} = 1.8\ \ minutes$$

Time to flow through the vomitory:

$$\frac{21\ people}{feet \cdot minute} \times (11.2\ foot\ wide\ vomitory\ width) = \frac{235.2\ people}{minute}$$

$$398\ people\ (population) \times \frac{1\ minute}{235.2\ people} = 1.7\ \ minutes$$

Time to flow down the stair from the vomitory to the Main Concourse Level:

$$\frac{17\ people}{feet \cdot minute} \times (8.1\ foot\ wide\ stair\ width) = \frac{137.7\ people}{minute}$$

$$197\ people\ (population) \times \frac{1\ minute}{137.7\ people} = 1.4\ \ minutes$$

The greatest flow time is 1.8 minutes down the narrow aisle stairs.

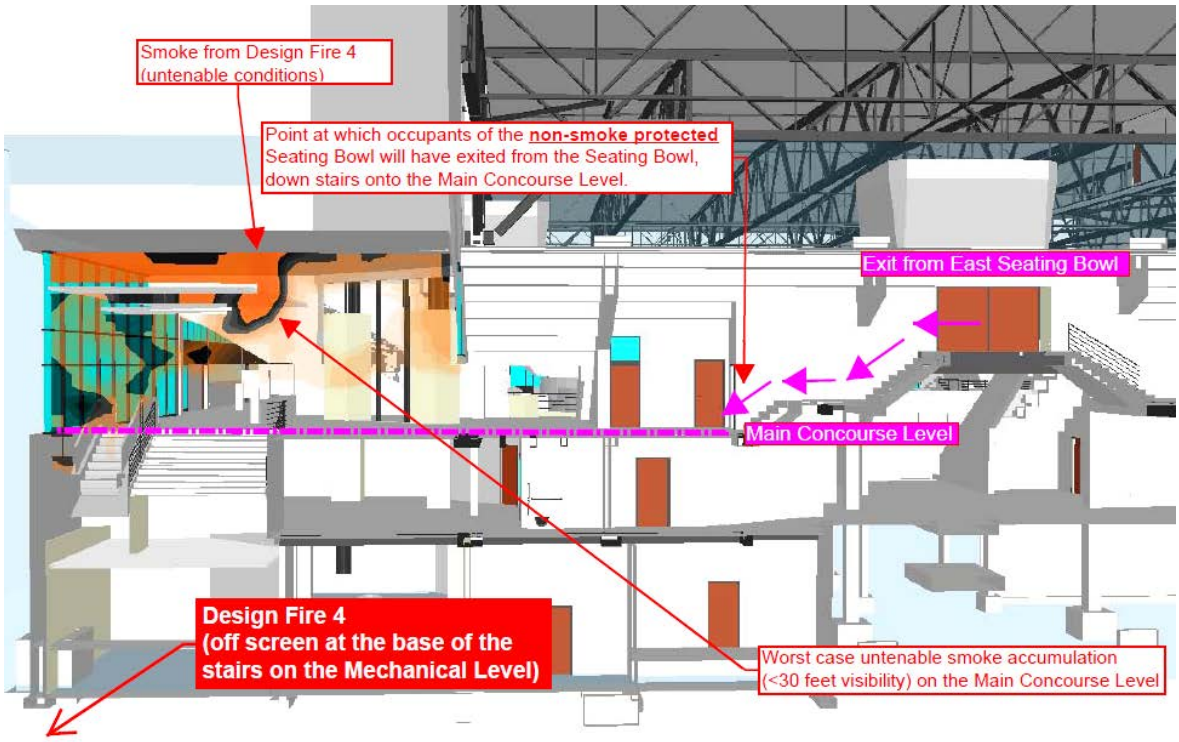
Since the exit flow time (1.8 minutes) is greater than the travel time (1.4 minutes), the exit flow time of 1.8 minutes will be used for the total egress time calculations. The total egress time is summed up in Table E.2.2 below:

Table E.2.2
Seating Bowl Total Egress Time

PHASE	TIME
Fire Alarm activation (area smoke detector)	0.8 minutes
Time to initiate egress	0.5 minutes
Vomitory flow from Seating Bowl (greater than travel time)	1.8 minutes
Seating Bowl Total Egress Time:	**3.1 minutes**
Total Egress Time with 2009 MUBEC Safety Factor (1.5):	**4.6 minutes**

The visibility for the occupants to exit the east Seating Bowl to the Main Concourse Level is sufficient before the visibility six feet above the Main Concourse Level drops below 30 feet as referenced by Appendix A of the *Smoke Control Report* dated October 16, 2012 (the tenability limit for visibility based on data from studies referenced in the Society of Fire Protection Engineers Handbook). See Figure E.2.3 below for an illustration of the east end of the Main Concourse Level where the occupants of the east Seating Bowl egress through the vomitory. This illustration shows that the visibility is still tenable on the Main Concourse Level. Note in the illustration that no untenable smoke conditions are present in the east end of the Main Concourse at 5 minutes (the time this image was taken from the simulation).

Figure E.2.3
West Elevation of East Main Concourse
at 5 Minutes of Simulation Time



E.3 TIMED EGRESS ANALYSIS [Design Fire Scenario 1 – Seating Bowl Fire]

A timed egress analysis is presented to demonstrate that the occupants of the east Seating Bowl of the Cumberland County Civic Center can exit from the Seating Bowl and onto the Main Concourse Level before the visibility on the Main Concourse Level drops below 30 feet as referenced by Appendix A of the *Smoke Control Report* dated October 16, 2012 (the tenability limit for visibility based on data from studies referenced in the Society of Fire Protection Engineers Handbook). The following timed egress calculations evaluate a fire scenario that occurs in the Seating Bowl.

1. Methodology

The exit rate calculations used in this analysis are similar to the flow rates found in Dr. John Fruin's work, Pedestrian Planning and Design as a Level of Service "E" referenced in Chapter 14, Section 3 of the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 3rd Edition. The flow rates and travel speeds used in this study are conservative and are consistent with emergency exiting considerations. During non-emergency conditions, many persons exit at their leisure and exit times longer than those reported in this study are expected. Studies indicate the human behavior known as panic is rare and does not occur if adequate exits are provided.

The flow rate used for persons traveling through doors or on level accessways is on the lower end of the range provided by Fruin.

The following flow rates and travel speeds have been used:

Table E.3.1
Travel Speeds and Flow Rates

ELEMENT	TRAVEL SPEED IN FEET/MINUTE (ft/m)	FLOW RATE IN PEOPLE/FEET/MINUTE (pfm)
Stairs & stepped aisles (7 inch risers)	60.0 (slow); 100.0 (fast)*	17.0
Stairs & stepped aisles (8 inch risers)	35.0 (slow); 80.0 (fast)*	15.3
Doors	-----	21.0
Seating Rows	35.0 (slow); 80.0 (fast)*	-----
Level exit components	150 (slow); 200 (fast) *	21.0

** The faster speed is used to consider the time for the first person to reach an exit (i.e., the lead person in a crowd). The slower speed is used to address the movement expected by the elderly, persons with disabilities and the last person in a crowd.*

2. Definitions

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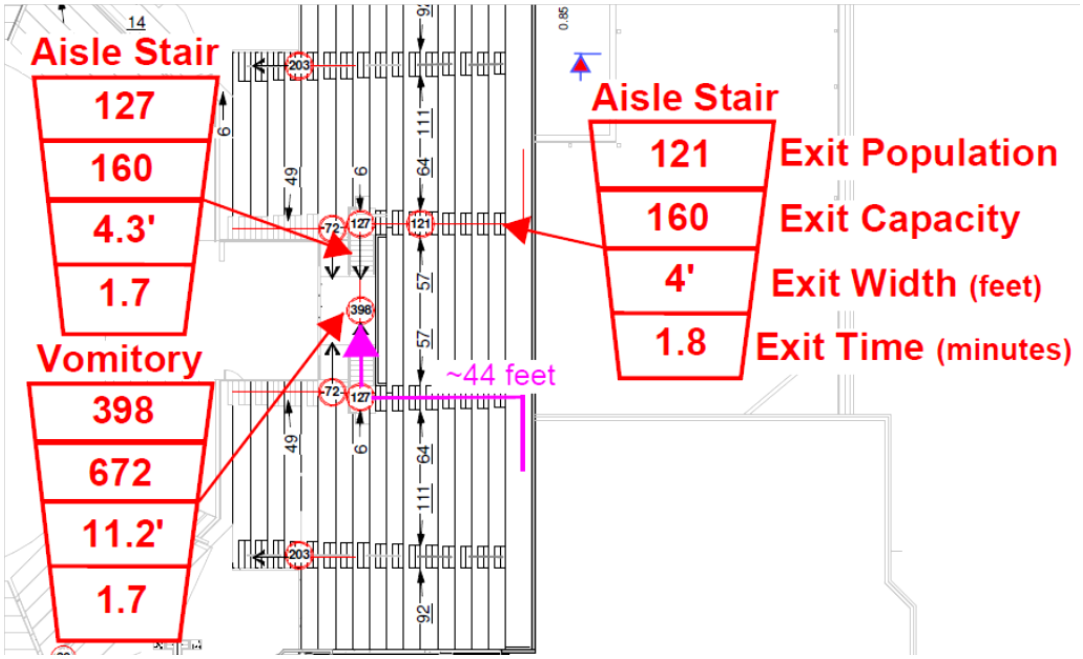
3. Population

The exit analysis uses the populations calculated from the east Seating Bowl seating section manifests (see Figure E.3.1 and Figure E.3.2 below). The Seating Bowl opens into the Main Concourse through the vomitory located midway up the Seating Bowl from the Event Level.

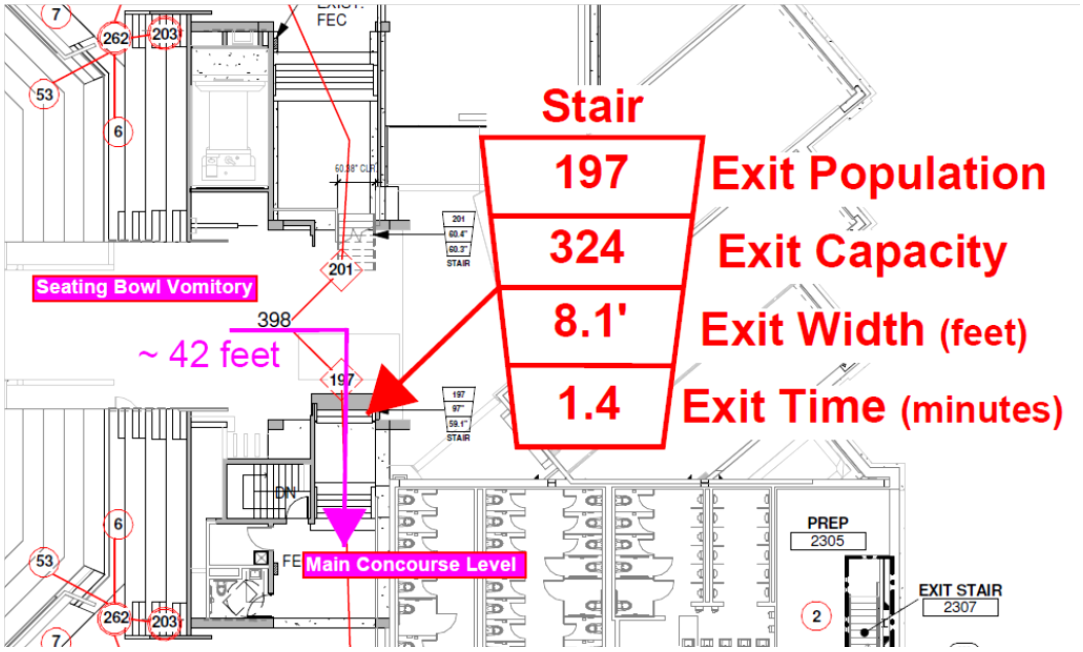
Figure E.3.1
Exiting in the East Seating Bowl



The vomitory provides 11.2 feet of clear egress width. The vomitory can accommodate 672 people. This was calculated using the non-smoke-protected exit factors in Section 1005.1 of the 2009 MUBEC and Table 7.3.3.1 of the 2009 Edition NFPA 101 for level exit components (0.2 inches per occupant).

$$W_{Vomitory} = \left(0.2\ \frac{inches}{occupant} \times \frac{1\ foot}{12\ inches} \times \frac{Vomitory\ width}{11.2\ feet}\right)^{-1} = 672\ occupants$$

Figure E.3.2
Exiting in the East Seating Bowl



The exit stair from the vomitory to the Main Concourse provides 8.1 feet of clear egress width. The stair can accommodate 324 people. This was calculated using the non-smoke-protected exit factors in Section 1005.1 of the 2009 MUBEC and Table 7.3.3.1 of the 2009 Edition of NFPA 101 for level exit components (0.3 inches per occupant).

$$W_{Stair} = \left(0.3\ \frac{inches}{occupant} \times \frac{1\ foot}{12\ inches} \times \frac{Vomitory\ width}{8.1\ feet}\right)^{-1} = 324\ occupants$$

4. System Activation and Alarm Notification

The occupants of the Seating Bowl can see the Event Level floor so notification of a fire event was assumed to be by observation from the Seating Bowl occupants and not by alarm.

5. Egress Initiation

For a fire in the Seating Bowl, the time for occupants to recognize there was a fire and start to move is estimated to be 0.5 minutes. This time accounts for people to realize there is an emergency and begin their egress from the Seating Bowl.

6. Timed Egress Calculations

The following section calculates the time required for the last person to exit the east Seating Bowl onto the Main Concourse Level after egress initiation.

The time required for the last person to exit through the vomitory in the east Seating Bowl and onto the Main Concourse is calculated by dividing the longest travel distance to the vomitory by the slow travel speed(s), in Table E.3.1 above, and comparing these times to the times required for queues to flow through the various egress elements encountered. The maximum travel distance was calculated from the center seat of the highest row of the Seating Bowl to the vomitory.

Time to travel the maximum travel distance of 86 feet (a summation of different egress conditions including seating rows and stairs with 7 inch risers) was calculated using the slow travel speed (60 feet/minute) from Table E.3.1 above. The following equations illustrate the methodology for determining the total required egress time based on travel distance (based on the calculated travel distance shown in Figure E.3.1 and Figure E.3.2 above):

Travel Time at 60 Feet per Minute:

$$86\ feet\ \times \frac{1\ minute}{60\ feet} = 1.4\ minutes$$

The flow time for the aisle stairs, the flow time through the vomitory, and the flow time down the stairs to the Main Concourse was calculated using the flow rate down stairs with 7 inch risers (17 people/feet/minute) and the flow rate through doors (21 people/feet/minute) from Table E.3.1 above. The following equations illustrate the methodology for determining the total required flow time (based on the calculated flow width and population shown in Figure E.3.1 and Figure E.3.2 above):

Time to flow down the narrowest aisle stair in the east Seating Bowl (4-feet wide):

$$\frac{17\ people}{feet \cdot minute} \times (4\ foot\ wide\ aisle\ stair\ width) = \frac{68\ people}{minute}$$

$$121\ people\ (population) \times \frac{1\ minute}{68\ people} = 1.8\ \ minutes$$

Time to flow through the vomitory:

$$\frac{21\ people}{feet \cdot minute} \times (11.2\ foot\ wide\ vomitory\ width) = \frac{235.2\ people}{minute}$$

$$398\ people\ (population) \times \frac{1\ minute}{235.2\ people} = 1.7\ \ minutes$$

Time to flow down the stair from the vomitory to the Main Concourse Level:

$$\frac{17\ people}{feet \cdot minute} \times (8.1\ foot\ wide\ stair\ width) = \frac{137.7\ people}{minute}$$

$$197\ people\ (population) \times \frac{1\ minute}{137.7\ people} = 1.4\ \ minutes$$

The greatest flow time is 1.8 minutes down the narrow aisle stairs.

Since the exit flow time (1.8 minutes) is greater than the travel time (1.4 minutes), the exit flow time of 1.8 minutes will be used for the total egress time calculations. The total egress time is summed up in Table E.3.2 below:

Table E.3.2
Seating Bowl Total Egress Time

PHASE	TIME
Fire Alarm activation (beam smoke detector)	N/A [1]
Time to initiate egress	0.5 minutes
Vomitory flow from Seating Bowl (greater than travel time)	1.8 minutes
Seating Bowl Total Egress Time:	**2.3 minutes**
Total Egress Time with 2009 MUBEC Safety Factor (1.5):	**3.4 minutes**

[1] *See Item 4 above. The occupants of the Seating Bowl can see the Event Level floor so notification of a fire event was assumed to be by observation from the Seating Bowl occupants and not by alarm.*

The evaluation of a fire scenario in the Seating Bowl was a comparison between the maximum required egress time from the non-smoke-protected east Seating Bowl and the maximum required egress time from the smoke-protected Seating Bowl. The maximum required egress time for a fire in the Seating Bowl for the smoke-protected seating areas was 4.5 minutes (Smoke Control Report dated October 16, 2012, page B-4). This time exceeds the maximum required egress time from the east Seating Bowl (3.4 minutes). Since the referenced report demonstrated that occupants in the smoke-protected areas of the Seating Bowl had sufficient time to egress in the event of a Seating Bowl fire, the occupants of the east Seating Bowl will also have sufficient time.