DEPARTMENT OF FIRE PROTECTION ENGINEERING

TEAM 4

Big DAWG Consulting

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Problem

Baltimore/Washington International Airport (BWI) is undergoing a renovation project to add an A/B connector between piers A and B as part of their Concourse A/B Connector and Baggage Handling System project. An evacuation plan is needed to ensure occupant survival, facilitate egress, and limit occupant evacuation from the connector airside and through security.

Current fire protection features will be analyzed and new features may be implemented to maintain mission continuity and occupant safety during a fire event in which occupants are required to evacuate.

Design Goals, Objectives, and Criteria

Goal #1: Prevent fire from endangering occupants and minimize the possibility of injury.

Design Objective: Maintain a tenable environment for occupants during egress.

Performance Criteria:

- Ensure carbon monoxide levels within egress routes do not go above 2000 ppm and cyanide levels above 1000 ppm.
- Maintain radiant exposure to less than 2.5 kW/m^2
- Maintain visibility conditions to 20 m.
- Ensure smoke layer remains at least 2 m from the ground in occupied areas.

Goal #2: Ensure mission continuity to allow clients to resume business promptly after a fire event.

Design Objective #1: Minimize damage to structural elements.

Performance Criteria: Ensure walls of enclosure are influenced by no more than 25 kW/m^2 of heat flux.

Design Objective #2: Prevent fire spread from reaching catastrophic levels.

Performance Criteria: Prevent temperature in room of origin from reaching 1000℃.

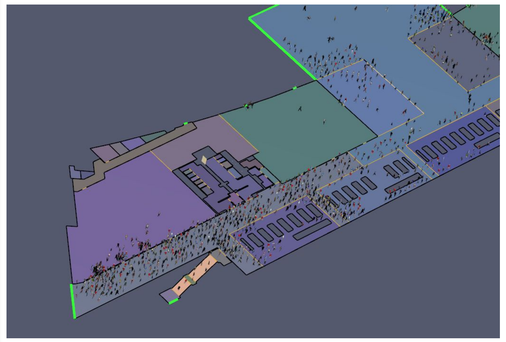

Figure 1. Pathfinder model of occupants in A/B connector

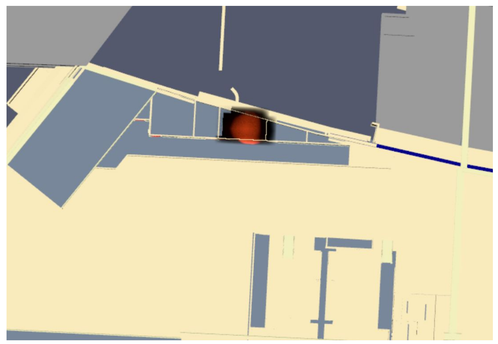

Figure 2. Fire modeled in the electrical room, located in the flex space of the A/B connector.

$$RSET = t_d + t_n + t_{ta} + t_{evac}$$

t_d (s)	t_n (s)	t_{ta} (s)	t_{evac} (s)	RSET (min)	ASET (min)
25.7	**5**	**30**	**177.2**	**3.96**	**4.03**

Figure 3. RSET and ASET values.

Final Design and Results

Smoke layer descent for fast t-squared fire, t_g=150 sec:

$$\frac{z}{H} = \left[1 + \frac{4.1 k_v}{A}\left(\frac{H}{t_g}\right)^{2/3} t^{5/3}\right]^{-3/2}$$

Visibility/smoke density:

$$Visibility = \frac{0.43K}{D} \qquad Density = \frac{D_m Q}{\chi_a \Delta H_c A(H-z)}$$

- CO levels and HCN levels are found from fuel output to determine the concentrations during the evacuation
- Radiant exposure and heat flux onto walls and environment from our design fire will be analyzed through Pyrosim. The peak temperature is analyzed to ensure the room of origin does not exceed 1000℃

A full evacuation was modeled using Pathfinder. A majority of occupants were directed to Piers A, B, the food court, and public areas. 3.6% of occupants were directed to evacuate airside. This scenario assumed BWI to be at peak operating hours with a maximum number of 2732 occupants in the space.

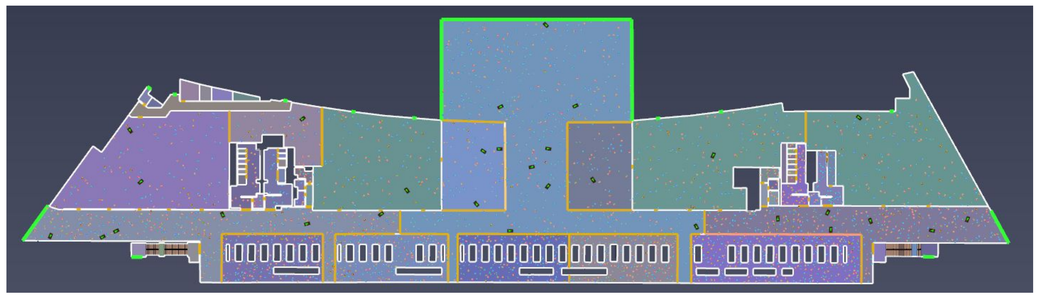

Figure 4. Pathfinder model, including A/B connector, concourse, and flex spaces.

Methods of Analysis

The success of this design will be facilitated by the required safe egress time (RSET) and available safe egress time (ASET). RSET is calculated using the equation below, where t_d is detection time, t_n is notification time, t_{ta} is the time to take action or pre-movement time, and t_{evac} is the evacuation time. t_d is calculated using the smoke layer descent equation, t_n and t_{ta} are estimated using engineering judgement, and t_{evac} is calculated using a first-order analysis.

RSET < ASET for the design to be deemed successful.

Jacobs