FPE TEAM #1

FIRST IN Fire Protection

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Problem Definition

Task: BWI is building a new terminal to connect Terminals A and B. It is necessary to protect this space in a way that protects property and the environment, maximizes overall life safety, and maintains mission continuity. MDOT has additionally requested that out-of-terminal evacuation either airside or landside be minimized.

Performance Criteria: The building will not endure structural failure before the minimum time required for egress, the time for the smoke layer to descend to 6 feet should exceed the time for egress, and ambient heat will not exceed 10°C above ambient in more than one holdroom.

Design Fire Scenario: A defective lithium-ion battery, kept inside a traveler's carry-on, ignites while the traveler is waiting for their plane. Ignition is limited only to the suitcase.

Trial Design: Proposed changes include draft curtains that drop to 8 feet above the floor; if those are insufficient, HVAC intake can be bolstered

Design Calculations & Analysis

Solved analytically, the smoke layer descends in 312 seconds. This is determined with the below equation

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

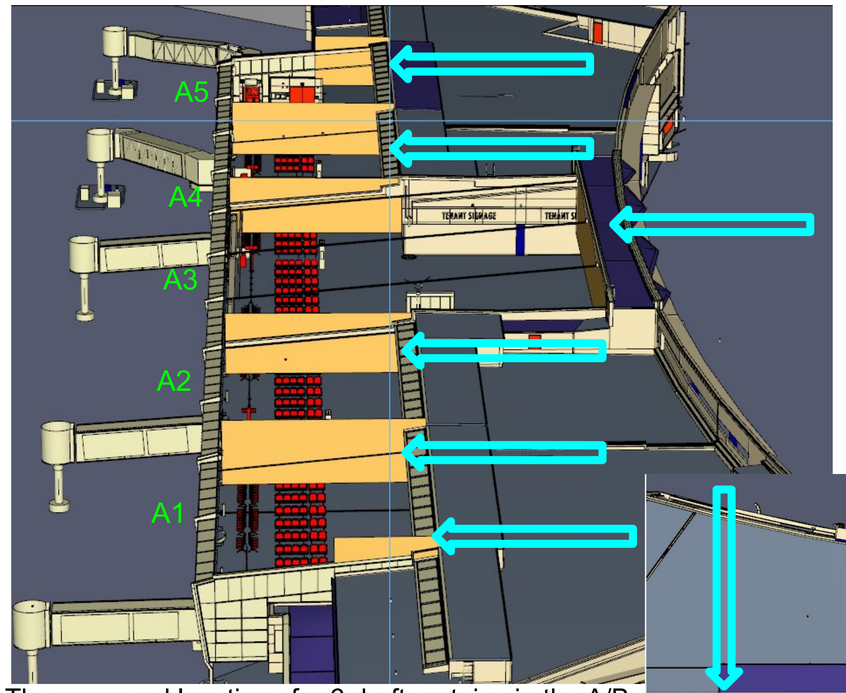
Based on the descent of the smoke layer, the draft curtains were effective at preventing smoke from reaching the occupants.

The holdrooms take 170 seconds to raise 10°C above ambient temperature The below equations were solved to give the time for the room to increase temperature. Epsilon was assumed to be 0.85, which is consistent with emissivity values of other fabrics.

$$q''_{rad} = \epsilon\sigma(T_s^4 - T_{sur}^4) \qquad \Delta t = \frac{Q \cdot A}{q''_{rad}}$$

Jacobs

Final Design

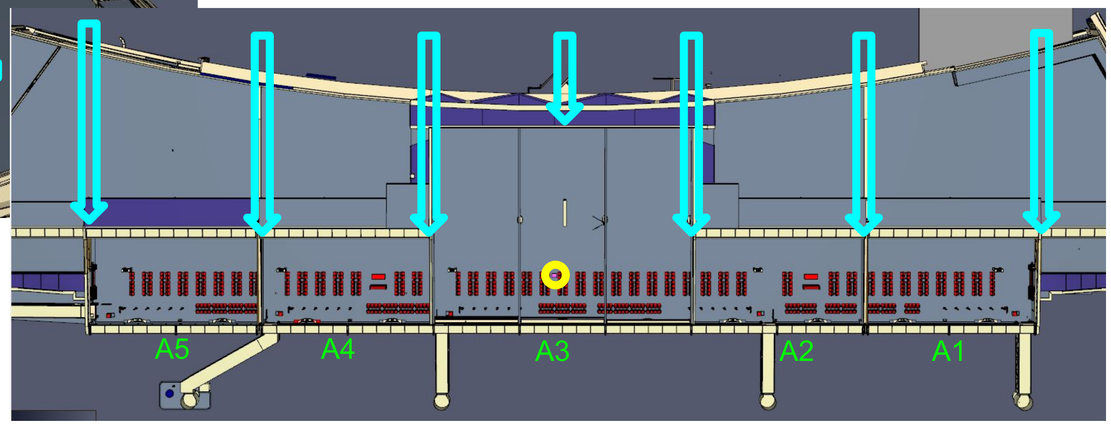


The proposed locations for 6 draft curtains in the A/B Connector are indicated with blue arrows. The curtains are intended to descend to 8 feet above the floor.

The fire begins in a suitcase, circled below in yellow. Holdrooms are noted in green.

Space: Shown below are five holdrooms in the A/B connector. They are divided along major structural members by draft curtains. When implemented, these draft curtains would not be deployed unless a fire is detected.

Already Present: BWI contains sprinklers, detectors, and notification devices. The notification devices explicitly include the public address system, which is otherwise not connected to the fire notification system. BWI also has 1 hour fire walls on the lower level and 1 hour rated fire walls between tenants on the upper level. Existing fire extinguishment systems were not taken into account to simulate a conservative scenario.



The Occupant Load of the A/B Connector was found to be 500 people.

With delay, full evacuation took 282 seconds; evacuation was into the A and B Terminals, and the Food Court.

Prototype & Test Results

Prototype Features: The Pyrosim includes draft curtains that descend to 8 feet above the floor. These are intended to prevent smoke from spreading to multiple holdrooms, and are attached to the major structural members closest to the division between each holdroom.

The fire was designed with a total Heat Release Rate of 28kW, based on HRR data of soft-sided luggage in the SFPE Handbook.