Analysis of Two Typical Barriers to Fire Spread

Assignment #1

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FPE 570 Building Firesafety 1 – Worcester Polytechnic Institute

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**Building Characteristics**

The structure at 500 Tallevast Road, Sarasota, Florida is a large multi-use or multi-occupancy building, similar in appearance to an airport hangar (figure 2). This structure is approximately 100 feet (30.5 m) in length and 50 feet (15.2 m) in width. The ceiling is a pitched roof with the sidewalls approximately 16 feet (4.88 m) in height with the peak height of 20 feet (6.09 m). The entire structure is equipped with automatic sprinklers and two-hour fire rated wall and ceiling assemblies.

There are a total of five occupancies. However, there are a total of eight separable spaces or compartments (figure 1). The Flying Dog Café is a restaurant and coffee shop located at the northeast corner of the structure. The café has restrooms and an office that are separated from the rest of the restaurant. Copytalk is a dictation service consisting of many office cubicles and is located in the north-center of the building. HPC Technical Services is another office space and warehouse occupancy located at the northwest corner of the structure. Directly south of HPC Technical Services is a dance studio called Player’s Studio. The entire south half of the structure is a warehouse containing John Ringling and Brothers storage. Copytalk and the dance studio are single open spaces with no partition or separation walls. The HPC Technical services occupancy has two compartments or rooms, which include the warehouse at the south and the office space at the north. The café also has two compartments; the office and bathrooms are separated from the remainder of the restaurant. John Ringling & Brothers consists of two large compartments, both of which are storage and warehouse spaces.

![Figure 1: Plan View Diagram of the structure](image-url)


**Barrier Analysis**

Construction on this structure was completed in early 2005. According to the Deputy Fire Marshal George Ellington of the Cedar Hammock Fire Department and the analysis of the building, the structure exceeds all of the local building and fire codes and standards. The building is equipped with automatic sprinklers that have been designed to meet NFPA 13 requirements given the fuel load and location (NFPA, 1999). All separation walls have been rated as two-hour fire barriers based upon their construction and lining of gypsum wallboard. To perform an accurate analysis of the barriers, an emphasis was placed on all the openings or penetrations through these barriers. Specifically, the analysis focused on the opening protective.

**Barrier #1**

The most prevalent barriers throughout this structure are the separation walls, which separate one business or compartment from the other. These walls are constructed of gypsum wallboard and have a two-hour fire rating. The walls extend from floor to ceiling, but are non-load-bearing walls. These types of walls are the ideal barrier for controlling and preventing smoke, hot gasses and fire from spreading into the next compartment (Watts, 2003). However, the effectiveness of these barriers depends on the penetrations and opening protectives that are in-place (Watts, 2003).

There are seven walls that are strong, effective barriers because they have no large openings (i.e. doors, windows). These are the walls that separate the café and Copytalk, the café and the John Ringling & Brothers warehouse, Copytalk and HPC technical services, Copytalk and the John Ringling & Brothers warehouse, HPC technical services warehouse and Player’s studio, and both walls that separate the studio and the John Ringling & Brothers warehouse (figure 1). Even though these walls do not have large openings there are still obvious penetrations, including: ducts, pipe chases, grilles, and electrical raceways (figures 3, 4 & 8). In most cases these smaller openings might be viewed as weaknesses or possible locations for hot spot failures (i.e. $T$ failure) (Fitzgerald, 2004). However, the contractors of this building utilized “3M’s fire barrier sealant” latex caulk to protect these openings (figure 3). The following is a description from 3M’s website concerning their “fire barrier sealant”:
“3M™ Fire Barrier Caulk is a premium elastomeric latex caulk designed for use as a one-part fire, smoke, noxious gas and water sealant. In addition, the unique intumescent property of this material (expands when heated) means that as cable or pipe insulation is consumed by fire, Fire Barrier Caulk expands to maintain the penetration seal (3M, 2006).”

According to this description, if the sealant caulk were to work properly, then hot spot failures (\(\bar{T}\)) should not occur.

There are two walls that have large openings and may be strong or weak depending on the protection of the openings. The first wall is located in the HPC technical services occupancy and separates the office space to the north from the warehouse/storage space to the south (figures 1 & 4). This wall has one doorway approximately 3 feet (0.91 m) wide by 7 feet (2.13 m) high. The door is constructed of fire rated steel and according to the employees was closed the majority of the time (figure 5). When the door is in the closed position, the barrier is effective and would delay or prevent fire from propagating from one compartment to another. The major weakness with this door assembly, and therefore a major weakness for the barrier, is that the door is not equipped with a self-closing device. Thus, if the door were accidentally left opened the barrier would be rendered ineffective, allowing for a massive failure (\(\bar{D}\) failure) of the barrier (Fitzgerald, 2004).

The second wall with a large opening is located in the John Ringling & Brothers warehouse and separates the first warehouse section from the second warehouse section (figure 1). There is one overhead doorway approximately 10 feet (3.05 m) wide by 10 feet (3.05 m) high located in the center of this separation wall. The overhead door is a roll-up fire door equipped with an active fire defense system, which includes a heat detector and automatic door closer (figures 6-7). When the heat detector activates, the door will automatically close. If the door were to activate properly during a fire and close, the barrier would be effective. However, if the door was blocked from closing or if the heat detection device were to malfunction, then the barrier would be rendered ineffective resulting in a massive failure (\(\bar{D}\) failure) of the barrier (Fitzgerald, 2004).
**Barrier #2**

The second barrier analyzed was the ceiling of the office and restroom space inside the café (figure 8). The other occupancies utilized the ceiling of the structure as the ceiling for their space (e.g., there were no false ceilings or drop ceilings created in these occupancies). However, the café owner created an office and restroom space inside the café with a separate, lower ceiling (figure 8). The space is approximately 15 feet (4.57 m) in length and 12 feet (3.66 m) in width and the ceiling was constructed of gypsum wallboard. The ceiling of this space is approximately 8 feet (2.44 m) in height. The restrooms are located on either side of the office (figure 1). There were only small openings in the ceilings for routing of electrical lines, sprinkler pipes and ducts. All of these openings were protected by “3M’s fire barrier sealant” latex caulk. Therefore, the ceiling of this space is an effective barrier. However, to consider the effectiveness of the space, one must also analyze the effectiveness of the walls. The walls of the space were also constructed of gypsum wallboard. Each bathroom had a single door approximately 3 feet (0.91 m) wide by 7 feet (2.13 m) high. Each of these doors was equipped with self-closing devices. The office also had a single door approximately 3 feet (0.91 m) wide and 7 feet (2.13 m) high, but was not equipped with a self-closing device. According to management, the office door is rarely closed, therefore rendering the barrier ineffective.

If the door was left opened and a fire occurred, a massive failure (\(\Delta D\) failure) of this barrier would result (Fitzgerald, 2004).

One of the major issues with constructing a space with a low ceiling is the possibility of a quicker transition to full room involvement of that compartment. If the origin of the fire were to be located within the office and the door was left open, flashover would likely occur (given the fuel load and adequate ventilation) in less than a couple minutes. Once a small space has transitioned through flashover into full-room involvement the production of hot gases is intensified and those products of incomplete combustion spread out from that single compartment into other compartments. This results in the multiroom fire propagation. On the other hand, if the office door were closed or equipped with a self-closing device, then the transition to full room involvement inside the office would likely be slower or may never happen. If flashover did occur, then post-flashover burning would be limited due to the inadequate ventilation.
The door may eventually be compromised and smoke and hot gases exit into other compartments ($\bar{D}$ failure), but by this time the fire department has been given more time to arrive and take action (Fitzgerald, 2004). Also, the closed door would allow the automatic sprinklers within the office space to be more effective.
REFERENCES

http://www3.3m.com/catalog/us/en001/architecture_construction/fire_protection/
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CLC0PX0gl/theme_us_fireprotectionproducts_3_0/command_AbcPageHandler/o
utput_html


Buildings and Structures*, NFPA, Quincy, MA.

Sprinkler Systems*, NFPA, Quincy, MA.


FIGURES

![Figure 2: Photograph of the North Exterior of the Structure](image)

**Figure 2**: Photograph of the North Exterior of the Structure

![Figure 3: Example of 3M Fire Barrier Sealant (left); Photograph of Pipe Chases and the Use of the Fire Barrier Sealant (Separation wall between café and John Ringling Storage)](images)

**Figure 3**: Example of 3M Fire Barrier Sealant (left); Photograph of Pipe Chases and the Use of the Fire Barrier Sealant (Separation wall between café and John Ringling Storage)
Figure 4: Photograph of Separation Wall between Warehouse and office space Of the HPC Technical Services Occupancy

Figure 5: Fire Rated Steel Door located in separation wall between office space and storage space of the HPC Technical Services Occupancy

Figure 6: Fire Rated Overhead Steel Door located in separation wall between the two John Ringling & Brothers Storage/Warehouse Facilities
Figure 7: Heat Detector and Automatic Door Closer (Active Fire Defense System)

Figure 8: Photograph of the South and West wall inside the Café. The office is through the open doorway. (Management prohibited photographs of the office)

GLOSSARY

Barrier: is any surface that can delay or prevent fire or smoke moving from one space to another. (Fitzgerald, 2004, p.147)

$\overline{D}$ failure: occurs when a large opening appears in the barrier. May result from an open door, a large broken window, partial or full barrier collapse, or a $\overline{T}$ failure that enlarges into a $\overline{D}$ failure. (Fitzgerald, 2004, p. 133)

$\overline{T}$ failure: hot-spot ignition. May result from too much heat transmission through a barrier. (Fitzgerald, 2004, p. 133)

Multiple Occupancy: A building or structure in which two or more classes of occupancy exist. (NFPA 5000 & 101, NFPA Glossary of Terms)