Building 310, The Landing

- Located in Renton, WA.
- Mixed retail and business occupancy. Part of a large shopping center.
- 1 story, with mezzanine
- 24,000 square feet
- Completed in 2009.
Applicable Codes for Design

• NFPA 72 (2007 Edition)
• NFPA 13 (2007 Edition)

Codes Used for Analysis

• NFPA 72 (2013 Edition)
• NFPA 13 (2013 Edition)
Prescriptive Egress

Total occupant load of building is 777 people

1 Story

Each tenant space has at least one exit directly to the outside
<table>
<thead>
<tr>
<th>Tenant Space</th>
<th>Description</th>
<th>Occupant Load Factor</th>
<th>Net/ Gross</th>
<th>Occupancy</th>
<th>Area (sq. ft)</th>
<th>Allowable Occupant Load (persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pizza Restaurant/Bar</td>
<td>15</td>
<td>Net</td>
<td>Assembly</td>
<td>6720</td>
<td>448</td>
</tr>
<tr>
<td>*1</td>
<td>Mezzanine</td>
<td>15</td>
<td>Net</td>
<td>Assembly</td>
<td>1321</td>
<td>88</td>
</tr>
<tr>
<td>2</td>
<td>Wine &amp; Chocolate Bar</td>
<td>15</td>
<td>Net</td>
<td>Assembly</td>
<td>1172</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
<td>Vacant</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>Glazed Art Cosmetics</td>
<td>30</td>
<td>Gross</td>
<td>Mercantile</td>
<td>1518</td>
<td>51</td>
</tr>
<tr>
<td>5</td>
<td>Vietnamese Café Store</td>
<td>30</td>
<td>Gross</td>
<td>Mercantile</td>
<td>1428</td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td>Vietnamese Café</td>
<td>15</td>
<td>Net</td>
<td>Assembly</td>
<td>1143</td>
<td>76</td>
</tr>
<tr>
<td>7</td>
<td>Yogurt Café</td>
<td>15</td>
<td>Net</td>
<td>Assembly</td>
<td>868</td>
<td>58</td>
</tr>
<tr>
<td>8</td>
<td>Vacant</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>Nail Salon</td>
<td>100</td>
<td>Gross</td>
<td>Business</td>
<td>890</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>Insurance Office</td>
<td>100</td>
<td>Gross</td>
<td>Business</td>
<td>882</td>
<td>9</td>
</tr>
</tbody>
</table>

* Occupant load factors obtained from table 7.3.1.2 NFPA 101, 2012 edition and table 1004.1.2 IBC 2012 edition

*Pizza restaurant area includes mezzanine area
Nail Salon

• A nail salon is classified as a business occupancy in the IBC (304.1).

• Occupant Load is 9 people with this classification. However, Nail salon has 10 salon chairs.

• Occupant Load may be increased by the AHJ (IBC 1004.2, and NFPA 101, 7.3.1.3)

• It can be assumed that this was the case and the occupant load was increased.

• If not, the nail salon is in violation of the IBC and Life Safety Code because its actual occupancy load exceeds its allowable occupancy load.
Exit Requirements

• Total Occupancy of Building: 777 people (assuming nail salon only has allowable occupancy)

• At least 3 exits required for entire building (LSC 7.4.1.2)

• Building has 24 exits

• At least 2 exits for each sp (LSC 7.4.1.1), with some exceptions

• Exits required to be separated by more than 1/3 of room diagonal (LSC 7.5.1.3.3 and IBC 1015.2.1)
<table>
<thead>
<tr>
<th>Tenant Space</th>
<th>Description</th>
<th>Diagonal (ft)</th>
<th>1/3 of Diagonal</th>
<th>Exit Distance (ft)</th>
<th>Acceptable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pizza</td>
<td>120</td>
<td>40.0</td>
<td>95</td>
<td>YES</td>
</tr>
<tr>
<td>*1</td>
<td>Mezzanine</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>Wine &amp; Chocolate Bar</td>
<td>53</td>
<td>17.7</td>
<td>43</td>
<td>YES</td>
</tr>
<tr>
<td>3</td>
<td>Vacant</td>
<td>53</td>
<td>17.7</td>
<td>45</td>
<td>YES</td>
</tr>
<tr>
<td>4</td>
<td>Glazed Art</td>
<td>58</td>
<td>19.3</td>
<td>48</td>
<td>YES</td>
</tr>
<tr>
<td>5</td>
<td>Cosmetics Store</td>
<td>56</td>
<td>18.7</td>
<td>51</td>
<td>YES</td>
</tr>
<tr>
<td>6</td>
<td>Vietnamese Café</td>
<td>57</td>
<td>19.0</td>
<td>35</td>
<td>YES</td>
</tr>
<tr>
<td>7</td>
<td>Yogurt Café</td>
<td>48</td>
<td>16.0</td>
<td>22</td>
<td>YES</td>
</tr>
<tr>
<td>8</td>
<td>Vacant</td>
<td>48</td>
<td>16.0</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>Nail Salon</td>
<td>42</td>
<td>14.0</td>
<td>35</td>
<td>YES</td>
</tr>
<tr>
<td>10</td>
<td>Insurance Office</td>
<td>41</td>
<td>13.7</td>
<td>31</td>
<td>YES</td>
</tr>
</tbody>
</table>

*See pages attached for determination of diagonals and distance between exits

*Measurements Have been rounded to the nearest foot
Room Diagonal Distances
<table>
<thead>
<tr>
<th>Tenant Space</th>
<th>Description</th>
<th>Number of Exits</th>
<th>Capacity/Exit (people)</th>
<th>Capacity Total (people)</th>
<th>Capacity Acceptable?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pizza Restaurant/Bar</td>
<td>6</td>
<td>180</td>
<td>1080</td>
<td>YES</td>
</tr>
<tr>
<td>*1</td>
<td>Mezzanine</td>
<td>1</td>
<td>147</td>
<td>147</td>
<td>YES</td>
</tr>
<tr>
<td>2</td>
<td>Wine &amp; Chocolate Bar</td>
<td>2</td>
<td>180</td>
<td>360</td>
<td>YES</td>
</tr>
<tr>
<td>3</td>
<td>Vacant</td>
<td>2</td>
<td>180</td>
<td>360</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>Glazed Art</td>
<td>3</td>
<td>180</td>
<td>540</td>
<td>YES</td>
</tr>
<tr>
<td>5</td>
<td>Cosmetics Store</td>
<td>2</td>
<td>180</td>
<td>360</td>
<td>YES</td>
</tr>
<tr>
<td>6</td>
<td>Vietnamese Café</td>
<td>2</td>
<td>180</td>
<td>360</td>
<td>YES</td>
</tr>
<tr>
<td>7</td>
<td>Yogurt Café</td>
<td>2</td>
<td>180</td>
<td>360</td>
<td>YES</td>
</tr>
<tr>
<td>8</td>
<td>Vacant</td>
<td>1</td>
<td>180</td>
<td>180</td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>Nail Salon</td>
<td>2</td>
<td>180</td>
<td>360</td>
<td>YES</td>
</tr>
<tr>
<td>10</td>
<td>Insurance Office</td>
<td>2</td>
<td>180</td>
<td>360</td>
<td>YES</td>
</tr>
</tbody>
</table>

*All exits are 36” doors except for mezzanine, which is 44” stair

*Double doors are considered to be 2 exits*
Mezzanine

• Steel Frame construction

• Mezzanine is considered part of the story below it (IBC 505)

• Mezzanine has only one exit.

• Mezzanines are allowed only one exit if they have an occupancy of less than 50 (LSC 12.2.4.5 and IBC Table 1015.1)

• Seating may have been calculated as fixed or bench seating by AHJ.

• However, according to calculations presented the occupancy of the mezzanine is 88 people.

• Direct violation of both codes. Mezzanine should have 2 exits.
Sprinkler System

- Automatic wet pipe sprinkler system

- System does have some dry sprinkler heads. These are located in the trash room and outdoors below canopies in some spaces

- All sprinklers are made by TYCO
Design Criteria

Density/Area Method

Ordinary Hazard II (Mercantile Occupancies)

Density: 0.2 GPM/sq. ft

Area of Operation: 1500 sq. ft

Sprinkler Characteristics

Sprinkler Type: Extended Coverage

Models: TY5137-Upright, TY5339-Sidewall

Number Operating: 11

K-Factor: 11.2

HSA: 250 GPM
Supply

Static Pressure 151 psi

Residual Pressure 126 psi at 5000 GPM

Demand

139 psi at 718 GPM + 250 GPM for hose stream allowance

Total Demand

968 GPM at 139 psi

Supply > Demand

Design is acceptable with...
Sprinkler System is Overdesigned

Most Demanding Area

Current Design:

Flowing Sprinklers = 11
- 3 dry sprinklers located under canopy

Required PSI = 138.65

Required Flow = 967.7 GPM

Usual Design for OHII

Required Flow = 1500 \times 0.2
= 300 GPM

Flowing Sprinklers
= 1500 / (16 \times 16)
= 6 Sprinklers
+ 3 Dry = 9 Sprinklers
Proposed Changes

Remove unnecessary branch line

New # Flowing Sprinklers = 9

Matches expected design criteria

Will yield significant reduction in pressure and flow requirements

Branch Line is unnecessary
Fire Detection
Duct Smoke Detectors

• 4 duct smoke detectors
• Locations assumed mainly in central areas of tenant spaces

SL-2000 Air Products and Controls inc.
Smoke Detector

• Only one

• Located in Fire Alarm/Electrical Room (NFPA 72 10.4.4)

Bosch D285 Series Photoelectric Smoke Detector
Sprinklers

• Sprinklers act as heat detectors

• All sprinklers are standard response

• All sprinklers bulbs are rated for 155 degrees F except for 2 located above kilns in ceramics store. These are rated for 200 degrees F

• Alarm is activated through waterflow switch
Pull Stations

Located at or near all exits in addition to other various places throughout building

E-278 Edwards Signaling Pull Station
Notification Devices

• Horn-Strobes

• Either 15 cd (bathrooms) or 115 cd

• 84 dB audible output

• Entire building designed as Business Occupancy to be conservative.

• 70 dB required

System Sensor PC2R Model
Structural

• Noncombustible steel frame construction
• 24,000 sq. ft
• Type II-B construction
• Fully Sprinklered
• No SFRM present on any members
• Walls are steel stud constructed
• Exterior walls finished with either brick veneer or concrete
• Interior walls finished with gypsum
Requirements

• Type II-B construction requires no fire resistance rating for any members (IBC table 601)

• NFPA 101 does require fire resistant barriers between spaces of different occupancy (NFPA 101, 16.1.14.4)

• Maximum fire resistance required is 1 hour with presence of sprinkler system (NFPA 101, Table 16.1.14.4)

- Barrier between mercantile and business

Design

• All walls are 2-hour fire rated to meet separation requirements
Performance Based Design
Fire Scenario 1

Cooking Fire in the Pizza Restaurant Area

Grease fire ignition and subsequent spread to stack of cartons/cardboard combustibles
Location of Fire
• Method 2 of section A.5.2.2 Life Safety Code

• “demonstrate that each room or area will be fully evacuated before the smoke and toxic gas layer in that room descends to a level lower than 6 ft (1830 mm) above the floor.” (A.5.2.2, NFPA 101)

• Required egress time determined using Pathfinder

• Allowable egress time determined by FDS and Pyrosim.

• $ASET > RSET$
• Duct Detector sounds alarm immediately

• 30 seconds pre movement time
<table>
<thead>
<tr>
<th>Incident Type</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confined fires</td>
<td>57.1</td>
</tr>
<tr>
<td>Cooking fire, confined to container</td>
<td>46.3</td>
</tr>
<tr>
<td>Chimney or flue fire, confined to chimney or flue</td>
<td>3.4</td>
</tr>
<tr>
<td>Incinerator overload or malfunction, fire confined</td>
<td>0.2</td>
</tr>
<tr>
<td>Fuel burner/boiler malfunction, fire confined</td>
<td>1.9</td>
</tr>
<tr>
<td>Commercial compactor fire, confined to rubbish</td>
<td>0.2</td>
</tr>
<tr>
<td>Trash or rubbish fire, contained</td>
<td>5.0</td>
</tr>
<tr>
<td>Nonconfined fires</td>
<td>42.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Source: NFIRS 5.0.
Heat Release Rate

Figure 3-1.6. HRR of single-pallet loads of packaged fruit/berry baskets.
Sprinkler Activation

FDS: 234 seconds
DETACT: 267 seconds

Sprinklers are irrelevant
Results

• FDS layer device used to measure smoke layer height with respect to time

• Tenability limit reached when smoke layer descends to 4.84m (6 ft above mezzanine floor)

• Smoke layer descended to 4.84m at 103 seconds
ASET vs RSET

ASET = 103 seconds

RSET = 110 + 30 = 140 seconds

RSET > ASET
Conclusion

• Smoke layer descends to 6 ft above floor before occupants can exit mezzanine

• Mezzanine needs two exits.
Fire Scenario 2

Electrical fault in office space ignition

Fire spread to computer chair, desk, and encompasses paper stacks

No sprinkler activation

One of every four fires in these offices was caused by cooking. Most of these fires were minor.

Electrical distribution and lighting equipment was the second leading major cause.

10% of these fires were intentional, but they accounted for 20% of the direct property damage.

Smoking materials were involved in 9% of the fires and 5% of the dollar loss. Exposures also caused 4% of these fires but 18% of the dollar loss.

Table B.
Sprinkler Systems in Office Structure Fires
2007-2011 Annual Averages*

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of structure fires in offices reporting some type of sprinkler present</td>
<td>33%</td>
</tr>
<tr>
<td>Percent of fires with wet pipe sprinklers in which sprinklers operated</td>
<td>90%</td>
</tr>
<tr>
<td>Percent of fires with wet pipe sprinklers present in which sprinklers operated effectively</td>
<td>88%</td>
</tr>
<tr>
<td>Reduction in average loss per fire when wet pipe sprinklers were present</td>
<td>46%</td>
</tr>
</tbody>
</table>

* Excludes properties under construction and fires where sprinklers were not present in the fire area.

Source: NFIRS 5.0 and NFPA survey.
Little/no threat to life safety

Goal: minimize property damage

Objective: prevent flashover until fire department arrives

Flashover occurs at 500 degrees Celsius gas temperature (SFPE Handbook 3-204)
Fractal time corresponds to 90th percentile

7:41 used as response time

30 seconds used as time to activation of alarm

Total time from ignition to arrival = 8:11

Location of Fire
Heat Release Rate

SFPE Handbook

FDS
Results and Conclusion

Maximum temperature = 471 degrees Celsius before time of arrival

Flashover will not occur and property damage will remain minimal
Conclusions/Recommendations

• Building walls are over designed with regards to fire rating.

• Sprinkler system is over designed

• Mezzanine violates code and is inadequate with regards to performance based analysis and prescriptive code

• The mezzanine needs one more exit
Questions?