Code and Standards

- Fire Alarm and Signaling Code - NFPA 72.
- International Building Code - IBC.
Location
Building Overview

Year of Completion
1993

Code used
UBC (1985)

Occupancy Classification
LSC (2015) Group B/A

Area
81,738 sq ft.

Construction Type
- UBC (1985): Type II FR
- IBC (2015): Type I-B

Unsprinklered Building
Building Features

- Constructed adjacent to the Education Building.
Building Features

- Connected levels by three open walkways.
Building Features

- Horizontal exit on the Third Floor to Education Building.
Building Features

- Open stairway connects First and Second floors.
Building Features

- Courtyard between the two buildings.
Building Features

- Large lecture hall “Silo”.
Building Uses

- Offices
Building Uses

- Classrooms
Building Uses

- Computer Labs
Building Uses

- Students Areas
Building Uses

- Conference Rooms
Occupancy Classification

- First Floor
Occupancy Classification

- Second Floor
Occupancy Classification

- Third Floor
Occupancy Classification

- Fourth Floor
Means of Egress

- First Floor

<table>
<thead>
<tr>
<th>Occupant Load</th>
<th>Exit Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>165</td>
<td>-</td>
</tr>
</tbody>
</table>
Means of Egress

- Second Floor

<table>
<thead>
<tr>
<th>Occupant Load</th>
<th>Exit Capacity</th>
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<tbody>
<tr>
<td>410</td>
<td>503</td>
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</table>
Means of Egress

- Third Floor

<table>
<thead>
<tr>
<th>Occupant Load</th>
<th>Exit Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>393</td>
<td>577</td>
</tr>
</tbody>
</table>
Means of Egress

- Fourth Floor

<table>
<thead>
<tr>
<th>Occupant Load</th>
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<tbody>
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<td>153</td>
<td>577</td>
</tr>
</tbody>
</table>
## Exit Arrangement

- Common Path of Travel (Table A.7.6 of the LSC, 2015)

<table>
<thead>
<tr>
<th>Room</th>
<th>Floor</th>
<th>Occupancy</th>
<th>Distance (ft)</th>
<th>Limit (ft)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>201</td>
<td>Second</td>
<td>Assembly</td>
<td>39</td>
<td>20</td>
<td>Exceed</td>
</tr>
<tr>
<td>204</td>
<td>Second</td>
<td>Assembly</td>
<td>40.5</td>
<td>20</td>
<td>Exceed</td>
</tr>
<tr>
<td>205</td>
<td>Second</td>
<td>Assembly</td>
<td>38</td>
<td>20</td>
<td>Exceed</td>
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<tr>
<td>206</td>
<td>Second</td>
<td>Assembly</td>
<td>37</td>
<td>20</td>
<td>Exceed</td>
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<tr>
<td>341</td>
<td>Third</td>
<td>Business</td>
<td>62</td>
<td>75</td>
<td>OK</td>
</tr>
<tr>
<td>301 B</td>
<td>Third</td>
<td>Business</td>
<td>35</td>
<td>75</td>
<td>OK</td>
</tr>
</tbody>
</table>

![Diagram of Business 0030 Floor2](image)
Exit Arrangement

- Travel Distance (Table A.7.6 of the LSC, 2015)

<table>
<thead>
<tr>
<th>Room</th>
<th>Floor</th>
<th>Occupancy</th>
<th>Distance (ft)</th>
<th>Limit (ft)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>209</td>
<td>Second</td>
<td>Assembly</td>
<td>110</td>
<td>200</td>
<td>OK</td>
</tr>
<tr>
<td>329</td>
<td>Third</td>
<td>Business</td>
<td>111</td>
<td>200</td>
<td>OK</td>
</tr>
</tbody>
</table>
Exit Arrangement

- Exit Remoteness (not less than 1 half of the diagonal)
  Shortest way 165 ft. > 101.5 ft.

D = 203 ft.
Obstructed Exits

- Room (113) on First Floor.
Obstructed Exits

- Silo
Obstructed Exit Path

- Life Safety Code requires corridor serving >50 persons to have minimum width of 44”.

- Corridors now have 45.5” width.
Exit Signs

- Third Floor, horizontal exit
Exit Signs

- Second Floor
## Interior Finishes

<table>
<thead>
<tr>
<th>Use</th>
<th>Exits</th>
<th>Exit Access and Corridors</th>
<th>Other Spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly – Existing &gt; 300 occupant load</td>
<td>A</td>
<td>A or B</td>
<td>A or B</td>
</tr>
<tr>
<td>Business – Existing</td>
<td>A or B</td>
<td>A or B</td>
<td>A or B or C</td>
</tr>
</tbody>
</table>
Fire Alarm and Detection Systems

- Supervising station alarm system with a central station.

- Notifier NFS2-640 FACP is located on the first floor of the building in Room 108.
Manual Appliances

- Total of 15 manual pull stations used through the building covering end of corridors and exit doorways.

- NFPA 72 requires manual appliances to be located within 60 inches of exit doorway and not more than 48 inches above floor level.
Manual Appliances

- Travel distance to nearest pull station not to exceed 200 feet.

Distance = 165 ft.
Heat Detectors

- Fixed temperature heat detector (57 °C).
- Five detectors, cover mechanical rooms.
Smoke Detectors

- Photoelectric smoke detectors.
- Original design consists of 16 smoke detectors to activate automatic fire doors.
- 31 smoke detectors were added to the system;
  - 4 in first floor.
  - 7 in second floor.
  - 16 in third floor.
  - 4 in fourth floor.
First Floor Layout
Second Floor Layout

Business 0030 Floor2
Third Floor Layout

Business 0030 Floor3

Devices Key
- New Device
- From old design
Fourth Floor Layout
Obstructed Smoke Detector
Fire Alarm Strobes and Horns

- 26 visual/audible devices in end of corridors and exits.

Corridor Spacing:

- Not more than 15 ft. from the end of corridor. (Meet the code requirements)
- Maximum distance between devices 100 ft. (Meet the code requirements)
Fire Alarm Strobes and Horns

- Visual/audible device in room 300.

Rated 75 cd, which is sufficient to cover 45x45 ft. areas. This room has larger space. It does not meet visual coverage requirement.
Fire Alarm Strobes and Horns

- 2 visual/audible device in Silo. (Meet the code requirements)
Smoke Control System

- 28 smoke dampers activated by fusible link to restrict the smoke spread in HVAC system

- Magnetic door holder released
  - Manual pull stations
  - Smoke detectors

- Associated fan shut down
  - Duct detector activation
Smoke Control System (Magnetic doors)
Water-based Suppression System

- Dry pipe risers in three stairwells, with 2 ½ ” connection.
Water-based Suppression System

- Wet stand pipes for fire hoses cabinets through the building.
- Replaced with fire extinguisher.
Water-based Suppression System

- Fire department connections located on the First Floor.

- (Under ground utility work in campus until May, 2017 prevent direct access).
Water-based Suppression System

- Water supply details are provided by water flow test.
- Available from flow test for 192-Engineering building.

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static pressure</td>
<td>80 psi</td>
</tr>
<tr>
<td>Residual pressure</td>
<td>60 psi</td>
</tr>
<tr>
<td>Water Flow</td>
<td>1210 gpm</td>
</tr>
</tbody>
</table>
Room with greatest demand area; largest room on the Fourth Floor (Room 401).
Sprinkler system design
Hydraulic calculation summary

<table>
<thead>
<tr>
<th>CALCULATION DESIGN INFORMATION</th>
<th>BUSINESS COLLEGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AREA NAME</td>
<td>BUSINESS COLLEGE</td>
</tr>
<tr>
<td>HAZARD</td>
<td>LIGHT</td>
</tr>
<tr>
<td>DENSITY</td>
<td>0.10 GPM/Sq.ft</td>
</tr>
<tr>
<td>AREA OF OPERATION</td>
<td>625 Sq.ft</td>
</tr>
<tr>
<td>AREA PER HEAD</td>
<td>225 Sq.ft</td>
</tr>
<tr>
<td>HOSE ALLOWANCE</td>
<td>100 GPM</td>
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<tr>
<td>DURATION</td>
<td>30 min</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SYSTEM DEMAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRESSURE DEMAND</td>
</tr>
<tr>
<td>FLOW DEMAND</td>
</tr>
<tr>
<td>FIRE PUMP REQUIREMENT</td>
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</tbody>
</table>
Structural Fire Protection

- Type I-B construction.

- Concrete blocks and structural steel used for construction.
## Structural Fire Protection: (Type-IB)

<table>
<thead>
<tr>
<th></th>
<th>IBC 2015 Requirement</th>
<th>Construction (1985 UBC)</th>
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<tbody>
<tr>
<td>Primary Structural Frame</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bearing walls Exterior</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Bearing walls Interior</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Non-bearing walls Interior</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor and secondary members</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Roof construction and secondary members</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
# Fire Resistance Rating

<table>
<thead>
<tr>
<th></th>
<th>Life Safety Code</th>
<th>Current Rating</th>
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<tbody>
<tr>
<td>Exit Corridor</td>
<td>1-hour</td>
<td>1-hour</td>
</tr>
<tr>
<td>Horizontal Exit</td>
<td>2-hour</td>
<td>2-hour</td>
</tr>
<tr>
<td>Shaft enclosure</td>
<td>2-hour</td>
<td>2-hour</td>
</tr>
</tbody>
</table>
Fire exposure/education building

- Actual distance is 20 ft.
- Separation distance is 10 ft.
- IBC 2015, Table 602 requires 1 hour-rated exterior wall based on fire separation.
- IBC 2015, Table 705.8 allows for only 15% of exterior wall opening area for unsprinklered buildings with unprotected openings.
Actual distance is 15 ft.
Separation distance is 7.5 ft.
IBC 2015, requires 1 hour-rated exterior wall based on fire separation.
IBC 2015, Table 705.8 allows for only 10% of exterior wall opening area for unsprinklered buildings with unprotected openings.
Performance-based Analysis

- **Scope:**
  - Fire protection system must provide protection for all occupants not intimate with the initial fire development.

- **Design Fire Scenario:**
  - Life Safety Code 2015, Scenario 6
    - Most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building
Performance-based Analysis

- **Fire Protection Goal:**
  - Minimize fire related injuries

- **Stakeholder Objective:**
  - Allow safe egress for all occupants outside the room of origin

- **Design Objective:**
  - Maintain tenable conditions
Tenability Criteria

Visibility
Dr. Jin (SFPE handbook) categorized visibility based on the degree of familiarity with building;
- 4 m for familiar people.
- 13 m for unfamiliar people.
Average value of 9 m chosen for the analysis.

Thermal effect
60 °C - not to be exceeded (SFPE 5th edition)

Toxicity
For light activity, 30,000 ppm.min CO cause incapacitation. (Value of 1500 ppm CO will allow for 20 min evacuation).
Egress Analysis

- Occupant characteristics:
  - Awake
  - Adults
  - Healthy
  - 3.9 ft./s

- Egress time:
  - Entire building (4.05 Minutes).
  - Fourth Floor (80 Seconds).
Fire scenario 1

- **Location**: in the Fourth floor room 400.
- **Use**: Break room.
- Different ignition sources.
- Large fuel load in small space.
- No smoke detection.
- Door left open.
Fire scenario 1
Design Fire Load

- Fuel: Three seat sofa, (90% polyurethane foam)

- The NIST test for polyurethane three seat sofa gives a peak of HHR 3000 KW (Chapter 26, SFPE 5TH edition).

- Not considered with TB 133.
FDS Model

- Fast growth fire, with fire coefficient = 0.0469 kW/s²
- (2m x 0.5m) burner, HRRPUA = 3000 kW/m².

- Fuel: Polyurethane
- Soot yield: 0.1 g/g
- CO yield: 0.04 g/g

(Table: A.39 SFPE 5TH edition)
Results

- Visibility criteria violated in corridor at 42 seconds.
Results

- Temperature at time visibility was violated < 60 °C
Results

- Temperature untenable at 61.2 sec.
Results

- Toxicity has not been exceeded in corridor at end of the simulation.
RSET

- Time to detection (FDS): at 38 seconds.
- Pre-movement: Study by Proulx and Fahy on mid-rise office buildings; found an average of (0:36) seconds.
- Movement time: 80 seconds.
- Total = 154 seconds.

Result: RSET > ASET
Recommendation for the scenario

- TB 133 compliant materials to be used.
- Installation for smoke detection devices.
- Keep the door closed.
Other possible scenario

- Location: Third floor
Other possible scenario

- Ventilation concerns
- Two doors open to room 300 and corridor.
- Room 300 has its door open as well.
Other possible scenario
Recommendations for the building

- Keep exits doors and corridors clear from obstructions.
- Exit signs to be added on the required locations.
- Keep smoke detectors clear from obstructions.
- Test magnetic release door regularly.
- Upgrade the coverage for smoke detection and alarm system to cover the entire building.
- Ensure that windows inside exit enclosures to be closed
Thank you!

- Questions?
Supplemental- First Floor ratings
Second Floor
Fourth Floor
Wrong Direction- H/E
Third Floor Enclosure
Tag