The Construction Innovation Center
Cal Poly Campus
Matthew Atwell
Matthew Atwell

- 2010-2014
  - The University of Alabama
    - Civil Engineering
- 2014-2016
  - Halliburton
    - Technical Professional
- 2016-Present
  - Cal Poly
    - Fire Protection Engineering
Building Description

- Cal Poly
  - Building 186
  - Completed In 2008
  - Group B Occupancy
  - Type IIA Construction
  - Fully Sprinklered

- Three Separate Buildings
  - Building A
  - Building B
  - Building C
Top View
Applicable Criteria

- NFPA 101
- SFPE Handbook
  - 5th Edition
- International Building Code
  - 2015 Edition
- California Building Code
  - 2016 Edition
- Various NFPA Codes
Floor One
Floor Two
Floor Three
Building A

- Building Size And Height
  - 15,150 Sq ft
  - 46 ft

- Occupant Load
  - Floor 1: 100
  - Floor 2: 59
  - Floor 3: 22
  - Total: 181

<table>
<thead>
<tr>
<th>Room</th>
<th>Occupant Load Factor (ft^2/Person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting Area</td>
<td>15</td>
</tr>
<tr>
<td>Conference Room</td>
<td>15</td>
</tr>
<tr>
<td>Lecture Hall</td>
<td>20</td>
</tr>
<tr>
<td>Lab</td>
<td>50</td>
</tr>
<tr>
<td>Office</td>
<td>100</td>
</tr>
</tbody>
</table>
Building B

- Building Size And Height
  - 24,600 Sq ft
  - 46 ft

- Occupant Load
  - Floor 1: 124
  - Floor 2: 125
  - Floor 3: 130
  - Total: 379

<table>
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<td>50</td>
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<tr>
<td>Office</td>
<td>100</td>
</tr>
</tbody>
</table>
Building C

- Building Size And Height
  - 9,100 Sq ft
  - 58 ft

- Occupant Load
  - Floor 1: 148
  - Floor 2: 143
  - Floor 3: 145
  - Total: 436

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<th>Occupant Load Factor (ft^2/Person)</th>
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<td>Lab</td>
<td>50</td>
</tr>
<tr>
<td>Office</td>
<td>100</td>
</tr>
</tbody>
</table>
Egress Capacity

- Number Of Exits
- Arrangement Of Exits
- Doorway
  - 36”
  - 72”
- Stairway
  - 3 Stairways
  - 66”

Egress capacity > occupant load
Dead Ends and Common Path

- Dead-Ends
- Common-Path

<table>
<thead>
<tr>
<th>Type of Occupancy</th>
<th>Common Path Limit</th>
<th>Dead-End Limit</th>
<th>Travel Distance Limit</th>
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<tbody>
<tr>
<td></td>
<td>Unsprinklered</td>
<td>Sprinklered</td>
<td>Unsprinklered</td>
</tr>
<tr>
<td></td>
<td>ft</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>Assembly New</td>
<td>20/75 6.1/23a</td>
<td></td>
<td>20/75 6.1/23a</td>
</tr>
<tr>
<td>Assembly Existing</td>
<td>20/75 6.1/23a</td>
<td></td>
<td>20/75 6.1/23a</td>
</tr>
</tbody>
</table>
Fire Rated Doors

- 2\textsuperscript{nd} And 3\textsuperscript{rd} Floor
- 90 Minute Rating
- Held Open Magnetically
Allowable Building Area

- Type II-A Construction
- Allowable
  - Per floor: 129,000 Sq ft
  - Total: 387,000 Sq ft
- Existing Building Area
  - 48,800 Sq ft
## Fire Resistance Rating

- Building Elements
- IBC Table 601
  - Footnote D

<table>
<thead>
<tr>
<th>Building Characteristics</th>
<th>Minimum Fire Rating</th>
<th>Actual Fire Rating</th>
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<tbody>
<tr>
<td>Primary Structural</td>
<td>1 Hour</td>
<td>0 Hours</td>
</tr>
<tr>
<td>Bearing Walls Interior And Exterior</td>
<td>1 hour</td>
<td>0 Hours</td>
</tr>
<tr>
<td>Non Bearing Walls And Partitions Exterior</td>
<td>CBC Table 602</td>
<td>1 Hour</td>
</tr>
<tr>
<td>Non Bearing Walls And Partitions Interior</td>
<td>0 Hours</td>
<td>0 Hours</td>
</tr>
<tr>
<td>Floor Construction And Associated Secondary Members</td>
<td>1 Hour</td>
<td>0 Hours</td>
</tr>
<tr>
<td>Roof Construction And Associated Secondary Members</td>
<td>1 Hour</td>
<td>0 Hours</td>
</tr>
</tbody>
</table>
Interior Finish

- The Exposed Surface
  - Walls
  - Ceilings

<table>
<thead>
<tr>
<th>Group</th>
<th>Interior Egress Paths</th>
<th>Corridor and Enclosures for Egress Paths</th>
<th>Rooms and Enclosed Spaces</th>
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</thead>
<tbody>
<tr>
<td>A-3</td>
<td>B</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>S</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<table>
<thead>
<tr>
<th>Class</th>
<th>Flame Spread Index</th>
<th>Smoke-Developed Index</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>0-25</td>
<td>0-450</td>
</tr>
<tr>
<td>B</td>
<td>26-75</td>
<td>0-450</td>
</tr>
<tr>
<td>C</td>
<td>76-200</td>
<td>0-450</td>
</tr>
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</table>
Riser Building A

- 3” Riser
  1. Control Valve
  2. Check Valve
  3. Gage Assembly
  4. System Sensor
  5. Test-An-Drain-Valve
  6. Main Drain Valve
  7. Air-Gap Fitting
Riser Building B and C
Automatic Sprinkler System - Water Supply B and C

- **City Water Supply**
  - Static Pressure = 90 psi
  - Residual Pressure = 82 psi
  - Flow = 1,138 gpm

- **Demand**
  - Pressure = 78.7 psi
  - Flow = 520.9 gpm
  - H.S.A. = 100 gpm
Location of Most Remote Area B and C
Automatic Sprinkler System

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Density (GPM/ft^2)</th>
<th>Combined Hose (GPM)</th>
<th>Coverage Area (ft^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary Hazard Group 1</td>
<td>0.15</td>
<td>250</td>
<td>1500</td>
</tr>
<tr>
<td>Light Hazard</td>
<td>0.1</td>
<td>100</td>
<td>1500</td>
</tr>
</tbody>
</table>

FIGURE 11.2.3.1.1  Density/Area Curves.
Automatic Sprinkler System

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</tr>
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</table>

Table 11.2.3.1.2 Hose Stream Allowance and Water Supply Duration Requirements for Hydraulically Calculated Systems

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Inside Hose</th>
<th>Total Combined Inside and Outside Hose</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>gpm</td>
<td>L/min</td>
<td>gpm</td>
</tr>
<tr>
<td>Light hazard</td>
<td>0, 50, or 100</td>
<td>0, 190, or 380</td>
<td>100</td>
</tr>
<tr>
<td>Ordinary hazard</td>
<td>0, 50, or 100</td>
<td>0, 190, or 380</td>
<td>250</td>
</tr>
<tr>
<td>Extra hazard</td>
<td>0, 50, or 100</td>
<td>0, 190, or 380</td>
<td>500</td>
</tr>
</tbody>
</table>
Automatic Fire Sprinkler System

Quick Response
3 MM Bulb

Standard Response
5 MM Bulb

* Temperature rating is indicated on Deflector.
** Pipe thread connections per ISO 7-1 can be provided on special request.

QUICK RESPONSE SERIES TY-FRB UPRIGHT (TY3131) AND PENDENT (TY3231) SPRINKLERS
5.6 K-FACTOR, 1/2 INCH NPT
Sprinkler Location Building A-Floor 1

<table>
<thead>
<tr>
<th>Tyco Sprinkler</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upright Quick Response</td>
<td>Red</td>
</tr>
<tr>
<td>Concealed Response</td>
<td>Teal</td>
</tr>
<tr>
<td>Concealed response on Sprig</td>
<td>Green</td>
</tr>
</tbody>
</table>
Sprinkler Location Building B and C-
Floor 1
Initiating Devices

- Manual Pull Station
- Heat Detector
- Multi-Sensor Detector
- Photoelectric Duct Detector
Smoke Control

- Photoelectric Duct Detector
- Smoke Damper
Notification Devices

- Horn
- Strobe
- Horn And Strobe Combination
Conclusion of Prescriptive Analysis

- Prescriptive Analysis
  - Fire Alarm Systems, Suppression System, Structural fire Protection, and Mean of Egress
Performance Analysis

- Performance Design 1
  - First Floor Lobby of Building A
- Performance Design 2
  - Buildings 186 and 187
- Pyrosim
- Pathfinder

PyroSim
Pathfinder
Performance Design 1

- Building A
- Fire Design
- HRR Criteria
- Objectives
- Results
Fire Design

- Design Fire Scenario 1
  - Typical Fire For The Occupancy
  - Accounts For The Following
    - Occupant Activities
    - Location of Occupants
    - Room Size
    - Fuel Properties
    - Ventilation Conditions
    - Location of ignition
HRR Criteria

- California Technical Bulletin 116, 117, 133
- Polyurethane Fiber Batting
- HRR 320 kW (80 kW Per Chair)
HRR Criteria
HRR Criteria

- 157 kw
- Ramp Up
  - 58 Seconds

157 kW is attained at a time of 58 seconds
Fire Design Objectives

- Heat Exposure To Occupants
- Maintain 5 Feet Of Clearance
- ASET > RSET
Pathfinder

<table>
<thead>
<tr>
<th>Floor 1 Building A</th>
<th>0 Seconds</th>
<th>15 Seconds</th>
<th>30 Seconds</th>
<th>59 Seconds</th>
</tr>
</thead>
</table>

---
Pyrosim

- Smokeview
  - 61.1 Sec
Pyrosim

- Visibility
  - 5 Meters
Pyrosim

- Max Temperature
  - 25 Degrees Celsius
Pathfinder

- 2nd and 3rd Floor
  - 0 Sec
Pathfinder

- 2nd and 3rd Floor
  - 45 Sec
Pathfinder

- 2nd and 3rd Floor
  - 61.1 Sec
Pathfinder

- 2\textsuperscript{nd} and 3\textsuperscript{rd} Floor
  - 128 Sec
Pyrosim

- Smokeview
  - 128 sec
Pyrosim

- Visibility
  - 5 Meters
Pyrosim

- Max Temperature
  - 30 Degrees Celsius
Conclude Performance 1

- Max Visibility Does Not Reach 5 Feet Above Walking Surfaces
- Max Temperature Does Not Reach 50 Degrees Celsius
- RSET > ASET
  - 1st Floor Evacuation 61 Seconds
  - 2nd and 3rd Floor Evacuation 128 Seconds
Performance Design 2

- Fire Design 2
- HRR Criteria
- Objectives
- Results
Fire Design 2

- Design Fire Scenario 1
  - Typical Fire For The Occupancy
  - Accounts For The Following
    - Occupant Activities
    - Location of Occupants
    - Fuel Properties
    - Ventilation Conditions
    - Location of ignition
HRR Criteria

- Douglas Fir Larch
  - 98 - 134 kW/m²
  - 130 kW/m² Was Modeled
Objectives

- See effects on Buildings B and C
- ASET > RSET
Pathfinder

B and C Top View 0 Seconds
Pathfinder

0 Seconds
Pathfinder

1 Minute
Pathfinder

1 Minute 20 Seconds
Pathfinder
Pathfinder

Side View Room C101 is Last to Evacuate 1 Minute 45 Seconds

Full Evacuation 2 Minutes 20 Seconds
Pyrosim

- Smokeview
Pyrosim

- Max Visibility
Pyrosim

- Max Temperature
Conclude Performance 2

- Max Visibility Does Not Reach 5 Feet Above Walking Surfaces
- Max Temperature Does Not Reach 50 Degrees Celsius
- RSET > ASET
  - Evacuation Complete 2 Minutes 20 Seconds
- Recommendation
  - Connected Fire Alarm Systems
Conclusion of Presentation

- Prescriptive Analysis
  - Fire Alarm Systems, Suppression System, Structural fire Protection, and Mean of Egress

- Performance Analysis
  - 2 Fire Design Scenarios
  - RSET > ASET

- Recommendation
  - Connected Fire Alarm Systems
Questions