Fire and Life Safety Evaluation

Micro-Mechanics
465 Woodview Avenue,
Morgan Hill, CA 95037

Michael Beam
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1. Introduction/general description of Micro-Mechanics
2. Applicable Codes and References
3. Occupancy and Hazard Classification
4. Structural Fire Protection
5. Egress Analysis
6. Fire Detection, Alarm and Communication Systems
7. Fire Suppression System
8. Performance Based Analysis
Micro-Mechanics

- 1 story Manufacturing Building
- Total Square Footage: 41301 s.f.
  - Office Space: 8,239 s.f.
  - Non-Public Industrial Occupancy: 32,214 s.f.
  - Non-Public Finishing Department 848 s.f.
- Earliest set of plans dated 1993
  - Sprinkler System Installation
- Micro-Mechanics specializes in manufacturing high precision tools, parts and assemblies for the semiconductor, medical, and aerospace industries
  - Automated 24/7 processes
- Minimal storage of material
Applicable Codes and References

- International Building Code (IBC 2013)
  - California Building Code (CBC 2013)
- Structural Design for Fire Safety – Andrew H. Buchanan
Occupancy Classification

Industrial Occupancy
• NFPA 101
  • Section 6.1.12.1* Definition – Industrial Occupancy. An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted.
• CBC
  • Factory Industrial Group F-1: moderate hazard

Secondary Occupancies
• Office Areas
Hazard Classification

- NFPA 101 section 6.2.2
  - Ordinary Hazard Contents

- Majority of space occupied by machinery
- Water-based coolants
- Minimal scrap material stored in bins and isolated
  - Aluminum
  - Stainless Steel
  - Brass
- Minimal shipping and receiving
Maintenance of Manufacturing Area

• Majority of processes produce recyclable size chips and scraps
  • Bin storage emptied twice a week

• Finishing Rooms
  • Only process that can produce dust/powdered metals
  • Uses wet sanding process to prevent airborne particles
  • Deep clean and change of filters weekly

• Regulation of Combustible Metals
  • NFPA 484 (Chapter 12 – Aluminum)
    • Table 1.1.11 Applicability Thresholds
      • 5lbs for Industrial Occupancy
    • Section 12.2.2 Fire Protection
Prevention/Fire Protection for Aluminum Dust

• **Prevention**
  - Avoid contact with water
    - If a wet process is used the collection systems should be vented
    - Material from wet type collectors should be mixed with inert material (5:1)
  - Maintain clean work environment to prevent airborne particles
  - Ground equipment to prevent static electricity

• **Fire Protection**
  - Ring fire with inert material or class D extinguishing powder
  - Class A, B, and C extinguishers and Halogen extinguishing agents shall not be used.
  - Manual application of water should be a last resort.
  - Automatic Sprinkler Protection should only be used when approved by the local AHJ.
Description of Building Structure and Construction

• Exterior Walls
  • Load Bearing
  • Solid Concrete (5” thick)

• Primary Structure
  • 5” x 5” steel columns
  • 5 1/8” x 34 1/2” to 5 1/8” x 36” glulam beams
  • 28” I-joists

• Roof Assembly
  • 1/2” plywood
  • 2” x 6” wood stiffeners spanning purlins at 2’-0 on center

• Interior Walls
  • Non-load Bearing
  • Not full height rated walls
  • 2” x 6” wood studs at 16” on center
  • 5/8” gypsum board on each side
  • R-11 sound insulation between studs

Table 721 of CBC

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>ITEM NUMBER</th>
<th>CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Solid concrete()</td>
<td>4-1.1</td>
<td>Siliceous aggregate concrete.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carbonate aggregate concrete.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sand-lightweight concrete.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lightweight concrete.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MINIMUM FINISHED THICKNESS FACE-TO-FACE(^b) (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 3 2 1</td>
</tr>
<tr>
<td>7.0 7.0 5.0 5.0</td>
</tr>
<tr>
<td>6.6 6.6 5.6 5.6</td>
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<tr>
<td>5.4 4.6 3.8 3.2</td>
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<tr>
<td>5.1 4.4 3.6 3.2</td>
</tr>
</tbody>
</table>
## Rating Requirements

**Table 721 of CBC**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>ITEM NUMBER</th>
<th>CONSTRUCTION</th>
<th>MINIMUM FINISHED THICKNESS FACE-TO-FACEb (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Solid concreteb, l</td>
<td>4-1.1</td>
<td>Siliceous aggregate concrete.</td>
<td>4 hours: 7.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carbonate aggregate concrete.</td>
<td>4 hours: 6.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sand-lightweight concrete.</td>
<td>4 hours: 5.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lightweight concrete.</td>
<td>4 hours: 5.1</td>
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**Table 601 of CBC**

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I A</th>
<th>TYPE I B</th>
<th>TYPE II A b</th>
<th>TYPE II B</th>
<th>TYPE III A d</th>
<th>TYPE III B</th>
<th>TYPE IV HT</th>
<th>TYPE V A d</th>
<th>TYPE V B</th>
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</thead>
<tbody>
<tr>
<td>Primary structural frame (see Section 202)</td>
<td>3^a 2b</td>
<td>1 0</td>
<td>1 0</td>
<td>HT</td>
<td>1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearing walls</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>3 2</td>
<td>1 0</td>
<td>2 2</td>
<td>2 1</td>
<td>1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior</td>
<td>3^a 2^a</td>
<td>1 0</td>
<td>2 1</td>
<td>1 0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Nonbearing walls and partitions</td>
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<td></td>
<td>See Table 602</td>
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<tr>
<td>Exterior</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Interior</td>
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<td>0 0</td>
<td>0 0</td>
<td>See Section 602.4.6</td>
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<td>Floor construction and associated secondary members (see Section 202)</td>
<td>2 2</td>
<td>1 0</td>
<td>1 0</td>
<td>HT</td>
<td>1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof construction and associated secondary members (see Section 202)</td>
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<td>1 b,c</td>
<td>1 b,c</td>
<td>0 c</td>
<td>1 b,c</td>
<td>1 b,c</td>
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<td></td>
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</tr>
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</table>

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**Note:**
- abc: Refer to Section 602.4.6 for specific requirements.
- b,c: Refer to Section 202 for additional details.
## Building Height & Area Limitations

Table 503 of CBC

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TYPE OF CONSTRUCTION</th>
<th>A</th>
<th>B</th>
<th>A</th>
<th>B</th>
<th>A</th>
<th>B</th>
<th>HT</th>
<th>A</th>
<th>B</th>
</tr>
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<tbody>
<tr>
<td>STORIES(S) AREA (A)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A-1</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>5</td>
<td>UL</td>
<td>3</td>
<td>15,500</td>
<td>2</td>
<td>8,500</td>
<td>3</td>
</tr>
<tr>
<td>A-2</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>11</td>
<td>UL</td>
<td>3</td>
<td>15,500</td>
<td>2</td>
<td>9,500</td>
<td>3</td>
</tr>
<tr>
<td>A-3</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>11</td>
<td>UL</td>
<td>3</td>
<td>15,500</td>
<td>2</td>
<td>9,500</td>
<td>3</td>
</tr>
<tr>
<td>A-4</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>11</td>
<td>UL</td>
<td>3</td>
<td>15,500</td>
<td>2</td>
<td>9,500</td>
<td>3</td>
</tr>
<tr>
<td>A-5</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
<td>UL</td>
</tr>
<tr>
<td>B</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>11</td>
<td>UL</td>
<td>5</td>
<td>37,500</td>
<td>3</td>
<td>23,000</td>
<td>5</td>
</tr>
<tr>
<td>E</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>5</td>
<td>UL</td>
<td>3</td>
<td>26,500</td>
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<td>14,500</td>
<td>3</td>
</tr>
<tr>
<td>F-1</td>
<td>S A</td>
<td>UL</td>
<td>UL</td>
<td>11</td>
<td>UL</td>
<td>4</td>
<td>25,000</td>
<td>2</td>
<td>15,500</td>
<td>3</td>
</tr>
</tbody>
</table>
Building Area Modifications

\[ A_a = \{A_t + [A_t \times I_f] + [A_t \times I_s]\} \quad (5-1) \]

where
\( A_a \) = allowable building area per story \((ft^2)\)
\( A_t \) = tabular building area per story in accordance with Table 503 \((ft^2)\)
\( I_f \) = area increase factor due to frontage as calculated in accordance with Section 506.2
\( I_s \) = area increase factor due to sprinkler protection as calculated in accordance with Section 506.3

\[ I_f = \left[ \frac{F}{P} - 0.25 \right] \frac{W}{30} \quad (5-2) \]

Section 506 of CBC

where
\( F \) = building perimeter that fronts on a public way or open space having 20 feet open minimum width \((ft)\)
\( P \) = perimeter of entire building \((ft)\)
\( W \) = width of public way or open space in accordance with Section 506.2.1

\[ A_a = \{12,000 \, ft^2 + [12,000 \, ft^2 \times 0.75] + [12,000 \, ft^2 \times 3]\} \]

\[ A_a = 57,000 \, ft^2 \]
Allowable Building Area

- Building Area Modifications:
  - 57,000 sq. ft.

- Section 507.3 of CBC
  - 1 story
  - Group F Occupancy
  - Fire Sprinklers throughout
  - Unlimited building area
Egress Analysis

- Annotation
  - Usage
  - Room Numbers
  - Door Numbers
  - Occupant Load Factor
  - Area

- No dead end corridors
- Table A.7.6 of NFPA 101 requires a 100 foot limit for Common Paths of travel

<table>
<thead>
<tr>
<th>Space Designations</th>
<th>Color Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly</td>
<td></td>
</tr>
<tr>
<td>Breakroom</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td></td>
</tr>
<tr>
<td>Industrial Floor</td>
<td></td>
</tr>
<tr>
<td>Shop</td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td>Electrical Rooms</td>
<td></td>
</tr>
<tr>
<td>Restrooms</td>
<td></td>
</tr>
<tr>
<td>Lobby/Exit Corridor</td>
<td></td>
</tr>
</tbody>
</table>
### Occupant Load/Egress Capacity

**Occupant Load** = \( \frac{\text{Net Area}}{\text{Occupant Load Factor}} \)

**Egress Capacity** = \( \frac{\text{Door Width}}{\text{Capacity Factor}} \)

#### Manufacturing Floor

<table>
<thead>
<tr>
<th>Room</th>
<th>Room #</th>
<th>Area (sqft)</th>
<th>Occupant Load Factor</th>
<th>Occupant Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly</td>
<td>13</td>
<td>984</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Storage</td>
<td>14</td>
<td>976</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Shop</td>
<td>15</td>
<td>616</td>
<td>50</td>
<td>13</td>
</tr>
<tr>
<td>Storage</td>
<td>16</td>
<td>224</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>Shop</td>
<td>17</td>
<td>532</td>
<td>100</td>
<td>6</td>
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<tr>
<td>Office</td>
<td>18</td>
<td>168</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Restroom</td>
<td>19</td>
<td>194</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Restroom</td>
<td>20</td>
<td>194</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Finishing Room</td>
<td>21</td>
<td>832</td>
<td>50</td>
<td>17</td>
</tr>
<tr>
<td>Electrical Room</td>
<td>22</td>
<td>108</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>Manufacturing Floor</td>
<td>24</td>
<td>30661</td>
<td>100</td>
<td>307</td>
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</table>

<table>
<thead>
<tr>
<th>Door</th>
<th>Width</th>
<th>Capacity Factor</th>
<th>Exit Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>36</td>
<td>0.2</td>
<td>180</td>
</tr>
<tr>
<td>30</td>
<td>36</td>
<td>0.2</td>
<td>180</td>
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<td>33</td>
<td>36</td>
<td>0.2</td>
<td>180</td>
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<td>49</td>
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<td>180</td>
</tr>
<tr>
<td>52</td>
<td>36</td>
<td>0.2</td>
<td>180</td>
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</table>

Total: 1260

Total: 391
Fundamental Movement Calculations

Flow Calculations when considering population density:

**Office Area**

\[ W_e = 36\text{in.} - 2 \times 6\text{in.} = 24\text{in.} \]

\[
F_s(\text{Office}) = (1 - 2.86 \times \frac{91\text{persons}}{2622\text{ft}^2}) \times 275 \times \frac{91\text{persons}}{2622\text{ft}^2} = 8.60 \frac{\text{persons}}{\text{ft effective width}}
\]

\[
F_c(\text{Office}) = F_s(\text{Office}) W_e = 8.60 \frac{\text{persons}}{\text{ft effective width}} \times 24\text{in.} \times \frac{1\text{ft.}}{12\text{in.}} = 17.2 \frac{\text{persons}}{\text{min}}
\]

\[
t_{\text{Office}} = \frac{91\text{persons}}{3\times 17.2 \frac{\text{persons}}{\text{min}}} = 1.76\text{min}
\]

**Manufacturing Floor**

\[ W_e = 36\text{in.} - 2 \times 6\text{in.} = 24\text{in.} \]

\[
F_s(\text{Manufacturing}) = (1 - 2.86 \times \frac{391\text{persons}}{30661\text{ft}^2}) \times 275 \times \frac{391\text{persons}}{30661\text{ft}^2} = 3.38 \frac{\text{persons}}{\text{ft effective width}}
\]

\[
F_c(\text{Manufacturing}) = F_s(\text{Manufacturing}) W_e = 3.38 \frac{\text{persons}}{\text{ft effective width}} \times 24\text{in.} \times \frac{1\text{ft.}}{12\text{in.}} = 6.76 \frac{\text{persons}}{\text{min}}
\]

\[
t_{\text{Manufacturing}} = \frac{391\text{persons}}{7\times 6.76 \frac{\text{persons}}{\text{min}}} = 8.26\text{min}
\]
Fundamental Movement Calculations

Flow Calculations assuming everyone is moving at maximum exit speed:

\[ F_c = 24 \frac{\text{persons}}{\text{ft effective width}} \times 24 \text{in.} \times \frac{1 \text{ft}}{12 \text{in.}} = 48 \frac{\text{persons}}{\text{min}} \]

SFPE Handbook – Table 3-13.5

Office Area

\[ t_{\text{Office, min}} = \frac{91 \text{persons}}{3 \times 48 \frac{\text{persons}}{\text{min}}} = 0.63 \text{min} \]

Manufacturing Floor

\[ t_{\text{Manufacturing, min}} = \frac{391 \text{persons}}{7 \times 48 \frac{\text{persons}}{\text{min}}} = 1.16 \text{min} \]
Pathfinder Simulation vs. Flow Calculations

<table>
<thead>
<tr>
<th>Method</th>
<th>Evacuation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual (Density Based)</td>
<td>8.26 minutes</td>
</tr>
<tr>
<td>Manual (Max Flow Rate)</td>
<td>1.16 minutes</td>
</tr>
<tr>
<td>Model (Open Floor)</td>
<td>1.47 minutes</td>
</tr>
<tr>
<td>Model (With Machine Lines)</td>
<td>1.14 minutes</td>
</tr>
</tbody>
</table>
Fire Alarm System

• Protected Premises Fire Alarm System
  • Governed by NFPA 72 section 23
• Notifier SFP-400B fire alarm control panel (FACP)
  • Input
    • Smoke Detectors
    • Water Flow Switch
    • Tamper Switch
Fire Alarm System Requirements

• NFPA 101 Section 40.3.4 outlines detection, alarm and communication requirements for Industrial Occupancies
  • Alarm System must be activated by one of the following:
    ○ Manual means in accordance with 9.6.2.1
    ○ Approved automatic fire detection system in accordance with 9.6.2.1 throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6
    ○ Approved, supervised automatic sprinkler system in accordance with 9.6.2.1 throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6

• CBC Section 907.2.4
  • Manual fire alarm box not required when equipped with a sprinkler system and occupant notification appliances activate upon sprinkler activation
  • Group F occupancies
Detection Devices

• Heat Detection
  • Reliable Solder Link Sprinkler
  • 212 degree, ½” orifice, brass upright
  • 165 degree, ½” orifice, chrome pendent

• Water Flow
  • 4” Vane Type Water Flow Switch

• Smoke Detection
  • Series 400 System Sensor
  • Ionization Type Detector
Uniform Building Code (UBC)

• UBC was used at the time of construction
• Fire Alarm Plans
  • Smoke Detection System in lieu of 1 hour corridor per UBC 3305g exception #5
  • Office corridor is the only location for smoke detectors
• CBC now replaces UBC
Alarm Notification Appliances

• ADA horn/strobe
  • Manufacturer: Wheelock
  • Operating range: 18-31 VDC
  • Nominal Voltage: 24 VDC
  • Current Draw: 0.088 amps at 117 candela

• MIZ-24 Mini Horn
  • Manufacturer: Wheelock
  • Operating Voltage: 20-31 VDC
  • Rated sound pressure level (SPL): 90dBA at 10 feet
  • Current Draw: 0.024 Amps
Horn/Strobe Locations

NFPA 101 Section 40.3.4.3.1: Fire alarm system shall sound an audible and visible signal in a constantly attended location for the purposes of initiating emergency action.
Power Requirements

Battery Calculations for Office Area
Per NFPA 72 Section 10.6.7

Secondary Power Supply shall have sufficient capacity to operate for 24 hours under non-alarm conditions and then an additional 5 minutes under alarm conditions

Micro-Mechanics System Supplied with 2 x 7 amp-hour batteries

<table>
<thead>
<tr>
<th>Description</th>
<th>Standby Current Per Unit (amps)</th>
<th>QTY</th>
<th>Standby Current Per Unit (amps)</th>
<th>Alarm Current Per Unit (amps)</th>
<th>QTY</th>
<th>System Alarm Current (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACP</td>
<td>0.096</td>
<td>x</td>
<td>1</td>
<td>0.096</td>
<td></td>
<td>0.096</td>
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<tr>
<td>Detector</td>
<td>0.0001</td>
<td>x</td>
<td>7</td>
<td>0.0007</td>
<td>x</td>
<td>0.041</td>
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<tr>
<td>ADA Horn</td>
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<td>2</td>
<td>none</td>
<td>x</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total System Standby Current</td>
<td>0.0967</td>
<td></td>
<td>Total System Alarm Current</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(amps)</td>
<td></td>
<td></td>
<td>(amps)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Required Standby Time (hours)</th>
<th>Total System Standby Capacity (amps)</th>
<th>Required Standby Capacity (amp-hours)</th>
<th>Required Alarm Capacity (amp-hours)</th>
<th>Required System Alarm Current (amps)</th>
<th>Required Alarm Current (amp-hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>x 0.0967 = 2.3208</td>
<td>0.083333 x 0.511 = 0.042583</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Required Standby Capacity (amp-hours)</th>
<th>Required Alarm Capacity (amp-hours)</th>
<th>Total Required Capacity (amp-hours)</th>
<th>Factor of Safety</th>
<th>Required Battery Capacity (amp-hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.32</td>
<td>0.0426</td>
<td>= 2.3626</td>
<td>x 1.2</td>
<td>2.83512</td>
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</tbody>
</table>
Sprinkler System Description

• Wet System
• Gridded throughout entire building
• Upright sprinkler throughout building at ceiling level
• Pendent Sprinklers dropped to office areas and clean rooms
Underground Description

- 8” city main runs along front of building
- Property main fed by 8” x 6” reducer
- Flow passes through 6” Wilkins Backflow Assembly
- Tees off for FDC and 6” supply for building
- Underground piping is PVC
  - Except at connection points to the backflow, FDC, and building where the pipe is Ductile Iron
Hanging & Bracing

• 1 ¼” Branch Lines
  • Coach screw rod and ring to I-joist

• Cross mains
  • Beam clamps to I-joist at intermediate locations between beams
  • 3/8” U-hook with 2 x 3/8” lag screws to glulam beams

• Braces on mains use lag screws to the glulam beams and top chord of I-joist
  • Lag screws no longer allowed by California Fire Code (CFC) for bracing

• No branch line restraints required since hangers are less than 6” long
# Sprinkler Design

## Original Building Classification

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Ordinary Hazard (Group III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Coverage per Head</td>
<td>130 sq.ft.</td>
</tr>
<tr>
<td>Area</td>
<td>3000 ft²</td>
</tr>
<tr>
<td>Density</td>
<td>0.18 gpm²/ft²</td>
</tr>
<tr>
<td>Sprinkler</td>
<td>Standard Upright</td>
</tr>
<tr>
<td>Orifice</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>K-factor</td>
<td>5.62</td>
</tr>
<tr>
<td>Temperature</td>
<td>212°F</td>
</tr>
<tr>
<td>Number</td>
<td>483</td>
</tr>
<tr>
<td>Hose Demand</td>
<td>+ 500 gpm</td>
</tr>
<tr>
<td>Total System Demand</td>
<td>1089.79 gpm @ 71.672 psi</td>
</tr>
</tbody>
</table>

## New Building Classification

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Ordinary Hazard (Group II)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Coverage per Head</td>
<td>130 sq.ft.</td>
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<tr>
<td>Area</td>
<td>3000 ft²</td>
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<tr>
<td>Density</td>
<td>0.17 gpm²/ft²</td>
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<tr>
<td>Sprinkler</td>
<td>Standard Upright</td>
</tr>
<tr>
<td>Orifice</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>K-factor</td>
<td>5.62</td>
</tr>
<tr>
<td>Temperature</td>
<td>212°F</td>
</tr>
<tr>
<td>Number</td>
<td>483</td>
</tr>
<tr>
<td>Hose Demand</td>
<td>+ 250 gpm for 60 minutes</td>
</tr>
<tr>
<td>Total System Demand</td>
<td>823.86 gpm @ 71.559 psi</td>
</tr>
</tbody>
</table>

---

**Diagram:**

![Graph showing area of sprinkler operation against density and flow rate](image)

*Pre-1991 ed. density/area curve*

*Current density/area curve*

For SI units, 1 ft² = 0.092 m²; 1 gpm/ft² = 40.746 (L/min)/m².

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**Source:**

Cal Poly

Fire Protection Engineering
Hydraulic Calculations

Water Supply

Current:
Static Pressure = 85 psi
Residual Pressure = 65 psi
Flow = 1360 gpm

Previous (for calculation comparison):
Static Pressure = 83 psi
Residual Pressure = 50 psi
Flow = 2566 gpm

Results

System Pressure Demand: 71.672 psi
System Flow Demand: 589.79 gpm
Total Demand: 1089.79 gpm
Pressure Below Supply Curve: ≈5 psi

Model
75.239 psi
592.75 gpm
1092.75 gpm
≈1 psi
Fire Scenarios

• Manufacturing Area Fire
  • During business hours fire is likely to be seen by occupants attending any machinery
    • Extinguishment
    • Evacuation
  • High ceilings and large area
    • Smoke layer will descend slowly
    • Occupants have more time to react
  • Less Critical

• Office Area Fire
  • Smaller space where smoke layer presents greater threat to occupants
  • Areas such as break room not always attended during business hours
  • Appliance left on unattended in break room
    • Malfunction causes the appliance to ignite and set fire to nearby wood tables and cabinets
    • Assume a slow t-squared fire growth until sprinkler activation (Figure 3.7.2 of FPH)
    • Peak Heat Release Rate of 2000kW (Table 5.6.3.1 of FPH)
    • Determine if tenability threshold is passed before sprinkler activation
FDS Sprinkler Activation
Soot Distribution at Sprinkler Activation
Tenability at Sprinkler Activation

Temperature

Thermal Tolerance for unprotected skin occurs around 120 degrees C (FPH)

FDS Slice Files at 6 feet above the floor
Tenability at Sprinkler Activation

Visibility

Suggested OD limits for impairment of egress range from 0.5 1/m (2 meters of visibility) to 0.065 1/m (15 meters of visibility)

FDS Slice Files at 6 feet above the floor
Tenability after Egress Time

Temperature
Tenability after Egress Time

Visibility

Smokeview 8.1.12 - Oct 1 2014

Frame: 257
Time: 257.0

mech: 1

CAL POLY
Fire Protection Engineering


