Project Overview

• Building Description
• Egress Analysis
• Fire Detection, Alarm and Communication Systems
• Water-based Fire Suppression Systems
• Structural Fire Protection
• Performance Based Analysis
Building Description

• Located central coast of California
• Building approximately 133’ x 203’ = footprint of 27,000 ft$^2$
  • 3 floors
  • Maintenance Shop
  • Offices
  • Storage
Building Description – 1st Floor Layout

UNIT 2 COLD MACHINE SHOP - GROUND FLOOR
Building Description – 1st Floor Shops
Building Description – 2\textsuperscript{nd} Floor Layout
Building Description – 2nd Floor Offices
Building Description – 3rd Floor HVAC Area
Egress Analysis

• Access and Egress Routes are as follows:

  • **Primary:** North end via sliding doors, or personnel doors; South end via doors at enclosed stairway.

  • **Secondary:** East side via welding shop or at East end of office hallway.
Egress Analysis

Classifications:
- Industrial
- Business
- Storage
- Stairway
- Restroom
- Mechanical
- Electrical
- Hallway

UNIT 2 COLD MACHINE SHOP - GROUND FLOOR

NORTH
Egress Analysis

Classifications:
- Industrial
- Business
- Storage
- Stairway
- Restroom
- Mechanical
- Electrical
- Hallway

UNIT 2 COLD MACHINE SHOP - 2ND & 3RD FLOOR
Egress Analysis

<table>
<thead>
<tr>
<th>Occupant Load</th>
<th>Exit Capacity</th>
<th>Required Exits</th>
<th>Available Exits</th>
<th>Diagonal Distance</th>
<th>1/3 Diagonal Distance</th>
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<tbody>
<tr>
<td></td>
<td>Stairway</td>
<td>Doors</td>
<td></td>
<td></td>
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<tr>
<td>Floor 1</td>
<td>196</td>
<td>1620</td>
<td>2</td>
<td>9</td>
<td>241</td>
</tr>
<tr>
<td>Floor 2</td>
<td>85</td>
<td>705</td>
<td>2</td>
<td>5</td>
<td>172.5</td>
</tr>
<tr>
<td>Floor 3</td>
<td>0</td>
<td>120</td>
<td>1</td>
<td>1</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>281</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Floor 3 not required to have two exits as it is a story used exclusively for mechanical equipment (LSC Section 7.12.2)
- Floors 1 and 2 have the proper separation of exits based on sprinklered building and the 1/3 rule. (LSC Section 7.5.1.3.3)
Egress Analysis

UNIT 2 COLD MACHINE SHOP — GROUND FLOOR

NORTH

CAL POLY
Fire Protection Engineering
Egress Analysis

UNIT 2 COLD MACHINE SHOP - 2ND & 3RD FLOOR

NORTH

Signage:
- Exit - •
- Direction - •
- No Exit - •
Egress Analysis

• Sprinklered Building Travel Distance (LSC Table A.7.6):
  • 300ft for Business classification
  • 250ft for Industrial - General Classification
  • 400ft for Storage - Ordinary Hazard Classification

• Common Path Limits (LSC Table A.7.6):
  • 100ft for Business, Industrial, and Storage Classifications

• Dead End Limits (LSC Table A.7.6):
  • 50ft for Business and Industrial Classifications
  • 100ft for Storage Classification
Fire Detection, Alarm and Communication Systems

• Electric main is located on the East side of first floor
• Ventilation fans in third floor mechanical room.
  • Photoelectric smoke detectors shut down Supply and Return Air Systems.
  • Detectors are resettable at temperature control panels on exterior of main duct
• Building fire annunciator panel is located in lobby by Stair #2
• Site evacuation fire alarm panels are located on other side of wall from annunciator panel, in electric shop reception area.
Fire Detection, Alarm and Communication Systems

- **Annunciator (Left):**
  - Johnson Controls Inc
    - IFC-3030 - Intelligent Addressable Fire Alarm System

- **Fire Alarm Control Panels (Right):**
  - Federal Signal Corp
    - 300SSC - Supervised SelecTone Command - Series B
Fire Detection, Alarm and Communication Systems

• Primary detection device used is sprinklers (flow switch)
  • Building is completely sprinklered
  • Hose reels also used as a notification device (flow switch)
  • No smoke detectors installed in building, except on 3\textsuperscript{rd} floor in fan room

• Fire annunciator panel and fire alarm control panels communicate with the panels / alarm systems of the other buildings on site and would actuate an alarm in those buildings.
Fire Detection, Alarm and Communication Systems

• Spacing Requirements (NFPA 72, Section 17.6.3):

  • Detectors / sprinklers shall not exceed their listed spacing and shall be within half that distance from walls and no point shall be more than .7 times that spacing from a detector
    • Similar to smoke detectors without the 30' nominal spacing requirement.

• Sprinklers were designed to a Ordinary Hazard, Group II with a density of 0.19gpm/ft² and an application area of 1500ft²

  • Not current values for design of this building = 0.2gpm/ft² (FIGURE 11.2.3.1.1 Density/Area Curves of NFPA 13 (2013))
Fire Detection, Alarm and Communication Systems
Fire Detection, Alarm and Communication Systems
Fire Detection, Alarm and Communication Systems

• Detection activation times (DETACT)
  • Nominal Spacing = 13ft x 10ft = 3.96m x 3.05m
  • Radial distance = 8.2ft / 2.5m (0.7 x Nominal Spacing)

• Office Area → 228s @ 68.09°C
  • Ceiling Height = 8.5ft / 2.6m
  • Actuation Temperature = 155°F / 68°C
  • RTI = 80 m-s1/2 - Ordinary Response (NFPA 13 – 2010 Section 3.6.1)
Fire Detection, Alarm and Communication Systems

• Detection activation times (DETACT)
  • Nominal Spacing = 13ft x 10ft = 3.96m x 3.05m
  • Radial distance = 8.2ft / 2.5m (0.7 x Nominal Spacing)

• Shop Area ➔ 564s @ 79.22°C
  • Ceiling Height = 34ft / 10.36m
  • Actuation Temperature = 175°F / 79°C
  • RTI = 80+ m-s1/2 - Ordinary Response (NFPA 13 – 2010 Section 3.6.1)
Fire Detection, Alarm and Communication Systems

• Detection activation times (DETACT)
  - Nominal Spacing = 13ft x 10ft = 3.96m x 3.05m
  - Radial distance = 8.2ft / 2.5m (0.7 x Nominal Spacing)

• Fan Area → 116s @ 27.33°C
  - Ceiling Height = 8.5ft / 2.6m
  - Actuation Temperature = 68°F + 13°F = 71°F / 20°C + 7.2°C = 27.2°C
    (NFPA 72 – 2010 Table B.4.7.5.3)
  - RTI = 2 m-s1/2 (Detector inaccurate based on heat so low RTI)

![Graph showing temperature and heat release rate over time.](image)
Fire Detection, Alarm and Communication Systems

• **Protected Premises System**
  • Activate audible alarms to notify occupants they must evacuate
    • **Alarm Signal** - Audible alarms activated by flow switches for sprinklers / hose reels and ducting smoke detectors.
    • **Supervisory Signals** - Actions signals to onsite Fire Department to take action based on a fire event in the Cold Machine Shop. These come from the tamper switches on the riser manifold.
    • **Trouble Signal** - could include a signal from the tamper switches or loss of primary or secondary power.
    • **Proprietary System** - All buildings onsite are part of an interconnected system that is monitored by main control room for the site.
    • **Automated actions** - Shut down supply fans if duct smoke detectors detect smoke.
Fire Detection, Alarm and Communication Systems

- **Selectone Site Emergency/Fire Alarm Horn**
  - Federal Selectone Audible Signaling Device
  - Decibel Output = 88 at 10 Feet / 98 at 1 Meter

- **Code Call Bell - Chime type**
  - Federal single-stroke chime
  - Decibel Output = 98 at 10 Feet / 108 at 1 Meter

- **Code Call Bell - Vibratone Type**
  - Federal Vibratone bell
  - Decibel Output = 98 at 10 Feet / 108 at 1 Meter
Fire Detection, Alarm and Communication Systems
Fire Detection, Alarm and Communication Systems

<table>
<thead>
<tr>
<th>Area</th>
<th>Ambient dBA</th>
<th>Required dB</th>
<th>Distance from Alarm (ft)</th>
<th>Alarm Volume (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>45</td>
<td>60</td>
<td>160</td>
<td>64</td>
</tr>
<tr>
<td>Industrial</td>
<td>80</td>
<td>85</td>
<td>60</td>
<td>70</td>
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</tbody>
</table>
Fire Detection, Alarm and Communication Systems

UNIT 2 COLD MACHINE SHOP - GROUND FLOOR
Fire Detection, Alarm and Communication Systems

UNIT 2 COLD MACHINE SHOP - 2ND & 3RD FLOOR

NORTH
Fire Detection, Alarm and Communication Systems

• **Site PA system**

  • Used to make announcements site wide

  • Not directly controlled or connected to the fire alarm / notification system; used to communicate information to employees' onsite in the event of a fire or other emergency.
Fire Detection, Alarm and Communication Systems

• Section 10.6.7 "Secondary Power Supply" of NFPA 72 (2016)
  • Stand-by power for 24 hours
  • Alarming power for 15 minutes

• Calculation of load requirements for this system to meet NFPA 72:
  • Annunciator Panel:
    • Required capacity: 19.1 Ah
    • Equipped capacity: 26 Ah
  • FACP:
    • Required capacity: 6.9Ah
    • Equipped capacity: 8Ah
## Fire Detection, Alarm and Communication Systems

**Johnson Controls - IFC-3030 Intelligent Addressable Fire Alarm System**

<table>
<thead>
<tr>
<th>Device</th>
<th>Quantity</th>
<th>Current (Amps)</th>
<th>Total Current (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU-3030D - IFC-3030 Primary Display</td>
<td>1</td>
<td>0.2000 0.1000</td>
<td>0.2000 0.1000</td>
</tr>
<tr>
<td>NCM-W - Network Communications Module, Wire</td>
<td>1</td>
<td>0.1100 0.1100</td>
<td>0.1100 0.1100</td>
</tr>
<tr>
<td>LCM-320 - Loop Control Module</td>
<td>1</td>
<td>0.1300 0.1300</td>
<td>0.1300 0.1300</td>
</tr>
<tr>
<td>LEM-320 - Loop Expander Module</td>
<td>1</td>
<td>0.1000 0.1000</td>
<td>0.1000 0.1000</td>
</tr>
<tr>
<td>RPT-W - Repeater Board, Wire Connection</td>
<td>1</td>
<td>0.0170 0.0000</td>
<td>0.0170 0.0000</td>
</tr>
<tr>
<td>XP10-M - Ten-input monitor module</td>
<td>1</td>
<td>0.0004 0.0055</td>
<td>0.0004 0.0055</td>
</tr>
<tr>
<td>XP6-R - Six-Supervised Control Module</td>
<td>1</td>
<td>0.0002 0.0032</td>
<td>0.0002 0.0032</td>
</tr>
<tr>
<td>AMPS-24 - Power Supply</td>
<td>1</td>
<td>0.1040 0.0000</td>
<td>0.1040 0.0000</td>
</tr>
</tbody>
</table>

- Includes 640-character backlit LCD display, QWERTY programming and control keypad.
- Interface between a control panel and normally-open contact devices.
- Monitors wiring to devices that require external power supply to operate.
- Addressable power supply and battery charger with two 24 VDC outputs. Addressable by any FlashScan® or CLIP mode FACP. Charges 25 to 200 Ah batteries. Primary input power for panel; AMPS-24: 110-120 VAC, 50/60 Hz, 4.5 A maximum.

### Calculation

- Total (Amps): 0.6615 0.4487
- Duration (hr): 24.0000 0.0833
- Required Amp-hr (Ah): 15.8760 0.0374
- Margin of 20% (Ah): 3.1752 0.0075
- Total Batter Demand (Ah): 19.096
- Batter Capacity (Ah): 26.000
Fire Detection, Alarm and Communication Systems

<table>
<thead>
<tr>
<th>Device</th>
<th>Quantity</th>
<th>Current (Amps)</th>
<th>Total Current (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Standby</td>
<td>Alarm</td>
</tr>
<tr>
<td>SelecTone® Audible Signaling Device - Model 50GC</td>
<td>9</td>
<td>0.0250</td>
<td>0.0900</td>
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<tr>
<td>Vibratone® Bells</td>
<td>9</td>
<td>0.0000</td>
<td>0.0800</td>
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<tr>
<td>3.9k End of Line Resistor</td>
<td>1</td>
<td>0.0100</td>
<td>0.0100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.2350</td>
<td>1.5400</td>
</tr>
<tr>
<td>Duration (hr)</td>
<td></td>
<td>24.0000</td>
<td>0.0833</td>
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<tr>
<td>Required Amp-hr (Ah)</td>
<td></td>
<td>5.6400</td>
<td>0.1283</td>
</tr>
<tr>
<td>Margin of 20% (Ah)</td>
<td></td>
<td>1.1280</td>
<td>0.0257</td>
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<tr>
<td>Total Batter Demand (Ah)</td>
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<td>6.922</td>
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<tr>
<td>Batter Capacity (Ah)</td>
<td></td>
<td>8.000</td>
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</tbody>
</table>
Fire Detection, Alarm and Communication Systems

- **Inspection, Testing and Maintenance Requirements:**
  - NFPA 72, Chapter 14 prescribes the inspection, testing and maintenance requirements for a fire alarm system.
  - Some inspections performed by Fire Department Staff onsite.
  - Majority of inspection and testing contracted out to vendor Cosco.
  - Maintenance is performed on the system by both the onsite maintenance personnel and Vendor Cosco.
Water-based Fire Suppression Systems

• Completely sprinklered with an upper and lower system
  • Upright and pendent sprinklers of varying size are utilized throughout

• Covered by standpipe/hose system

• **Riser:**
  • One riser manifold to three systems on west side of building
Fire Detection, Alarm and Communication Systems
Water-based Fire Suppression Systems
Water-based Fire Suppression Systems

**Water Supply:**

- Water is supplied to building from two firewater pumps and a 470,000 gallon tank.
  - Static Pressure = 165 psi
  - Flowing Pressure = 132 psi
  - Flow = 3002 gpm

- Water is fed via a 12” PVC main
  - Reduces to 8” line that enters building and feeds manifold for three risers for both sprinkler systems and standpipe system.

- Fire Department Connection at southeast corner of building.
Water-based Fire Suppression Systems

- **Sprinklers:**
  - Designed hydraulically to 0.19 and 1500ft$^2$ for entire building
  - Grid system / layout

- **Components:**
  - ½” Reliable Upright rated at 175°F / 155°F - Standard Response
  - ½” Reliable Pendent rated at 175°F / 155°F - Standard Response
  - 17/32” Reliable Upright rated at 175°F / 155°F - Standard Response
17 Sprinklers within remote (analysis) area
Water-based Fire Suppression Systems

12 sprinklers in remote (analysis) area
Water-based Fire Suppression Systems

• **Hose Reels:**
  • System is installed on both floors of building with stations throughout
  • Operated by onsite Fire Department
  • Required hose stream is 250 gpm for 60-90 minutes (NFPA 13, Table 11.2.3.1.2).
  • System design and install per NFPA 14.
  • All piping is 4" and provides 100psi to most remote station.
Water-based Fire Suppression Systems

<table>
<thead>
<tr>
<th></th>
<th>Manual Calculations</th>
<th>Computer Calculations</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Flow Demand (gpm)</td>
<td>Pressure Demand (psi)</td>
</tr>
<tr>
<td>Standpipe System</td>
<td>250</td>
<td>250</td>
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<tr>
<td>Lower Sprinkler</td>
<td>299</td>
<td>135.5</td>
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<tr>
<td></td>
<td>360</td>
<td>46.4</td>
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<tr>
<td>Lower System Total</td>
<td>549</td>
<td>135.5</td>
</tr>
<tr>
<td></td>
<td>610</td>
<td>46.4</td>
</tr>
<tr>
<td>Upper Sprinkler</td>
<td>340</td>
<td>128.3</td>
</tr>
<tr>
<td></td>
<td>261</td>
<td>64.0</td>
</tr>
<tr>
<td>Upper System Total</td>
<td>590</td>
<td>128.3</td>
</tr>
<tr>
<td></td>
<td>511</td>
<td>64.0</td>
</tr>
</tbody>
</table>
Structural Fire Protection

• **Use and Occupancy Classifications:**
  • Business, Group B (IBC 304.1)
  • Moderate-hazard factory industrial, Group F-1 (IBC 306.2)
  • Low Hazard Storage, Group S-2 (IBC 311.3)

• **The building was designed as a Type IIB with sprinklers**
  • The most common use of Type IIB construction is in big box retail stores, warehouses, and industrial buildings
Structural Fire Protection

• Max Height (IBC Table 504.3)
  • B - 75ft max height for S, IIB
  • F-1 - 75ft max height for S, IIB
  • S-2 - 75ft max height for S, IIB

• Cold Machine Shop = 52ft

• Max stories (IBC Table 504.4)
  • B - 4 for S, IIB
  • F-1 - 3 for S, IIB
  • S-2 - 4 for S, IIB

• Cold Machine Shop = 3 stories

• Max Area (IBC Table 506.2)
  • B - 69,000 ft² allowable area factor for SM, IIB
  • F-1 - 46,500 ft² allowable area factor for SM, IIB
  • S-2 - 78,000 ft² allowable area factor for SM, IIB

• Max Area with Area Increase Factor (IBC Section 506.2.4):
  • B - $A_a = [A_t + (NS \times I_f)] = [69,000 + (23,000 \times .5)] = 80,500$ ft²
  • F1 - $A_a = [A_t + (NS \times I_f)] = [46,500 + (15,500 \times .5)] = 54,250$ ft²
  • S-2 - $A_a = [A_t + (NS \times I_f)] = [78,000 + (26,000 \times .5)] = 91,000$ ft²

• Cold Machine Shop total area = 35,710 ft²
Structural Fire Protection

• **Fire Separation Requirements:**
  • B to F-1 = No separation requirement (IBC Table 508.4)
  • S-2 to B or F-1 = 1hr separation (IBC Table 508.4)
    • All classifications separated by masonry block walls and preformed or poured concrete

• **Fire Resistance Requirements:**
  • Type IIB - 0 hour rating on (IBC Table 601):
    • Primary structural frame
    • Bearing walls - Exterior and Interior
    • Floor construction and associated secondary members
    • Roof construction and associated secondary members
    • Nonbearing walls and partitions
Prescriptive Summary

• **Egress:**
  • Acceptable ✔

• **Fire Detection, Alarm and Communication Systems:**
  • Does not meet requirement for Shop Area alarm distance / dB ✗

• **Water-based Fire Suppression Systems:**
  • Acceptable ✔

• **Structural Fire Protection:**
  • Acceptable ✔
Performance Based Analysis - Egress Analysis

• Factors of occupancy making it conducive to short evacuation times:
  • Employees work in building daily and are familiar with layout.
    • Alert, focused, capable, and familiar with the building leading to short times.
  • Building not generally populated at night and will not have people sleeping there so all people present at the start of a fire will be awake and “alert”.
  • Employees would have a good sensibility, reactivity, mobility, and susceptibility
Performance Based Analysis - Egress Analysis

- SFPE:
  Maximum specific flow = 1.3 P/s/m (doorway)

\[ t(\text{min}) = \frac{\text{Occupant Load}}{1.3 \times w_e} \]

<table>
<thead>
<tr>
<th></th>
<th>Occupant Load</th>
<th>Total Effective Door Widths ( w_e ) (ft)</th>
<th>Total Effective Door Widths ( w_e ) (m)</th>
<th>t(s)</th>
<th>t(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor 1</td>
<td>196</td>
<td>216</td>
<td>5.5</td>
<td>27.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Floor 2</td>
<td>85</td>
<td>144</td>
<td>3.7</td>
<td>17.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Floor 3</td>
<td>0</td>
<td>24</td>
<td>0.6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>281</td>
<td></td>
<td></td>
<td>Total</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Performance Based Analysis - Egress Analysis

• Assumptions related to these calculations would be as follows:
  • All people start evacuation at same instant
  • All people able bodied and have no interruptions in evacuation
  • All floors are exactly the same
  • All stairwells are available
  • No issues or limiting factors on the first floor
  • Assumed ALL floor space in calculation of occupant load with no subtractions

• Some limitations to the above calculations for exit time would include
  • Assumptions above optimizing egress times, therefore often underestimating actual egress times
  • Occupant Loads will vary widely and often will be less than prescribed
    • Many employees spend their day outside of building performing work
    • Influx of additional employees at certain times
  • Fails to account for any restrictions or issues within each floor.
  • Assumes that the doors/stairwells are the limiting factor in every case.
Performance Based Analysis - Pathfinder

• **Pathfinder Simulation:**
  
  • Total egress time = 60 seconds
    • 14 seconds longer than the 46 second egress time found using the SFPE formula
  
  • The following rooms used for design fires were found to have the following egress times:
    • 2nd floor weld room cleared in 20s
    • 2nd floor electrical offices cleared in 42s
    • 1st floor shop area cleared in 34s
  
  • The following areas were found to be the bottleneck areas:
    • **Second Floor:** South two stairwells and west stairwell
    • **First Floor:** Northwest doors and east middle door
Performance Based Analysis - Pathfinder
Performance Based Analysis - Pathfinder
Performance Based Analysis – ASET / RSET

- Detection Time = 84 seconds in Shop Area / 208 seconds in Office Area
- Pre-Movement Time = 66 seconds (Table 4.2.1, NFPA Fire Protection Handbook)
- Travel Time = 60 seconds
- Safety Factor = 1.25
- RSET = 263 seconds in Shop Area / 418 seconds in Office Area
Performance Based Analysis – Tenability

• **Tenability:**

  • Temperature Limit: 60°C at 6ft (140°F) for 30 minutes
  
  • Visibility: 10m at 6ft
  
  • Toxicity: 800ppm CO for 15 minutes
Performance Based Analysis – FDS / PyroSim

• **Design Fire #1:**
  • Pallets used for sending/receiving materials stacked in a location next to column in shop area

**Pallets (NFPA 72, Table B.2.3.2.6.2(a)):**
  • Growth Time = 80-110s
  • Heat Release Density = 6810 kW/m$^2$
  • Classification = Fast
  • Area = 1.1m x 1.2m = 1.32 m$^2$
  • Peak HRR = 8989 kW
  • Fuel Load Density = 1671 MJ/m$^2$
Performance Based Analysis – FDS / PyroSim

• Pallet Fire:
Performance Based Analysis – FDS / PyroSim

Temperature Profile @ 120s

Smoke Profile @ 120s
Performance Based Analysis – FDS / PyroSim

Temperature Profile @ 240s

Smoke Profile @ 240s
Performance Based Analysis – FDS / PyroSim

- **Pallet Fire:**

<table>
<thead>
<tr>
<th>Door</th>
<th>Temperature (°C)</th>
<th>Visibility (m)</th>
<th>CO Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>245s</td>
<td>263s</td>
<td>245s</td>
</tr>
<tr>
<td>North (West)</td>
<td>33.4</td>
<td>30.6</td>
<td>11.3</td>
</tr>
<tr>
<td>North (East)</td>
<td>95.2</td>
<td>44.5</td>
<td>2.6</td>
</tr>
<tr>
<td>East (North)</td>
<td>30.7</td>
<td>29.7</td>
<td>15.5</td>
</tr>
<tr>
<td>East (Middle)</td>
<td>31.0</td>
<td>32.5</td>
<td>17.7</td>
</tr>
<tr>
<td>East (South)</td>
<td>29.5</td>
<td>30.5</td>
<td>17.5</td>
</tr>
<tr>
<td>South (West)</td>
<td>31.8</td>
<td>30.7</td>
<td>15.4</td>
</tr>
<tr>
<td>South (East)</td>
<td>25.3</td>
<td>30.9</td>
<td>22.4</td>
</tr>
</tbody>
</table>

Sprinklers actuate at 84s
Performance Based Analysis – FDS / PyroSim

• **Design Fire #2:**
  • Office fire on second floor.

**Office Materials (SFPE Handbook):**
  • Fire Load Density = 420 MJ/m²
  • Area = Conference Room
  • Peak HRR = 35 - 70 kW/m²
  • Maximum HRR = 165 kW
  • Burn Time = 420 / 70 x 1000 = 6000 s
Performance Based Analysis – FDS / PyroSim

- **Office Fire:**
  - Fire in conference room in SE corner of second floor
Performance Based Analysis – FDS / PyroSim

Temperature Profile @ 40s

Smoke Profile @ 40s
Performance Based Analysis – FDS / PyroSim

Temperature Profile @ 126s

Smoke Profile @ 126s
Performance Based Analysis – FDS / PyroSim

• 2nd Floor Office Fire:

<table>
<thead>
<tr>
<th>Stairwell</th>
<th>Temperature (°C)</th>
<th>Visibility (m)</th>
<th>CO ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>376s</td>
<td>418s</td>
<td>376s</td>
</tr>
<tr>
<td>West</td>
<td>21.1</td>
<td>21.2</td>
<td>30.0</td>
</tr>
<tr>
<td>South (West)</td>
<td>34.4</td>
<td>35.1</td>
<td>1.3</td>
</tr>
<tr>
<td>South (East)</td>
<td>30.6</td>
<td>31.4</td>
<td>1.7</td>
</tr>
<tr>
<td>East</td>
<td>21.1</td>
<td>21.6</td>
<td>29.7</td>
</tr>
</tbody>
</table>

Sprinklers actuate at 208s (Detection time)
Performance Based Analysis – Summary

- **Pallet Fire:**
  - ASET > RSET → 6 of 7 available exits

- **2nd Floor Office Fire:**
  - ASET > RSET → 2 of 4 available exits
Life Safety Analysis – Summary

• **Egress:**
  • Acceptable

• **Fire Detection, Alarm and Communication Systems:**
  • Does not meet requirement for Shop Area alarm distance / dB

• **Water-based Fire Suppression Systems:**
  • Acceptable

• **Structural Fire Protection:**
  • Acceptable

• **Pallet Fire:**
  • ASET > RSET → 6 of 7 available exits

• **2nd Floor Office Fire:**
  • ASET > RSET → 2 of 4 available exits
Performance Based Analysis – Summary

Questions?