PRESENTATION OUTLINE

1. Building Overview
2. General Building Construction
3. Applicable Codes and Standards
4. Building Code Analysis
5. Fire Alarm & Detection Systems
6. Automatic Fire Sprinklers & Water Supply
7. Clean Agent System
8. Egress Analysis
9. Fire Scenarios & Analysis
10. Recommendations & Conclusions
11. Question & Answer Session
BUILDING OVERVIEW
Project is a remodel/repurpose of an existing facility. Building was originally KONE elevator facility where elevators were built and tested. The seven story structure is still subleased by KONE for testing of elevators (fabrication has been moved elsewhere). The facility has been repurposed for an electronics recycling plant for recycling of the metals within electronics (e.g., gold, etc.). Below is a summary of areas and associated square footage, see site plan that follows. Time line of original construction; original Center WH ~1975’ (no drawings), expansion of Center WH 1981’, 2nd story office added in Center WH 1995’, 2-story office & KONE 7-story test area 1998’, back warehouse 2000’.

<table>
<thead>
<tr>
<th>Area</th>
<th>Level</th>
<th>Gross Floor Area (SF)</th>
<th>Occupancy Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Office</td>
<td>1st Floor</td>
<td>19,718</td>
<td>B-Occupancy, Accessory Use to Warehouse</td>
</tr>
<tr>
<td>Front Office</td>
<td>2nd Floor</td>
<td>9,796</td>
<td>B-Occupancy, Accessory Use to Warehouse</td>
</tr>
<tr>
<td>KONE</td>
<td>1st thru 7th</td>
<td>11,249</td>
<td>B-Occupancy, Accessory Use to Warehouse</td>
</tr>
<tr>
<td>Back WH</td>
<td>1st</td>
<td>49,330</td>
<td>S-2 Occupancy with Accessory B-Occupancy Office Space</td>
</tr>
<tr>
<td>Center WH</td>
<td>1st</td>
<td>111,442</td>
<td>S-2 Warehouse and Non-HPM areas, H-3 &amp; H-4 HPM areas.</td>
</tr>
</tbody>
</table>

| Total    |         | 201,536          |                                                             |
GENERAL BUILDING CONSTRUCTION
GENERAL BUILDING CONSTRUCTION

Back Warehouse (Type II-B Construction)
- Single Level
- Main steel framing w/metal purlin intermediate framing
- High bay ~35-ft clear
- Concrete floor
- Sheet metal siding
- Standing seam metal roof
- Roof and wall insulation with exposed vapor barrier
GENERAL BUILDING CONSTRUCTION - CONTINUED

Center Warehouse (Type II-B Construction)
- Single Level (has 2\textsuperscript{nd} story office in SW corner)
- Main steel framing w/metal purlin intermediate framing
- High bay \(~20+\) ft clear
- Concrete wall up to \(~8\)-ft and sheet metal side from there up
- Metal roof with EPDM applied
- Roof and wall insulation with exposed vapor barrier
GENERAL BUILDING CONSTRUCTION - CONTINUED

Office Area (Type II-B Construction)

- 2-Story (1-story original then adjoining 2-story built later)
- Tilt panel construction for original single level office, 2-level addition is metal siding
- Concrete floors
- Steel construction
- EPDM roofs
- Metal stud walls.
KONE (Type II-B Construction)
• 7-story structure (195-ft tall) to test elevators. 3 test shafts
• Main steel framing w/metal purlin intermediate framing
• Metal roof with EPDM applied
• Open grated flooring in elevator test area from ground floor to roof.
• Metal stud walls
Installed Fire Systems
• Fully sprinklered
  • Wet sprinkler used throughout.
  • Class 1 standpipe throughout
  • 1,500-gpm fire pump
  • Exterior docks utilize dry sprinklers
• Fire alarm throughout.
  • Addressable
  • IDC Class A wiring
  • NAC Class B wiring
  • Fire alarm throughout.
• Special Systems
  • Clean Agent used for main data room in addition to wet system (not pre-action)
  • Duct suppression system with ember detection for dust process (hammer mill)
  • Dust collector retrofitted with deflagration vents and CO2 flame front suppression.
APPLICABLE CODES & STANDARDS
The following codes were followed at time project:

**Building Codes (with City of McKinney Amendments)**
- 2006 International Building Code (IBC)
- 2006 International Mechanical Code (IMC)
- 2006 International Plumbing Code (IPC)
- 2006 International Fire Code (IFC)
- 2006 International Fuel Gas Code (IFGC)
- 2009 International Energy Conservation Code (IECC)
- 2005 National Electrical Code (NEC)

**NFPA Standards**
- 2002 NFPA 13—Standard for the Installation of Sprinkler Systems (CofM adopted STD)
- 2013 NFPA 14—Standard for the Installation of Standpipe and Hose
- 2013 NFPA 68—Standard on Explosion Protection by Deflagration Venting
- 2002 NFPA 72—National Fire Alarm Code (CofM adopted STD)
- 2013 NFPA 110—Standard for Emergency and Standby Power Systems
- 2013 NFPA 654—Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids.
- 2012 NFPA 2001—Standard on Clean Agent Fire Extinguishing Systems
APPLICABLE CODES & STANDARDS - CONTINUED

State & Federal Regulations
TCEQ (Texas Commission on Environmental Quality)
OSHA
TAS (Texas Accessibility Standard)

Insurer Guidelines
Hartford

McKinney Fire Department
Access Controlled Doors
Access Controlled Gates
Automatic Fire Sprinkler Systems
Emergency/Standby Generators
Fire Alarm Operational Requirements
Fire Alarm Systems
Fire Hydrants
Fire Lanes
Fire Sprinkler Underground
Hazardous Materials

High-Piled Storage
Knox Box FAQ
Site Plans
BUILDING CODE ANALYSIS
The base building is a “mixed used” occupancy containing S-2, B, H-3 and H-4 occupancies.

<table>
<thead>
<tr>
<th>USE OF SPACE/AREA</th>
<th>OCCUPANCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Space</td>
<td>B</td>
</tr>
<tr>
<td>Warehouse</td>
<td>S-2</td>
</tr>
<tr>
<td>HPM Areas</td>
<td>H-3 &amp; H-4</td>
</tr>
<tr>
<td>Mechanical/Electrical Rooms</td>
<td>Incidental Use Areas</td>
</tr>
<tr>
<td></td>
<td>See Table 509</td>
</tr>
<tr>
<td>Storage Rooms</td>
<td>Incidental Use Areas</td>
</tr>
<tr>
<td></td>
<td>See Table 509</td>
</tr>
</tbody>
</table>

Per IBC required separation between B & S-2 is 1-hr for fully sprinklered building. The separation between these two occupancies were not rated originally and not updated as part of the renovation. Since SF of office on 1st floor is less than 10% of SF can be considered an “accessory occupancy” per IBC 508.2 and no separation required.

---

**TABLE 508.4**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A, E</td>
<td>S</td>
<td>NS</td>
<td>S</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>NS</td>
<td>S</td>
<td>NS</td>
</tr>
<tr>
<td>I-1, I-3, I-4</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
</tr>
<tr>
<td>I-2</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
</tr>
<tr>
<td>R*</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>1</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>2</td>
<td>NP</td>
<td>2</td>
</tr>
<tr>
<td>F-2, S-2, U</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
</tr>
<tr>
<td>B, F-1, M, S-1</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
</tr>
<tr>
<td>H-1</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
</tr>
<tr>
<td>H-2</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
</tr>
<tr>
<td>H-3, H-4</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>NP</td>
<td>1</td>
<td>NP</td>
<td>2</td>
<td>NP</td>
</tr>
</tbody>
</table>

* S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
* NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
* N = No separation requirement.
* NP = Not permitted.

* The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but to not less than 1 hour.
* See Section 408.3.4.
* Separation is not required between occupancies of the same classification.
* Deleted.
OCCUPANCY CLASSIFICATIONS & REQUIRED SEPARATION – CONTINUED

Overall site plan with occupancy classifications.
AREA AND HEIGHT LIMITATIONS

The base building/warehouses were originally constructed as S-2 occupancy of Type II-B construction with ancillary B- occupancy for office space.

Per sections below of IBC 2006 since the building meets setback requirements so the SF is “unlimited” and hence can exceed the 26,000-SF/floor listed in Table 503.

507.2 Nonsprinklered, one story. The area of a one-story, Group F-2 or S-2 building shall not be limited when the building is surrounded and adjoined by public ways or yards not less than 60 feet (18 288 mm) in width.

507.3 Sprinklered, one story. The area of a one-story, Group B, F, M or S building or a one-story Group A-4 building, other than Type V construction, shall not be limited when the building is provided with an automatic sprinkler system throughout in accordance with Section 903.3.1.1 and is surrounded and adjoined by public ways or yards not less than 60 feet (18 288 mm) in width.
The Center Warehouse had the addition of H-3 and H-4 process areas into the S-2 occupancy.

### Table 307.1 and section 414 (Hazardous Materials) of IBC was utilized to confirm if allowable limits were exceeded for a “control area”. Due to the higher usage of chemicals utilized and stored the areas of use were classified as H-Occupancies.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TYPE OF CONSTRUCTION</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HEIGHT (feet)</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>HT</td>
</tr>
<tr>
<td>UL</td>
<td>160</td>
<td>65</td>
<td>65</td>
<td>55</td>
<td>55</td>
<td>55</td>
</tr>
</tbody>
</table>

**Notes:**
- B, E, F-1, F-2, H-1, H-2, H-3, H-4 are specific to the addition of H-3 and H-4 process areas into the S-2 occupancy.

**CAL POLY Fire Protection Engineering**
AREA AND HEIGHT LIMITATIONS - CONTINUED

Below are the H-Occupancies, see slides that follows for details on code analysis.
AREA AND HEIGHT LIMITATIONS - CONTINUED

H-OCCUPANCY SUMMARY

<table>
<thead>
<tr>
<th>AREA</th>
<th>ROOM #</th>
<th>OCCUPANCY</th>
<th>SF</th>
<th>FIRE RATING</th>
<th>INCLUDE INSIDE 3-HR</th>
<th>OCCUPANT LOAD [SF/PERSON]</th>
<th>OCCUPANT LOAD</th>
<th>EXTERIOR WALL [YES/NO]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1.5/P5 PROCESS AREA</td>
<td>101A</td>
<td>H-4</td>
<td>20,056</td>
<td>3-HR</td>
<td>YES</td>
<td>500</td>
<td>40</td>
<td>YES</td>
</tr>
<tr>
<td>P1.5/P5 ELECTROWINNING AREA</td>
<td>102B</td>
<td>H-3</td>
<td>9,710</td>
<td>2-HR</td>
<td>YES</td>
<td>500</td>
<td>2</td>
<td>NO</td>
</tr>
<tr>
<td>P1.5/P5 CHEMICAL STORAGE</td>
<td>102D</td>
<td>H-3</td>
<td>3,338</td>
<td>2-HR</td>
<td>YES</td>
<td>500</td>
<td>7</td>
<td>YES</td>
</tr>
<tr>
<td>P1.5/P5 PROCESS REceiving AREA</td>
<td>101I</td>
<td>H-4</td>
<td>5,846</td>
<td>2-HR</td>
<td>NO</td>
<td>500</td>
<td>12</td>
<td>NO</td>
</tr>
<tr>
<td>P2/P3 PROCESS AREA</td>
<td>102A</td>
<td>H-3</td>
<td>12,312</td>
<td>2-HR</td>
<td>NO</td>
<td>500</td>
<td>25</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>42,723</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

506.3 Automatic sprinkler system increase. Where a building is equipped throughout with an approved automatic sprinkler system in accordance with Section 503.3.1.1, the area limitation in Table 503 is permitted to be increased by an additional 300 percent \((I_f = 2)\) for buildings with more than one story above grade plane and an additional 500 percent \((I_f = 3)\) for buildings with no more than one story above grade plane. These increases are permitted in addition to the height and story increases in accordance with Section 504.2.

Exception: The area limitation increases shall not be permitted for the following conditions:

1. The automatic sprinkler system increase shall not apply to buildings with an occupancy in Use Group H-1.
2. The automatic sprinkler system increase shall not apply to the floor area of an occupancy in Use Group H-2 or H-3. For mixed-use buildings containing such occupancies, the allowable area shall be calculated in accordance with Section 508.3.3.2. with the sprinkler increase applicable only to the portions of the building not classified as Use Group H-2 or H-3.
3. Fire-resistance rating substitution in accordance with Table 601, Note e.

As an approved design based approach by the Fire Marshall and City of McKinney the allowable SF of H-Occupancy was allowed to be exceeded by providing a 3-HR rated enclosure around the P1.5/P5 process area to treat this as a separate BLDG and thus reducing the SF of H-3 and H-4 that counted toward the allowable allowance.
OCCUPANCY TYPES, VERTICAL/HORIZONTAL EXITS, EXIT SIGNAGE, FIRE/SMOKE WALLS

<table>
<thead>
<tr>
<th>Space Designation</th>
<th>Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td>Mechanical Rooms</td>
<td></td>
</tr>
<tr>
<td>Electrical Rooms</td>
<td></td>
</tr>
<tr>
<td>Restrooms</td>
<td></td>
</tr>
<tr>
<td>Elevators and Lobbies</td>
<td></td>
</tr>
<tr>
<td>Exit Corridors</td>
<td></td>
</tr>
<tr>
<td>Exit Stairs</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. EXITS are circled in RED.
2. EXIT SIGNS are shown in RED squares.

2306.6 Building access. Where building access is required by Table 2306.2, fire apparatus access roads in accordance with Section 503 shall be provided within 150 feet (45720 mm) of all portions of the exterior walls of buildings used for high-piled storage.

Exception: Where fire apparatus access roads cannot be installed because of topography, railways, waterways, non-negotiable grades or other similar conditions, the fire code official is authorized to require additional fire protection.

2306.6.1 Access doors. Where building access is required by Table 2306.2, fire department access doors shall be provided in accordance with this section. Access doors shall be accessible without the use of a ladder.

2306.6.1.1 Number of doors required. A minimum of one access door shall be provided in each 100 lineal feet (30480 mm), or fraction thereof, of the exterior walls which face required fire apparatus access roads.

IFC Chapter 23 - Storage

Back Warehouse

SLIDE 22
**OCCUPANCY TYPES, VERTICAL/HORIZONTAL EXITS, EXIT SIGNAGE**

1. EXITS are circled in RED.
2. EXIT SIGNS are shown in RED squares.
3. STAIRS are boxed in RED.

---

**Space Designation** | **Color Code**
---|---
Assembly | 
Business | 
Industrial | 
Storage | 
Mechanical Rooms | 
Electrical Rooms | 
Restrooms | 
Elevators and Lobbies | 
Exit Corridors | 
Exit Stairs | 

**Notes:**
1. EXITS are circled in RED.
2. EXIT SIGNS are shown in RED squares.
3. STAIRS are boxed in RED.
Notes:
1. EXITS are circled in RED.
2. EXIT SIGNS are shown in RED squares.
3. STAIRS are boxed in RED.

1st Floor Office
Notes:
1. EXITS are circled in RED.
2. EXIT SIGNS are shown in RED squares.
3. STAIRS are boxed in RED.
OCCUPANCY TYPES, VERTICAL/HORIZONTAL EXITS, EXIT SIGNAGE, FIRE/SMOKE WALLS - CONTINUED

Notes:
1. EXITS are circled in RED.
2. EXIT SIGNS are shown in RED squares.
3. STAIRS are boxed in RED.
The one room of concern is “P1.5/P5 PROCESS RECEIVING AREA” 101J, the space is an H-4 occupancy and per the IBC the maximum travel distance is 175-ft. The egress from this space is either thru the warehouse (S-2) or adjacent process area (H-4). Per IBC 1014.2 exceptions egress is allowed thru adjoining spaces as long as they are the same or less hazard classification.
### EGRESS TRAVEL DISTANCE & WIDTH BY SPACE

#### SPACE INFORMATION

<table>
<thead>
<tr>
<th>Space Name</th>
<th>Room #</th>
<th>Area (sq ft)</th>
<th>Ceiling Height (ft)</th>
<th>Floor Height (ft)</th>
<th>Height of Exit</th>
<th>Exit Width (in)</th>
<th>Exit Distance (in)</th>
<th>Travel Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office A</td>
<td>1</td>
<td>840</td>
<td>8</td>
<td>8.5</td>
<td>80</td>
<td>36</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Office B</td>
<td>2</td>
<td>960</td>
<td>8</td>
<td>8.5</td>
<td>80</td>
<td>36</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Office C</td>
<td>3</td>
<td>1200</td>
<td>8</td>
<td>8.5</td>
<td>80</td>
<td>36</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

#### LIFE SAFETY CODE - 2012

<table>
<thead>
<tr>
<th># of Occupants</th>
<th>LSC 2012</th>
<th>IBC 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

#### Minimum Egress Width (In)

<table>
<thead>
<tr>
<th>Floor</th>
<th>LSC 2012</th>
<th>IBC 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Floor</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>2nd Floor</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

#### Egress Width Assumptions

- **LSC 2012**: Assumes 0.20 for LSC and 0.35 for IBC. Values based on occupancy type, but all fall under numbers assumed.
- **IBC 2012**: Assumes 0.20 for LSC and 0.35 for IBC. Values based on occupancy type, but all fall under numbers assumed.

---

Sampling of summary per room, complete list not shown.
EGRESS – CHAIN LINK FENCING

GENERAL NOTES:

1. FENCING:

ALL MATERIAL TO BE GALVANIZED.

RIGID

8-FT HEIGHT, FENCING FABRIC 2" TG 8-CA. POST 2-3/8"ODX0.065" WALL GALV. STEEL, WELDED STEEL BASE PLATES WITH 1/2"X12-3/4" ANCHOR BOLTS, TOP RAIL WITH 6-1/2" TENSOH LINED AT THE BOTTOM.

OUTDOOR

8-FT HEIGHT, FENCING FABRIC 2" TG 8-CA. POST 2-3/8"ODX0.065" WALL GALV. STEEL, WELDED STEEL BASE PLATES WITH 1/2"X12-3/4" ANCHOR BOLTS, TOP AND BOTTOM RAIL.

2. EGRESS: DISTANCES FROM PRODUCTION SIDE TO WAREHOUSE ARE (3) 34' AND (1) 49' WITH TOTAL EGRESSES WIDTH OF 156'-0". AT 0.2-3/5 PERSON PER THE IRC THE EGRESS CAPACITY IS 769 OCCUPANCIES. THE OCCUPANCY LOADING FOR THE AREA IS 500-550 PERSON THEN THIS EQUALS TO 385,000 SF. THIS EQUIVALENT EGRESS NOT PROVIDED. IN ADDITION THE TRAFFIC DISTANCE ALLOWED FOR THE 2-3 WAREHOUSE IS 400'-0" FOR A FULLY SPRINKLERSED BUILDING THIS WILL NOT BE EXCEEDED. ALL H-OCUPANCIES ARE ON THE PERIMETER AND MAKE EGRESS TO THE OUTSIDE.

KEYS:

1. 34" PERSONNEL GATE, CRASH BAR PROVIDED IN DIRECTION OF EGRESS AND KEY LOCK FOR ACCESS FROM OPPOSITE SIDE. EXIT SIGN INTERIOR = ELECTRICAL POWERED (EMERGENCY) TO MATCH EXISTING, EXTERIOR = REFLECTIVE PAINTED STEEL.

2. 72" MATERIAL GATE, 180-DEG SWING.

3. 48" PERSONNEL GATE, CRASH BAR PROVIDED IN DIRECTION OF EGRESS AND KEY LOCK FOR ACCESS FROM OPPOSITE SIDE. ELECTRICALLY POWERED (EMERGENCY) EXIT SIGN TO MATCH EXISTING PROVIDED AT GATE ON EGRESS SIDE.

4. DOUBLE 80" VEHICLE GATE (10'-0" OPENING).

5. PROVIDE "NOID-DOS" AND PROVIDE SIGNAGE "TO ACCESS" WITH RED BACKGROUND AND WHITE LETTERS.

6. PROVIDE LOCALLY AUDIBLE ALARM "FIRE ACCESS DOOR" WITH CRASH BAR ENTRY. DOOR TO BE USED FOR FIRE DEPARTMENT ACCESS. DOOR TO HAVE KEYS OVERLAP TO DISABLE ALARM.
FIRE RESISTANCE RATING OF BUILDING ELEMENTS

Building construction is Type II-B per the IFC. Below are the required fire resistance ratings per the IBC. Fire rated separation walls and associated penetrations meet UL listings. See occupancy slides for fire separations requirements.

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A&lt;sup&gt;e&lt;/sup&gt;</td>
<td>B</td>
<td>A&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Structural frame&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior&lt;sup&gt;f&lt;/sup&gt;</td>
<td>3</td>
<td>2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interior&lt;sup&gt;f&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Including supporting beams and joists</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Roof construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Including supporting beams and joists</td>
<td>1&lt;sup&gt;1/2&lt;/sup&gt;&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Structural frame<sup>a</sup> excludes partitions and penetrations.

<sup>b</sup> For Type II-B construction, fire-rated separation walls and associated penetrations must meet UL listings.

<sup>c</sup> Floor and roof constructions must be evaluated for fire resistance.

<sup>d</sup> Eastern states have specific requirements for fire separations.
In order to keep trench sizes down in each HPM area to cover for 110% of largest tank and 20-min of fire sprinkler water the trenches were interconnected. By the detail to the left we were able carry the trenching under the fire rated wall separations between the HPM areas to share containment volume between the rooms. Per IFC 27034.2.2.3 secondary containment shall be designed to contain the largest vessel plus design fire area/coverage for 20-min activation.
The process area consist of H-3 and H-4 areas that HPM chemicals are stored and utilized. Per the IBC 507.8 the maximum square footage of H-Occupancies in an S-Occupancy unlimited area building is 10% of the SF or ~20,000 SF. The lesser of the 10% or allowable area per Table 503 is to be used. The total H-Occupancy SF ended up at ~26,000 SF. The allowable square footage for H-Occupancies was exceeded. As a compromise with the City of McKinney a performance based design approach was utilized and a 3-hr wall was provided around one of the large H-3/H-4 areas to treat as “separate building” per the IBC Section 510 thus reducing the H-Occupancy integral with the S-2 occupancy.
FIRE ALARM & DETECTION SYSTEMS
FIRE ALARM SYSTEM – OVERVIEW

• Fire alarm System
  • Installed throughout.
  • Addressable
  • IDC Class A wiring (minimum 6-ft separation per CofM)
  • NAC Class B wiring
• Components
  • Flow and tamper switches per fire protection zone.
  • Horn/Strobes. DBA from 15 to 110 DBA. In WH and process areas 95 DBA and 110 DBA by louder processes (shredding, hammer mill, mechanical rooms, etc.).
  • Smoke detectors at access controlled doors (interlocked with door)
  • Duct smoke detectors on HVAC equipment over 2,000-CFM (R/A per IMC).
    • NFPA 90A notes downstream (S/A) of the air filters (supply air) for SD. Required in R/A greater than 15,000-CFM (prior to outside air connection) or serving more than one floor.
  • Manual pull station at FACP ONLY. Manual pull stations not required per IBC 907.2.2 for Group B when fully sprinklered.
  • Heat detectors in KONE elevator test bays were replaced with smoke detectors per the CofM FM.
  • HAZMAT pull stations outside of HPM areas per IBC 414.7, see slide that follows. Reports to central station/FD as HAZMAT.
  • Ember detection and deflagration detection.
FIRE ALARM SYSTEM – HAZMAT EMERGENCY ALARM
AUTOMATIC FIRE SPRINKLERS & WATER SUPPLY
ZONE #5 has open chemical processes with water reactive acids. Was discussed to look at chemical, inert gas or water mist systems. Due to the cost it was compromised with the city to use a wet system separately zoned and alarmed as HPM.
### AUTOMATIC FIRE SPRINKLER DESIGN CRITERIA

<table>
<thead>
<tr>
<th>Item</th>
<th>Zone-1</th>
<th>Zone-1A</th>
<th>Zone-2</th>
<th>Zone-3</th>
<th>Zone-4</th>
<th>Zone-5</th>
<th>Zone-6</th>
<th>Zone-6A</th>
<th>Zone-7</th>
<th>Zone-7A</th>
<th>Standpipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupancy</td>
<td>Group A Plastics</td>
<td>Misc. Storage</td>
<td>Group A Plastics</td>
<td>OH-2</td>
<td>Group A Plastics</td>
<td>OH-2</td>
<td>OH-2</td>
<td>N/A</td>
<td>OH-2</td>
<td>Misc. Storage</td>
<td>N/A</td>
</tr>
<tr>
<td>Area Served</td>
<td>Back WH Rack Storage</td>
<td>Back WH Rack Storage</td>
<td>Back WH Rack Storage</td>
<td>Center WH Rack Storage</td>
<td>Production</td>
<td>Production</td>
<td>Ductwork (Dust)</td>
<td>Production</td>
<td>Center WH Covered Awning</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Type of System</td>
<td>Wet</td>
<td>Dry</td>
<td>Wet</td>
<td>Wet</td>
<td>Wet</td>
<td>Wet</td>
<td>Wet</td>
<td>Wet</td>
<td>Wet</td>
<td>Dry</td>
<td>Class L - Standpipe</td>
</tr>
<tr>
<td>Max Coverage per Head (SF)</td>
<td>N/A</td>
<td>0.15</td>
<td>N/A</td>
<td>0.17</td>
<td>N/A</td>
<td>0.17</td>
<td>0.17</td>
<td>0.17</td>
<td>17-GPM</td>
<td>0.17</td>
<td>0.15</td>
</tr>
<tr>
<td>Density (gpm/ft²)</td>
<td>12-HEADS</td>
<td>1,050</td>
<td>12-HEADS</td>
<td>3,000</td>
<td>12-HEADS</td>
<td>3,000</td>
<td>3,000</td>
<td>N/A</td>
<td>3,000</td>
<td>1,850</td>
<td>N/A</td>
</tr>
<tr>
<td>Sprinkler</td>
<td>ESFR</td>
<td>CMDA</td>
<td>ESFR</td>
<td>CMDA</td>
<td>ESFR</td>
<td>CMDA</td>
<td>CMDA</td>
<td>APS</td>
<td>CMDA</td>
<td>CMDA</td>
<td>N/A</td>
</tr>
<tr>
<td>Driftor (ft)</td>
<td>3/4&quot;</td>
<td>1/2&quot;</td>
<td>3/4&quot;</td>
<td>17/32&quot;</td>
<td>3/4&quot;</td>
<td>17/32&quot;</td>
<td>3/4&quot;</td>
<td>17/32&quot;</td>
<td>17/32&quot;</td>
<td>1/2&quot;</td>
<td>N/A</td>
</tr>
<tr>
<td>K-Factor</td>
<td>14.0</td>
<td>5.6</td>
<td>14.0</td>
<td>8.0</td>
<td>14.0</td>
<td>8.0</td>
<td>8.0</td>
<td>-</td>
<td>8.0</td>
<td>5.6</td>
<td>N/A</td>
</tr>
<tr>
<td>Min Pressure (PSI)</td>
<td>75</td>
<td>7</td>
<td>75</td>
<td>7</td>
<td>7</td>
<td>44</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>N/A</td>
</tr>
<tr>
<td>Temp Rating (F)</td>
<td>200</td>
<td>286</td>
<td>200</td>
<td>286</td>
<td>200</td>
<td>286</td>
<td>286</td>
<td>-</td>
<td>286</td>
<td>286</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum Storage Height (ft)</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>N/A</td>
<td>25</td>
<td>25</td>
<td>N/A</td>
</tr>
<tr>
<td>Sprinkler Demand (gpm)</td>
<td>1,455</td>
<td>1,783</td>
<td>1,455</td>
<td>510</td>
<td>1,455</td>
<td>510</td>
<td>510</td>
<td>N/A</td>
<td>510</td>
<td>178</td>
<td>N/A</td>
</tr>
<tr>
<td>Hose Size Allowance (gpm)</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>N/A</td>
<td>250</td>
<td>250</td>
<td>4 @ 250 = 1,000</td>
</tr>
<tr>
<td>Total Demand (gpm)</td>
<td>1,705</td>
<td>418</td>
<td>1,705</td>
<td>760</td>
<td>1,705</td>
<td>760</td>
<td>760</td>
<td>17</td>
<td>760</td>
<td>428</td>
<td>1,000</td>
</tr>
</tbody>
</table>

**Note:** Front Office and KONE area served from Wet Systems in Center WH. No separate flow switch except for KONE.
Fire pump is rated for 1,500-gpm. Driving factor for fire pump was not pressure for fire sprinklers. The City of McKinney mandated a Class I standpipe system throughout and per CofM requirements a fire pump must serve a standpipe system (100-psig hose pressure). During flow test static pressure was 90-psig and residual 70-psig so exceptional pressure at the site.
SITE FIRE WATER LOOP

- 12” City Main – PURPLE
- 8” Fire Loop – YELLOW
- FH’s – RED (additional on city main, not shown)
- FDC – GREEN (one at pump room as well)
- Fire Pump Room - BLUE
### FIRE FLOW TEST

**Flow Test Information Sheet**

<table>
<thead>
<tr>
<th>Hydrant No.</th>
<th>Location</th>
<th>Coefficient</th>
<th>Orifice</th>
<th>Static PSI</th>
<th>Residual PSI</th>
<th>Pitot PSI</th>
<th>Flow GPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Backside of building</td>
<td>0.9</td>
<td>2.5</td>
<td></td>
<td>20</td>
<td>855</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Backside of building</td>
<td>0.9</td>
<td>2.5</td>
<td>90</td>
<td>70</td>
<td>0</td>
<td>1712</td>
</tr>
</tbody>
</table>

\[ Q = 29.83 \text{ cfd} \cdot \frac{d^4}{p} \quad (Q = \text{gpm}; \ c = \text{coefficient of discharge (0.9); } d = \text{diameter of the outlet; } p = \text{velocity in psi}) \]

Flow hydrant was FH-4 and pressure hydrant was FH-1

See site plan for location of test hydrants
AutoSPRINK was utilized to calculate system pressures. Per calculations a fire pump is not required for the fire sprinklers however per the CofM a Class I standpipe is required and is to be served by a Fire Pump (100-PSIG required at hose).

2704.5 Automatic sprinkler systems. Indoor storage areas and storage buildings shall be equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. The design of the sprinkler system shall not be less than that required for Ordinary Hazard Group 2 with a minimum design area of 3,000 square feet (279 m²). Where the materials or storage arrangement are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler system protection shall be provided.
WATER FLOW ANALYSIS – HPM AREA (OH-2) – HAND CALCULATION

Mech-Chem Area

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard Classification</td>
<td>OH2</td>
</tr>
<tr>
<td>Design Area</td>
<td>3,000</td>
</tr>
<tr>
<td>GPM/SF</td>
<td>0.17</td>
</tr>
<tr>
<td>K</td>
<td>5.5</td>
</tr>
<tr>
<td>Lateral Head Spacing</td>
<td>16 ft</td>
</tr>
<tr>
<td>Main Spacing</td>
<td>12.5 ft</td>
</tr>
<tr>
<td>Sprinkler Area</td>
<td>125 ft²</td>
</tr>
<tr>
<td>System Type</td>
<td>WET</td>
</tr>
<tr>
<td>Pipe Aboveground</td>
<td>940</td>
</tr>
<tr>
<td>Pipe Below Ground</td>
<td>CS00 PVC DR-18</td>
</tr>
<tr>
<td>C-Value</td>
<td>120</td>
</tr>
<tr>
<td>C-Value</td>
<td>150</td>
</tr>
</tbody>
</table>

Sprinkler Flow | 21.35 gpm required |
Pressure        | 14.40 PSI required  |
Sprinkler Flow  | 14.8 gpm minimum   |
# of Sprinklers on Lateral | 7 |
# of Sprinklers Operating | 25 |
# of Complete Lateral | 3 |
# of Sprinklers on Last Lateral | 4 |
WATER FLOW ANALYSIS – HPM AREA (OH-2) – HAND CALCULATION - CONTINUED

<table>
<thead>
<tr>
<th>S. No.</th>
<th>RISER #</th>
<th>FLOW IN G.P.M.</th>
<th>PIPE SIZE</th>
<th>EQUIV DIA</th>
<th>MODIFIED DIA</th>
<th>PRESSURE</th>
<th>NORMAL PRESSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Floor #1</td>
<td>150</td>
<td>2 1/2</td>
<td>1.025</td>
<td>1.087</td>
<td>6.058</td>
<td>5.830</td>
</tr>
<tr>
<td>2</td>
<td>Floor #2</td>
<td>210</td>
<td>3 1/2</td>
<td>1.204</td>
<td>1.320</td>
<td>12.02</td>
<td>11.69</td>
</tr>
<tr>
<td>3</td>
<td>Floor #3</td>
<td>250</td>
<td>4</td>
<td>1.597</td>
<td>1.764</td>
<td>18.94</td>
<td>18.56</td>
</tr>
</tbody>
</table>

Riser #1
(similarly calculated for other risers)
AutoSPRINK was utilized to calculate system pressures. Per calculations a fire pump is not required for the fire sprinklers however per the CofM a Class I standpipe is required and is to be served by a Fire Pump (100-PSIG required at hose).

A 16.8 K-Factor head was used for calcs which only requires 50-psig for rack storage at hand. FP contractor elected to use a 14.0 K-Factor head which requires 75-psig, since a fire pump was required for standpipes not an issue.
**Table 17.2.3.1 ESFR Protection of Rack Storage Without Solid Shelves of Plastics Commodities Stored Up to and Including 25 ft (7.6 m) in Height**

<table>
<thead>
<tr>
<th>Storage Arrangement</th>
<th>Commodity</th>
<th>Maximum Storage Height</th>
<th>Maximum Ceiling/Structure Height</th>
<th>Nominal K-Factor</th>
<th>Orientation</th>
<th>Minimum Operating Pressure psi</th>
<th>bar</th>
<th>In Rack Sprinkler Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single, double, and multipurpose racks (no open-top containers)</td>
<td>Commodity not expanded</td>
<td>32</td>
<td>ft</td>
<td>m</td>
<td>ft</td>
<td>m</td>
<td>140 (200)</td>
<td>Upright/pendent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.8 (260)</td>
<td>Upright/pendent</td>
<td>40</td>
<td>2.9</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.0 (200)</td>
<td>Upright/pendent</td>
<td>25</td>
<td>1.8</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.8 (260)</td>
<td>Upright/pendent</td>
<td>50</td>
<td>3.6</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>22.4 (320)</td>
<td>Pendant</td>
<td>40</td>
<td>2.8</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.2 (360)</td>
<td>Pendant</td>
<td>25</td>
<td>1.7</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.0 (200)</td>
<td>Pendant</td>
<td>60</td>
<td>4.3</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.8 (260)</td>
<td>Pendant</td>
<td>50</td>
<td>3.6</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>22.4 (320)</td>
<td>Pendant</td>
<td>40</td>
<td>2.8</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.2 (360)</td>
<td>Pendant</td>
<td>25</td>
<td>1.7</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rack Storage Sprinkler Design**

- Commodity = Group A Plastics, exposed and non-expanded.
- Racks = Single and Double Row
- Maximum Storage Height = 25-ft
- Maximum Ceiling/Structure Height = 35-ft
- Aisles = 8-ft minimum
- Heads = ESFR, K=14.0, 200degF, 75-psig min, 12 operating
- Hose Stream = 250-gpm
- Original install was for Class I-IV rack commodities utilizing Large Drop sprinklers (CMSA – Control Mode Specific Application).
- CMSA maximum SF = 100SF and maximum spacing of 12-ft (unobstructed).
- ESFR for ceiling heights over 30-ft have maximum spacing of 10-ft. Existing laterals since spaced at 12’ centers had to be replaced.
CLEAN AGENT SYSTEM
CLEAN AGENT SYSTEM
ECARO-25

Owner opted not to replace existing wet pipe system in the data room with a pre-action system.
EGRESS ANALYSIS
EGRESS ANALYSIS

RSET < ASET

Objective is to satisfy the criterion above.
OCCUPANT CHARACTERISTICS

- Healthy adults
- Working Hours
  - M-F normal hours
  - No sleeping facilities
- Sensibility
  - Awake / alert
- Reactivity
  - Industrial facility so regular training
  - Minimal visitors
- Mobility
  - Dominated by queuing
# Tenability Limits

## Tenability Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Limits</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>60 degC</td>
<td>SFPE Handbook, 5th Edition, Chapter 63 pg 2326, discomfort starts at this temperature &amp; NFPA 130</td>
</tr>
<tr>
<td>Visibility</td>
<td>10 m</td>
<td>SFPE Handbook, 5th Edition, Chapter 61 pg 2188, visibility distance of exit sign</td>
</tr>
<tr>
<td>CO PPM</td>
<td>1,000 ppm (0.001 kg CO/kg Air, or 10^(-4) kg CO/kg Air)</td>
<td>SFPE Handbook, 5th Edition, Figure 63.13 pg 2331</td>
</tr>
<tr>
<td>Radiation Heat Flux</td>
<td>2.5 kW/m²</td>
<td>SFPE Handbook, 5th Edition, Chapter 63 pg 2418</td>
</tr>
</tbody>
</table>

At 1.8m above floor (~6-ft)

## Table B.2.1.1 Maximum Exposure Time

<table>
<thead>
<tr>
<th>Exposure Temperature</th>
<th>Without Incapacitation (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td>60</td>
<td>140</td>
</tr>
<tr>
<td>55</td>
<td>131</td>
</tr>
<tr>
<td>50</td>
<td>122</td>
</tr>
<tr>
<td>45</td>
<td>113</td>
</tr>
<tr>
<td>40</td>
<td>104</td>
</tr>
</tbody>
</table>

NFPA 130
Assumed only 3 exits to the north, assumed 3 south exits not usable due to fire. Add obstructions for racks, pallets, etc.
EGRESS ANALYSIS – OFFICE (FIRE SCENARIO #2)

Egress Calculation - Office

<table>
<thead>
<tr>
<th>Item</th>
<th>Value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total occupants on floor</td>
<td>74 people (from space by space analysis)</td>
</tr>
<tr>
<td>Number of Exits</td>
<td>4</td>
</tr>
<tr>
<td>Assumed Usable Exit</td>
<td>2</td>
</tr>
<tr>
<td>Person/Exit</td>
<td>37</td>
</tr>
<tr>
<td>Travel to Exit</td>
<td></td>
</tr>
<tr>
<td>1st Floor Travel Distance</td>
<td>150 ft</td>
</tr>
<tr>
<td>Unimpeded Max Travel Speed</td>
<td>235.00 ft/min (SFPE 4th Edition, Table 3-13.4)</td>
</tr>
<tr>
<td>Unimpeded Travel Time</td>
<td>0.64 min</td>
</tr>
<tr>
<td>Maximum Specific Flow</td>
<td>24 persons/min/ft (SFPE 4th Edition, Table 3-13.5)</td>
</tr>
<tr>
<td>Door Effective Width</td>
<td>24 in (36in door, less 12in boundary SFPE 4th Edition, Table 3-13.1)</td>
</tr>
<tr>
<td>Door Effective Width</td>
<td>2.00 ft</td>
</tr>
<tr>
<td>Discharge Rate</td>
<td>48 persons/min</td>
</tr>
<tr>
<td>Discharge Time</td>
<td>0.77 min</td>
</tr>
<tr>
<td>Total Egress Time</td>
<td>1.41 min (Travel time + exit time)</td>
</tr>
</tbody>
</table>

Notes:

- Blocked all but exits circled in Pathfinder, since fire is in Lobby.
- Allowed for egress thru Center WH, S-2 occupancy. Since combustible are minimal and Christmas Tree is fuel limited did not pose an concern with integrity of non-rated separation wall.

Notes:

1. 15 seconds for notification time (flow switch alarm) and 40 seconds for sprinkler activation (FDS), total = 55 seconds.
2. Assumed time.
3. See hand calculation.
The AutoCAD background was utilized for Pathfinder. Spaces were identified and occupancy loading assigned. Doors were identified as well as main exits. Total occupants was calculated to be 917 and total egress time calculated as 2:03 mins (123 sec)
FIRE SCENARIOS & ANALYSIS
Rack Storage Fire
• Cartons of non-expanded electronics (computers, phones, etc.) – Class A Plastics.
• 1m x 1m x 0.5m cartons
• Double-Row rack
• 8-ft aisles between racks
• 25-ft max storage height and ceiling height of 35-ft.
• Fire #1 – Sprinklers operate (386degF smoke/heat vents).

• Assume a burner on each level the size of each rack
• Assume fire follows a t-squared ramp rate.
• Sequeued initiation per level. Assume entire lower level is ignited simultaneously.
• ESFR, 200-degF, K=14.0, RTI=50
FIRE SCENARIO - #1 MODEL

Double Row Rack Fire

Smoke Vents

Sprinklers

SLIDE 58
FIRE SCENARIO - #1 PICTURES
FIRE SCENARIO - #1 RACK SECTION

RACK STORAGE
A - PRINTERS/CRT MONITORS - PALLETS
B - CIRCUIT BOARDS - GAYLORDS
C - CIRCUIT BOARDS - GAYLORDS
D - CIRCUIT BOARDS - GAYLORDS
E - CIRCUIT BOARDS - GAYLORDS
F - CIRCUIT BOARDS - GAYLORDS
G - CIRCUIT BOARDS - GAYLORDS
H - FINISHED GOODS - GAYLORDS, COMPUTERS/LCD'S - PALLETS
I - FINISHED GOODS - GAYLORDS, COMPUTERS/LCD'S - PALLETS
J - FINISHED GOODS - GAYLORDS, COMPUTERS/LCD'S - PALLETS
K - FINISHED GOODS - GAYLORDS, COMPUTERS/LCD'S - PALLETS, OUTBOUND BATTERIES IN 55-GAL DRUMS (FLOOR LEVEL ONLY, NO LITHIUM)
L - FLOOR LEVEL - BATTERIES IN 55-GAL DRUMS (2-3 DRUMS OF LITHIUM, 2ND LEVEL - SUPPLIES AND EMPTIES)
### FIRE SCENARIO - #1 MODEL

#### Heat Release Rate (kW) and Burn Factor

<table>
<thead>
<tr>
<th>Levels Involved</th>
<th>Heat Release Rate (kW)</th>
<th>Burn Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Level 1</td>
</tr>
<tr>
<td>Level 1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Level 1 &amp; 2</td>
<td>31</td>
<td>4,495</td>
</tr>
<tr>
<td>Level 1, 2 &amp; 3</td>
<td>61</td>
<td>8,990</td>
</tr>
<tr>
<td>Level 1, 2, 3 &amp; 4</td>
<td>91</td>
<td>13,484</td>
</tr>
<tr>
<td>Level 1, 2, 3, 4 &amp; 5</td>
<td>121</td>
<td>17,979</td>
</tr>
</tbody>
</table>

**Fig. 26.26 HRR of computer CPU**

(SFPE HB 5TH Edition)

---

**Table Details:**
- **HRR/PC:** 10 kW
- **Area:** 56.12 m²
- **# Pallets/Level:** 30
- **# Pallets/Row:** 50
- **# Pallets/Column:** 456
- **HRR/total/level:** 4,495 kW

**Fire Growth:**
- **W:** 2.9 m
- **L:** 24.4 m
- **Area:** 75.5 FT
- **HRR/PC:** 10 kW
- **# Pallets/Level:** 30
- **# Pallets/Row:** 50
- **# Pallets/Column:** 456
- **HRR/total/Level:** 4,495 kW

**Fire Growth Medium:**
- **Area:** 0.01172 kW/sec²
- **HRR/PC:** 0.01172 kW/sec²
- **HRR/PC/Row:** 0.01172 kW/sec²
- **HRR/PC/Column:** 0.01172 kW/sec²
- **HRR/PC/Level:** 0.01172 kW/sec²

--

**SLIDE 61**
FIRE SCENARIO - #1
(386\textdegree F Vents, 200\textdegree F ESFR)

Sprinklers - Operate
• First sprinkler activated at \(~130\) seconds.

Sprinklers - Operate
• All sprinklers above fire are activated at \(~196\) seconds.
FIRE SCENARIO - #1
(386degF Vents, 200degF ESFR)

Temperature < 60°C
- Temperature Section Cut @ 600-seconds. Tenable throughout compartment (BLACK = 60degF, tenable conditions)

Temperature < 60°C
- Temperature section cut @ 600-seconds
FIRE SCENARIO - #1
(386degF Vents, 200degF ESFR)

Smoke Layer
• Smoke right when the 1st sprinkler activates

Smoke Layer
• As additional sprinklers activate smoke is “dragged” down to the floor due to the high flow sprinklers, thus reducing visibility to below tenable conditions.
FIRE SCENARIO - #1
(386degF Vents, 200degF ESFR)

Visibility < 10 m
• Visibility at ~189-seconds is less than 10m by office areas, north of the racks much less than 10m but employees at this location are intimately familiar with the fire. Running out to 600-seconds visibility is less than 1-m.

CO Concentration < 1,000-ppm
• At 600-seconds CO concentration is less than 300-ppm throughout. Tenability limit is 1,000-ppm.
FIRE SCENARIO - #1 - CONTINUED

Results

- Driving factor in tenability is smoke generation/visibility. CO levels are not exceeded just visibility so even though visibility is exceeded since CO levels are not it is anticipated egress travel speeds may reduce but workers will be able to exit the facility.

- Smoke Heat/Vents are spread equally throughout space, may should have concentrated more heavily above rack storage where highest fuel load is located to relief heat/smoke locally and considered as Option 2 (more strict/dense) per BLDG code on density of vents.

- Facility is within 5-minute response time of fire department, visibility is exceeded but not CO so it deemed tenability is attainable. In the event of a fire the overhead doors could be open to ventilate the fire and keep the smoke layer above occupant level and visibility limits.

<table>
<thead>
<tr>
<th>Fire Scenario</th>
<th>Description</th>
<th>RSET - sec (min)</th>
<th>TEMPERATURE (60degC)</th>
<th>VISIBILITY (10 m)</th>
<th>CO - PPM (1,000 ppm)</th>
<th>HEAT FLUX (2.5 kW/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire #1</td>
<td>288 degF Smoke Vents, Sprinklers</td>
<td>581 (9.88)</td>
<td>GOOD²</td>
<td>“189” (9.3)³</td>
<td>GOOD² (100-ppm, limit = 1000-ppm)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

1. Used higher value of HAND CALC and PATHFINDER.
2. Evaluated at 10min (600sec) run time for FDs.
3. 10m visibility not met but CO concentration not exceeded.
FIRE SCENARIO - #2

Office Fire

- Christmas tree fire in the lobby with doors open to office area. HRR = 3-MW.
- Light Hazard sprinkler coverage, K=5.6, RTI=100
FIRE SCENARIO - #2 - CONTINUED

**TEMPERATURE**

Temperature > 60°C
- In less than 20-seconds tenable temperatures are exceeded at receptionist desk.
- Radiant heat flux limit of 2.5 kW/m² is experienced at ~40-seconds. Time was determined from CSV export file from FDS from Heat Flux gauge at receptionist located 6-ft AFF.

**VISIBILITY**

Visibility < 10-m
- In less than 20-seconds tenable visibility is exceeded at receptionist desk.
FIRE SCENARIO - #2 - CONTINUED

Visibility < 10-m
- Entire compartment visibility is below tenable levels ~2-mins into fire.
- Running fire out to 600-s (10-min) CO tenability levels were not exceeded (250-ppm vs. 1,000-ppm tenability)

Sprinklers Operating
- First sprinkler operates at ~40 seconds.
Visibility < 10-m
• Visibility at ~2mins is less than 10m tenability criteria and at the lower end of 3m for small spaces with employees who are familiar with the space

Temperature > 60°C
• Temperature at ~2-1/2 mins is greater than 60degF tenability criteria. Simulation was ran for 600-seconds, peak heat in space was 80degF.
**Results**

- With the fire origination in the lobby and the quick growth, the receptionist chance of survival is very low depending on how quickly the fire is perceived and action is taken.
- Tenable limits although slightly exceeded in the large compartment (open cubicle space) with the fire being fuel limited and employees being intimate with the fire the expected egress time should be better than calculated and levels over the tenable limits for the short duration should not deem life threatening.
- Front doors are accessed control so a smoke detector should be installed at these doors interlocked with the fire alarm/door. This was not verified, if in place this should provide a quicker notification of fire.

<table>
<thead>
<tr>
<th>Fire Scenario</th>
<th>Description</th>
<th>RSET - sec (min)</th>
<th>TEMPERATURE (60degC)</th>
<th>VISIBILITY (10-μm)</th>
<th>CO - PPM (1,000-ppm)</th>
<th>HEAT FLUX (2.5-kW/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire #2</td>
<td>Christmas Tree Fire - Lobby - LOBBY</td>
<td>224 (0.74)</td>
<td>&quot;20 (0.35)&quot;</td>
<td>&quot;20 (0.35)&quot;</td>
<td>GOOD (250-ppm, limit = 1,000-ppm)</td>
<td>&quot;40 (0.86)&quot;</td>
</tr>
</tbody>
</table>

1. Used higher value of HAND CALC and PATHFINDER.
2. Evaluated at 10min (600sec) run time for FDs.
3. 10m visibility not met but CO concentration not exceeded.
RECOMMENDATIONS & CONCLUSIONS
RECOMMENDATIONS & CONCLUSIONS

- Install inert gas fire suppression on heating station machine used to unsolder components of circuit boards, periodic internal fires.
- P1.5/P5 Process Receiving Area 101J egress distance is exceeded (H-3) occupancy. Only used for storage of materials ready to be processed (no HPM’s), reclassify as S-2.
- Review dBA rating of notification appliances in all process areas during operation. Testing of fire alarm was done before processes where in operation. Some of the processes the sound power level of the appliances may not be sufficient.