Aircraft Maintenance & Flight Test Hangar

Frederick Tanis
April 11, 2018
Agenda

- Prescriptive Analysis
  - Building Overview
  - Egress Analysis
  - Fire Detection, Alarm and Mass Notification System
  - Smoke Management
  - Fire Suppressions Systems
  - Code Analysis (Structural Design)

- Performance Based Analysis
  - Goals and Performance Criteria
  - Design Fire Scenarios
  - ASET versus RSET
  - Asset Protection

- Conclusions
- Recommendations
Building History

- Built in 1958
- Major expansion in the 1970’s and re-purposed to Manufacturing
- 2010-14 Renovated and returned to Fueled Aircraft Maintenance
Building Overview

Hangar Bay

Hangar Bay Configured for Luncheon

Office Area Today

Office Area 1958
Occupyancy Classification Per NFPA 101

- Hangar is industrial
  - Occasional use as assembly area
- Office area is Mixed
Occupancy Classification Per NFPA 101

Second Floor
Occupancy Classification Per NFPA 101

Third Floor

ROOF AREA

North

<table>
<thead>
<tr>
<th>Business Area</th>
<th>Restrooms</th>
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<tbody>
<tr>
<td>Assembly Classification (Conf Rm &amp; Break Areas)</td>
<td>Elevators</td>
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<tr>
<td>Industrial</td>
<td>Elevator Lobby</td>
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<td>Storage</td>
<td>Exit Corridors Inside</td>
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<tr>
<td>Mechanical rooms</td>
<td>Exit Stairs Inside</td>
</tr>
<tr>
<td>Electrical Rooms</td>
<td>Exit stairs outside</td>
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</tbody>
</table>
Ground Floor Hangar Exits

See next page for exits in this area

North

H1

H2

H3

H4

H5

H6

H7

H8

H9

EXIT Door to Outside
Common Path from rooms 4 & 10-13 do not meet code
Only Exit E6 available due to secure one way doors without going through hangar
Second Floor Exits

All common paths and dead ends meet code for length
Third Floor Exits

All common paths and dead ends meet code for length
## Ground Floor Occupancy

<table>
<thead>
<tr>
<th>Room/Area</th>
<th>Rm #</th>
<th>Size (FT²)</th>
<th>Occupancy Type</th>
<th>Occ Load Factor (ft²/person)</th>
<th>Occupants</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Total Ground Floor</td>
<td></td>
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<tr>
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<td>2015 IBC- Table 1004.1.2 Aircraft Hangars</td>
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<td>1100</td>
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### Ground Floor Exit Capacity

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<th>Exit Dimensions</th>
<th>Exit Capacity</th>
<th>Occupancy</th>
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<tr>
<td></td>
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<td>Door capacity using 0.2 #/in (#/door)</td>
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<td>72</td>
<td>360</td>
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<td>Life support room</td>
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<td>Truck Way to Outside</td>
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<td>Instrumentation Lab</td>
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<td>East Hallway</td>
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<td>Total Occupant Load</td>
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- Assemblies in Hangar do not exceed exit capacity of hangar
- Total building occupancy capacity 1022
# Second Floor Occupancy and Exit Capacity

<table>
<thead>
<tr>
<th>Room/Area</th>
<th>Rm #</th>
<th>Size (FT^2)</th>
<th>Occupancy Type</th>
<th>Occ Load Factor (ft^2/person)</th>
<th>Occupants</th>
<th>Notes</th>
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<td>Break room</td>
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<td>Assembly</td>
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<th>Room/Area</th>
<th>Exit Dimensions</th>
<th>Exit Capacity</th>
<th>Occupancy</th>
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<td></td>
<td>Door Width (inches)</td>
<td>Stair Width (inches)</td>
<td>Stair Exit Width (inches)</td>
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<tr>
<td>North Outside Stairs</td>
<td>36</td>
<td>45</td>
<td>NA</td>
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<td>Center Stairs</td>
<td>36</td>
<td>56</td>
<td>36</td>
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<tr>
<td>South Stairs</td>
<td>36</td>
<td>46</td>
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<td>Exterior Office</td>
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<td>Electrical</td>
<td>72</td>
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</tr>
<tr>
<td>Mechanical rooms</td>
<td>72</td>
<td>45</td>
<td>NA</td>
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**Building Exit Capacity Exceeds Occupancy Load**
### Third Floor Occupancy and Exit Capacity

#### Third Floor

<table>
<thead>
<tr>
<th>Room/Area</th>
<th>Rm #</th>
<th>Size (FT^2)</th>
<th>Occupancy Type</th>
<th>Occ Load Factor (ft^2/person)</th>
<th>Occupants</th>
<th>Notes</th>
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<td>Total for floor</td>
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<td>Computer room</td>
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<td>990</td>
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<td>High Density</td>
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<td>Data processing</td>
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<td>483</td>
<td>Business</td>
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<td>10</td>
<td>High Density</td>
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<td>Computer room</td>
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<td>Business</td>
<td>50</td>
<td>13</td>
<td>High Density</td>
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<td>100</td>
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<td>735</td>
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<td>Conference room</td>
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<td>521</td>
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<td>Conference room</td>
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<td>Assembly</td>
<td>15 net</td>
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<td>37</td>
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**Total Occupants**: 307

#### Third Floor Exit Capacity

<table>
<thead>
<tr>
<th>Exit</th>
<th>Exit Dimensions</th>
<th>Exit Capacity</th>
<th>Occupancy</th>
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<tbody>
<tr>
<td></td>
<td>Door Width (inches)</td>
<td>Stair Width (inches)</td>
<td>Stair Exit Width (inches)</td>
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<tr>
<td>North Outside Stairs</td>
<td>36</td>
<td>45</td>
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<tr>
<td>Center Stairs</td>
<td>36</td>
<td>56</td>
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</tr>
<tr>
<td>South Stairs</td>
<td>36</td>
<td>46</td>
<td>60</td>
</tr>
</tbody>
</table>

**Building Exit Capacity Exceeds Occupancy Load**
Detection, Alarm and Mass Notification System

- Multiple zones and alarm panels due to security requirements
  - Each Secure area has its own FACP
  - All panels report to Main Panel then to Monaco Transceiver
- Alarms report to 24/7 Fire Dispatch and local security station
  - Fire department has <5 minute response time
- Battery Calculations per UFC Requirements
  - UFC: 48 Hour standby capability then 15 minute activation
  - NFPA 72: 24 Hour standby capability then 5 minute activation
Initiating and Detection Devices

- **Pull Stations**
  - Alarm
  - High Expansion Foam Activation

- **Optical Flame detectors**
  - Alarm
  - Activate HEF with Flow switch

- **Water flow Switches**
  - Alarm
  - Hangar
    - Activate HEF with ODF

- **Smoke Detectors**
  - Elevator Lobby and at FACP
  - Recall Elevator

- **Duct Smoke Detectors**
  - Activated Alarm
  - Shuts down ALL AHUs
Optical Flame Detector Coverage & Installation

- Sprectrex SharpEye model 40/40i, Triple IR (IR3)
- Response time: typically 5 seconds
- Detection range: 1 ft² Pan fire JP-5 at 150 ft
Notification Devices

- Office Area & Machine shop
  - Combination Speaker Strobe
  - Ceiling and Wall mounted
  - Clear Strobe for fire Alarm
  - Amber strobe for Alert (MNS)
  - Speaker with voice commands

- Hangar
  - Horns and strobes
  - Ceiling and Wall mounted
  - Clear for fire alarm
  - Blue for Hi Ex Foam Activation

- Exterior of Building
  - Speakers for MNS
Hangar Notification Devices

- Horns and Strobes
- Clear for fire alarm
- Blue for High Expansion Foam Activation
Mass Notification System (MNS)

- Designed Per UFC
- Operator stations near exits
- Preprogramed Announcements
  1. Bomb Threat
  2. Intruder
  3. Take Cover
  4. Hi-Ex Foam Active
  5. Fire
  6. Weather
  7. All Clear
  8. Test
- Microphone
- MNS not in Hangar
  - Poor Acoustics
- 48 Hour Battery test
  - 48 hours stand by
  - 15 minutes announcements
Smoke Control

- HVAC systems shut down when fire alarm activates
- HVAC systems have duct smoke detectors
- Ceiling vent in Hangar
  - Not designed for smoke control
NFPA 13 Hazard Classification (Chapter 5)

Mechanical & Electrical Rooms: Ordinary Hazard Class 1

Covered storage: Ordinary Hazard Class 1

East Side Overhang: Ordinary Hazard Class 1

Machine Shop Building: Ordinary Hazard Class 1

Machine Room: Ordinary Hazard Class 1

Office areas, telecom, data process: Light Hazard

Hangar: Extra Hazard Group 1

Hangar area 200’ x 300’

Fire Pump & foam Building: Ordinary Hazard Class 2
NFPA 13 Hazard Classification (Chapter 5)

Third Floor
- Office and data process areas: Light Hazard
- Mechanical & Electrical Rooms: Ordinary Hazard Class 1

Second Floor
- Office areas: Light Hazard
Density/Area Requirements for Classifications

**FIGURE 11.2.3.1.1 Density/Area Curves.**

Per AF ETL 02-15
Location Of Fire Risers And Area Of Coverage

Water Based Fire systems

12KV substation: No sprinkles

Covered storage: Dry Pipe system Riser 1B

East Side Overhang: Deluge system. Riser 2

Machine Shop Building: Wet Pipe system. Riser 11

Office areas, telecom, data process and building utility rooms, 1st Mezzanine and 2nd Mezzanine: Wet Pipe system. Riser 1A

Fire Pump & foam Building: Wet Pipe System. Riser 10

Hangar: Wet Pipe & High Expansion Foam Systems. Risers 3 to 9

Hangar area 200’ x 300’

Riser location and Number

1

North
Building Fire Risers

Riser 1A & B

Riser 2

Risers 3-7 & 9

Riser 8

Riser 10

Riser 11
Risers 3-7 & 9 Hangar Wet Pipe System

- Designed Per AF ETL 02-25
- 0.2 gpm/ft² over 5000 ft² (ETL 02-15 Section A1.3.1.1.2)
- Quick Response 200°F (ETL 02-15 Section A1.3.2.5)
- K-5.6 Heads
- North End 90ft south end 70ft high
Riser 3-7 & 9 Water Demand

112 psi Static

-95 psi Residual
2700 gpm

Hose Allowance
500 gpm

90 ft End

Total required
1660 gpm

70 ft End

Total required
1660 gpm

Sprinkler Demand
Hydraulic calculations
1160 gpm
High Expansion Foam

- Designed per AF Engineering Technical Letter (ETL) 02-15
- Cover shadow of aircraft in 60 seconds
- Fill hangar 1 meter deep in 4 minutes
- Initiation required both sprinkler flow switch and OFD (IR3)
  - New UFC 4-211-01 (April 2017) requires 2 IR3 detectors (No Flow Switch)

\[
R = ((V/T) + RS) \times CN \times CL
\]

| Area= | 60000 ft^2 |
| Depth= | 3.2 ft |
| V= | 192000 ft^3 |
| T= | 4 min |
| RS=SxQ | |
| S= | 10 ft^3/(min-gpm) |
| Q= | 1200 gpm |
| RS= | 12000 ft^3/min |
| CN= | 1.15 Per AF ETL 02-15 |
| CL= | 3 Per AF ETL 02-15 |
| Rate= | 207000 ft^3/min |
| # Generators= | 12 |
| generator Rate | 17250 ft^3/min/Generator |
| Chemguard model 25000 WP | 19063 CFM at 40 psi |
| Flow Rate | 178 gpm fluid |

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<th>Pressure</th>
<th>CFM</th>
<th>Flow Rate</th>
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<td>240</td>
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<tr>
<td>90</td>
<td>26200</td>
<td>244</td>
</tr>
<tr>
<td>95</td>
<td>25800</td>
<td>248</td>
</tr>
<tr>
<td>100</td>
<td>25300</td>
<td>252</td>
</tr>
</tbody>
</table>
High Expansion Foam Water Supply

Actual Conditions
277,000 CFM of HEF
Fill Hangar 1 m deep < 2 min
High Expansion Foam Activation
2015 IBC

Hangar:
- 60,000 ft²
- 90 ft tall (70 ft at low end)
- S-1 Occupancy Per Section 311.2
- **Hangar required to be IB Construction**
  - Height over 75 ft

Office area:
- Total Area 28,100 ft²
- 3 stories 70 ft to Office roof
- B Occupancy per Section 304
- **Office Required to be IIB Construction**
# 2015 IBC requirements for Type IB Construction

## TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

<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>Primary structural frame(^1) (see Section 202)</td>
<td>3(^a)</td>
<td>2(^a)</td>
<td>1 0</td>
<td>1 0</td>
<td>HT</td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>3</td>
<td>2(^b)</td>
<td>1 0</td>
<td>2 2</td>
<td>2</td>
</tr>
<tr>
<td>Interior</td>
<td>3(^a)</td>
<td>2(^a)</td>
<td>1 0</td>
<td>1 0</td>
<td>1(^d)</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></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior</td>
<td>0</td>
<td>0</td>
<td>0 0</td>
<td>0 0</td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior(^d)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor construction and associated secondary members</td>
<td>2</td>
<td>2(^b)</td>
<td>1 0</td>
<td>1 0</td>
<td>HT</td>
</tr>
<tr>
<td>(see Section 202)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof construction and associated secondary members</td>
<td>1 (1/2)(^b)</td>
<td>1(^b), (c)</td>
<td>1(^b), (c)</td>
<td>0(^c)</td>
<td>HT</td>
</tr>
<tr>
<td>(see Section 202)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For SI: 1 foot = 304.8 mm,

---

\(^a\) Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

\(^b\) Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

\(^c\) In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

\(^d\) Not less than the fire-resistance rating required by other sections of this code.

\(^e\) Not less than the fire-resistance rating based on fire separation distance (see Table 602).

\(^f\) Not less than the fire-resistance rating as referenced in Section 704.10.
Wall Requirements

- The wall separating the office area and the hangar is required to be a 3 hour rated wall per IBC Table 706.4 for the office and hangar to be considered separate buildings.
- Exit stairs and halls require 1 hour rating.
- Building meets or exceeds these requirements.
Performance Analysis

- Goals & Objectives
  - Minimize injury and loss of life
  - Minimize damage to aircraft assets
- Define fire scenarios
- Determine RSET
  - Egress analysis using Hand calculations and Pathfinder
- Determine ASET
  - FDS Modeling fire scenarios
  - Tenability conditions for life safety
  - Temperature and thermal radiation on aircraft
- Verify that ASET > RSET
- Verify Aircraft does not get damaged
Fire Scenarios

- Fire Scenario 1: Large fuel pool fire in hangar (Greatest Risk)
  - JP-5 fuel spill (200+ gallons) and ignition
  - Most likely aircraft suffers major damage
  - Secondary fires likely

- Fire Scenario 2: Small fuel pool fire in hangar (Most Likely)
  - JP-5 fuel spill and ignition
  - Aircraft could survive fire
  - Sprinkler activation questionable due to height of hangar

- Fire Scenario 3: Fire in office store room
  - Allowed to grow un-observed
  - Sprinkler controlled

- Fire Scenario 4: Fire in hangar during assembly
  - Fuel consists of tables, chairs, wood stage, paper products, etc.
Relationship between ASET and RSET

ASET

RSET

\( \Delta t_{\text{esc}} \)

Escape Time

Evacuation Time

\( \Delta t_{\text{evac}} \)

Pre-Movement Time

\( \Delta t_{\text{pre}} \)

Recognition Time

Response Time

\( \Delta t_{\text{trav}} \)

Travel Time

\( \Delta t_{a} \)

\( \Delta t_{\text{det}} \)

\( \Delta t_{\text{evac}} \)

\( \Delta t_{\text{pre}} \)

\( \Delta t_{\text{trav}} \)

Determined from fire models

Determined from occupant characteristics and historical data

Determined from Egress models

Determined from fire and alarm system models

Safety Margin

Evacuation Complete

Tenability Limit

Time

Ignition  Detection  Alarm

Determined from fire and alarm system models

Determined from occupant characteristics and historical data

Determined from Egress models
Egress Analysis for Hangar

- **Hand Calculations**
  - 120 people in Hangar
  - Max travel 150 ft (1/2 length)
  - 8 Exits
  - ~60 Sec to evacuate Hangar

- **Pathfinder Analysis**
  - Filled hangar with 120 people
  - Filled Office to Max capacity based on Occupancy Loads for each room
  - 50 Sec to evacuate Hangar
  - 280 Sec to evacuate entire building

### Hangar floor

<table>
<thead>
<tr>
<th>Length</th>
<th>300 Feet</th>
<th>Table 4.2.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>200 feet</td>
<td>Table 4.2.6</td>
</tr>
<tr>
<td>Area</td>
<td>60000 ft^2</td>
<td></td>
</tr>
<tr>
<td># Occupants</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>0.002 people/ft^2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>K</th>
<th>275</th>
<th>From Table 4.2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.86</td>
<td>From Equ 1</td>
</tr>
<tr>
<td>D</td>
<td>0.002</td>
<td>Actual Density</td>
</tr>
<tr>
<td>Speed</td>
<td>273.427 ft/min</td>
<td>Equation 1</td>
</tr>
</tbody>
</table>

- Longest distance to a exit: 150 feet (1/2 the length)
- Time to reach exit: 0.5 Min

### Initial Rate out the door

<table>
<thead>
<tr>
<th>Initial Rate out the door</th>
<th>1.093708 People/min/exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 # Exits</td>
<td>8.749664 People/ min</td>
</tr>
<tr>
<td>120 # Occupants</td>
<td></td>
</tr>
</tbody>
</table>

- Time to exit at initial rate: 13.71481 Min

Cueing will start at the exit and the rate will increase until the maximum rate is achieved. Use Fs Max to estimate time to exit hangar.

<table>
<thead>
<tr>
<th>Fs Max</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>flow</td>
<td>48 people/ min/ per exit</td>
</tr>
<tr>
<td>8 # Exits</td>
<td>384 People/ min</td>
</tr>
<tr>
<td>120 # Occupants</td>
<td></td>
</tr>
</tbody>
</table>

- Time to exit: 0.3125 Min

**Total time** = Time to reach exit + time to exit

<table>
<thead>
<tr>
<th>Total Time</th>
<th>0.9 min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>52 Sec</td>
</tr>
</tbody>
</table>
Start Hangar Evacuation T=0
Hangar Evacuation T=30 Seconds

Exited: 81/771
Hangar Evacuation Complete
Office Area Evacuation T=0 Seconds
Office Area Evacuation T=30 seconds
Office Area Evacuation T=120 Seconds
Evacuation Complete
Detection Time: IR3 detectors detect fire in 10 Seconds
Alarm Time: 10 seconds to activate alarms
Pre-movement time: up to 180 Seconds
Movement time: 60 seconds
Total 260 Seconds
20% Safety Factor (52 Seconds)
RSET = 312 seconds for hangar
Hangar ASET and Asset Evaluation Criteria

- **Tenability Requirements**
  - Visibility: greater than 30 feet (Ref: SFPE Handbook Chapter 61)
  - CO less than 750 ppm or $0.75 \times 10^{-4}$ kg/kg.
    - SFPE Handbook. 30,000 ppm-min
    - 20 exposure and 1,500 ppm 2x safety margin = 750 ppm
  - Temperature < 110 °C (Ref: SFPE Handbook Table 63.17)

- **Asset Protection**
  - Model skin as 0.125” aluminum 6061-T6 alloys
    - In FDS back side “Exposed’
  - Property degradation starts at 150 °C *
  - 50% loss in yield strength at 275 °C *
  - 6061 Aluminum Melts at 585 °C
  - Material property dependent on Aluminum alloy
  - Skin should not exceed 150 °C to be safe and not have damage

* Ref: Summers et al Fire Science Reviews (2015) 4:3
JP-5 Flame Spread Rate and HRR

- JP-5 fuel spill
- Pool 0.34 cm deep
  - Based on surface tension of JP-5 (Ref 1)
  - Assume floor level
- Flame spread rate based on liquid phase flame spread (Ref 2)
  - 4.5 cm/s
- HRRPUA = 2043 kW/m² (Ref 3)

References:
1) Handbook of Aviation Fuel Properties, CRC Report #530
3) NFPA 72
FDS Model

- Multiple mesh
- Hangar with doors open 3m
- Aircraft with approximate 767 dimensions
- Sprinklers in lower level
- Smoke curtains
- Fire in open and under wing
8 Gallon JP-5 Pool Fire Under Wing (3m x 3m)

- 67 seconds to fully developed
- Ran fire in FDS for 200 seconds
- Max HRR 18.5 MW
- Tenability conditions were never exceeded except in vicinity of fire
- Aircraft skin greater 150°C
  - Max skin °C
- Fuel consumed in about 85 seconds
  - 8 Gallons = 24 kg
- Sprinkler activation at 98 seconds
- Fire burns out prior to High Expansion Foam activation
Visibility >10 m except in the vicinity of fire

CO concentration less than 750 ppm

Temperature < 110 °C except in the vicinity of fire

ASET essentially infinite since fire burns out and conditions start to improve

RSET was determined to be 312 Seconds

ASET is greater than RSET
Aircraft greater than 150°C thus damage to aircraft
- Max skin temperature >1000°C
- Portions of Wing melted
- Portion of fuselage also > 150°C thus damaged
- Significant damage to aircraft skin and internal structure

8.0 Gallon JP-5 Pool Fire (3m x 3m) Under Wing

![Diagram showing temperature distribution with color scale indicating Melt 585°C, 150°C, and 1120°C.]

---

**CAL Poly**

Fire Protection Engineering
8 Gallon JP-5 Pool Fire Under Wing Sprinkler Activation

- Sprinkler system activation required for high Expansion foam activation
- Sprinklers activate at 98 seconds around time fire burns out
- Sprinkler system would cool aircraft

T=55 seconds

T=98 seconds
3.6 Gallon JP-5 Pool Fire (2m x 2m)

- 45 seconds to fully developed
- Max HRR 8.4 MW
- No sprinkler activation
- Tenability conditions were not exceeded
- Aircraft skin greater than 150°C
  - Max skin temperature >700°C
  - Portions of Wing Skin melted

Melt 585°C
150°C
8.0 Gallon JP-5 Pool Fire Forward of Wing

- Fire 3.5 m forward of wing
- Fire symmetrical and heat reaches ceiling quickly
- 64 Seconds Sprinklers activate
- 90 seconds significant spray
- Wing starts to cool from Sprinklers
- Leading Edge of Wing damaged
- No Melting
High Expansion Foam Activation Sequence

- T=0 : Fire occurs
- T=10 : OFD detects fire and activates alarm
- T=98 : Sprinklers activate
- T= 148 : Flow Switch activates (50 sec delay timer)
- T= 158 : Hi Ex Foam suppression system activates (10 sec delay)
- T= 188 : Foam exits first generator (30 sec from activation test)
- T= 228 : Foam covers silhouette of aircraft (~80% of floor 40 sec)
- T= 300 : Floor 1 meter deep in foam Fire Suppressed

- Manual activation of HEF system faster option

would allow HEF on the fire in 40 sec with OFD only activation. Save ~140 seconds in this scenario

UFC 4-211-01 Dated 13 April 2017 - HEF activation by dual IR3 optical sensors
Conclusions

- Building meets most of the prescriptive code requirements
  - Few areas need changes to meet code
- Performance modeling of hangar showed that ASET was Greater than RSET
- Asset protection is hard to accomplish if the fire is in the vicinity of the asset
Reconfigure the doors on the ground floor to meet the common path travel requirements

Add additional door to conference room on third floor

Add additional Strobes in Hangar area for better coverage
  ◦ Add rotating beacon per UFC 4-211-01 Dated 13 April 2017

Activate the High Expansion Foam from Optical Flame detectors
  ◦ Add additional Optical Flame detectors (OFDs) for better dual coverage
Questions