ROBERT E. KENNEDY LIBRARY
CAL POLY, SAN LUIS OBISPO
FIRE PROTECTION ANALYSIS
FPE CULMINATING PROJECT

Prepared For:

Dr. Frederick W. Mowrer &
Dr. Christopher Pascual
California Polytechnic State University
College of Engineering
Fire Protection Engineering Programs
1 Grand Avenue
San Luis Obispo, California

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# TABLE OF CONTENTS

TABLE OF CONTENTS ........................................................................................................... i  
LIST OF TABLES ................................................................................................................... v  
LIST OF FIGURES ............................................................................................................... vi  
EXECUTIVE SUMMARY ...................................................................................................... 1  
INTRODUCTION ................................................................................................................... 2  
APPLICABLE CODES .......................................................................................................... 3  
STRUCTURAL FIRE PROTECTION ..................................................................................... 4  
  OCCUPANCY ................................................................................................................... 4  
  TYPE OF CONSTRUCTION ............................................................................................... 4  
  FIRE SEPARATION DISTANCE AND FIRE RESISTANCE OF EXTERIOR WALLS.. 5  
CONCRETE ASSEMBLIES ................................................................................................. 6  
STEEL ASSEMBLIES .......................................................................................................... 6  
OPENING PROTECTIVES .................................................................................................... 8  
ALLOWABLE BUILDING AREA ........................................................................................... 9  
MIXED-OCCUPANCY SEPARATION .................................................................................. 9  
WATER-BASED FIRE SUPPRESSION SYSTEMS ............................................................ 10  
  AUTOMATIC SPRINKLER SYSTEM ............................................................................... 10  
  STANDPIPE SYSTEM ..................................................................................................... 11  
FIRE DETECTION, ALARM, AND COMMUNICATION ..................................................... 12  
  TYPE OF FIRE ALARM SYSTEM .................................................................................. 12  
  FIRE ALARM CONTROL PANEL (FACP) ..................................................................... 13  
  REMONTE ANNUNCIATOR ............................................................................................. 13  
  FAULT ISOLATOR MODULE .......................................................................................... 13  
INITIATING DEVICES ....................................................................................................... 14  
  SMOKE DETECTORS ..................................................................................................... 14  
  SMOKE DETECTOR LOCATION ..................................................................................... 14  
  SLIDING FIRE DOOR SMOKE-DETECTORS ................................................................. 15  
  FIRE DOOR SMOKE-DETECTORS .............................................................................. 15  
  DUCT SMOKE DETECTORS ......................................................................................... 15
PULL-STATIONS LOCATION .......................................................... 16
SPACING ............................................................................... 16
WATER FLOW SWITCH ............................................................ 16
NOTIFICATION DEVICES ......................................................... 16
HORN AND LIGHT PLATE/STROBE ....................................... 16
SECONDARY POWER SUPPLY .................................................. 17
DISPOSITION OF ALARM, SUPERVISORY AND TROUBLE SIGNALS ........................................................................... 19
ALARM ................................................................................ 19
SUPERVISORY .................................................................. 19
TROUBLE SIGNALS ............................................................ 19
INSPECTION TEST AND MAINTENANCE .................................. 19
CONCLUSION ...................................................................... 20
EGRESS ............................................................................... 20
OCCUPANT LOADS ............................................................... 20
EGRESS WIDTH .................................................................. 21
WIDTH OF EXIT ENCLOSURE DOORS IN STAIRWELL #2 AND #3 .................................................................................. 22
STAIRWAY TREADS AND RISER ............................................. 22
EXIT SIGNS ......................................................................... 22
EGRESS THROUGH INTERVENCING SPACES .............................. 22
COMMON PATH OF EGRESS TRAVEL .................................... 23
EXIT ACCESS TRAVEL DISTANCE .......................................... 23
NUMBER OF EXITS OR EXIT ACCESS DOORWAYS ................... 24
DOOR SWING ........................................................................ 24
EGRESS SEPARATION ............................................................ 25
VERTICAL EXIT ENCLOSURE .................................................. 25
EXIT PASSAGEWAY .............................................................. 25
WIDTH OF BOOK STACK AISLES ........................................... 28
INTERIOR FINISHES .............................................................. 28
WALL AND CEILING FINISHES ............................................. 28
FLOOR FINISH REQUIREMENTS ............................................. 29
ELEVATOR OPENING PROTECTION ................................................................. 29
PERFORMANCE-BASED ANALYSIS ......................................................... 30
MODELING ANALYSIS ............................................................................. 30
TENABILITY APPROACH .......................................................................... 30
  PERFORMANCE OBJECTIVES ............................................................... 31
  TENABILITY ............................................................................................. 31
    VISIBILITY ............................................................................................ 31
    TEMPERATURE ...................................................................................... 32
    TOXICITY ............................................................................................. 32
FIRE SCENARIO ....................................................................................... 33
SCENARIO-ARSON FIRE .......................................................................... 33
COMBUSTION PROPERTIES OF BOOKS .................................................. 34
FIRE GROWTH .......................................................................................... 35
  NON-SPRINKLERED FIRE GROWTH ...................................................... 36
  SPRINKLERED BUILDING FIRE GROWTH ............................................. 38
    LOCATION AND SPACING OF SPRINKLERS ......................................... 38
    SPRINKLER ACTIVATION TIME .......................................................... 39
MODEL LIMITATIONS AND ASSUMPTIONS .............................................. 41
TENABILITY RESULTS .............................................................................. 41
  UNSPRINKLERED BUILDING – EXISTING CONDITION ............................. 42
    VISIBILITY ............................................................................................ 42
    TEMPERATURE ...................................................................................... 42
    TOXICITY- CO CONCENTRATION ......................................................... 43
  SPRINKLERED BUILDING ....................................................................... 43
    VISIBILITY ............................................................................................ 43
    TEMPERATURE ...................................................................................... 43
    TOXICITY ............................................................................................. 43
FEASIBILITY OF PROVIDING SPRINKLERS ............................................. 43
PERFORMANCE-BASED EGRESS ANALYSIS .............................................. 45
  PRE-MOVEMENT ACTIVITIES AND TIMES BASED ON OCCUPANT
CHARACTERISTICS............................................................................................................. 45

ESTIMATED TOTAL EVACUATION TIME- HAND CALCULATION METHOD........ 46

HYDRAULIC METHOD .................................................................................................... 46

PAUL’S EMPIRICAL EQUATIONS .................................................................................. 47

DESIGN CONSTRAINTS ................................................................................................... 48

COMPUTER-BASED EVACUATION TIME....................................................................... 48

DESIGN CONSTRAINTS ................................................................................................... 48

ASSUMPTIONS OF ANALYSIS ......................................................................................... 48

RESULTS OF COMPUTER-BASED EVACUATION TIME.............................................. 49

COMPARISON TO HAND CALCULATIONS ................................................................. 49

MODEL LIMITATIONS .................................................................................................... 50

SUMMARY OF TOTAL EVACUATION TIME ................................................................. 50

REQUIRED SAFE EGRESS TIME (RSET)........................................................................ 51

RSET IN ANALYSIS ......................................................................................................... 51

AVAILABLE SAFE EGRESS TIME (ASET) ...................................................................... 52

RSET VS ASET .................................................................................................................. 52

NON-CONFORMING CONDITIONS ............................................................................... 53

RECOMMENDATIONS ..................................................................................................... 54

SPRINKLER INSTALLATION ............................................................................................ 54

VISIBLE AND AUDIBLE NOTIFICATION APPLIANCES ........................................... 54

EMERGENCY VOICE/ALARM COMMUNICATION SYSTEM ........................................ 54

FIRE LIFE SAFETY PLAN ............................................................................................... 54

APPENDIX A- STRUCTURAL FIRE PROTECTION ......................................................... 56

APPENDIX B- WATER-BASED SUPPRESSION SYSTEMS ........................................... 58

APPENDIX C- FIRE ALARM, DETECTION AND COMMUNICATION ............................ 82

APPENDIX D- EGRESS ANALYSIS .............................................................................. 90

APPENDIX E- PERFORMANCE-BASED DESIGN .......................................................... 114

EGRESS HAND CALCULATIONS ................................................................................... 141

HYDRAULIC METHOD AND PAUL’S EMPIRICAL METHOD ....................................... 141

APPENDIX G- FIRE LIFE SAFETY PLAN .................................................................... 145
LIST OF TABLES

Table 1: Fire-resistance rating of structural elements .......................................................... 4
Table 2: Exterior wall fire resistance rating based on fire separation distance .................. 6
Table 3: SFRM thickness required for structural beams ......................................................... 8
Table 4: Allowable building area .......................................................................................... 9
Table 5: Secondary power battery capacity calculation ....................................................... 18
Table 6: Occupant load factors based on use of space ......................................................... 21
Table 7: Common path of egress travel maximums ............................................................... 23
Table 8: Exit access travel distance based on occupancy of a nonsprinklered building 23
Table 9: Number of exits provided per floor ....................................................................... 24
Table 10: Exit separation distance per floor ....................................................................... 25
Table 11: Occupant load and capacity of exit components of the exit extension ........ 27
Table 12: Flame spread index in selected spaces of a building ............................................ 28
Table 13: Tenability limit summary ....................................................................................... 33
Table 14: Quantity of byproducts of combustion and heat of combustion of paper ......... 35
Table 15: Estimated sprinkler activation parameters ........................................................... 39
Table 16: Tenability Results* ............................................................................................... 42
Table 17: Summary of total evacuation times for Hydraulic Method, Paul's Empirical Method, and Pathfinder ............................................................... 50
Table 18: Egress phase times ............................................................................................... 52
LIST OF FIGURES

Figure 1: Fire separation distance ................................................................. 5
Figure 2: Fire alarm evacuation temporal scheme ........................................... 17
Figure 3: Exit extension on second floor ......................................................... 28
Figure 4: Second floor fire location ............................................................... 34
Figure 5: Open shelf configuration HRR test (Walton and Budnick, NIST, 1988) .... 35
Figure 6: Configuration of open book shelves in Kennedy Library .................. 36
Figure 7: Experimental HRR of Book Shelves ................................................ 37
Figure 8: Experimental and Model analysis HRR ............................................. 38
Figure 9: Estimated time to sprinkler activation ............................................ 40
Figure 10: HRR curves for non-sprinklered and sprinklered conditions .......... 41
Figure 11: FDS Heat Release Rate of an non-sprinklered and sprinklered building. 44
Figure 12: FDS calculated time to sprinkler activation ................................. 45
Figure 13: Pathfinder results .......................................................................... 49
Figure 14: Sequence of occupant response to fires (Proulx, SFPE Handbook, 3rd Edition, Table 3-13.3) ............................................................. 51
Figure 15: Comparison between RSET and ASET for the non-sprinkler Library building ................................................................. 52
Figure 16: Comparison between RSET and ASET for the sprinkler Library building .... 53
EXECUTIVE SUMMARY

California State University has acquired fire protection services to conduct a survey of and produce a fire protection report that analyzes the current condition of the existing Robert E. Kennedy Library on the Cal Poly campus. The prescriptive analysis of the Library is based on the 2010 California Building Code - the analysis considers the building a new building and will not consider the building provision for existing buildings as permitted by Chapter 34 of the CBC. A performance-based design using FDS is also analyzed to determine the tenability advantages of providing fire sprinklers within the Library.

Non-conforming conditions include, among others, exit extension has non-common use areas opening into the exit extension (i.e., electrical room), and visible/audible notification coverage deficiencies.

The performance-based design fire is based on a “free burn” test conducted using oxygen consumption calorimetry. The tested material included parallel metal open bookshelves with paper material stacked on their shelves. The data from the test produced maximum heat release rate of 1.6 MW. This data was extrapolated to define a fire scenario that produced a 6.2 MW heat release rate based on the configuration of bookshelves and the plentiful amount of fuel (i.e., paper) in the Library stack areas.

Based on the time to sprinkler activation, a sprinkler controlled fire is also modeled to compare to the non-sprinklered building condition. It was determined that a 1.1 MW fire was the maximum heat release rate of a sprinklered controlled fire.

From the performance-based model it was determined that a sprinklered building improves the tenability conditions and increases the Available Safe Egress Time for the occupants in the building.

All in all, it is recommended that the Library be provided with a sprinkler system. It is also recommended that the Library be provided with visual/audible notification appliances in accordance with NFPA 72. It is also recommended that an EVAC system be provided as required by the CBC. Additional recommendations are described within this report.

The appendix of this fire protection report includes a proposed sprinkler design for the Library, a fire life safety plan, and a design for the audible/visible notification appliances of the second floor (fire floor).
INTRODUCTION

The Trustees of the California State University (Client) have retained Fire Protection Engineering Services to conduct an engineering survey and complete a fire protection report of the fire protection systems of the Robert E. Kennedy Library on the California Polytechnic State University campus in San Luis Obispo, California. The report will analyze the current conditions of the fire protection systems based on the prescriptive requirements of the 2010 California Building Code and referenced NFPA documents. The fire protection systems that are analyzed in the report include structural fire protection, water-based fire suppression systems, fire alarm and communication systems, and egress systems.

The Client has also requested that a feasibility study be conducted to determine if providing fire sprinklers throughout the Library would improve life safety in the event of a fire. As such, a performance-based analysis is conducted to demonstrate how fire sprinklers influence the tenability within the Library during a fire event.

The Kennedy Library is a five story building located on the west side of the University campus. The original code of construction for the Library is the 1976 Uniform Building Code (UBC). The first floor of the Library contains offices, computer rooms, and study areas. The second floor contains a lounge area and study areas. Floors three through five contain book stacks, offices, and study areas. There is an outdoor courtyard in the center of the building; access to the courtyard is provided via the first floor. Fire Protection Services understands that portions of the second floor have been remodeled to include additional classrooms and computer labs. As part of the remodel, the fire alarm devices in the area of the remodel have been added and/or updated with new horn/strobe appliances.
APPLICABLE CODES

This general fire protection requirements for the Kennedy Library are based on the requirements of the State of California as follows:


Mechanical Code: 2010 California Mechanical Code (Part 4 of CCR Title 24), which is based on 2009 Uniform Mechanical Code published by International Association of Plumbing and Mechanical Officials (IAPMO).

Plumbing Code: 2010 California Plumbing Code (Part 5 of CCR Title 24), which is based on 2009 Uniform Plumbing Code published by International Association of Plumbing and Mechanical Officials.

Energy Code: 2010 California Energy Code (Part 6 of Title 24)


National Fire Protection Association (NFPA) standards, as referenced by the CBC and the local fire department.
STRUCTURAL FIRE PROTECTION

OCCUPANCY

The Robert E. Kennedy Library (Building 35) is a mixed-use assembly occupancy (Group A) with accessory business and storage occupancies (Group B and S-2).

Group A-3 occupancies include the book stack and reading areas of the Library and Group B occupancies that contain 50 or more occupants. The Group B occupancy areas include office spaces and classrooms. Group S-2 occupancies include general storage areas, electrical/mechanical rooms.

TYPE OF CONSTRUCTION

Based on the original certificate of occupancy the Kennedy Library is of Type I Fire-Resistive (Type I-FR) construction, based on the 1976 UBC. Type I-FR construction requires more stringent fire-resistance ratings for structural elements and fire-protection ratings for openings of the building than the most stringent construction type in the 2010 CBC. As such, the Library analysis is based on Type I-A construction, the most stringent type of construction in Table 601 of the 2010 CBC.

It should be noted that the Library is permitted to be considered a Type I-B construction building under the 2010 CBC. Group A-3 occupancies with a Type I-B construction is permitted to have a maximum building height of 160 feet, a maximum of 11 stories, and unlimited area per floor level per Table 501. Although the height and floor areas of the Library are less than the maximums permitted by Table 501, the building is considered a Type I-A construction building in this analysis to take advantage of the non-separated, mixed use and occupancy approach of Section 508.3 (discussed below).

The following table shows the fire-resistance rating requirements for the building elements as prescribed by Table 601 and the existing fire-resistance rating provided for the structural elements:

<table>
<thead>
<tr>
<th>Structural Element</th>
<th>Fire Resistance Rating (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type I-A</td>
</tr>
<tr>
<td>Structural Frame</td>
<td>3</td>
</tr>
<tr>
<td>Bearing Walls</td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td>3</td>
</tr>
<tr>
<td>Interior</td>
<td>3</td>
</tr>
<tr>
<td>Exterior Non-Bearing Walls and Partitions</td>
<td>Depends on fire separation distance</td>
</tr>
<tr>
<td>Interior Non-bearing Walls and Partitions</td>
<td>0*</td>
</tr>
<tr>
<td>Floor Construction</td>
<td>2</td>
</tr>
<tr>
<td>Roof Construction</td>
<td>1 ½</td>
</tr>
</tbody>
</table>

* But not less than the requirements of other sections of the Code
FIRE SEPARATION DISTANCE AND FIRE RESISTANCE OF EXTERIOR WALLS

The fire separation distance is the distance measured from the building face to one of the following: the closest interior lot line; to the centerline of a street or public way; to an imaginary line between two buildings on the property (Section 702.1).

The fire separation distance of the west, north, and east exterior walls of the Library are measured to the centerline of a road; the fire separation distance of the south exterior wall is measured to an imaginary lot line half-way between the Library’s south wall and the north wall of the neighboring building-Dexter Building (Building 34). Figure 1 below illustrates the fire separation distance measured from the face of building to their corresponding measurement limits.

![Map of the area surrounding the Library and Dexter Building](image)

Figure 1: Fire separation distance

Table 602 permits exterior walls with a fire separation distance greater than or equal to 30 feet to have no fire-resistance rating. The Library’s exterior walls are non-load bearing therefore they are permitted to have fire-resistance ratings based on fire separation distance only.

The following table shows the fire separation distance of each exterior wall of the Library and the fire-resistance rating required based on fire separation distance per Table 602:
Table 2: Exterior wall fire resistance rating based on fire separation distance

<table>
<thead>
<tr>
<th>Exterior Wall</th>
<th>Fire Separation Distance (feet)</th>
<th>Fire Separation Measured to:</th>
<th>Fire-Resistance Rating Required (Hours)**^</th>
</tr>
</thead>
<tbody>
<tr>
<td>North (Facing N. Perimeter Road)</td>
<td>41</td>
<td>Center of N. Perimeter Road</td>
<td>0</td>
</tr>
<tr>
<td>South (Facing Dexter Building [34])</td>
<td>36</td>
<td>Interior lot line**</td>
<td>0</td>
</tr>
<tr>
<td>East (Facing University Drive)</td>
<td>126</td>
<td>Center of University Drive</td>
<td>0</td>
</tr>
<tr>
<td>West (Facing Dexter Road)</td>
<td>41</td>
<td>Center of Dexter Road</td>
<td>0</td>
</tr>
</tbody>
</table>

*Per Table 602 of 2010 CBC
**Interior lot line located half-way between the south wall of Kennedy Library and Dexter Building.
^ Fire-resistance rating for non-bearing exterior walls or partitions; exterior bearing walls require 3-hour fire-resistance rating based on Table 601.

CONCRETE ASSEMBLIES

The fire-resistance ratings of the structural elements within the Library are determined based on the prescriptive requirements of Section 721. Table 721.2.4 requires a column thickness of 12 inches to achieve a fire-resistance rating of three hours as required by Table 601 for a Type I-A construction building. The thickness is based on a siliceous concrete mixture with a compressive strength of less than 12,000 pounds per square inch. The concrete columns in the library have dimensions of 18 inches by 18 inches. The library columns exceed the thickness required to achieve a three hour fire-resistance rating per Section 721.2.4; the column have a fire-resistance rating of at least three-hours.

Section 721.2.4.2 also requires that the minimum thickness of concrete cover to the reinforcement in columns shall not be less than one-inch times the number of hours of fire resistance required or a maximum of two inches, whichever is less. The columns in the Library require a fire-resistance rating of three hours based on Table 601 for a Type I-A construction. The minimum reinforcement required is two inches. The reinforcements of the columns in the library have a three inch concrete cover; reinforcement coverage exceeds the minimum required by Section 721.2.4.2.

The minimum thickness of cast-in-place or precast concrete wall – load bearing or nonload bearing- is determined by Table 721.2.1.1. Table 601 requires exterior and interior load bearing walls of a Type I-A construction building to have a minimum of three hour fire-resistance rating. Walls forming shafts and stair enclosures are required...
to have a fire-resistance rating of two hours. The minimum thickness of a concrete slab
for a wall or partition to achieve a three hour fire-resistance rating is 6.2 inches (from
one face of the wall to the other), per Table 721.2.1.1. The same table requires a wall
thickness of five inches to achieve a two hour fire-resistance for walls or partitions.

All concrete walls or partitions in the library have a minimum thickness of eight inches.
The concrete walls have a fire-resistance rating of at least three hours, which satisfy the
fire-resistance rating requirements of walls in Table 601

**STEEL ASSEMBLIES**

The roof assemblies of the Library are constructed of structural steel beams and girders
supporting concrete slab. The fire-resistance rating of steel beams and girders is based
on the size of the element and the protection provided by the spray-applied fire-resistant
material (SFRM), as permitted by Section 721.5.2.1.

Section 721.5.2.1 establishes the basis for determining the fire-resistance-rating of
structural beams and girders which differ in size from that specified in the approved
Underwriter’s Laboratory (UL) assembly. The fire-resistance rating is a function of the
thickness of the SFRM, weight and heated perimeter of the beam or girder. Section
721.5.2.1.2 permits the substitution of a beam in a specified UL assembly provided that
the weight-to-heated perimeter ratio (W/D) of the substitute beam is equal to or greater
than that of the beam specified in the approved UL assembly. Section 721.5.2.2.1 also
requires that the weight-to-heated perimeter ratio of the substituted beam or girder is
not less than 0.37, the thickness of the SFRM of the substituted beam is not less than
3/8 inch, and the unrestrained or restrained beam fire-resistance rating is not less than
one-hour. The thickness of the SFRM on the substituted beam or girder shall be
determined using Equation 7-17 of the CBC.

Documentation of the SFRM thicknesses provided to the roof assembly beams and
girders in the Library was not available and therefore this report will determine the
required SFRM thicknesses to achieve a one-and-a-half hour fire-resistance rating as
required by Table 601. The SFRM thickness provided on the roof assemblies of the
Library should be verified to have the minimum SFRM thickness provided in this report.

The roof assemblies in the Library most nearly resemble UL assembly S-701. This UL
assembly shall have a minimum steel beam size of W8x18.

The following table shows the wide flange beams and girders provided for the roof
assemblies in the Library and the required SFRM thickness to achieve the one- and-a-
half hour fire-resistance rating required by Table 601:
Table 3: SFRM thickness required for structural beams

<table>
<thead>
<tr>
<th>Location</th>
<th>W size</th>
<th>W/D</th>
<th>Required Rating (hrs)</th>
<th>Required Thickness (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Assembly Beams and Girders</td>
<td>W12X19</td>
<td>0.53</td>
<td>1.5</td>
<td>1.29</td>
</tr>
<tr>
<td></td>
<td>W16X36</td>
<td>0.69</td>
<td>1.5</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td>W8X10</td>
<td>0.37</td>
<td>1.5</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>W12X22</td>
<td>0.61</td>
<td>1.5</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td>W18X35</td>
<td>0.66</td>
<td>1.5</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>W16X26</td>
<td>0.55</td>
<td>1.5</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>W21X68</td>
<td>1.03</td>
<td>1.5</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>W21X62</td>
<td>0.94</td>
<td>1.5</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>W16X26</td>
<td>0.55</td>
<td>1.5</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>W21X44</td>
<td>0.73</td>
<td>1.5</td>
<td>1.09</td>
</tr>
</tbody>
</table>

OPENING PROTECTIVES

Table 705.8 permits exterior walls that have a fire separation distance greater than 30 feet to have an unlimited amount of non-protected openings on exterior walls. As such, the Library exterior wall openings are non-protected.

Section 705.8.5 requires that openings in exterior walls in adjacent stories shall be separated vertically to protect against fire spread on the exterior of the buildings where the openings are within 5 feet of each other horizontally and the opening in the lower story is not a protected opening. Such openings shall be separated vertically at least three feet by assemblies that have at least one-hour fire-resistance rating or by flame barriers that extend horizontally at least 30 inches beyond the exterior wall.

The openings of the Library’s exterior walls are unprotected and are within five feet measured horizontally of unprotected openings in the adjacent stories. Therefore, the openings in the exterior walls shall be required to be vertically separated by three feet from the openings in the adjoining stories or have a flame barrier that extends at least 30 inches beyond the exterior wall.

Openings of adjoining floors are separated by five feet concrete portions of the exterior walls. The exterior wall thickness at these locations is eight inches with an equivalent fire-resistance rating of three hours. These satisfy the fire-resistance requirements of Section 705.8.5.
ALLOWABLE BUILDING AREA

Table 503 permits Group A-3 occupancies of Type 1-A construction to be constructed with unlimited height and stories and unlimited area per floor.

The following table shows the area of each floor:

**Table 4: Allowable building area**

<table>
<thead>
<tr>
<th>Level</th>
<th>Floor Area (square feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>52,712</td>
</tr>
<tr>
<td>Second</td>
<td>47,610</td>
</tr>
<tr>
<td>Third</td>
<td>41,628</td>
</tr>
<tr>
<td>Fourth</td>
<td>35,006</td>
</tr>
<tr>
<td>Fifth</td>
<td>31,603</td>
</tr>
<tr>
<td>Total Area of Building</td>
<td>208,559</td>
</tr>
<tr>
<td>Maximum Allowable Building Area</td>
<td>Unlimited*</td>
</tr>
</tbody>
</table>

*Per Table 503

Since the building is permitted to be constructed of unlimited height and area, no sprinkler area increase or frontage area increase is required for the building.

MIXED-OCCUPANCY SEPARATION

The non-separated mixed use approach of Section 508.3 is to not separate the various occupancies by fire-resistance-rated assemblies if the building complies throughout with the more restrictive code requirements for construction type and fire protection systems of the occupancies within the building. Based on Type I-A construction and Table 503, all occupancies within the building are permitted to be of unlimited height and area. The building occupancy with the most restrictive code requirements for fire protection systems as established by Chapter 9 of the CBC is the Group A-3 occupancy. The proceeding analysis for fire alarm and water-based fire suppression are based on the requirements for a Group A-3 occupancy.

Per Section 715.5.3, penetration of shafts must be protected with an approved fire and smoke damper. The four duct shafts in the building are provided with fire/smoke dampers where ducts penetrate the shaft walls.

Damper shall be actuated when the temperature within the duct system is 50 degrees Fahrenheit above normal, but not less than 160 degrees Fahrenheit. Table 716.3.2.1 also requires that fire dampers have a fire-protection rating of 1.5 hours where the wall
being protected has a fire-resistance rating of less than 3 hours.

The shafts within the Library are required to have a two-hour fire-resistance rating, therefore the ducts penetrating the shafts a required to have a 1.5 hour fire damper per Table 716.3.2.1. The State Fire Marshal (SFM) also requires that fire dampers installed in the Library be listed by the State Fire Marshal. The existing fire dampers have a SFM listing number as follows: A 3225-206:14. The fire dampers in the Library are no longer listed under the SFM or have a different listing number. If the dampers are replaced within the Library, the new fire dampers will have to be listed with the SFM at the time of AHJ approval.

Please see Appendix-A for fire ratings of floors.

WATER-BASED FIRE SUPPRESSION SYSTEMS

AUTOMATIC SPRINKLER SYSTEM

An automatic sprinkler system is required in Group A-3 occupancies where one of the following conditions exist:

- The fire area exceeds 12,000 square feet
- The fire area has an occupant load of 300 or more
- The fire area is located on a floor other than a level of exit discharge serving such occupancies

Each floor of the library is considered a fire area and each floor is greater than 12,000 square feet in area. Each floor has an occupant load greater than 300. Therefore, the Library is required to have an automatic sprinkler system installed in accordance with 903.3.1.1.

The library is not equipped with an automatic sprinkler system per Section 903.3.1.1, but is partially sprinklered via a combination sprinkler-standpipe system. The Library contains 25 pendent sprinkler in select storage rooms throughout the Library. Based on the nature of this analysis, it is recommended that the Library be retrofitted with a sprinkler system per Section 903.3.1 and NFPA 13 to comply with the current code.

A performance-based analysis is performed and detailed in the Performance-Based Design section of this report to determine the degree of fire safety a sprinkler system would add to the Library. A proposed fire sprinkler system is designed in Appendix-B.
STANDPIPE SYSTEM

Section 905.3.1 requires Class III standpipes (2 ½” and 1 ½” valves) systems to be installed throughout each floor where the floor level of the highest story is located more than 30 feet above the lowest level of fire department access or where the building is four or more stories in height.

Section 905.3.3 further requires Group-A occupancies be provided with Class I automatic wet standpipes (2 ½” valves) in nonsprinklered buildings with an occupant load greater than 1,000 persons.

Section 905.4 requires Class I standpipes to be provided in the following locations:

- In every required stairway, a hose connection shall be provided for each floor level above or below grade.

- Class I hose connections shall be located at an intermediate floor level landing between floors, unless otherwise approved by the AHJ.

- Where the roof has a slope less than four units vertical in 12 units horizontal (33.3-percent slope), each standpipe shall be provided with a hose connection located either on the roof or at the highest landing of a stairway with stair access to the roof. An additional hose connection shall be provided at the top of the most hydraulically remote standpipe for testing purposes.

The Library is not provided with a Class III standpipe and therefore does not comply with 905.3.1.

The Library is equipped with a automatic wet-type Class II standpipe combined with a sprinkler system. The Class II standpipe serves six hose cabinets on every floor that provide Class II hose connection (30 hose cabinets throughout building). The hose cabinets no longer are provided with hoses but are provided with fire extinguishers. It is assumed that the occupants of the building will not use the Class II fire hoses for extinguishing a fire. Rather, the occupants are assumed to evacuate the building. The cabinets still maintain the 1 ½ inch connections that the fire department can use with a hose connection reducer (typical hose connection that the fire department uses are 2 ½ inches).

Per Section 905.9, the wet-standpipe system is supervised by a waterflow alarm that transmits a signal to the fire alarm panel and to the supervisory station on the university campus.

The occupant load of the Library is greater than 1,000 persons, therefore an automatic-wet Class I connections are required per Section 905.4. A manual dry Class I standpipe
is provided on stairwells # 2, 3, 4, and 5. The hose connections are provided on the floor level landing, this configuration is permitted by the State Fire Marshal, Per Section 905.4. The Library does not comply with Section 905.3.3 for automatic-wet Class I standpipe in a Group A occupancy.

Stairwell # 4 is provided with roof access. There is a 3-way hose outlet on the roof level landing. The roof is also provided with an additional 3-way hose outlet near Stairwell# 2.

**FIRE DETECTION, ALARM, AND COMMUNICATION**

The CBC requires that fire detection and alarm systems be installed in accordance with NFPA 72. In addition to the requirements of NFPA 72, the CBC appends the following requirements for Group A occupancies:

- Group A occupancies with an occupant load of 300 or more shall have a manual fire alarm system that activates the occupant notification system (Section 907.2.1)
- Group A occupancies with an occupant load of 1,000 or greater shall initiate a signal using an emergency voice/alarm communication system (Section 907.2.1.1)

The occupant load of the Library is greater than 1,000 therefore manual pull-stations and an emergency voice/alarm communication system are required.

The Library is provided with manual pull-stations on every floor, but does not have an emergency voice/alarm communication system as required by Section 907.2.1.1.

The following is an analysis of the existing fire detection, alarm, and communication systems within the Library based NFPA 72.

The cited references in the discussion below are from NFPA 72 unless otherwise noted.

**TYPE OF FIRE ALARM SYSTEM**

The Cal Poly Library is monitored by a proprietary system where all alarm and trouble signal are relayed to the University Police Department (UPD) on campus. The dispatchers relay the information to the City of San Luis Obispo Fire Department. The personnel that receive alarm, supervisory and trouble signals are the police dispatchers that receive their training and certification through the State of California. The personnel at the university’s proprietary system meet NFPA 72 requirements, Section 26.4.2.1.

The building where the police dispatch personnel receive alarm signals is located 930 feet from the Kennedy Library- satisfying Section 26.4.3.1. Per Section 26.4.3.2, the
alarm control center has restricted access to those directly concerned with the implementation and direction of emergency action and procedure-police officers, dispatch personnel, and administrators.

**FIRE ALARM CONTROL PANEL (FACP)**

The FACP is located on the west side of the building on the first floor in Mechanical Room 120-B. The FACP is a Simplex 4120 Fire Alarm Control.

Access to this room is limited to Cal Poly facilities personnel.

All alarm, signal and trouble signals are annunciated on the FACP interface panel.

**REMONTE ANNUNCIATOR**

The remote annunciator is located in the west side of the building in the corridor leading to the emergency exit door. The annunciator is placed here to allow emergency responders to quickly observe where the initiating devices have triggered an alarm. The Panel is labeled with appropriate zones and descriptions that light-up to identify where the alarm was initiated.

**ELEVATOR CONTROL RECALL PANEL**

The elevator control recall unit is located on the fifth floor in the mechanical room north of the elevators (two passenger elevators located on the west side of the building). This system is isolated from the building’s FACP; information of elevator recalls is transmitted to the Cal Poly’s proprietary supervisory system. Per section 21.3.1, the fire fighters’ service recall is connected to the buildings fire alarm system. When actuated, any detector that has initiated fire fighters’ elevator recall is annunciated in the elevator control recall panel (Section 21.3.8).

All lobby smoke detectors are located 9 feet from the centerline of each elevator door. Nine feet is within the 21 feet maximum distance from elevator door centerline to detector that Section 21.3.5 requires.

**FAULT ISOLATOR MODULE**

Fault isolator modules are installed with addressable elevator recall fire control panel to protect the system against wire-to-wire short circuits on the SLC loop (see Appendix 4 for manufacturer’s data). The fault isolator modules allow other devices on the circuit to continue to operate normally in the event of a short-circuit. There are 3 fault isolator modules, one for each of the SLC connecting the elevator lobby smoke detectors and the smoke detector above the elevator recall fire control panel and the smoke detector in the elevator mechanical room on the 5th floor (Rm 507B—directly behind the elevator shafts on the west side of building).
INITIATING DEVICES

Smoke Detectors

The smoke detectors located on all floors of the Kennedy Library are Simplex 2098-9201. They are spot-type photo-electric detectors. The detectors in the Library are used for elevator recall and to release fire-doors to prevent smoke propagation throughout the building. Section 907.2 of the CBC does not require Group A-3 occupancies to be provided with smoke detection.

The building HVAC system is also equipped with duct smoke-detectors. In the event of a fire alarm the HVAC system shuts down to prevent smoke from being transferred through the ducts to other zones of the Library.

Smoke Detector Location

The first floor (Figure 1 of Appendix C) has eight smoke-detectors. One smoke detector is located in the elevator lobby used for the elevator recall function of the alarm system. Six detectors are located on the first floor on the southeast side of the building in three adjacent rooms. One room is a freight elevator lobby and the other two rooms are computer server rooms for the Cal Poly Library PolyCat system. An eighth smoke detector is located in the fire alarm control panel room on the west side of the building (Room 120B).

Second floor has five smoke-detectors (Figure 2 of Appendix C). One detector is located in the elevator lobby dedicated to the elevator recall function. Four detectors are located on the base of the main staircase of the building. These four detectors are dedicated to automatically closing fire doors when there is a fire alarm initiated anywhere in the building.

Third floor has three smoke-detectors (Figure 3 of Appendix C). One in the elevator lobby dedicated to elevator recall; two smoke-detectors are located in the main staircase access door to the third floor. One detector is placed on in the ceiling of the staircase above the sliding fire door. The other smoke detector is placed in the third floor ceiling above the sliding fire door (Section “Fire Door Smoke-Detector” of this report elaborates on the placement of fire door smoke-detectors).

Fourth floor smoke-detectors have similar positioning and function as third floor smoke-detectors (see paragraph above and Figure 4 of Appendix C).

Fifth floor has five smoke-detectors (Figure 5 of Appendix C). Two are dedicated for the operation of the fire door at the main stairwell. One smoke-detector is located in the elevator lobby. Another smoke-detector is in the elevator operating room behind the two passenger elevators on the west side of the building. A smoke-detector is also located
in room 508 (adjacent to the elevators) above the FACP that monitors the smoke-detectors dedicated to elevator recalls (Figure 5 of Appendix C).

**Sliding Fire Door Smoke-Detectors**

All smoke-detectors near fire doors are photoelectric (Section 17.7.5.6.4). Sliding fire doors are located on the third and fourth floors of Stairwell #1.

Per section 17.7.5.6.5.1, the doors are to be closed if any initiating device is in alarm. Per part "C" of the same section, if the wall depth above the door is greater than 24 inches on both sides of the door then a ceiling smoke-detectors is required on both sides.

On the floor level of the sliding door there is a false ceiling made up of panels that decreases the interior wall depth above the sliding door to less than 24 inches. The actual ceiling height (without false ceiling panels) exceeds 24 inches. In this sliding door configuration, there is one ceiling smoke-detector on either side of the sliding door.

From figure 17.7.5.6.5.1 (A), the detectors are not to exceed 5 feet from the vertical plane of the door. The detectors installed in the library are 3 feet from the vertical plane of the sliding door.

**Fire Door Smoke-Detectors**

Fire-doors with smoke detectors are located on the second floor at the base of Stairwell #1 and on the fifth floor of the same stairwell. All fire-doors have a smoke detector on both sides.

Per Figure 17.7.5.6.5.3(A) for double-doors, the smoke-detectors are located on the centerline of the doorway and are 3 feet from the doorway (maximum distance 5 ft).

The double-door smoke-detectors are zoned by door. Figure 6 of Appendix-C shows the zone labels as called out on the FACP. The automatic doors are labeled on the zone chart as "Auto. Door # _". The numbers correspond to the five automatic doors with detectors- three fire double-doors, two sliding fire doors.

**Duct Smoke Detectors**

There are a total of 25 duct smoke-detectors located in rooms 503, 508 and 509 (Figures 7-9). The detectors are Simplex 2098-9201. The housing case for these detectors are installed outside of the duct and the sampling tubes protrude into the duct (section 17.7.5.5.2)

These duct-detectors are zoned by pair (two per zone). See Figure 6 of Appendix C for zones and corresponding devices for building.
Pull-Stations Location

The manual alarm boxes in the Library are only for fire alarm initiating purposes. The manual alarm boxes are red in color and are mounted on a background of contrasting color (section 17.14.1). The manual pull-stations are Simplex Model 2099.

The operating mechanism of each manual fire alarm box is 46 inches above the finished floor; complying with section 17.14.4.

All manual pull-stations are located 60 inches of the exit doorway opening, per section 17.14.6.

The manual fire alarm pull-stations are installed in tandem with a horn/strobe notification appliance.

Spacing

All manual pull-stations are within 200 feet travel distance from another manual pull-station- per section 17.14.8.

Water Flow Switch

The flow switch for the wet-standpipe system installed in the Library is located in mechanical room 120 (Figure 1 of Appendix C). NFPA 72, section 17.12.2 requires that the activation of this initiating device occur within 90 seconds of water flow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system. The State Fire Marshal requires activation within 60 seconds; the flow switch signal timing satisfies code requirement.

NOTIFICATION DEVICES

Horn and Light Plate/Strobe

The Kennedy Library is equipped with combination horn/strobe notification devices. The building has two types of horn/strobe devices: Simplex 2901 /4054 (Appendix 1), Gentex GEC3 Horn/Strobe (Appendix 3). The Simplex horn/light are the original notification devices installed in 1979. The Simplex horn/lights are installed on all floors. The Gentex horn/strobe notification devices are installed on the northwest side of the second floor. This area of the second floor has been remodeled with new computer rooms. The additional wall partitions required the installation of horn/strobe and strobe notification devices. Where the new notification devices were installed, NFPA 72 Figure 18.5.4.3.1 was used to determine the intensity of the Gentex strobes installed in the
new construction on the second floor.

Section 18.4.8.3 permits combination audible/visible appliances to be installed in accordance with Section 18.5.4 for visible notification appliances. The current configuration of the combination horn/strobes does not satisfy the requirements of Section 18.5.4. Appendix C includes a code compliant combination horn/strobe design of the second floor.

Per section 18.5.4.1, the horn/strobe appliances are wall-mounted at a height of 90 inches from the finished floor.

From Table A 18.4.3 places of assembly and business occupancies have an ambient sound level of 55 dBA. Per section 18.4.3.1, the audible level of the horn appliance should be 15 dBA above the ambient level. The required decibel level of the horn appliances should be at minimum 70 dBA (55 dBA +15 dBA). The horns in the Library are set to a decibel level of 75. The decibel levels of the horns in the Library satisfy Section 18.4.3.1 but do not satisfy the combination horn/strobe locations of Section 18.5.4.

Section 10.7 and 18.4.2.1 requires that the primary evacuation signal follow a temporal scheme as illustrated below.

---

**FIRE ALARM EVACUATION SIGNAL**

![Diagram of fire alarm evacuation temporal scheme](image)

**3 PULSE TONE FOLLOWED BY PAUSE**

*Figure 2: Fire alarm evacuation temporal scheme*

SECONDARY POWER SUPPLY
Section 10.5.6 of NFPA 72 requires that secondary power be provided to the fire alarm system by a storage battery or an automatic-starting, engine-driven generator. The Library uses storage batteries to provide secondary power to the fire alarm system.

Per Section 10.5.6.3.1, the secondary power supply shall have sufficient capacity to operate the system under normal non-alarm load for a minimum of 24 hours and, at the end of that period, shall be capable of operating all alarm notification appliances for 5 minutes. The calculated secondary power supplied will also incorporate a 20 percent safety factor to account for battery deterioration.

The following secondary power supply calculations reflect the required storage battery capacity to serve the fire alarm devices currently installed in the Library.

### Table 5: Secondary power battery capacity calculation

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>STANDBY CURRENT PER UNIT (AMPS)</th>
<th>QTY</th>
<th>TOTAL STANDBY CURRENT (AMPS)</th>
<th>TOTAL ALARM CURRENT (AMPS)</th>
<th>QTY</th>
<th>TOTAL SYSTEM ALARM CURRENT (AMPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FACP</td>
<td>0.12</td>
<td>X</td>
<td>= 0.12</td>
<td>1.5</td>
<td>X</td>
<td>= 1.5</td>
</tr>
<tr>
<td>Smoke Detectors</td>
<td>0.0004</td>
<td>X</td>
<td>= 0.0108</td>
<td>0.086</td>
<td>X</td>
<td>= 2.322</td>
</tr>
<tr>
<td>Duct Smokes</td>
<td>0.0004</td>
<td>X</td>
<td>= 0.01</td>
<td>0.086</td>
<td>X</td>
<td>= 2.15</td>
</tr>
<tr>
<td>Horn/Strobes</td>
<td>0</td>
<td>X</td>
<td>= 0</td>
<td>0.106</td>
<td>X</td>
<td>= 3.286</td>
</tr>
<tr>
<td>Relay</td>
<td>0.007</td>
<td>X</td>
<td>= 0.021</td>
<td>0.007</td>
<td>X</td>
<td>= 0.021</td>
</tr>
<tr>
<td>Strobe</td>
<td>0</td>
<td>X</td>
<td>= 0</td>
<td>0.08</td>
<td>X</td>
<td>= 0.32</td>
</tr>
<tr>
<td><strong>TOTAL SYSTEM STANDBY CURRENT (AMPS)</strong></td>
<td><strong>0.16</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>TOTAL SYSTEM ALARM CURRENT (AMPS)</strong></td>
</tr>
</tbody>
</table>

**REQUIRED OPERATING TIME OF SECONDARY POWER SOURCE FROM NFPA 72 SEC. 10.5.6.3**

**STANBY: 24 HOURS**

**ALARM: 5 MINUTES X (1/60) = 0.083 HRS**

<table>
<thead>
<tr>
<th>REQUIRED STANDBY TIME (HOURS)</th>
<th>REQUIRED STANDBY CURRENT (AMPS)</th>
<th>REQUIRED STANDBY CAPACITY (AMP-HOURS)</th>
<th>REQUIRED ALARM TIME (HOURS)</th>
<th>REQUIRED ALARM CURRENT (AMPS)</th>
<th>TOTAL SYSTEM ALARM CURRENT (AMPS)</th>
<th>REQUIRED ALARM CURRENT (AMP-HOURS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>X</td>
<td>0.16</td>
<td>3.88</td>
<td>0.0833</td>
<td>9.60</td>
<td>0.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REQUIRED STANDBY CAPACITY (AMP-HOURS)</th>
<th>REQUIRED ALARM CAPACITY (AMP-HOURS)</th>
<th>TOTAL REQUIRED CAPACITY (AMP-HOURS)</th>
<th>FACTOR OF SAFETY</th>
<th>REQUIRED BATTERY CAPACITY (AMP-HOURS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.88</td>
<td>+</td>
<td>0.80</td>
<td>4.68</td>
<td>1.20</td>
</tr>
</tbody>
</table>
DISPOSITION OF ALARM, SUPERVISORY AND TROUBLE SIGNALS

Alarm

Per section 26.4.5.6.1:
Upon receipt of an alarm notification the proprietary supervising station notifies the City of San Luis Obispo Fire Department (SLOFD).

In an emergency UPD officers are the first investigators during an alarm or trouble signal (section 26.4.4.6). The officers have direct communication with university dispatch through handheld transceivers.

Supervisory

Per section 26.4.5.6.3:
Upon receipt of a supervisory signal—water flow switch for sprinkler system—the supervisory personnel dispatch UPD officers to investigate the signal. Also, the library’s Manager is called and notified to help in the reconnaissance of the motive for the activation of the flow switch.

The State Fire Marshal also requires that the fire department be notified upon receipt of the signal.

Trouble Signals

Per section 26.4.5.6.4:
Upon receipt of a trouble signal, supervisory personnel dispatch police officers to make sure the signal is only a trouble signal and that there is not an immediate danger to the occupants of the Library.

Once it is determined that it is only a trouble signal, Cal Poly Facilities Department is notified and they send the appropriate technicians reestablish the appliance to its normal, non-alarm status.

Inspection Test and Maintenance

Per section 14.2.1.1 of NFPA 72, the Kennedy Library has a yearly inspection program. The test is conducted in April during spring break when students, the majority of occupants, are not present on campus. The inspection consists of activating a smoke detector which prompts the activation/closure of fire doors. This test verifies correct operation of the fire alarm system (Section 14.2.1.2).

The testing is conducted by the university’s Environmental Health and Safety department (Per Section 14.2.2.1). As required by 14.2.2.2, the testing/inspection outcomes are reported to the California State Fire Marshal. Before the test, all
occupants and supervisory personnel are forewarned about the test to prevent unnecessary human response.

Per Section 14.2.5.5, during the test the FACP is observed to confirm that the annunciated alarm signal is accurate and that the supervisory station (proprietary system) receives the appropriate signal.

Section 14.5.3 requires that the frequency of cleaning of system components shall depend on ambient conditions and the manufactures recommendations should be considered. Simplex (detector manufacturer) recommends cleaning dust around smoke detector with a vacuum and that any cleaning of the internal chamber of the detector should be done by a Simplex technician only.

In conducting interviews with the university’s alarm testing personnel, it was found that the cleaning of smoke detectors (initiating devices in Library) is not a task that the University schedules. The Environmental Health and Safety department representative expressed that university budget cuts and task reassignment of departments, has affected the maintenance of fire alarm components.

The cleaning/maintenance of smoke detectors are done reactively, rather than proactively: the smoke detectors are cleaned when they initiate a fire alarm sequence due to dust in the chamber of the detector.

Conclusion

The Kennedy Library does not satisfy the requirements of the CBC for notification devices in a Group A occupancy and the 2010-NFPA 72 spacing requirements for notification devices. The notification devices are not easily seen from all areas in the Library. The high bookshelves impede the line of sight to the strobe lights. The high amount of fuel (books, paper, etc) can promote a fast burning fire that can quickly make a floor level untenable for humans. Appendix C includes a proposed layout of strobes and horn strobes for the second floor, designed per NFPA 72.

EGRESS

OCCUPANT LOADS

In determining means of egress requirements, the number of occupants is determined in accordance with Section 1004.1. Where a building contains two or more occupancies, the means of egress requirements apply to each portion of the building based on the occupancy of that space, per Section 1004.9.

The following table identifies applicable occupant load factors based on the occupancy and function of spaces in the scope of work of this project (Table 1014.1.1):
Table 6: Occupant load factors based on use of space

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Function of Space</th>
<th>Occupant Load Factor (ft^2/occupant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Offices, business areas</td>
<td>100</td>
</tr>
<tr>
<td>A-3</td>
<td>Lounge areas</td>
<td>15</td>
</tr>
<tr>
<td>A-3</td>
<td>Library stack areas</td>
<td>100</td>
</tr>
<tr>
<td>A-3</td>
<td>Library study areas</td>
<td>50</td>
</tr>
<tr>
<td>A-3</td>
<td>Outside deck areas</td>
<td>50</td>
</tr>
<tr>
<td>S-2</td>
<td>Accessory storage areas, mechanical equipment room</td>
<td>300</td>
</tr>
</tbody>
</table>

Tables 1 identified in Appendix-D reflect the occupant load of each space in the Library. Refer to drawings in Appendix D for directional egress drawings.

EGRESS WIDTH

Section 1005.1 requires that the minimum egress width be not less than the total occupant load served by the means of egress multiplied by 0.3 inches per occupant for stairways and 0.2 inches per occupant for other egress components. The minimum width of each door is required to have a clear width of 32 inches, per Section 1008.1. Section 1009.1 requires that the minimum width of stairs be 44 inches.

Multiple means of egress are required to be sized so that the loss of any one means of egress will not reduce the available capacity to less than 50 percent of the required egress capacity. The maximum capacity required from any story of a building is to be maintained to the termination of the means of egress.

Doors, when fully opened, and handrails, are required to not reduce the required means of egress width by more than seven inches. Doors in any position shall not reduce the required width by more than one-half.

The doors of the exit enclosures have clear width of 34 inches; the stairs of the exit enclosures have a clear width of 48 inches. The exit capacity of exit enclosure doors is 170 occupants (34 inches / 0.2 inches per occupant), while the stairs have an exit capacity of 160 occupants (48 inches / 0.3 inches per occupant). Therefore capacity of the exit enclosures at each level is 160 occupants - the lowest capacity of the egress components in series.
Width of Exit Enclosure Doors in Stairwell #2 and #3

Occupants exiting from the first floor via Stairwell #2 and Stairwell #3 converge with occupants from the second floor. Occupants from the first floor enter the exit enclosure through a door with a clear width of 34 inches; these occupants then converge with the occupants descending the stairs and exit to the exterior of the building through 46 inch doors. The egress width of the first floor exit enclosure doors have sufficient capacity to serve the occupants exiting from the first floor and the converging occupants from the second floor. See first floor egress drawing in Appendix-D.

STAIRWAY TREADS AND RISER

The stair riser heights are required to be 7 inches maximum and 4 inches minimum. The riser height is required to have a depth of 11 inches minimum (Section 1009.4.2).

Stair risers heights and tread depths are 7 inches and 11 inches, respectively, in the stairs within the Library.

EXIT SIGNS

Exits and exit doors are required to be marked by an approved exit sign that is readily visible from the direction of egress travel. The exit sign is required to indicate the direction of egress. Exit sign placement shall be such that no point in an exit access corridor or exit passageway is more than 100 feet from the nearest visible exit sign (Section 1011.1).

Rooms that require only one exit are not required to have exit signs.

Exit sign locations within the Library are depicted in Appendix-D. Exit signs in the Library comply with Section 1011.1.

EGRESS THROUGH INTERVENING SPACES

In accordance with Section 1014.2, means of egress is prohibited through adjoining or intervening rooms or spaces with a greater hazard occupancy group.

No spaces within the Library egress through intervening spaces with a greater hazard occupancy group.
COMMON PATH OF EGRESS TRAVEL

The maximum common path of egress travel is 75 feet (1014.3). Exception 2 of the same section permits Group B and S occupancies to have a maximum 100 feet common path of egress travel when the occupant load of the space is less than 30 persons. The following table lists the maximum common path of egress travel for the occupancy groups within the Library:

Table 7: Common path of egress travel maximums

<table>
<thead>
<tr>
<th>Groups</th>
<th>A</th>
<th>B</th>
<th>S-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Path</td>
<td>75</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Feet</td>
<td>Feet</td>
<td>Feet</td>
</tr>
</tbody>
</table>

* Common path of travel permitted to be 100 feet when Group-B and Group-S serve 30 or less occupants (Section 1014.3).

The common path of egress travel is exceeded in Mechanical Room 509A. The maximum common path of egress travel permitted for a Group S-2 occupancy is 100 feet. The common path of travel in the mechanical room is 155 feet. See fifth floor egress plan in Appendix-D for depiction of measured common path of travel.

EXIT ACCESS TRAVEL DISTANCE

Section 1016.1 requires that the exit access travel distance on each story be measured from the most remote point within a story along the natural and unobstructed path of egress travel to an exterior exit door at the level of discharge of a vertical enclosure. Table 1016.1 establishes the maximum travel distance permitted in a building based on the occupancy of the space where exit access travel originated.

The following table lists the maximum exit access travel distance in a non-sprinklered building:

Table 8: Exit access travel distance based on occupancy of a nonsprinklered building

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Without Sprinkler System (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200</td>
</tr>
<tr>
<td>B</td>
<td>200</td>
</tr>
<tr>
<td>S-2</td>
<td>300</td>
</tr>
</tbody>
</table>

The exit access travel distance is exceeded on the fifth floor from room 510B to Stairwell #2. The measured exit access travel distance is 205 feet, and the maximum exit access travel distance permitted by Table 1016.1 is 200 feet for a Group B.
occupancy. See fifth floor egress plan in Appendix-D for depiction of measured travel
distances and common paths of travel.

NUMBER OF EXITS OR EXIT ACCESS DOORWAYS

Table 1021.1 requires that spaces that serve 1-500 occupants be provided with a
minimum of two exits. Spaces serving 501-1000 occupants shall be provided with a
minimum of three exits.

The table below shows the number of occupants per floor, the minimum required exits
required, and the exits provided per floor:

<table>
<thead>
<tr>
<th>Floor</th>
<th>Occupant Load</th>
<th>Minimum Number of Exits Required</th>
<th>Number of Exits Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>547</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>631</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>468</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>379</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>308</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

The number of exits provided on each floor exceeds the minimum required by Table
1021.1

Table 1015.1 requires that spaces within each floor classified as a Group-A or B have a
minimum of two exits when the occupant load of the space exceeds 49. The same table
requires spaces classified as Group-S be provided with two exits when the occupant
load within the space exceeds 29.

All spaces are provided with the minimum number of exits as required by Table 1015.1.
See Appendix D for the egress floor plans.

DOOR SWING

Doors serving an occupant load of 50 or more must swing in the direction of egress
(1008.1.2).

The first floor exterior courtyard serves 60 occupants. The courtyard is provided with
two doors on the east and west side of the courtyard; both doors swing into the
courtyard. Per Section 1008.1.2, the doors are required to swing in the direction of
egress.
EGRESS SEPARATION

Section 1015.2.1 requires that the distance between two exits be a minimum of one-half the diagonal distance of the floor being served by the exits. Furthermore, where three or more exits are provided, Section 1015.2.2 permits that only two exits have the minimum exit separation as established by Section 1015.2.1.

All floors of the library contain three or more exit stairwells. The following table shows exit separation distance and the minimum required separation per floor:

<table>
<thead>
<tr>
<th>Floor</th>
<th>Diagonal Distance of Floor (Feet)</th>
<th>Minimum Required Separation of Exits (Feet)</th>
<th>Actual Separation of Exits (Feet)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>358</td>
<td>179</td>
<td>193</td>
</tr>
<tr>
<td>2</td>
<td>335</td>
<td>167</td>
<td>193</td>
</tr>
<tr>
<td>3</td>
<td>316</td>
<td>158</td>
<td>193</td>
</tr>
<tr>
<td>4</td>
<td>303</td>
<td>151</td>
<td>193</td>
</tr>
<tr>
<td>5</td>
<td>283</td>
<td>141</td>
<td>193</td>
</tr>
</tbody>
</table>

*Exit separation distance of all floors is measured from stairwell #4 to stairwell #2.

The exit separation distance of each floor conforms to Section 1015.2.1.

VERTICAL EXIT ENCLOSURE

Exit stairways are required to be enclosed with fire barriers constructed with Section 707. Where the exit enclosure serves four stories or more it is required to have a fire-resistance rating of two-hours.

The five exit enclosures within the Library connect more than four stories. The fire barriers enclosing the stair have a fire-resistance rating of at least two-hours based on an eight inch thick concrete wall as prescribed by Table 721.2.1.1.

EXIT PASSAGEWAY

An exit passageway serving as an exit component in a means of egress cannot be used for any purpose other than as a means of egress (Section 1023.1). The width of the exit passageway is required to be determined based on Section 1005.1 (above) but shall not be less than 44 inches wide.

Openings in exit passageways shall be limited to those necessary for exit access to the exit passageway from normally occupied spaces and for egress from the exit.
passageway (Section 1023.5).

Penetrations in the exit enclosure are required to be limited to required doors, standpipes, sprinkler piping, and electrical raceway for fire department communication. Such penetration shall be protected in accordance with Section 713.

Section 1022.2.1 also requires that the exit extension be separated from the rated stairwell with a fire-resistance rating equal to the fire-resistance rating of the stairwell. A fire door assembly complying with Section 715.4 shall be installed in the fire barrier separating the exit passageway and the rated stairwell.

An exit passageway serving as an extension from the main stairwell (Stairwell #1) to Stairway #5 is located on the second floor. Occupants from the second floor have exit access to the exit passageway.

The double doors on the second floor of Stairwell #1 have a width of 92 inches. The egress capacity of the double door is 460 persons (92 inches / 0.2 inches per occupant = 460 persons). Occupants from the second floor enter the double doors on the second floor and enter the passageway that leads to Stairwell #5.

To determine the exit capacity of the exit passageway and its components, it is assumed 118 occupants use the double doors at the base of the Stairwell #1 for exit access to the exit passageway. The second floor has four exit stairwells available for egress. It is also assumed that 25 occupants from the corridor west of door A (see figure below) enter the exit extension. The capacity of Stairwell #5 is 160 occupants and has an occupant use of 152 occupants.

Section 1023.5 requires that openings into the exit extension be limited to those necessary for exit access to the exit passageway from normally occupied spaces. The exit extension on the second floor has two doors from non-normally occupied spaces opening on to the exit extension. The non-normally occupied rooms opening into the exit extension include electrical room 219, and freight elevator lobby room 218.

In Appendix-D, the directional egress drawing for floor level 2 depicts the occupant loads and exit capacities described above.

The following table is a summary of the various egress elements and the occupant load of the egress elements that make up the exit passageway:
Table 11: Occupant load and capacity of exit components of the exit extension

<table>
<thead>
<tr>
<th>Egress Element</th>
<th>Egress Element Width (inches)</th>
<th>Exit Capacity (persons)</th>
<th>Occupant load (persons)</th>
<th>Exit Capacity greater than Occupant Load ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double doors on 2nd floor</td>
<td>92</td>
<td>460</td>
<td>118</td>
<td>Yes</td>
</tr>
<tr>
<td>Opening between Stairwell #1 and exit passageway</td>
<td>102</td>
<td>510</td>
<td>118</td>
<td>Yes</td>
</tr>
<tr>
<td>Passageway (location 2 on Figure 3)</td>
<td>129</td>
<td>645</td>
<td>151</td>
<td>Yes</td>
</tr>
<tr>
<td>Passageway (location 3)</td>
<td>102</td>
<td>510</td>
<td>152</td>
<td>Yes</td>
</tr>
<tr>
<td>Exit Enclosure Door (location 4)</td>
<td>34</td>
<td>170</td>
<td>152</td>
<td>Yes</td>
</tr>
<tr>
<td>Exit Enclosure Door</td>
<td>48</td>
<td>160*</td>
<td>152</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Limiting capacity

The exit extension on the second floor does not comply with the requirements of an exit passageway as defined by the CBC. The following is recommended to make the exit extension code compliant:

- Provided a fire door at the opening between Stairwell #1 and the exit extension with a 1 ½ hour fire protection rating
- Remove all doors opening into exit extension; except fire doors used for exit access to the exit passageway.
WIDTH OF BOOK STACK AISLES

Section 1028.9.2 requires that main aisles of open book stacks have a minimum width of 44 inches and range and end aisles have a minimum of 36 inches in width.

The main aisles of the stack areas have a width that ranges from 46 inches to 60 inches. The range aisles have a width of 32 inches. The main aisles widths exceed the minimum aisle width required by Section 1028.9.2. The width of the range aisles is less than the 36 inch minimum width required by 1028.9.2.

INTERIOR FINISHES

Wall and Ceiling Finishes

Interior wall and ceiling finishes for non-sprinklered buildings are required to have a flame spread index not greater than that indicated in the table below (Table 803.9) for the group and location designated in the table.

<table>
<thead>
<tr>
<th>Group</th>
<th>Exit Enclosures and Exit Passageways</th>
<th>Corridors</th>
<th>Rooms and Enclosed Spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-3</td>
<td>A</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>S</td>
<td>B</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>
Floor Finish Requirements

Interior floor finish and floor covering materials in exit enclosures, exit passageways and corridors are required to comply with ASTM E 648 and have a smoke density rating of less than 450 per ASTM E 662. (804.4.1 Exception).

ELEVATOR OPENING PROTECTION

Section 708.14 requires that elevator lobbies be provided at each floor where an elevator shaft enclosure connects more than two stories in Group-A occupancies. Exception 2 of the same section permits elevator lobbies to be omitted where additional doors are provided at the hoistway opening in accordance with Section 3002.6. Such doors shall be tested in accordance with UL 1784 without an artificial bottom seal.

The two passenger elevators in the west side of the building connect five stories and are not provided with elevator lobbies where the elevator opens into each floor level. These elevators are provided with an additional listed door assembly that prevents smoke from entering the elevators in the event of a fire at any floor, per Section 718.14 Exception 2. Passenger elevators comply with Section 728.14.

The freight elevator on the east side of the building serves five stories of the Library. The freight elevator is provided with elevator lobbies at all levels.

PERFORMANCE-BASED ANALYSIS

The Client has requested that a tenability analysis be conducted to determine whether installing a sprinkler system in the Library will improve tenability conditions during a fire event. To determine the feasibility of installing sprinklers in the Library, two tenability analyses will be conducted to compare the tenability conditions of the Library with and without an installed sprinkler system.

MODELING ANALYSIS

The intent of the performance-based tenability analysis of the Library is to demonstrate that the fire protection systems installed within the Library will provide an acceptable level of fire protection for the building occupants, consistent with the level of fire protection intended by the CBC.

The performance-based tenability analysis includes a detailed computer modeling evaluation of the fire floor to provide an assessment of the smoke spread and the quantities of the particles of combustion. The goal of using a computer model is to demonstrate that the occupants of the fire floor are not exposed to harmful products of combustion or smoke when the building is equipped with a sprinkler system. This approach was justified using a computational fluid dynamics fire model (CFD).

The modeling of the Library was completed using Fire Dynamics Simulator (FDS) Version 5, developed by the National Institute of Standard and Technology (NIST). FDS is a CFD model which separates the area being modeled into hundreds of thousands small grid cells and simulates the fluid flow and heat transfer through the mesh of grid cells. The small grid cells permit users of FDS to evaluate temperature rise, smoke density, among other information, at specific points or planes within the model space.

TENABILITY APPROACH

Section 5.2.2 of the 2009 Life Safety Code (NFPA 101) states that any occupant who is not intimate with the fire ignition shall not be exposed to instantaneous or cumulative untenable conditions. Section 5.2.2 lists four methods that can be used to avoid exposing occupants to untenable conditions. The methods used in this analysis is Method 2, where the design can demonstrate that each area or room will be fully evacuated before the smoke and toxic gas layer in the room reaches a level lower than 6 feet above the finished floor.

The following sections define the performance objectives, tenability criteria, and design assumptions of the tenability analysis.
PERFORMANCE OBJECTIVES

For the tenability analysis of the Library, the acceptable performance objectives were to maintain adequate visibility, limit the occupants’ exposure to products of combustion, including soot, heat and carbon monoxide. Design criteria for these parameters were developed to provide threshold values in engineering terms and to quantify the analysis.

The tenability criteria were used to evaluate conditions for building occupants not intimate with the fire. The tenability conditions in the vicinity of the fire (within enclosed fire enclosure or within 20 feet of the fire) will exceed the criteria established for acceptable tenability.

TENABILITY

The tenability limits described below are based on the values or calculation methods found in various referenced documents.

The required duration for tenable conditions to be maintained was based on the egress time of the occupants in the building. For this analysis, 14.25 minutes is the time required for evacuation of the entire Library as described in the performance-based egress section of this report.

Visibility

Reduced visibility can cause occupants to become disoriented and become trapped within a building because they are unable to find their way to an exit. Purser (SFPE Fire Protection Engineering 3rd Edition, Section 2, Chapter 6) references research from Rabash and Babrasand that suggests a 10-meter visibility limit for large areas.

Based on the references above, the visibility threshold of 10 meters (33 feet) was used as the visibility criterion for this analysis. Fire Dynamic Simulator was used to determine if the occupants would be exposed to conditions where the visibility within the fire floor will be less than 33 feet for the duration of egress time of the building. For the purposes of determining if the visibility levels pass or fail the visibility criteria established, if any portion of the floor level more than 20 feet away from the fire plume has visibility less than 33 feet at the horizontal plane six feet above the finished floor the visibility criterion limit has been exceeded and tenability of the floor has failed.

Most of the occupants will be familiar with the building layout but some occupants might be visiting the University and not familiar with the building layout. As such, placements of exit signs have to be strategically placed to direct occupants to available emergency exits (Appendix-D depicts exit sign proposed locations of all floors of the Library).
Temperature

The three basic ways in which occupants can become incapacitated in a fire due to heat are: heat stroke, skin pain and burns, or respiratory tract burns. Heat stroke can occur when occupants are exposed to hot environment, especially where there is high humidity and the subject is active, there is a danger of incapacitation and death due to hyperthermia. Even if the temperatures are not high enough to cause skin burns, prolonged exposure can raise the body core temperature and incapacitate the subject.

Temperatures of 120 degrees Celsius have been observed to cause skin pain and burns in humans. Occupant’s clothing affects the time and temperature of the onset of skin pain and burns to subjects in a fire.

Thermal burns to the respiratory tract never occur in the absence of burns to the skin of the face. But thermal burns to the respiratory tract may occur upon the inhalation of air above 60 degrees Celsius that is saturated with water vapor. An environment where air is saturated with water vapor can be present where water-based fire extinguishment is present.

For this analysis, the temperature tenability limit is 60 degrees Celsius based on the temperature of water saturated air that can cause respiratory tract burns. The temperature tenability limit will have failed where the temperature six feet above the walking surface exceeds 60 degrees Celsius.

Toxicity

The toxicity levels released by the by-products of a fire are of concern in the tenability analysis of fire within an enclosed space. The main toxins present during a fire are carbon monoxide (CO) and hydrogen cyanide (HCN). Purser writes that hydrogen cyanide is likely present to some extent when nitrogen-containing materials are involved in the fire. Nitrogen-containing materials include, acrylics, polyurethane foams, melamine, nylon and wool. This analysis assumes that the fire will involve cellulosic material such as books and paper which is the most abundant fuel in the fire floor. As such, this report only analyzes the toxic level of CO.

Carbon monoxide levels are of concern during a fire in enclosed spaces because CO combines with hemoglobin in the blood stream to form carboxyhemoglobin (COHb). The COHb reduces the amount of oxygen in the blood and causes toxic narcosis which leads to unconsciousness and eventually death. Purser predicts death caused by COHb concentrations in the blood between 50 percent and 70 percent. Loss of consciousness has been predicted to occur at 40 percent concentrations.

This analysis predicts the concentration of CO (parts per million) at two meters (6 feet) above the highest walking surface within the enclosed space to achieve 40 percent COHb in the bloodstream. It should be noted that the concentration of CO determined
to cause incapacitation is the concentration that a human needs to constantly breathe for a specified duration. For this analysis, 14 minute exposure duration was used to determine the limiting CO concentration to cause incapacitation.

The concentration of CO that causes incapacitation is as follows (Purser):

\[
%\text{COHb} = (3.317 \times 10^{-5})(\text{ppm CO})^{1.036}\text{RMV}(t)
\]

where

- \(\text{ppm CO}\) = CO concentration (ppm)
- \(\text{RMV}\) = volume of air breathed (L/min)
- \(t\) = exposure time (min)

Rearranging equation to solve for ppm CO at 40 percent COHb and a volume of air breathed (RMV) of 25 liters per minute (typical for a 70 Kg human that is walking) equals 2,590 ppm for a 14 minute exposure.

In this analysis it was assumed that if the CO concentration six feet above the highest walking surface reaches 2,590 ppm for any time step, the limiting toxicity concentration has been exceeded and the tenability criterion has failed.

<table>
<thead>
<tr>
<th>Tenability Criteria</th>
<th>Tenability Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility</td>
<td>10 m (33 feet)</td>
</tr>
<tr>
<td>Temperature</td>
<td>60 degrees Celsius</td>
</tr>
<tr>
<td>Toxicity</td>
<td>2,590 ppm</td>
</tr>
</tbody>
</table>

The tenability limits are evaluated at 6 feet above the top of finished floor.

**FIRE SCENARIO**

The tenability of the fire floor in the Library was evaluated based on a fire scenario intended to represent a reasonably severe fire event. Two fire scenarios were presented for the same ignition source; one scenario representing the existing non-sprinklered fire floor and another representing the existing configuration of the fire floor with a sprinkler system installed.

**SCENARIO-ARSON FIRE**

The design scenario involves a fire located on the second floor of the Library on the southeast side of the building. The paper and books on the shelves are the most abundant fuel in the Library. The ignition of the book stacks is initiated by intentional
means- arson. Arson is the leading cause of fires in libraries both in the number of fires and in the value of property damaged (McDaniel, Danny L., NFPA Handbook 20th Edition).

The second floor has the greatest occupant load and has Group A and Group B occupancy spaces that include a lounge area, offices, classrooms, and library stack areas.

The location of the fire is in the stack area of the floor (Figure 4 below). The second floor also has doors that lead into a stair enclosure and into an exit extension to Stairwell #5. The door that leads into the stair enclosure and into the exit extension are maintained open with magnetic door holders; the doors are released and automatically close when an alarm sequence is initiated anywhere in the Library. The tenability of the exit enclosure and the exit extension are also analyzed in this report due to the close proximity of the fire door to the fire location.

![Figure 4: Second floor fire location](image)

**COMBUSTION PROPERTIES OF BOOKS**

The Library book stacks are seven feet six inches tall with books arranged vertically side by side on the bookshelves. The paper in the books is largely made up of an organic compound called cellulose. Cellulose is obtained from wood pulp and cotton to produce paper; paper is made up of 95 percent cellulose (Cholin, NFPA Fire Protection Handbook).
For this analysis, and due to lack of experimental data, the heat of combustion of paper that was used for the FDS model was the heat of combustion of newspaper which is also largely made up of cellulose. The heat of combustion is 18,300 kJ/kg.

Two important byproducts of combustion include the carbon-monoxide (CO) yield and the soot yield of paper. These values are used to determine the tenability conditions within the fire space. For this analysis the CO yield is 0.005 kg/kg and the soot yield is 0.015 kg/kg (Table 3-4.14, SFPE Fire Protection Engineering Handbook).

<table>
<thead>
<tr>
<th>Properties of Combustion</th>
<th>CO Yield</th>
<th>0.005 kg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soot Yield</td>
<td>0.015 kg/kg</td>
</tr>
<tr>
<td></td>
<td>Heat of Combustion</td>
<td>18,300 kJ/kg</td>
</tr>
</tbody>
</table>

**FIRE GROWTH**

The fire growth was modeled with experimental data conducted by Walton and Budnick (1988) at NIST. Walton and Budnick tested various configurations of open shelf steel bookshelves in a “free burn test” using oxygen consumption calorimetry. The shelves were 71 inches tall by 36 inches wide by 18 inches deep. A total of four shelves were used in the test. The shelves were arranged in two parallel sets of back-to-back units separated by a 30 inch aisle. Each shelving unit consisted of six shelves loaded with paper products. The bottom two shelves contained paper stacked horizontally, the next two shelves contained paper arranged vertically, and the top two shelves had cardboard boxes with paper material arranged horizontally inside the boxes. The ignition source for the test was a diffusion flame natural gas burner with the flame located 14.5 inches above the floor. See figure below for open shelf configuration.

Figure 5: Open shelf configuration HRR test (Walton and Budnick,
The book shelves in the Library are arranged similarly to the open book shelves used in the Walton and Budnick’s test. The shelves in the Library are made of metal and there is a 30 inch aisle in between book shelves.

The book shelves in the experiment consisted of two pairs of back-to-back open shelf bookshelves; the Library bookshelves are constructed as one open book shelf. For this analysis, the configuration of the Library bookshelves and the experimental bookshelves were considered to be the same.

The Library bookshelves are 19 inches taller than the bookshelves used in the heat release rate test and have an additional shelf (see Library bookshelves in Figure 6 below). It is assumed that the arsonist will not ignite the paper contents of the lower bookshelves because the arsonist would have to kneel or bend over to ignite the contents. This would draw attention from and be more obvious to occupants of the Library. As such, a fire started at the third or second shelf from the bottom is assumed and is comparable to the test data.

![Figure 6: Configuration of open book shelves in Kennedy Library NON-SPRINKLERED FIRE GROWTH](image-url)
The heat release rate curve produced from the “free burn test” conducted by Walton and Budnick is shown below in Figure 7. The maximum heat release rate produced by the parallel book shelves (a total of four shelf units) was 1.6 MW at 330 seconds after ignition. It is observed from the curve that the initial growth rate of the open shelf unit fire tends to follow a medium time square fire until 200 seconds. After 200 seconds the fire growth rate increases and its slope more nearly resembles a fast growing fire. According to the observations of Walton and Budnick, at around 200 seconds the second set of shelves across the aisle began to ignite.

The initial fire growth rate was slower possibly due to the horizontal orientation of the paper materials in the lower two shelves. As the middles shelves with vertically oriented paper material ignited and the second set of shelves across the aisle began to ignite, the fire growth rate increased until reaching a maximum heat release rate of 1.6 MW.

For this analysis, it was assumed that the equivalent of three test units is burned. The open bookshelves used in the heat release rate test of Walton and Budnick were 36 inches (3 feet) long. The bookshelves in the Library, particularly those in the fire area, are about 40 feet long. The density of bookshelves in the fire area renders a large amount of fuel for a fire.

To determine the maximum heat release rate, the slope of the heat release rate curve was extrapolated for two additional equivalent test units. The test curve begins to resemble a fast growing fire at about 200 seconds and reaches its maximum heat release rate at about 320 seconds; the time difference is 120 seconds. Since this
analysis is considering three equivalent test units, the total time to maximum heat release rate is approximately 560 seconds (200 seconds of initial medium growing fire plus 360 seconds of the fast growing fire phase). The maximum heat release rate is 6.2 MW.

A conservative fire growth rate was assumed to remain constant after the maximum heat release rate (HRR) of 6.2 MW was reached. The constant heat release rate of 6.2 MW will consider the fact that there is an abundant amount of fuel in the stack areas (i.e., paper books). The Figure 8 below shows both the experimental HRR and the HRR used for this analysis.

![Experimental and Model Analysis HRR](image)

**Figure 8: Experimental and Model analysis HRR**

**SPRINKLERED BUILDING FIRE GROWTH**

Installing sprinklers as a fire protection feature within a building can reduce the heat release rate and temperatures achieved by a fire. It is assumed that the sprinklers installed will only control the fire (i.e., stop the fire from growing) rather than extinguish the fire. A controlled fire allows the occupants more time to exit the building and reduces the amount of harmful byproducts of combustion. In this analysis sprinklers were modeled to determine the effect sprinklers had on the fire size and on the tenability conditions within the second floor.

**Location and Spacing of Sprinklers**

Based on the proposed sprinkler design attached to this report in Appendix-B, the sprinklers in this analysis are spaced 11 feet apart. The library is an ordinary hazard
group 1 therefore the maximum area coverage per sprinkler is 130 square feet and the minimum volumetric water density of the coverage area is 0.15 gallons per minute per square feet, per NFPA 13. The area coverage of the proposed sprinkler design is 121 square feet (11 feet by 11 feet) with the most remote sprinkler flowing 18.2 gallons per minute; all sprinklers have a 5.6 K-factor.

For this analysis, the sprinklers in the FDS model are spaced 11 feet apart and are each designed to flow the minimum 18.2 gallons per minute. The volumetric flow of water is conservative for this analysis because in reality only the most remote sprinkler will flow a minimum of 18.2 gallons per minute and the other sprinklers will flow more water because the sprinklers will operate with a greater pressure.

**Sprinkler Activation Time**

Sprinkler activation time was determined based on the principles in the NFPA Fire Protection Handbook 19th Edition. These calculation have been developed into a detector activation spreadsheet and referenced in industry as a DETACT model. The calculation of sprinkler activation time is a function of ceiling jet temperature, convective heat release rate, radial distance to ceiling height ratio, ceiling jet velocity, and performance characteristic of the sprinklers. To conservatively estimate the time to sprinkler activation, the fire is placed in the middle of four sprinklers. This configuration will produce the greatest distance between sprinkler and the fire plume and thus increase the time to sprinkler activation. The table below shows the input parameters for calculating the estimated time to sprinkler activation.

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Values:</th>
<th>Units:</th>
<th>Conversion:</th>
<th>Units:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ceiling height</td>
<td>12.3</td>
<td>feet</td>
<td>3.7</td>
<td>meters</td>
</tr>
<tr>
<td>sprinkler spacing</td>
<td>11.0</td>
<td>feet</td>
<td>3.4</td>
<td>meters</td>
</tr>
<tr>
<td>Alpha</td>
<td>0.0469</td>
<td>kW/s²</td>
<td>none</td>
<td>same</td>
</tr>
<tr>
<td>convective fraction</td>
<td>0.7</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>actuation temp.</td>
<td>155.0</td>
<td>°F</td>
<td>68.3</td>
<td>°C</td>
</tr>
<tr>
<td>ambient temp.</td>
<td>68.0</td>
<td>°F</td>
<td>20</td>
<td>°C</td>
</tr>
<tr>
<td>RTI value</td>
<td>145.0</td>
<td>(ft-s)½</td>
<td>80.1</td>
<td>(m-s)½</td>
</tr>
<tr>
<td>height of fuel</td>
<td>0</td>
<td>feet</td>
<td>0.0</td>
<td>meters</td>
</tr>
<tr>
<td>fire growth power</td>
<td>2</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>c_p</td>
<td>1.005</td>
<td>kJ/kg·°C</td>
<td>none</td>
<td>same</td>
</tr>
<tr>
<td>G</td>
<td>9.81</td>
<td>m²/s²</td>
<td>none</td>
<td>same</td>
</tr>
<tr>
<td>density of air</td>
<td>1.20</td>
<td>kg/m³</td>
<td>none</td>
<td>same</td>
</tr>
<tr>
<td>r/H</td>
<td>0.63</td>
<td>none</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables:</th>
<th>Values:</th>
<th>Units:</th>
<th>Conversion:</th>
<th>Units:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation time</td>
<td>155</td>
<td>seconds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The ceiling height of the second floor is 12.3 feet. The spacing height, as determined in
proposed sprinkler design in Appendix-B, is 11 feet spacing. An alpha value of 0.047 kW/s² was chosen to represent a fast growing fire as observed in the test data conducted by Walton and Budnick.

The actuation temperature and the RTI value of the sprinkler were determined based on the manufacture data of the pendent sprinklers used in the proposed sprinkler design (Viking 134 Pendent Sprinkler).

The height of the fuel was conservatively chosen to be zero; this condition will prolong the time to activation of the sprinkler. The fire growth power is assumed as a t-squared fire.

The estimated sprinkler activation time is 155 seconds after ignition. The following figure graphically shows the temperatures of the gases, the time to sprinkler activation, and the heat release rate of the fire at the time of sprinkler activation.

![Figure 9: Estimated time to sprinkler activation](image)

From the figure above it is observed that the heat release rate at the time of sprinkler activation is 1100 kW. The sprinkler controlled 1.1 MW maximum heat release rate fire is based on a fast growing t-squared fire as shown in Figure 9 above.
Figure 10 below shows the heat release rate curves of the non-sprinklered and sprinklered condition compared to the test data curve of Walton and Budnick.

![Experimental and Model Analysis HRRs](image)

**Figure 10**: HRR curves for non-sprinklered and sprinklered conditions.

**MODEL LIMITATIONS AND ASSUMPTIONS**

The FDS outputs used for this analysis are focused on determining visibility, toxicity and temperature of the modeled space. As such, FDS is not a quantitative approach to determining and accounting for all the environmental and conditions during a fire. Rather, FDS is only used as a tool for engineering purposes.

The following are limitations to the model:
- Run times and mesh size
- FDS only considers CO formed in the combustion process

The following are assumptions made in the model:
- Fire size and location
- Material properties
- Configuration of space
- Fire doors are open when fire is ignited
- Calculation mesh size of model is 1 foot wide by 1 foot tall by 1 foot long

**TENEBILITY RESULTS**

The FDS model includes the capability to provide visual output that can be viewed in
Smokeview- FDS companion computer software. The FDS user can specify slice files that display output data for every time-step.

For this analysis, slice files were specified for visibility, temperature, and toxicity values. The temperature, visibility, and toxicity were measured at six feet above the walking surface. The tenability limit is considered to have failed when any portion of six foot plane above the walking surface shows that the tenability criteria have reached its limit. Screen-shots were captured from both scenarios for each tenability criterion. The screen captures show visibility slices at 855 seconds (14.25 minutes), which is the total building evacuation time as determined by the performance-based methods described in the performance-based egress section of this report. Screen-shots are captured for both the sprinklered and nonsprinklered conditions at the calculated total building evacuation time.

Table 16 presents a summary of the basic tenability criteria and the worst-case modeling results over a 14.25-minute modeling period.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>CO Limit</th>
<th>CO Maximum Value</th>
<th>Temperature Limit</th>
<th>Temperature Maximum Value</th>
<th>Visibility Limit</th>
<th>Visibility Lowest Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non- sprinklered Building</td>
<td>2,590 ppm</td>
<td>trace</td>
<td>60°C</td>
<td>95°C</td>
<td>33 feet</td>
<td>12 feet</td>
</tr>
<tr>
<td>Sprinklered Building</td>
<td>2,590 ppm</td>
<td>trace</td>
<td>60°C</td>
<td>28°C</td>
<td>33 feet</td>
<td>88 feet</td>
</tr>
</tbody>
</table>

*Red values indicate values that have exceeded the tenability limit for the corresponding criterion.

UNSPRINKLERED BUILDING – EXISTING CONDITION

Visibility

Based on the FDS and the renderings of Smokeview, the visibility of the second floor drops below 33 feet (tenability limit) in an egress path at 8.5 minutes after ignition (See appendix E for Smokeview rendering). By the 14.25 minute, the time determined to be the total building evacuation time, most of the second floor has a visibility of 13 feet. Based on these results the tenability of the second floor has failed.

Temperature

Based on the FDS and the renderings of Smokeview, the temperature of some areas of the second floor rises above 60 degrees Celsius (tenability limit) by 8.25 minute. (See Appendix-E for Smokeview rendering).
Toxicity - CO Concentration

The CO concentration present in the second floor does not reach untenable conditions for the duration required for total building evacuation. The concentration CO does not exceed 100 parts per million. The low level of CO concentration is due to low CO yield of cellullosic material such as paper. For this model, the soot yield of wood products - also cellullosic material - was used as the CO yield input in FDS.

SPRINKLERED BUILDING

Visibility

Based on the FDS and the renderings of Smokeview, the visibility of the second floor never falls below 33 feet (tenability limit) in any portion of the floor (See appendix E for Smokeview rendering). The lowest visibility distance during the time of ignition to the 14.25 minute total building egress time is 88 feet. Visibility Criterion is satisfied.

Temperature

Based on the FDS and the renderings of Smokeview, the temperature six feet above the walking surface never exceeds 28 degrees Celsius in any portion of the floor after 14.25 minutes. (See Appendix-E for Smokeview rendering).

Toxicity

The CO concentration present in the second floor does not reach untenable conditions for the duration required for total building evacuation. The concentration CO does not exceed 80 parts per million. The low level of CO concentration is due to low CO yield of cellullosic material such as paper. For this model, the soot yield of wood products - also cellullosic material - was used as the CO yield input in FDS. In both the sprinklered and nonsprinklered condition the CO concentrations are negligible, but the sprinklered condition reduces the concentration of CO even more than the nonsprinklered condition.

FEASIBILITY OF PROVIDING SPRINKLERS

Based on the results of the CFD model, a sprinkler system would improve the tenability of the Library in the event of a fire. The sprinkler system reduces the heat release rate by about 6 MW and thusly reduces the amount of byproducts produced by a fire.

Below is the heat release rate of the sprinklered building condition and the nonsprinklered condition of the Library.
Sprinklers are not designed to suppress the fire, but are designed to control a fire. That is, a controlled fire is one where spread and growth of the fire is prevented by wetting the area in the vicinity of the fire. The temperature in the area of the fire is also reduced due to the heat absorbed by the droplets of water; less heat is transferred to the environment and is instead used to convert water to vapor.

The time to the first sprinkler activation as calculated in FDS and illustrated in Figure 12, is 280 seconds. The fire was positioned in between four sprinklers spaced 11 feet apart. This configuration produces the most conservative sprinkler activation time because the fire is furthest away from a sprinkler.

The activation time calculated by FDS is greater than the estimated time to sprinkler activation determined by DETACT. The difference between these estimations is 125 seconds. The DETACT estimated time to activation assumed a fast growing fire from the moment of ignition. The fire used in the model initially reflected a medium growing fire until 200 seconds after ignition and then proceeded with a fast growing fire. The heat release rate of the DETACT model increased at a faster rate than FDS heat release rate curve and therefore the sprinkler's fusible link reached its activation temperature at a faster time than the fusible links in the FDS model.
The following performance-based egress analysis is largely based on NFPA 101 Life Safety Code. The current CBC does not address how to conduct performance-based egress analysis, but does permit that a performance-based design be substituted for prescriptive requirements if it meets the life safety goals of the code and the authority having jurisdiction permits the use of performance-based analysis as a substitute for the prescriptive requirements.

**PRE-MOVEMENT ACTIVITIES AND TIMES BASED ON OCCUPANT CHARACTERISTICS**

The Kennedy Library serves predominantly college students (young adults) between 18 and 25 years old. This age group is the healthiest and has the fastest walking speeds based on Table 4.2.1 through 4.2.3 in the 2009 Life Safety Code (LSC).

Occupant characteristics per Section 5.4.5.1 of the 2009 LSC shall be represented as the characteristics of the normal occupant profile. The following are characteristics of occupants that will influence occupants egress times:

- Healthy young adults between the ages of 18 and 25 years
- Educated adults
- Solidarity among fellow university students
- Self involved with work (not respondent to immediate surroundings)
- Unfamiliar with emergency exits
The following are pre-movement activities and times based on occupant characteristics:

- Packing up or putting away personal items (i.e. computer, cell phone, books)
- Waiting for friends/colleagues to pack their personal items.
- Deciding whether to continue with school work or investigate cause of alarm.
- Receive cues from students in their immediate surroundings.

Packing and putting away personal property would be the most common pre-movement activity in an emergency where there is not an immediate danger to the person. Many students carry laptops into the Library to conduct school work that in an event of an emergency the students would take with them. In some instances these computers have cables and mouse-pointers that would also need to be put away by the occupant before initiating egress. The time from initial decision to egress and complete packing time is about one minute and a half, assuming occupant waits to shut down computer, put away cables, and laptop in corresponding carrying bag.

The library also caters to study groups. Study room spaces in the library, particularly on the second floor, have a capacity of up to nine occupants. Where an emergency event ensues, occupants could wait for their friends/colleagues to pack their belongings, as there is a sense of solidarity among fellow university students.

Students frequently listen to music via earphones while conducting school work. The earphones block any external sounds in the occupant’s immediate surroundings potentially extending the occupant’s alarm recognition time and thus increasing the pre-movement time.

**ESTIMATED TOTAL EVACUATION TIME- HAND CALCULATION METHOD**

In the analysis of evacuations times it is paramount that the total estimated evacuation times take into consideration the delay time of occupants. The proceeding methods of estimating total evacuation times assume that all occupants start their egress movements at the same time. These calculated evacuation times often are shorter than the real evacuation times because of the delay time assumptions (Fahy, NFPA Fire Protection Handbook). These methods for estimating evacuation times do not consider behavior or physiological characteristics of the occupant population. The proceeding hand calculation methods are carried out in Appendix-F. The following estimated evacuation times assume that the main stairway (Stairwell #1) is rendered unusable in an emergency; the exit stairwells on the perimeter of the building are the means of egress available to the occupants of floor levels two through five.

*Hydraulic Method*
The first order approximation hydraulic flow model calculation estimates evacuation times based on a series of equations that relate observations and tests. Although the equations correlate absolute relationships, the data acquired has considerable variability (Fahy, NFPA). This method produced an estimated evacuation time for the Library of 11.0 minutes.

The assumptions of the evacuation time analysis for the Library are as follows:

1. **Queuing will occur at exits** - this assumption equates the specific flow \( F_s \) to the maximum specific flow \( F_{sm} \). \( F_s \) is the flow of evacuating people past a point in the exit route. Since specific flows are related to the density of people evacuating, the model uses the optimum density of 0.175 persons/ft\(^2\). These \( F_{sm} \) values are tabulated for various exit route elements in persons/min/ft of effective width.

2. **All occupants start egress at same time** - This assumption produces an evacuation time that underestimates the real total evacuation time of a building. By assuming that all occupants start egress at the same time, no consideration is given to occupants that have longer pre-movement times due to, among others, factors described in Section 4.1 of this report.

3. **The exits are used in optimum balance** - This assumption divides the occupants equally among the exit routes. This assumption can also underestimate the real total evacuation time because occupants in a building will use the closest exit route. If sections of floors in a building have a greater occupant density, certain exits will be overused while others will serve fewer occupants. In other instances an exit might be rendered unusable due to the emergency (i.e., fire). In this case, other exits will have a greater occupant load. This scenario can produce excessive queuing and therefore extend the total evacuation time.

**Paul’s empirical equations**

Paul’s empirical equation produced an evacuation time for the five story Library building of 10.1 minutes. This model is based on observed evacuation times of office buildings. The observed evacuation times were conducted in buildings of eight to 21 stories high. The data produced empirical equations that are extrapolated to analyze taller buildings. Paul’s empirical equations also take into consideration the speed and density of occupants on stairs during an uncontrolled evacuation. Paul’s empirical equations are based on the effective width of the exit elements to account for the propensity of people to sway laterally walking.

The input to Paul’s equation is the buildings population per effective stair width. There is one equation for large populations where the population per effective stair width \( \frac{P}{w_e} \)
exceeds 800. The other equation is for population per effective stair width less than 800. In the evacuation analysis of the Library the equation for population per effective width less than 800 is used, where $P/w_e = 526$ people per effective stair width for floors two through four and $P/w_e = 105$ people per effective stair width for the fifth floor. The applicable equation is:

$$t(min) = 2.0 + 0.0117\left(\frac{P}{w_e}\right)$$

The occupant load of the first floor was excluded because Paul’s equations assume that the people on the first floor will evacuate through other means of egress other than the stairways. Occupants of the first floor using the northeast stairwell exit merge with occupants from other floors and discharge to the exterior. This merger of occupant loads will cause queuing and thus increase the total evacuation time.

The $P/w_e$ for floors two through four are calculated separately from the fifth floor because the fifth floor has three exit stairwell exits, where the other floors have four exit stairways. These evacuations times are added to obtain an estimated evacuation time of 10.1 minutes (See Appendix-F hand calculation of the hydraulic method and Paul’s empirical method).

Design Constraints

The preceding methods for estimating total evacuation times were carried out assuming the main staircase (Stairwell #1) on the south side of the building was rendered unusable during the emergency evacuation.

COMPUTER-BASED EVACUATION TIME

Design Constraints

The computer-based evacuation model used in the analysis of the Library is Pathfinder. Each floor layout of the Library was modeled with its corresponding occupant loads as listed in the occupant load tables of Appendix-D and their corresponding exit capacities. The total occupant load of the building is 2,333. The evacuation model was designed with four exit stairways on the second through fourth floors and three exit stairways on the fifth floor. The first floor was modeled with all its available means of egress as depicted in the egress drawings of Appendix-D.

Assumptions of Analysis

The evacuation model was designed assuming that Stairwell #1 on the south side of the building was rendered unusable during the evacuation.
In the computer analysis the occupant characteristics were changed to reflect occupants less than 30 years old and a male to female percentage of 50% each.

Occupant movements in the model are based on the steering mode model; each occupant in the model maintains a path connecting their current position to a goal point on the navigation mesh. Other factors, such as collisions with other occupants, may cause the occupant to deviate from their intended route, but the motion of the occupant will roughly conform to their chosen path (Thunderhead Engineering: Pathfinder, 2009). This method produces longer evacuation times than the SFPE mode where walking speeds and flow rates through doors and corridors are defined.

The behavior of the occupants was modified in the model to account for pre-movement times. Thirty percent of the occupants in the model had an initial delay time of 90 seconds. The delay represents the pre-movement times of the occupants due to the occupant characteristics stated above.

Results of Computer-based Evacuation Time

The computer-based building evacuation time was estimated to be 795.2 seconds or 13.2 minutes.

![Figure 13: Pathfinder results](image-url)
Pathfinder’s total evacuation time is greater than the first order Hydraulic Model and Paul’s empirical equation total evacuation times. Pathfinder calculated an evacuation time of 13.2 minutes where the Hydraulic Model method and Paul’s equation produced an evacuation time of 11.0 and 10.1 minutes, respectively.

The computer-based egress model produced a greater egress time because the model considered pre-movement times. Some of the occupants in the model had pre-movement times of 90 seconds while others had a no pre-movement time delay. This design approach was elected to account for a wide range of pre-movement time of the occupants.

Model Limitations

The model did not take into consideration the stack area configuration of the various floor layouts. Modeling the stack areas would have restricted the evacuation paths of the occupants in the study and stack areas of the Library and would have produced a longer egress time.

Summary of Total Evacuation Time

Table 17: Summary of total evacuation times for Hydraulic Method, Paul’s Empirical Method, and Pathfinder

<table>
<thead>
<tr>
<th>Floor</th>
<th>Occupant Load</th>
<th>Travel Time Per Person (minute/floor)</th>
<th>Flow From Each Floor (Persons/min)</th>
<th>Exits Per Floor</th>
<th>Evacuation Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>1478</td>
<td>0.6</td>
<td>48</td>
<td>4</td>
<td>8.3</td>
</tr>
<tr>
<td>5</td>
<td>308</td>
<td>0.51</td>
<td>48</td>
<td>3</td>
<td>2.7</td>
</tr>
</tbody>
</table>

SFPE Method Total time= 11.0

Paul’s Empirical Calculation for Total Evacuation Time (min)= 10.1

Pathfinder Egress Time= 13.2
REQUIRED SAFE EGRESS TIME (RSET)

The required safe egress time (RSET) is the time that occupants need to safely evacuate the building. As shown in Figure 14, the RSET starts when a fire has ignited and compounds the time for device detection, alarm warning time, perception and interpretation time and pre-movement time and the movement time of the occupants. The sum of these phases is the RSET for the space or building. To ensure occupant safety the RSET must be less than the Available Safe Egress Time (ASET), the time when the tenability limits have been reached.

![Sequence of occupant response to fires](image_url)

Figure 14: Sequence of occupant response to fires (Proulx, SFPE Handbook, 3rd Edition, Table 3-13.3)

RSET in Analysis

For this analysis, it is assumed that the occupants will become aware of a fire event before the fire is detected by a smoke detector. The smoke detectors in the Library have limited coverage as they are limited to the elevator recall function and the closing of the fire doors throughout the building. Due to the open spaces in the library and the limited smoke detector coverage, the time to detection of a fire by occupants before a smoke detector is assumed to be 60 seconds. An alarm sequence can be initiated by occupants by manual-pull boxes located throughout the Library.

The perception, interpretation and delay time to start movement varies for every occupant as described in the pre-movement activities section of this report (above). The pre-movement time is assumed to be 90 seconds. The movement time is the time it takes an occupant to exit the building. Movement times are calculated with the three methods described above. For this analysis, it is assumed that the time to alarm is 60 seconds and the pre-movement and movement time is 795 seconds as estimated by the Pathfinder computer program. The total building evacuation time is estimated at 855 seconds (60 seconds + 795 seconds = 855 seconds)
The following table summarizes the time required for each egress phase:

<table>
<thead>
<tr>
<th>Egress Phase</th>
<th>Time in Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to alarm</td>
<td>60</td>
</tr>
<tr>
<td>Pre-movement time</td>
<td>795</td>
</tr>
<tr>
<td>Movement time</td>
<td></td>
</tr>
<tr>
<td><strong>Total time:</strong></td>
<td><strong>855</strong></td>
</tr>
</tbody>
</table>

**AVAILABLE SAFE EGRESS TIME (ASET)**

The Available Safe Egress Time is the time from fire ignition to the moment any tenability limit is exceeded. In this analysis, FDS was used to calculate the tenable conditions within the second floor Library based on established fire size, materials and fire protection features of the Library. The calculated outputs of FDS do not consider all environmental conditions and interactions within the Library during a fire event. The outputs are considered conservative estimates of tenability conditions within the Library during a fire event.

**RSET vs ASET**

Figures 15 and 16 below compare the time it takes to reach each tenability limit compared to the RSET for total building evacuation for the non-sprinklered building and sprinklered building conditions.

![RSET vs ASET - Non-Sprinklered](image)

Figure 15: Comparison between RSET and ASET for the non-sprinkler Library building
The non-conforming conditions listed below are based on the requirements of the 2010 CBC as requested by the Client. These conditions can be considered existing non-conforming and would not be required to be updated to comply with current code upon the acceptance of the AHJ.

- Class III standpipes are not provided (Section 907)
- An emergency voice/alarm communication system is not provided (Section 907.2.1.1)
- Automatic sprinkler system is not provided (Section 903.2.1.3)
- Electrical room and non-common use areas open into exit extension on second floor (Section 1023.5).
- Egress passageway on second floor is not separated from Stairwell #1 with a fire door (1022.1).
- Travel distance and common path of travel are exceeded on fifth floor Mechanical Room 509A (Section 1014.3 and 1016.1)
- Width between stack area bookshelves is less than the 36 inch minimum permitted (Section 1028.9.2).
- Audible and visual notification appliance locations do not conform to NFPA 72.

Observed non-compliance during survey of property:

- Combustible material (chairs and books) are stored in the common use office space in the first floor in Space 105.

Figure 16: Comparison between RSET and ASET for the sprinkler Library building
RECOMMENDATIONS

The recommendations below are meant to improve the life safety potential within the Library. It should be understood that no fire protection feature guarantees a fire from occurring or from causing property damage or death. But the integration of various fire protection features can increase the probability of identifying a fire and initiating an appropriate response. These recommendations also entail a cost to implement; as such, stakeholders should be consulted to determine the appropriate, if any, recommended fire protection feature should be installed or developed.

SPRINKLER INSTALLATION

It has been shown in the performance-based analysis portion of this report how a sprinklers system can reduce the effects of combustion byproducts in an area with a high fuel load and increase the life safety potential within a building. Sprinkler installation for the control of fires is the most common method of providing fire suppression.

Other fire suppression systems that utilize chemicals are available and can be considered where water damage to the contents within the property is a concern. These alternate methods of fire suppression are more costly than sprinkler systems.

VISIBLE AND AUDIBLE NOTIFICATION APPLIANCES

Installing additional visible and audible notification appliances can increase the possibility of the occupants becoming aware of an emergency within the Library at a faster time. The additional notification appliances can reduce the perception times of the occupants and potentially reduce the time for total evacuation.

EMERGENCY VOICE/ALARM COMMUNICATION SYSTEM

An emergency voice/alarm communication system, has the same advantages for the Library as the visible and audible notification appliances. In addition to those advantages, the emergency voice/alarm communication system can be used to notify Library occupants of other emergency events such as terrorists threats.

FIRE LIFE SAFETY PLAN

The Cal Poly Campus has a general fire life safety plan that establishes the primary goals of such a plan. The Library should also have its own fire life safety plan as Section 404.5 of the California Fire Code requires all buildings with an occupant load of 500 or to maintain and update a fire life safety plan.

Appendix-F of this report has completed Fire Life Safety Plan for the Kennedy Library of
which the primary objectives of the plan are to ensure:

1. Everyone leaves the building safely;
2. A procedure is in place to safely evacuate individuals who cannot negotiate stairs;
3. Building occupants are accounted for after an emergency evacuation, and
4. Personnel (Building Coordinators) are selected from among building occupants, with functions to ensure plan objectives are met.
APPENDIX A- STRUCTURAL FIRE PROTECTION
Second floor fire resistance-fire rating of shafts and exit enclosures (typical for all floors except the fire barrier for the exit enclosure leading from Stairway #1 to Stairway #5)
APPENDIX B- WATER-BASED SUPPRESSION SYSTEMS
Wet-Pipe Sprinkler Design

Building 35 - Robert E. Kennedy Library
California Polytechnic State University, San Luis Obispo
INTRODUCTION/BACKGROUND

BUILDING CONSTRUCTION
The five-story Kennedy Library (Building-35) is of a concrete frame construction, completed in 1980. The building has computer laboratories, offices, study rooms/areas, and stack areas throughout its five floors. The building is of Type I-A construction per Section 602 and Table 601 of the 2010 CBC.

DESIGN APPROACH
The Kennedy Library was originally designed with a wet-stand pipe system that included fire hose cabinets. Twenty-five sprinklers were attached to the wet-standpipe, strategically placed on floors 1 through 3. Six fire hose cabinets are located on each floor for a total of 30 fire hose cabinets throughout the building. The fire hose cabinets are no longer equipped with hoses for the Class II valve connection in the cabinets; fire extinguishers have replaced the hoses within the hose cabinets.

The design presented in this report is of a wet-pipe sprinkler system in a “tree” configuration with pendent sprinklers per NFPA 13 (2010). The design in this report encompasses only the most hydraulically demanding area for sprinkler operation. It is assumed that the sprinkler system will have the same sprinkler spacing throughout the building. The existing water line from the main water distribution line on the west side of the building will be used to feed the sprinkler system (see Appendix, Figure 1).

BUILDING OCCUPANCY CLASSIFICATION AND DESIGN CRITERIA
The classification of the Kennedy Library is ordinary Hazard (Group 1) based on NFPA 13, section 5.3.2. The Design is based on the density/area method (section 11.2.3.2). Per the density/area method, the density and area of sprinkler coverage for an ordinary hazard (Group 1) classification from Figure 11.2.3.1.1 are 0.15 gpm/ft² and 1500 ft², respectively.

The theoretical water demand for an ordinary hazard (group 1) is:

$$0.15 \text{ gpm/ft}^2(1500 \text{ ft}^2) = 225 \text{ gpm}$$

From Table 11.2.3.1.2 for ordinary hazard, the combined hose-stream demand is 250 gpm for a duration of 90 minutes.

<table>
<thead>
<tr>
<th>Density (gpm/ft²)</th>
<th>Area Sprinkler Operation (ft²)</th>
<th>Nominal Water Demand</th>
<th>Combined H.S. (gpm)</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15</td>
<td>1500</td>
<td>225</td>
<td>250</td>
<td>90</td>
</tr>
</tbody>
</table>

*Table 1-Summary of Design Criteria*
WET-PIPE SPRINKLER DESIGN

SPRINKLER TYPES
Sprinkler heads for this design are Viking standard spray pendent sprinklers with K-Factors of 5.6 and an ordinary temperature rating, SIN: VK134 (see Appendix, Figure 2 for manufacture’s technical data).

PIPE TYPE
Black steel schedule 40 pipe is used for nominal pipe diameters of 1 inch to 2.5 inch; while schedule 10 pipe is used for 3 and 4 inch black-steel pipe. Below is a table with the black steel diameters for the various parts of the sprinkler system.

<table>
<thead>
<tr>
<th>Sprinkler System Section</th>
<th>Nominal Size (in.)</th>
<th>Interior Pipe Diameter (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Schedule 10</td>
<td></td>
</tr>
<tr>
<td>Riser</td>
<td>4</td>
<td>4.26</td>
</tr>
<tr>
<td>Feed Main</td>
<td>3</td>
<td>3.26</td>
</tr>
<tr>
<td></td>
<td>Schedule 40</td>
<td></td>
</tr>
<tr>
<td>Cross Main</td>
<td>2.5</td>
<td>2.469</td>
</tr>
<tr>
<td>Branch Line</td>
<td>1.5</td>
<td>1.61</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Table 2- Black Steel Diameters for Sections of Sprinkler System

DESIGN AREA
The most hydraulically demanding area of the sprinkler system is the northeast side of the 5th floor. The riser is located on the southwest side of the building on the 1st floor (see section Riser Detail of this report). Figure 11.2.3.1.1 of NFPA 13 requires that the area of the sprinkler coverage be 1500 ft² for ordinary hazard (OH1).

The maximum area of coverage per sprinkler for an ordinary hazard is 130 ft² (NFPA 13, Table 8.6.2.2.1 (b)). In this design, 11 ft spacing between sprinklers on the same branch line and 11 ft spacing between branch lines is used. The area of coverage per sprinkler is 121 ft² (11ft x 11ft).

The number of sprinklers (Nₙ) used in the design area based on NFPA 13, section 22.4 is:
The number of sprinklers per branch line with 11 ft spacing is:

\[ N_s = \frac{(1500 \text{ sq. ft})}{(121 \text{ sq. ft})} \]

\[ N_s = 12.4 \approx 13 \text{ sprinkler} \]

The design area is to be of rectangular shape with the side parallel to the branch lines (L) 1.2 times the square root of the design area.

\[ L \geq 1.2\sqrt{1500\text{ sq. ft}} \]
\[ L \geq 46.5 \text{ ft} \]

At 11 ft spacing between sprinklers on branch lines, 5 sprinklers per branch line are needed in the design area (L=55ft > 46.5ft). See Appendix, Figure 3 for design area.

**SPRINKLER LOCATIONS**

**Sprinkler Drop from Branch Lines**

The design area on the northeast side of the 5th floor of the building has false panel ceiling 9 ½ ft from the floor. The sprinkler heads, from ceiling to deflector, drop 1 ½ inches. The sprinklers are attached to a pipe drop from the branch lines of 1 ft (bottom of sprinkler thread to branch line). See Appendix Figure 4 for diagram.

**Spacing From Walls and Obstructions (Light Fixtures)**

Maximum distance from walls per section 8.5.3.2 of NFPA 13 shall not exceed one-half of the allowable maximum distance between sprinklers. For an OH1 standard pendent spray sprinkler the maximum allowable distance between sprinklers is 15 ft. The maximum allowable distance between sprinklers and walls is 7 ½ ft (15ft/2). From the design area in Appendix Figure 3, the maximum distance between walls and sprinklers is 7 ½ ft in the southeast side of the design area. Distance from wall to sprinkler criteria is met.

Section 8.15.9 for library stack areas allows sprinkler position not to consider aisle configurations if the sprinkler deflector is a minimum of 18 inches from the top of book shelves (Appendix Figure 5). For this design, the distance from top of book shelves to
light fixtures is 18 inches; all sprinklers installed will be above the bottom plane of the light fixtures and therefore the distance from the top of the shelves to the sprinkler is greater than 18 inches. Design satisfies section 8.15.9 (Appendix Figure 6).

Section 8.6.5 along with Table 8.6.5.1.2 for obstructions to sprinkler discharge requires that sprinklers located 1 ft to less than 1 ½ ft from an obstruction on the ceiling shall have a maximum distance above bottom of obstruction of 2 ½ inches. In this sprinkler system design the closest sprinkler installed is 1 ft from a light fixture (obstruction). To meet the requirements of the code, the sprinklers 1 ft to 1 ½ ft from a light fixture will require the use of 401-escutcheons so that the sprinkler can drop to 2 ½ inches above the light fixture. All other sprinklers are to be installed flush with the ceiling. See Appendix Figure 3 for distance between sprinklers and light fixtures.
For the calculations presented here, the equivalent K-factors from the 3 branch lines to
the cross main in the design area are calculated first. The calculation at reference points throughout the sprinkler system are then calculated based on the K-factors from the design area branch lines. See Appendix Figure 6 for branch lines.

Also, see Appendix Figure 7, 8, and 9 for calculation reference points throughout building.

**Design Area K-Factors at Cross Main from Branch lines**

<table>
<thead>
<tr>
<th>Sprinkler # / Calc. Ref. Point</th>
<th>Nozzle Ident and Location</th>
<th>Flow in gpm</th>
<th>Pipe size (in.) (Black Steel thru BOR)</th>
<th>Pipe Fittings and Devices</th>
<th>Equivalent Pipe Length (ft)</th>
<th>Friction loss (psi/ft)</th>
<th>Pressure Summary</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BL-1</td>
<td>q</td>
<td>1.5</td>
<td>T-(1)</td>
<td>L 12 C= 120 Pt 10.5</td>
<td>k= 5.6</td>
<td>Q= 18.15</td>
<td>D=0.15 gpm/sq.ft, K=5.6, Q,q(gpm),P(ksi)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q 18.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pt= 10.5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>BL-2</td>
<td>q 18.4</td>
<td>1.5</td>
<td>T-(1)</td>
<td>L 12 C= 120 Pt 10.8</td>
<td>k= 5.6</td>
<td>q=5.6(sqrt(10.8))</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q 37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pt= 1.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>BL-3</td>
<td>q 19.4</td>
<td>2</td>
<td>T-(2)</td>
<td>L 5.5 C= 120 Pt 12.0</td>
<td>k= 5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q 56.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pf= 0.7</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>CM</td>
<td>q</td>
<td></td>
<td></td>
<td>L C= 120</td>
<td>Pt 12.7</td>
<td></td>
<td>K_A= Q/(Pt)^0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q</td>
<td></td>
<td></td>
<td>F</td>
<td>Pe</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T</td>
<td></td>
<td></td>
<td>pf</td>
<td>Pf</td>
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</tr>
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<td>4,9</td>
<td>BL-2,3</td>
<td>q</td>
<td>1.25</td>
<td>90-(1)</td>
<td>L 12 C= 120 Pt 10.5</td>
<td>k= 5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q 18.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pt= 0.4</td>
<td></td>
</tr>
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<td>5,10</td>
<td>BL-2,3</td>
<td>q 18.5</td>
<td>1.25</td>
<td>T-(1)</td>
<td>L 12 C= 120 Pt 10.9</td>
<td>k= 5.6</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Q 37.0</td>
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<td></td>
<td></td>
<td>Pf= 1.9</td>
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<tr>
<td>6,11</td>
<td>BL-2,3</td>
<td>q 20.1</td>
<td>1.5</td>
<td>T-(1)</td>
<td>L 12 C= 120 Pt 12.8</td>
<td>k= 5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q 57.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pf= 2.2</td>
<td></td>
</tr>
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<td>7,12</td>
<td>BL-2,3</td>
<td>q 21.7</td>
<td>1.5</td>
<td>T-(1)</td>
<td>F 8</td>
<td>Pe</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>Q 79</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pf= 4.1</td>
<td></td>
</tr>
<tr>
<td>8,13</td>
<td>BL-2,3</td>
<td>q 24.5</td>
<td>2</td>
<td>T-(1)</td>
<td>L 7.5 C= 120 Pt 19.2</td>
<td>k= 5.6</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q 104.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pf= 1.8</td>
<td></td>
</tr>
<tr>
<td>B,C</td>
<td>CM</td>
<td>q</td>
<td></td>
<td></td>
<td>L C= 120</td>
<td>Pt 20.9</td>
<td></td>
<td>K_{B,C}= 22.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td>Pe</td>
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</table>
### Pipe Flow Information at Reference Points Throughout Sprinkler System

<table>
<thead>
<tr>
<th>Calc Reference Point</th>
<th>Nozzle Ident and Location</th>
<th>Flow in gpm</th>
<th>Pipe size (in.)</th>
<th>Pipe Fittings and Devices</th>
<th>Equivalent Pipe Length (ft)</th>
<th>Friction loss (psi/ft)</th>
<th>Pressure Summary</th>
<th>Notes : Q,q(gpm),P(psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>q</td>
<td>2.5</td>
<td>C-(1)</td>
<td></td>
<td>L 11</td>
<td>C= 120</td>
<td>Pt 12.7</td>
<td>K_A= 15.83</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F 12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 23</td>
<td>pf 0.014</td>
<td>Pf 0.3</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>q</td>
<td>82.0</td>
<td>C-(1)</td>
<td></td>
<td>L 11</td>
<td>C= 120</td>
<td>Pt 13.0</td>
<td>K_B= 22.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F 12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 23</td>
<td>pf 0.072</td>
<td>Pf 1.7</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>q</td>
<td>87</td>
<td>C-(1)</td>
<td></td>
<td>L 5.5</td>
<td>C= 120</td>
<td>Pt 14.7</td>
<td>K_C= 22.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F 12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 17.5</td>
<td>pf 0.177</td>
<td>Pf 3.1</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>q</td>
<td>3(Sch. 10)</td>
<td>90-(2)</td>
<td></td>
<td>L 301</td>
<td>C= 120</td>
<td>Pt 17.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F 14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 315</td>
<td>pf 0.046</td>
<td>Pf 14.4</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>q</td>
<td>4(Sch. 10)</td>
<td>T-(1),90-(1),BV(1),CV(1),GV(1)</td>
<td></td>
<td>L 76.5</td>
<td>C= 120</td>
<td>Pt 32.2</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>F 86</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 162.5</td>
<td>pf 0.012</td>
<td>Pf 2.0</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>B.O.R</td>
<td>6</td>
<td>(Ductile Iron)</td>
<td>90-(2),T-(1), CV-(1)</td>
<td>L 56</td>
<td>C= 140</td>
<td>Pt 59.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F 55</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T 111</td>
<td>pf 0.001</td>
<td>Pf 0.2</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>P.O.C</td>
<td>q</td>
<td></td>
<td></td>
<td>L</td>
<td>C=</td>
<td>Pt 59.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T</td>
<td>pf</td>
<td>Pf</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- B.O.R: Ductile Iron
- P.O.C: Pipe or Coupling
WATER SUPPLY AND DEMAND

The water supply to Building 35 is adequate to serve the fire sprinkler system. Below is the flow test summary sheet.
Supply Analysis

<table>
<thead>
<tr>
<th>Node Source</th>
<th>Static Pressure (psi)</th>
<th>Residual Pressure (psi)</th>
<th>Flow (gpm)</th>
<th>Available Pressure</th>
<th>Total Demand</th>
<th>Required Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>80</td>
<td>70</td>
<td>900</td>
<td>78</td>
<td>475</td>
<td>60</td>
</tr>
</tbody>
</table>

RISER DETAILS
The system riser is to be located in the southwest corner of the building in a mechanical equipment room (Appendix Figure 8 and 9). One riser is used in the design of the sprinkler system since each floor has an area less than 52,000 sq.ft.

COMPONENTS OF RISER

Waterflow Alarm Switch
- Section 6.9.2.4 allows Paddle-type waterflow alarm indicators to be installed in wet systems
- **4” Potter VSR Waterflow Alarm Switch** for steel pipe is to be installed in this system

Double Check Valve
- Per section 8.16.1.1.2.1, Chain and lock OS&Y in open position.
- Install **Flomatic-Model DCV Double Check Valve**.

FDC Check Valve
- Install **4” Flomatic-Model 92 Swing Check Valve**.

In addition, the double check valve assembly is to be equipped with tamper sensor that will relay signal to Cal Poly’s emergency dispatch, per Cal Poly’s Campus Emergency Management Plan.

MAINTENANCE (NFPA 25)

<table>
<thead>
<tr>
<th>Inspection</th>
<th>Item</th>
<th>Frequency</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Valves</td>
<td>Each normally open valve should be secured by means of a seal or lock if not electrically supervised.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly</td>
<td>Water flow Alarm Devices</td>
<td>Quarterly</td>
<td>Check to see if free of physical damage</td>
</tr>
<tr>
<td>Gauges</td>
<td>Ensure that guage is in &quot;good condition&quot; and that supply pressure is being maintained.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly</td>
<td>Hydraulic Nameplate</td>
<td>Quarterly</td>
<td>Verify that it is attached securely to the riser and that the information is clear</td>
</tr>
<tr>
<td>Hangers</td>
<td>Annuals</td>
<td></td>
<td>Visual inspection from floor level.</td>
</tr>
<tr>
<td>Pipe/Sprinklers</td>
<td>Visual inspection from floor level. Check sprinklers for corrosion, damage, paint overspray, and/or other alterations that can affect sprinkler performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>Water flow Alarm Device</td>
<td>Semiannually</td>
<td>For and pressure switch type: If device is monitored by an alarm company be sure to notify them before testing. Open main drain to test.</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------</td>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Gauges</td>
<td>5 year</td>
<td></td>
<td>A gauge can be permitted to have an erro of +/- 3 percent</td>
</tr>
<tr>
<td>Sprinklers</td>
<td>50 years and every 10 years after that</td>
<td></td>
<td>Where sprinklers have been in service for 50 years, they shall be replaced of sample sprinklers in system shall be tested for performance. Then every 10 years after that.</td>
</tr>
</tbody>
</table>

Information based on NFPA 25
Figure 1 - POC to BOR Water Pipe Connection
### Viking Technical Data

**Micromatic® Special Response Sprinklers**

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

#### Approval Chart

<table>
<thead>
<tr>
<th>Sprinkler Style</th>
<th>SIN</th>
<th>Thread Size</th>
<th>Nominal K-Factor</th>
<th>Overall Length</th>
<th>Listings and Approvals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NPT</td>
<td>BSP</td>
<td>U.S.</td>
<td>metric</td>
</tr>
<tr>
<td>Standard Orifice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pendent</td>
<td>09224</td>
<td>1/2&quot;</td>
<td>--</td>
<td>5.6</td>
<td>80.6</td>
</tr>
<tr>
<td>Pendent</td>
<td>09956</td>
<td>1/2&quot;</td>
<td>--</td>
<td>5.6</td>
<td>80.6</td>
</tr>
<tr>
<td>Upright</td>
<td>09226</td>
<td>12&quot;</td>
<td>15 mm</td>
<td>5.6</td>
<td>80.6</td>
</tr>
<tr>
<td>Upright</td>
<td>09959</td>
<td>12&quot;</td>
<td>15 mm</td>
<td>5.6</td>
<td>80.6</td>
</tr>
<tr>
<td>Conventional</td>
<td>09225</td>
<td>12&quot;</td>
<td>15 mm</td>
<td>5.6</td>
<td>80.6</td>
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<tr>
<td>Conventional</td>
<td>09958</td>
<td>12&quot;</td>
<td>15 mm</td>
<td>5.6</td>
<td>80.6</td>
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<tr>
<td>Large Orifice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pendent</td>
<td>09228</td>
<td>3/4&quot;</td>
<td>20 mm</td>
<td>8.0</td>
<td>115.2</td>
</tr>
<tr>
<td>Upright</td>
<td>09227</td>
<td>3/4&quot;</td>
<td>20 mm</td>
<td>8.0</td>
<td>115.2</td>
</tr>
<tr>
<td>Conventional</td>
<td>09229</td>
<td>3/4&quot;</td>
<td>20 mm</td>
<td>8.0</td>
<td>115.2</td>
</tr>
</tbody>
</table>

**Approved Temperature Ratings**
- A - 155°F (68°C), 175°F (79°C), 200°F (93°C), and 286°F (141°C)
- B - 155°F (68°C), 175°F (79°C), and 200°F (93°C)

**Approved Finishes**
1. Brass and Chrome-Enloy®
2. Brass, Chrome-Enloy®, and White Polyester
3. Approved Escutcheons
   - X - Standard surface-mounted escutcheons only
   - Y - Standard surface-mounted escutcheon, the Viking Microfast® Model F-1 Adjustable Escutcheon, or recessed with the Viking Micromatic® Model E-1 or E-2 Recessed Escutcheon

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**Figure 2- Viking Pendent Sprinkler Technical Data**
Figure 3- Sprinkler System Design Area (5th floor Northeast Corner of building)
Figure 4 – Sprinkler Drop from Branch Lines
Figure 5 – Dimensions of Light Fixture and Book Shelves
Figure 6- Branch Lines in Design Area
Figure 7- 5th Floor Sprinkler System Layout
Figure 8- Southside Elevation View with Riser and BOR
Figure 9-Westside Elevation View with Riser and BOR
Figure 10 - Riser Detail of Southwest side of Building
APPENDIX C - FIRE ALARM, DETECTION AND COMMUNICATION
Figure 1- Kennedy Library 1st Floor Fire Alarm Layout
Figure 2- Kennedy Library 2nd Floor Fire Alarm Layout
Figure 3- Kennedy Library 3rd Floor Fire Alarm Layout
Figure 4- Kennedy Library 4th Floor Fire Alarm Layout
Figure 5- Kennedy Library 5th Floor Fire Alarm Layout
<table>
<thead>
<tr>
<th>ZONE</th>
<th>DEVICE</th>
<th>LOCATION</th>
<th>ZONE</th>
<th>DETECTOR #</th>
<th>ROOM #</th>
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<tr>
<td>1</td>
<td>STATIONS</td>
<td>FIRST FLOOR WEST</td>
<td>17</td>
<td>1, 2</td>
<td>509</td>
</tr>
<tr>
<td>2</td>
<td>STATIONS</td>
<td>FIRST FLOOR EAST</td>
<td>18</td>
<td>3, 4</td>
<td>509</td>
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<tr>
<td>3</td>
<td>SMOKE DETECTORS</td>
<td>AUTO. DOOR #1</td>
<td>19</td>
<td>5, 6</td>
<td>509</td>
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<tr>
<td>4</td>
<td>WATER FLOW</td>
<td>ROOM 111</td>
<td>20</td>
<td>7, 8</td>
<td>509</td>
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<tr>
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**Figure 6- FACP Call-Out Zones**
SECOND FLOOR PROPOSED VISUAL/AUDIBLE APPLIANCE PLACEMENT
APPENDIX D- EGRESS ANALYSIS
Legend:

- Component Width factor
- Req'd width
- Prov'd width
- Occ. Load
- Capacity

Exiting Occupants
Converging Occupants

Exit Access Travel Distance
Common Path of Egress Travel

Note: Capacity of exit enclosures is based on stair width-the egress component with the least capacity
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<th>Use</th>
<th>DLF (ft²)</th>
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Total occupant load of floor = 631
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<th>Area (ft²)</th>
<th>Use</th>
<th>OLF (ft²/Occupant)</th>
<th>Occupant Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>0301-00</td>
<td>Lib SpecStdy</td>
<td>486</td>
<td>B</td>
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</tr>
<tr>
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<td>Lib SpecStdy</td>
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<td>Use</td>
<td>OLF (ft²/Occupants)</td>
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</tr>
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Total occupant load of floor = 468
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<td>OLF (ft² / Occupants)</td>
<td>Occupant Load</td>
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Total occupant load of floor = 379
## Fifth floor occupant load per room

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<td>Use</td>
<td>OLF (ft² / Occupant)</td>
<td>Occupant Load</td>
</tr>
<tr>
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Total occupant load of floor = 308
APPENDIX E - PERFORMANCE-BASED DESIGN
Visibility on the second floor of the Library after 13.2 minutes without sprinklers

Time and location where the visibility limit is first reached in an egress path (circled in blue)- Non-sprinklered building.
Temperature of the second floor Library measured on the horizontal plane six feet above the walking surface at 8.25 minutes (non-sprinklered building). Temperature tenability limit of 60 degrees Celsius exceeded.

Carbon-monoxide concentrations after 14.25 minutes for a nonsprinklered building. Carbon-monoxide toxicity limit was not reached.
Visibility on the second floor of the Library after 14.25 minutes with sprinkler system installed. Visibility limit of 33 feet not reached; lowest visibility value on the second floor is 88 feet.

Temperature of the second floor Library measured on the horizontal plane six feet above the walking surface at 14.25 minutes with a sprinklered system installed. Temperature did not exceed tenability limit of 60 degrees Celsius; highest temperature on second floor is 28 degrees Celsius.
Carbon-monoxide concentrations after 14.25 minutes with a sprinklered system installed. Carbon-monoxide toxicity limit was not reached.
NON-SPRINKLERED LIBRARY

&HEAD CHID='2nd_floor_unsprinklered'/
&TIME T_END=855.0/
&DUMP RENDER_FILE='2nd_floor_unsprinklered.ge1'/
&RADI RADTMP=900.0/

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&MESH ID='MESH2', IJK=128,80,15, XB=185.014,224.028,15.8496,40.2336,0.0,4.572/
&MESH ID='MESH3', IJK=135,108,15, XB=182.88,224.028,40.2336,73.152,0.0,4.572/
&MESH ID='MESH4', IJK=125,108,15, XB=224.028,262.128,40.2336,73.152,0.0,4.572/

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C=6.0,
H=10.0,
O=5.0,
N=0.0,
X_O2_LL=0.0,
HEAT_OF_COMBUSTION=1.8336E4,
CO_YIELD=0.005,
SOOT_YIELD=0.015,
MAXIMUM_VISIBILITY=60.96,
VISIBILITY_FACTOR=8.0/

FIRE GROWTH

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&RAMP ID='Fire_RAMP_Q', T=25.0, F=0.001/
&RAMP ID='Fire_RAMP_Q', T=50.0, F=0.002/
&RAMP ID='Fire_RAMP_Q', T=75.0, F=0.0029/
&RAMP ID='Fire_RAMP_Q', T=100.0, F=0.01/
&RAMP ID='Fire_RAMP_Q', T=125.0, F=0.02/
&RAMP ID='Fire_RAMP_Q', T=150.0, F=0.025/
&RAMP ID='Fire_RAMP_Q', T=175.0, F=0.03/
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&RAMP ID='Fire_RAMP_Q', T=250.0, F=0.116/
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&RAMP ID='Fire_RAMP_Q', T=325.0, F=0.366/
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&RAMP ID='Fire_RAMP_Q', T=375.0, F=0.508/
&RAMP ID='Fire_RAMP_Q', T=400.0, F=0.5787/
&RAMP ID='Fire_RAMP_Q', T=425.0, F=0.649/
&RAMP ID='Fire_RAMP_Q', T=450.0, F=0.72/
&RAMP ID='Fire_RAMP_Q', T=475.0, F=0.79/
&RAMP ID='Fire_RAMP_Q', T=500.0, F=0.86/
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&RAMP ID='Fire_RAMP_Q', T=550.0, F=1.0/
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   ALPHA_E=1.8,
   BETA_E=-1.0,
   ALPHA_C=1.0,
   BETA_C=0.8/
&DEVIC ID='SD- double door by open stair', PROP_ID='Cleary Photoelectric P1',
XYZ=238.506,21.8237,3.6576/
&DEVIC ID='SD2', PROP_ID='Cleary Photoelectric P1', XYZ=230.673,18.8062,3.6576/
&DEVIC ID='SD3- Passenger Elevator', PROP_ID='Cleary Photoelectric P1',
XYZ=197.663,34.7167,3.6576/
&DEVIC ID='THCP- fire door', QUANTITY='THERMOCOUPLE',
XYZ=238.506,21.8237,1.8288/
&DEVIC ID='THCP02', QUANTITY='THERMOCOUPLE', XYZ=245.059,29.2608,1.8288/
&DEVIC ID='THCP03', QUANTITY='THERMOCOUPLE', XYZ=245.059,39.1363,1.8288/
&DEVIC ID='THCP04- door, exit passageway', QUANTITY='THERMOCOUPLE',
XYZ=245.455,14.478,1.8288/
&DEVIC ID='THCP', QUANTITY='THERMOCOUPLE', XYZ=249.631,44.8056,1.8288/
&DEVIC ID='THCP04', QUANTITY='THERMOCOUPLE', XYZ=236.525,21.9456,1.8288/
&DEVIC ID='THCP05-near fire', QUANTITY='THERMOCOUPLE',
XYZ=263.347,17.6784,1.8288/

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INITIAL_STATE=.TRUE., INPUT_ID='tdelay'/
&CTRL ID='tdelay', FUNCTION_TYPE='TIME_DELAY', DELAY=2.0, LATCH=.FALSE.,
INPUT_ID='latch' /
&CTRL ID='latch', FUNCTION_TYPE='ALL', LATCH=.TRUE., INPUT_ID='or' /
&CTRL ID='or', FUNCTION_TYPE='ANY', LATCH=.FALSE., INPUT_ID='SD- double door by open stair','SD2','SD3- Passenger Elevator'/

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   SPECIFIC_HEAT=0.75,
   CONDUCTIVITY=1.6,
   DENSITY=2400.0/
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   FYI='Gyp Wall for interior partitions',
   SPECIFIC_HEAT=1.1,
   CONDUCTIVITY=0.17,
   DENSITY=960.0/

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   FYI='Walls',
   RGB=146,202,166,
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   MATL_MASS_FRACTION(1,1)=1.0,
   THICKNESS(1)=0.25/
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   FYI='interior walls',
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   MATL_MASS_FRACTION(1,1)=1.0,
   THICKNESS(1)=0.25/
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BOUNDARY PARAMETERS

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Obstruction
&OBST XB=237.859,240.385,64.7508,65.0008,0.0,3.75, SURF_ID='Concrete'/
Obstruction
&OBST XB=244.754,245.004,30.4354,37.7506,0.0,3.75, SURF_ID='Concrete'/
Obstruction
&OBST XB=257.7,258.7,17.2,18.2,0.0,0.1524, SURF_IDS='Fire','INERT','INERT',
TEXTURE_ORIGIN=0.0,-0.1524,0.0/ fire setting
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SURF_ID='INERT'/ Ceiling
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&OBST XB=242.011,265.481,10.0584,16.764,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=185.928,224.028,27.7368,30.48,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=196.596,224.028,16.764,27.7368,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=196.596,224.028,30.48,40.2336,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=183.185,224.028,53.9496,65.2272,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=183.794,196.901,67.9704,71.628,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=183.794,224.028,65.2272,67.9704,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=192.634,224.028,44.196,47.244,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=192.938,224.028,47.244,51.2064,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=194.158,224.028,51.2064,53.9496,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=196.596,224.028,40.2336,44.196,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=203.911,224.028,67.9704,71.628,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,238.049,67.9704,71.628,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,251.765,44.8056,57.912,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,257.556,57.912,58.2168,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,258.775,58.2168,67.9704,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=242.028,231.038,16.764,17.0688,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=224.028,245.059,20.1168,20.4216,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=231.038,231.343,17.0688,20.1168,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=231.343,242.316,16.764,17.0688,0.0,3.6576, SURF_ID='INERT'
Obstruction &OBST XB=232.562,238.354,23.7744,24.0792,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=235.306,235.61,24.0792,40.216,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=242.011,242.316,10.0584,16.764,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=244.754,245.059,10.0584,15.5448,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=244.754,245.059,15.8496,20.1168,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=244.754,247.802,15.8496,27.7368,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=245.059,245.364,20.4216,27.7368,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=245.059,247.802,27.7368,28.0416,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=247.498,247.802,15.8496,27.7368,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=260.909,261.214,30.7848,40.2336,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=260.909,265.481,30.7848,30.8416,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=265.176,265.481,10.0584,30.7848,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=231.038,231.343,16.764,17.0688,0.0,0.0, SURF_ID='INERT'/ Obstruction &OBST XB=231.038,231.343,16.764,17.0688,3.6576,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=231.038,231.343,16.764,16.764,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=242.316,244.754,10.0584,10.0584,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=245.059,265.176,10.0584,10.0584,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=232.562,232.562,20.4216,23.7744,0.0,3.6576, SURF_ID='INERT'/ Obstruction &OBST XB=199.644,199.949,32.6136,36.576,0.0,3.6576, SURF_ID='Partition Walls','INERT','Partition Walls','INERT'/ Obstruction &OBST XB=199.644,199.949,39.0144,40.2336,0.0,3.6576, SURF_ID='Partition Walls','INERT','Partition Walls','INERT'/ Obstruction &OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID='Partition Walls','INERT','Partition Walls','INERT'/ Obstruction &OBST XB=199.644,202.387,36.576,36.8808,0.0,3.6576, SURF_ID='Partition Walls','INERT','Partition Walls','INERT'
Walls', 'INERT', 'Partition Walls', 'INERT', 'INERT'/ Obstruction
&OBST XB=199.644,203.911,38.7096,39.0144,0.0,3.6576, SURF_ID6='Partition Walls', 'INERT', 'Partition Walls', 'INERT', 'INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls', 'INERT', 'Partition Walls', 'INERT', 'INERT'/ Obstruction
&OBST XB=202.387,206.35,34.4424,34.7472,0.0,3.6576, SURF_ID6='INERT', 'INERT', 'Partition Walls', 'INERT', 'INERT'/ Obstruction
&OBST XB=203.606,203.911,37.4904,38.7096,0.0,3.6576, SURF_ID6='Partition Walls', 'INERT', 'Partition Walls', 'Partition Walls', 'INERT', 'INERT'/ Obstruction
&OBST XB=206.35,206.654,20.4216,34.7472,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=206.35,224.028,20.1168,20.4216,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=202.387,202.387,32.6136,34.4424,0.0,3.6576, SURF_ID6='INERT', 'Partition Walls', 'INERT', 'INERT', 'INERT', 'INERT'/ Obstruction
&OBST XB=202.387,202.387,36.8808,37.1856,0.0,3.6576, SURF_ID6='Partition Walls', 'Partition Walls', 'Partition Walls', 'Partition Walls', 'INERT', 'INERT'/ Obstruction
&OBST XB=185.928,186.233,28.0416,30.48,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=185.928,196.901,27.7368,28.0416,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=196.596,196.901,17.0688,27.7368,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=196.596,196.901,30.48,40.2336,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=196.596,224.028,16.764,17.0688,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=186.233,196.596,30.48,30.48,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=183.185,183.49,54.2544,61.8744,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=183.185,196.901,53.9496,54.2544,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=183.185,196.901,61.8744,62.1792,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=183.794,184.099,65.2272,71.628,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=192.634,192.938,44.5008,47.244,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=192.634,196.901,44.196,44.5008,0.0,3.6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=194.158,194.462,51.2064,53.9496,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=196.596,196.901,40.2336,44.196,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=196.596,196.901,62.1792,64.6176,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=196.596,196.901,64.9224,71.628,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=196.596,203.911,64.6176,64.9224,0.0,3.6576, SURF_ID='INERT','Concrete','Concrete','Concrete','Concrete','Concrete'/
Obstruction
&OBST XB=203.911,204.216,65.532,67.9704,0.0,3.6576, SURF_ID='Concrete'/
Obstruction
&OBST XB=203.911,204.216,68.2752,71.628,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=203.911,210.922,67.9704,68.2752,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=210.617,210.922,68.2752,71.628,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=184.099,196.596,71.628,71.628,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=192.938,194.158,51.2064,51.2064,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=196.901,203.911,67.9704,67.9704,0.0,3.6576, SURF_ID='INERT'/
Obstruction
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Obstruction
&OBST XB=210.922,224.028,71.628,71.628,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=192.938,192.938,47.244,51.2064,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=203.911,203.911,62.1792,64.6176,0.0,3.6576, SURF_ID='Concrete'/
Obstruction
&OBST XB=203.911,203.911,64.9224,65.532,0.0,3.6576, SURF_ID='Concrete'/
Obstruction
&OBST XB=199.644,199.949,40.2336,41.4528,0.0,3.6576, SURF_ID='Partition
Walls','INERT','Partition Walls','Partition Walls','INERT','INERT'/
Obstruction
&OBST XB=199.644,206.654,41.4528,41.7576,0.0,3.6576, SURF_ID='Partition
Walls','Partition Walls','INERT','Partition Walls','INERT','INERT'/
Obstruction
&OBST XB=206.654,224.028,41.4528,41.7576,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=237.744,238.049,67.9704,71.628,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=240.487,245.364,64.6176,64.9224,0.0,3.6576, SURF_ID='Concrete'/
Obstruction
&OBST XB=245.059,245.364,62.1792,64.6176,0.0,2.7432, SURF_ID='Concrete'
Obstruction
&OBST XB=245.059, 245.364, 64.9224, 67.9704, 0.0, 2.7432, SURF_ID='Concrete'/ Obstruction
&OBST XB=245.059, 245.364, 67.9704, 71.628, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=251.765, 257.556, 57.912, 58.2168, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=251.765, 261.214, 44.5008, 48.8056, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=258.47, 258.775, 58.2168, 71.628, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=260.909, 261.214, 40.2336, 44.5008, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=224.028, 237.744, 71.628, 71.628, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=238.049, 245.059, 67.9704, 67.9704, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=245.364, 258.47, 71.628, 71.628, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=257.556, 258.47, 58.2168, 58.2168, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=251.765, 251.765, 44.8056, 57.912, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=224.028, 235.61, 41.4528, 41.7576, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=235.306, 235.61, 40.2336, 41.4528, 0.0, 3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=245.059, 245.364, 40.5384, 44.5008, 0.0, 3.6576, SURF_ID='Concrete'/ Obstruction
&OBST XB=245.059, 247.802, 40.2336, 40.5384, 0.0, 3.6576, SURF_ID='Concrete'/ Obstruction
&OBST XB=245.059, 247.802, 44.5008, 44.8056, 0.0, 3.6576, SURF_ID='Concrete'/ Obstruction
&OBST XB=247.498, 247.802, 40.5384, 44.5008, 0.0, 3.6576, SURF_ID='Concrete'/ Obstruction

&HOLE XB=233.125, 235.716, 20.2065, 20.4565, -0.03048, 3.0/ Hole
&HOLE XB=231.142, 231.392, 17.605, 19.7386, -0.03048, 2.75, CTRL_ID='CTRL'/ Hole
&HOLE XB=206.654, 224.058, 24.0792, 40.2641, 3.6576, 3.9624/ Hole[1]
&HOLE XB=206.654, 224.058, 40.2031, 41.4528, 3.6576, 3.9624/ Hole[1]
&HOLE XB=223.998, 235.306, 40.2031, 41.4528, 3.6576, 3.9624/ Hole[1]
&HOLE XB=238.049, 238.354, 20.7264, 22.86, -0.03048, 2.7432, CTRL_ID='CTRL'/ Hole

&VENT SURF_ID='OPEN', XB=269.748, 269.748, 3.6576, 40.2336, 0.0, 4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH1 [XMAX]
&VENT SURF_ID='OPEN', XB=265.176,269.748,40.2336,40.2336,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH1 [YMAX]
&VENT SURF_ID='OPEN', XB=224.028,269.748,3.6576,3.6576,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH1 [YMIN]
&VENT SURF_ID='OPEN', XB=224.028,269.748,40.2336,40.2336,0.0,0.0, COLOR='INVISIBLE'/ Mesh Vent: MESH1 [ZMAX]
&VENT SURF_ID='OPEN', XB=224.028,269.748,3.6576,40.2336,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH1 [ZMIN]
&VENT SURF_ID='OPEN', XB=178.308,178.308,3.6576,40.2336,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH2 [XMIN]
&VENT SURF_ID='OPEN', XB=178.308,224.028,40.2336,40.2336,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH2 [YMAX]
&VENT SURF_ID='OPEN', XB=178.308,224.028,3.6576,3.6576,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH2 [YMIN]
&VENT SURF_ID='OPEN', XB=178.308,224.028,3.6576,40.2336,4.572,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH2 [ZMAX]
&VENT SURF_ID='OPEN', XB=178.308,224.028,3.6576,40.2336,0.0,0.0, COLOR='INVISIBLE'/ Mesh Vent: MESH2 [ZMIN]
&VENT SURF_ID='OPEN', XB=182.88,182.88,40.2336,73.152,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH3 [XMIN]
&VENT SURF_ID='OPEN', XB=182.88,224.028,73.152,73.152,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH3 [YMAX]
&VENT SURF_ID='OPEN', XB=182.88,224.028,73.152,73.152,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH3 [YMIN]
&VENT SURF_ID='OPEN', XB=182.88,224.028,40.2336,73.152,4.572,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH3 [ZMAX]
&VENT SURF_ID='OPEN', XB=182.88,224.028,40.2336,73.152,0.0,0.0,0, COLOR='INVISIBLE'/ Mesh Vent: MESH3 [ZMIN]
&VENT SURF_ID='OPEN', XB=265.176,265.176,40.2336,73.152,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH4 [XMAX]
&VENT SURF_ID='OPEN', XB=224.028,265.176,73.152,73.152,0.0,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH4 [YMAX]
&VENT SURF_ID='OPEN', XB=224.028,265.176,40.2336,73.152,4.572,4.572, COLOR='INVISIBLE'/ Mesh Vent: MESH4 [ZMAX]
&VENT SURF_ID='OPEN', XB=224.028,265.176,40.2336,73.152,0.0,0.0,0, COLOR='INVISIBLE'/ Mesh Vent: MESH4 [ZMIN]

SLICE FILES

&SLCF QUANTITY='TEMPERATURE', PBZ=1.8288/
&SLCF QUANTITY='VISIBILITY', PBZ=1.8288/
&SLCF QUANTITY='VOLUME FRACTION', SPEC_ID='carbon monoxide', PBZ=1.8288/
&SLCF QUANTITY='MASS FRACTION', SPEC_ID='carbon monoxide', PBZ=1.8288/
&SLCF QUANTITY='TEMPERATURE', PBY=17.5948/
&SLCF QUANTITY='VISIBILITY', PBX=258.157/
&SLCF QUANTITY='VISIBILITY', PBY=17.5948/
&SLCF QUANTITY='TEMPERATURE', PBX=243.607/
&SLCF QUANTITY='TEMPERATURE', PBY=18.489/
&SLCF QUANTITY='TEMPERATURE', PBX=198.366/
&SLCF QUANTITY='VISIBILITY', PBX=243.607/
&SLCF QUANTITY='VISIBILITY', PBY=18.489/
&SLCF QUANTITY='VISIBILITY', PBX=198.366/
&SLCF QUANTITY='VISIBILITY', PBY=43.1001/
&SLCF QUANTITY='TEMPERATURE', PBX=258.157/

&TAIL /
SPRINKLERED BUILDING

&HEAD CHID='2nd_floor_SPRINKLERED'
&TIME T_END=855.0/
&DUMP RENDER_FILE='2nd_floor_SPRINKLERED.ge1'
&RADI RADTMP=900.0/

&MESH ID='MESH1', IJK=144,100,15, XB=224.028,267.919,9.7536,40.2336,0.0,4.572/
&MESH ID='MESH2', IJK=128,80,15, XB=185.014,224.028,15.8496,40.2336,0.0,4.572/
&MESH ID='MESH3', IJK=135,108,15, XB=182.88,224.028,40.2336,73.152,0.0,4.572/
&MESH ID='MESH4', IJK=125,108,15, XB=224.028,262.128,40.2336,73.152,0.0,4.572/

CHEMICAL REACTION

&REAC ID='FIRE',
   FYI='NFPA HK, 20th edition and SFPE FPE 3rd Ed.',
   C=6.0,
   H=10.0,
   O=5.0,
   N=0.0,
   X_O2_LL=0.0,
   HEAT_OF_COMBUSTION=1.8336E4,
   CO_YIELD=0.005,
   SOOT_YIELD=0.015,
   MAXIMUM_VISIBILITY=60.96,
   VISIBILITY_FACTOR=8.0/

FIRE GROWTH

&RAMP_Q='Fire_RAMP_Q'/
&RAMP ID='Fire_RAMP_Q', T=0.0, F=0.0/
&RAMP ID='Fire_RAMP_Q', T=25.0, F=0.001/
&RAMP ID='Fire_RAMP_Q', T=50.0, F=0.002/
&RAMP ID='Fire_RAMP_Q', T=75.0, F=0.018/
&RAMP ID='Fire_RAMP_Q', T=100.0, F=0.04/
&RAMP ID='Fire_RAMP_Q', T=125.0, F=0.06/
&RAMP ID='Fire_RAMP_Q', T=150.0, F=0.105/
&RAMP ID='Fire_RAMP_Q', T=175.0, F=0.2/
&RAMP ID='Fire_RAMP_Q', T=200.0, F=0.293/
&RAMP ID='Fire_RAMP_Q', T=225.0, F=0.437/
&RAMP ID='Fire_RAMP_Q', T=250.0, F=0.723/
&RAMP ID='Fire_RAMP_Q', T=275.0, F=1.0/
&RAMP ID='Fire_RAMP_Q', T=855.0, F=1.0/
DEVICES

&PROP ID='Cleary Photoelectric P1',
   QUANTITY='CHAMBER OBSCURATION',
   ALPHA_E=1.8,
   BETA_E=-1.0,
   ALPHA_C=1.0,
   BETA_C=-0.8/
&PART ID='Water',
   WATER=.TRUE.,
   AGE=60.0,
   SPECIFIC_HEAT=4.184,
   MELTING_TEMPERATURE=0.0,
   VAPORIZATION_TEMPERATURE=100.0,
   HEAT_OF_VAPORIZATION=2259.0/
&PROP ID='Default_Water Spray',
   QUANTITY='SPRINKLER LINK TEMPERATURE',
   INITIAL_TEMPERATURE=20.0,
   ACTIVATION_TEMPERATURE=68.3333,
   RTI=80.0526,
   PART_ID='Water',
   FLOW_RATE=68.88,
   FLOW_TAU=-3.0,
   DROPLET_VELOCITY=5.0/

&DEVC ID='SD- double door by open stair', PROP_ID='Cleary Photoelectric P1',
   XYZ=238.506,21.8237,3.6576/
&DEVC ID='SD2', PROP_ID='Cleary Photoelectric P1', XYZ=230.673,18.8062,3.6576/
&DEVC ID='SD3- Passenger Elevator', PROP_ID='Cleary Photoelectric P1',
   XYZ=197.663,34.7167,3.6576/
&DEVC ID='SPRK106', PROP_ID='Default_Water Spray', XYZ=259.59,12.4023,3.6576/
&DEVC ID='SPRK107', PROP_ID='Default_Water Spray',
   XYZ=256.237,12.4023,3.6576/
&DEVC ID='SPRK- SE of fiire', PROP_ID='Default_Water Spray',
   XYZ=259.59,15.7551,3.6576/
&DEVC ID='SPRK- SW of fire', PROP_ID='Default_Water Spray',
   XYZ=256.237,15.7551,3.6576/
&DEVC ID='SPRK- NE of fire', PROP_ID='Default_Water Spray',
   XYZ=259.59,19.1079,3.6576/
&DEVC ID='SPRK-NW of fire', PROP_ID='Default_Water Spray',
   XYZ=256.237,19.1079,3.6576/
&DEVC ID='THCP- fire door', QUANTITY='THERMOCOUPLE',
   XYZ=238.506,21.8237,1.8288/
&DEVC ID='THCP02', QUANTITY='THERMOCOUPLE', XYZ=245.059,29.2608,1.8288/
&DEVC ID='THCP03', QUANTITY='THERMOCOUPLE', XYZ=245.059,39.1363,1.8288/
&DEVC ID='THCP04-door, exit passageway', QUANTITY='THERMOCOUPLE', XYZ=245.455,14.478,1.8288/
&DEVC ID='THCP', QUANTITY='THERMOCOUPLE', XYZ=249.631,44.8056,1.8288/
&DEVC ID='THCP04', QUANTITY='THERMOCOUPLE', XYZ=236.525,21.9456,1.8288/
&DEVC ID='THCP05-near fire', QUANTITY='THERMOCOUPLE',
XYZ=263.347,17.6784,1.8288/

&CTRL ID='CTRL', FUNCTION_TYPE='ALL', LATCH=.FALSE., INITIAL_STATE=.TRUE., INPUT_ID='tdelay'/
&CTRL ID='tdelay', FUNCTION_TYPE='TIME_DELAY', DELAY=2.0, LATCH=.FALSE., INPUT_ID='latch'/
&CTRL ID='latch', FUNCTION_TYPE='ALL', LATCH=.TRUE., INPUT_ID='or'/
&CTRL ID='or', FUNCTION_TYPE='ANY', LATCH=.FALSE., INPUT_ID='SD-double door by open stair', 'SD2', 'SD3-Passenger Elevator'/

BOUNDARY MATERIAL

&MATL ID='Concrete Material',
  FYI='concrete walls',
  SPECIFIC_HEAT=0.75,
  CONDUCTIVITY=1.6,
  DENSITY=2400.0/
&MATL ID='Gypsum',
  FYI='Gyp Wall for interior partitions',
  SPECIFIC_HEAT=1.1,
  CONDUCTIVITY=0.17,
  DENSITY=960.0/

&SURF ID='Concrete',
  FYI='Walls',
  RGB=146,202,166,
  MATL_ID(1,1)='Concrete Material',
  MATL_MASS_FRACTION(1,1)=1.0,
  THICKNESS(1)=0.25/
&SURF ID='Partition Walls',
  FYI='interior walls',
  RGB=204,0,204,
  MATL_ID(1,1)='Gypsum',
  MATL_MASS_FRACTION(1,1)=1.0,
  THICKNESS(1)=0.25/
&SURF ID='Fire',
Maryland: 1988',
  COLOR='RED',
  HRRPUA=1000.0,
BOUNDARY PARAMETERS

&OBST XB=217.322,224.637,51.0094,51.2594,0.0,3.75, SURF_ID='Concrete'/ Obstruction
&OBST XB=237.849,238.099,62.191,68.0782,0.0,3.75, SURF_ID='Concrete'/ Obstruction
&OBST XB=237.859,240.385,64.7508,65.0008,0.0,3.75, SURF_ID='Concrete'/ Obstruction
&OBST XB=244.754,245.004,30.4354,37.7506,0.0,3.75, SURF_ID='Concrete'/ Obstruction
&OBST XB=257.7,258.7,17.2,18.2,0.0,0.1524, SURF_IDS='Fire','INERT','INERT', TEXTURE_ORIGIN=0.0,-0.1524,0.0/ fire setting
&OBST XB=185.928,224.028,27.7368,30.48,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=196.596,224.028,16.764,27.7368,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=196.596,224.028,30.48,40.2336,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=183.185,224.028,53.9496,65.2272,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=183.794,196.901,67.9704,71.628,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=183.794,224.028,65.2272,67.9704,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=183.794,224.028,44.196,47.244,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=192.938,224.028,47.244,51.2064,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=194.158,224.028,51.2064,53.9496,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=196.596,224.028,40.2336,44.196,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=203.911,224.028,67.9704,71.628,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,238.049,67.9704,71.628,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,251.765,44.8056,57.912,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,257.556,57.912,58.2168,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,258.775,58.2168,67.9704,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,261.214,40.2336,44.8056,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=245.059,258.775,67.9704,71.628,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,261.214,30.7848,40.2336,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=224.028,265.481,16.764,30.7848,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=242.011,265.481,10.0584,16.764,3.6576,3.9624, COLOR='INVISIBLE', SURF_ID='INERT'/ Ceiling
&OBST XB=185.928,186.233,28.0416,30.48,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=185.928,196.901,27.7368,28.0416,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=196.596,196.901,17.0688,27.7368,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=196.596,196.901,30.48,40.2336,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=186.233,196.596,30.48,30.48,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=183.185,183.49,54.2544,54.2544,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=183.185,184.099,64.9224,65.2272,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=183.185,184.099,64.9224,65.2272,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=183.185,194.462,53.9496,54.2544,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=183.185,196.901,61.8744,62.1792,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=183.794,184.099,65.2272,71.628,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=192.634,192.938,44.5008,47.244,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=192.634,196.901,44.196,44.5008,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=194.158,194.462,51.2064,53.9496,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=196.596,196.901,40.2336,44.196,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=196.596,196.901,62.1792,64.6176,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=196.596,196.901,64.9224,71.628,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=196.596,203.911,64.6176,64.9224,0.0,3.6576, SURF_ID6='INERT','Concrete','Concrete','Concrete','Concrete','Concrete'/ Obstruction
&OBST XB=203.911,204.216,65.532,67.9704,0.0,3.6576, SURF_ID='Concrete'/Obstruction
&OBST XB=203.911,204.216,68.2752,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=203.911,210.922,67.9704,68.2752,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=210.617,210.922,68.2752,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=184.099,196.596,71.628,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=192.938,194.158,51.2064,51.2064,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=196.901,203.911,67.9704,67.9704,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=204.216,210.617,71.628,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=210.922,224.028,71.628,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=203.911,203.911,62.1792,64.6176,0.0,3.6576, SURF_ID='Concrete'/Obstruction
&OBST XB=203.911,203.911,64.9224,65.532,0.0,3.6576, SURF_ID='Concrete'/Obstruction
&OBST XB=237.744,238.049,67.9704,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=240.487,245.364,64.6176,64.9224,0.0,3.6576, SURF_ID='Concrete'/Obstruction
&OBST XB=245.059,245.364,62.1792,64.6176,0.0,2.7432, SURF_ID='Concrete'/Obstruction
&OBST XB=245.059,245.364,64.9224,67.9704,0.0,2.7432, SURF_ID='Concrete'/Obstruction
&OBST XB=245.059,245.364,67.9704,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=251.765,257.556,57.912,58.2168,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=251.765,261.214,44.5008,44.8056,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=258.47,258.775,58.2168,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=260.909,261.214,40.2336,44.5008,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=224.028,237.744,71.628,71.628,0.0,3.6576, SURF_ID='INERT'/Obstruction
&OBST XB=238.049,245.059,67.9704,67.9704,0.0,3.6576, SURF_ID='INERT'/
Obstruction
&OBST XB=245.364,258.47,71.628,71.628,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=257.556,258.47,58.2168,58.2168,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=251.765,251.765,44.8056,57.912,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=199.644,199.949,32.6136,36.576,0.0,3.6576, SURF_ID6='Partition Walls','INERT','Partition Walls','Partition Walls','INERT','INERT'/ Obstruction
&OBST XB=199.644,199.949,39.0144,40.2336,0.0,3.6576, SURF_ID6='Partition Walls','INERT','Partition Walls','INERT','INERT', 'INERT'/ Obstruction
&OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID6='Partition Walls','Partition Walls','INERT','INERT', 'INERT'/ Obstruction
&OBST XB=199.644,202.387,36.8808,36.8808,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID6='Partition Walls','Partition Walls','INERT','INERT', 'INERT'/ Obstruction
&OBST XB=199.644,202.387,36.8808,36.8808,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID6='Partition Walls','Partition Walls','INERT','INERT', 'INERT'/ Obstruction
&OBST XB=199.644,202.387,36.8808,36.8808,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID6='Partition Walls','Partition Walls','INERT','INERT', 'INERT'/ Obstruction
&OBST XB=199.644,202.387,36.8808,36.8808,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID6='Partition Walls','Partition Walls','INERT','INERT', 'INERT'/ Obstruction
&OBST XB=199.644,202.387,36.8808,36.8808,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID6='Partition Walls','Partition Walls','INERT','INERT', 'INERT'/ Obstruction
&OBST XB=199.644,202.387,36.8808,36.8808,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,3.6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls', 'INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,32.3088,32.6136,0.0,0.3,6576, SURF_ID6='Partition Walls','Partition Walls','Partition Walls','INERT','INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,36.576,36.8808,0.0,0.3,6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls','INERT','INERT'/ Obstruction
&OBST XB=199.644,203.911,38.7096,39.0144,0.0,0.3,6576, SURF_ID6='Partition Walls','INERT','Partition Walls','INERT','INERT','INERT'/ Obstruction
&OBST XB=202.387,203.911,37.1856,37.4904,0.0,0.3,6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls','INERT','INERT'/ Obstruction
&OBST XB=202.387,206.35,34.4424,34.7472,0.0,0.3,6576, SURF_ID6='INERT','INERT','Partition Walls','INERT','INERT','INERT'/ Obstruction
&OBST XB=203.606,203.911,37.4904,38.7096,0.0,0.3,6576, SURF_ID6='Partition Walls','INERT','INERT','Partition Walls','INERT','INERT'/ Obstruction
&OBST XB=206.35,206.654,20.1168,20.4216,34.7472,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=206.35,224.028,20.1168,20.4216,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=202.387,202.387,32.6136,34.4424,0.0,0.3,6576, SURF_ID6='INERT','Partition Walls','INERT','INERT','INERT','INERT'/ Obstruction
&OBST XB=202.387,202.387,36.8808,37.1856,0.0,0.3,6576, SURF_ID6='INERT','Partition Walls','INERT','Partition Walls','Partition Walls','Partition Walls' / Obstruction
&OBST XB=199.644,199.949,40.2336,41.4528,0.0,0.3,6576, SURF_ID6='Partition Walls','INERT','Partition Walls','INERT','INERT','INERT'/ Obstruction
&OBST XB=199.644,206.654,41.4528,41.7576,0.0,0.3,6576, SURF_ID6='Partition Walls','Partition Walls','INERT','Partition Walls','INERT','INERT'/ Obstruction
&OBST XB=206.654,224.028,41.4528,41.7576,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=224.028,202.387,41.7576,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=235.306,235.61,41.4528,41.7576,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=224.028,235.61,41.4528,41.7576,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=224.028,235.61,14.528,41.4528,41.7576,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=224.028,231.038,16.764,17.0688,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=224.028,245.059,20.1168,20.4216,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=231.038,231.343,17.0688,20.1168,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=231.343,242.316,16.764,17.0688,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=232.562,238.354,23.7744,24.0792,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=235.306,235.61,24.0792,40.2336,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=238.049,238.354,20.4216,23.7744,0.0,0.3,6576, SURF_ID6='INERT'/ Obstruction
&OBST XB=242.011,242.316,10.0584,16.764,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=244.754,245.059,10.0584,15.5448,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=244.754,245.059,15.8496,20.1168,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=244.754,247.802,15.5448,15.8496,0.0,3.6576, SURF_ID='Concrete'/ Obstruction
&OBST XB=245.059,245.364,20.4216,27.7368,0.0,3.6576, SURF_ID='Concrete'/ Obstruction
&OBST XB=245.059,247.802,27.7368,28.0416,0.0,3.6576, SURF_ID='Concrete'/ Obstruction
&OBST XB=247.498,247.802,15.8496,27.7368,0.0,3.6576, SURF_ID='Concrete'/ Obstruction
&OBST XB=260.909,261.214,30.7848,40.2336,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=260.909,265.481,30.48,30.7848,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=265.176,265.481,10.0584,30.48,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=231.038,231.343,16.764,17.0688,0.0,0.0, SURF_ID='INERT'/ Obstruction
&OBST XB=231.038,231.343,16.764,17.0688,3.6576,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=231.038,231.343,16.764,16.764,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=242.316,244.754,10.0584,10.0584,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=245.059,265.176,10.0584,10.0584,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=232.562,232.562,20.4216,23.7744,0.0,3.6576, SURF_ID='INERT'/ Obstruction
&OBST XB=199.644,199.949,32.6136,36.576,0.0,3.6576, SURF_ID6='Partition Walls','INERT','Partition Walls','INERT','INERT'/ Obstruction
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&OBST XB=199.644,202.387,32.3088,32.6136,0.0,3.6576, SURF_ID6='Partition Walls','INERT','Partition Walls','INERT','INERT'/ Obstruction
&OBST XB=199.644,202.387,36.576,36.8808,0.0,3.6576, SURF_ID6='Partition Walls','INERT','Partition Walls','INERT','INERT'/ Obstruction
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&OBST XB=202.387,206.35,34.4424,34.7472,0.0,3.6576, SURF_ID6='INERT','INERT','Partition Walls','INERT','INERT'/ Obstruction
COLOR='INVISIBLE'/ Mesh Vent: MESH1 [ZMAX]
&VENT SURF_ID='OPEN', XB=224.028,269.748,3.6576,40.2336,0.0,0.0,0.0
COLOR='INVISIBLE'/ Mesh Vent: MESH1 [ZMIN]
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COLOR='INVISIBLE'/ Mesh Vent: MESH2 [YMAX]
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&VENT SURF_ID='OPEN', XB=178.308,224.028,3.6576,40.2336,4.572,4.572,
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COLOR='INVISIBLE'/ Mesh Vent: MESH2 [ZMIN]
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COLOR='INVISIBLE'/ Mesh Vent: MESH3 [XMIN]
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COLOR='INVISIBLE'/ Mesh Vent: MESH3 [YMAX]
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COLOR='INVISIBLE'/ Mesh Vent: MESH3 [YMIN]
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COLOR='INVISIBLE'/ Mesh Vent: MESH3 [ZMIN]
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COLOR='INVISIBLE'/ Mesh Vent: MESH4 [XMAX]
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COLOR='INVISIBLE'/ Mesh Vent: MESH4 [YMAX]
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COLOR='INVISIBLE'/ Mesh Vent: MESH4 [ZMAX]
&VENT SURF_ID='OPEN', XB=224.028,265.176,40.2336,73.152,0.0,0.0,0.0,
COLOR='INVISIBLE'/ Mesh Vent: MESH4 [ZMIN]

SLICE FILES

&SLCF QUANTITY='TEMPERATURE', PBZ=1.8288/
&SLCF QUANTITY='VISIBILITY', PBZ=1.8288/
&SLCF QUANTITY='VOLUME FRACTION', SPEC_ID='carbon monoxide', PBZ=1.8288/
&SLCF QUANTITY='MASS FRACTION', SPEC_ID='carbon monoxide', PBZ=1.8288/
&SLCF QUANTITY='TEMPERATURE', PBX=17.5948/
&SLCF QUANTITY='VISIBILITY', PBX=258.157/
&SLCF QUANTITY='VISIBILITY', PBX=17.5948/
&SLCF QUANTITY='TEMPERATURE', PBX=243.607/
&SLCF QUANTITY='TEMPERATURE', PBX=18.489/
&SLCF QUANTITY='TEMPERATURE', PBX=198.366/
&SLCF QUANTITY='VISIBILITY', PBX=243.607/
&SLCF QUANTITY='VISIBILITY', PBX=18.489/
&SLCF QUANTITY='VISIBILITY', PBX=198.366/
&SLCF QUANTITY='VISIBILITY', PBY=43.1001/
&SLCF QUANTITY='TEMPERATURE', PBX=258.157/

&TAIL /
Egress Hand Calculations
Hydraulic Method and Paul’s Empirical Method
HYDRAULIC METHOD

FLOW CAPACITY THROUGH A DOOR.

FROM TABLE 3.14.5

\[ F_{3 m 0} = 24 \text{ psi/min/ft} \]
\[ F_{m 3} = 18.5 \text{ psi/min/ft} \]

\[ w_m = 30^\circ - 24^\circ = 12^\circ \]
\[ w_s = 48^\circ - 24^\circ = 24^\circ \]

Flow from each door

\[ F_d = F_{3 m 0} w_m \]
\[ F_d = 48 \text{ psi/min} \]

Flow contributed by exit doors

\[ F_d = 48 \text{ psi/min} \]

SPEED OF MOVEMENT FOR STAIRWAY FLOW

\[ s = k - \alpha k D \]

\[ k \text{ from Table 3.14.2 for 71/2" stairs, } k = 2.12, \alpha = 2.86 \]
\[ D = 0.195 \text{ psi ft/psi} \text{ from Figure 2.14.1} \]
\[ s = 2.12 - 2.86 \times 0.195 \times 0.675 \]
\[ s = 105 \text{ ft/min} \]

TRAVEL DISTANCE BETWEEN FLOORS

14.3 FT DISTANCE BETWEEN FLOORS

\[ 14.3 \times 1.85 = 25.9 \text{ FT} \]

TRAVEL LANDING

\[ D_L = 9.08' \text{ (from Geometry of Landing)} \]

\[ L_{\text{fr}} = 25.9 \text{ ft} + 4(9.08 \text{ ft}) \] [For floors 2-4, which have exits.]
\[ L_{\text{fr}} = 62.22 \text{ ft} \]
Travel Time for a person moving w/flow ($t_p$)
\[ t_p = \frac{62.22 \text{ ft}}{10.5 \text{ ft/min}} = 0.6 \text{ min} \]

Evaluation Time for Floors 2-4
Occupant Load, Floor 2-4: 1478 People
Flow from each floor = 48 People/min
# of exits = 4
\[ \text{Evaluation Time} = \frac{1478 \text{ People}}{48 \text{ People/min}} + 0.6 \]
\[ \text{Evaluation Time} = 8.3 \text{ minutes, (Floor 2-4)} \]

Evaluation Time for Fifth Floor (3 exit enclosures)
Lsf = 25.9 ft + 3 (9.08 ft) = 53.04 ft
\[ \text{Evaluation Time} = 0.51 \text{ min.} \]

Travel Time for a person moving w/flow ($t_f$)
\[ t_f = \frac{53.04 \text{ ft}}{10.5 \text{ ft/min}} \]
\[ t_f = 0.51 \text{ min.} \]

Evaluation Time
Occupant Load, 5th Floor: 308 People
Flow from each floor = 48 People/min
# of exits = 3 exits
\[ \text{Evaluation Time} = \frac{308 \text{ People}}{48 \text{ People/min}} + 0.51 \text{ min.} \]
\[ \text{Evaluation Time} = 2.7 \text{ minutes.} \]

Total Evaluation Time
T. Eval. Time = 8.3 minutes + 2.7 minutes = 11.0 minutes
PAUL'S EQUATION

\[ \frac{P}{W_e} = \left( \frac{48 \text{ in} - 2(6\text{ in})}{3.05 \text{ m}} \right) 3 = 144'' \]

\[ W_e = 3.66 \text{ m} \]

Population of floors 2-4 = 1,478 people

\[ \frac{P}{W_e} = \frac{1,478}{3.66} = 404 \text{ people/m}^2 \text{ eff. width} \]

\[ \frac{P}{W_e} < 800 \text{ people/m}^2 \]

UBE EQUATION

\[ t(\text{min}) = 20 + 0.0117 \left( \frac{P}{W_e} \right) \]

\[ t(\text{min}) = 6.8 \text{ minutes} \]

EVALUATION TIME FOR 5th FLOOR W/ 3, 36'' EX. DOORS

\[ W_{3m} = \left( \frac{48 \text{ in} - 2(6\text{ in})}{3} \right) = 108'' \]

\[ W_{3m} = 2.74 \text{ m} \]

Population of 5th floor: 308 people

\[ t = 20 + 0.0117 \left( \frac{308}{2.74} \right) \]

\[ t = 3.3 \text{ minutes} \]

TOTAL EVALUATION TIME OF LIBRARY

\[ T_{\text{EVAO.}} = 6.8 \text{ minutes} + 3.3 \text{ minutes} \]

\[ T_{\text{EVAO.}} = 10.1 \text{ minutes} \]
APPENDIX G- FIRE LIFE SAFETY PLAN
TABLE OF CONTENTS
Emergency Contact Personnel and Information ........................................... 147
Introduction ............................................................................................................. 148
Fire Evacuation Procedures and Plans ................................................................. 148
  Emergency Egress Routes ..................................................................................... 149
  Employee Procedures ......................................................................................... 149
    Building Coordinators ...................................................................................... 150
    During an Emergency ....................................................................................... 150
  Assisted Rescue .................................................................................................. 150
Accounting for Building Occupants ................................................................. 151
Emergency Aid ....................................................................................................... 152
Occupant Notification of Fire or Emergency ....................................................... 152
Reporting Fires and other Emergencies ............................................................... 153
Fire Prevention ....................................................................................................... 153
  What to do When a Fire Occurs ......................................................................... 155
Fire safety plans ..................................................................................................... 156
Site Plans ................................................................................................................ 156
  Occupancy Assembly Point and Areas of Refuge .............................................. 156
  Normal Routes of Fire Department Vehicle Access .......................................... 157
Floor Plans ............................................................................................................. 158
  Exits ..................................................................................................................... 158
  Manual Fire Alarm Boxes .................................................................................. 163
  Occupant-use Hose Stations .............................................................................. 168
  Fire Alarm Annunciators and Controls ............................................................... 168
Appendix ................................................................................................................ 169
Emergency Contact Personnel and Information

Key Campus Contacts:
- Emergency: 911
- University Police Non-Emergency: 805-756-2281

Director of Environmental Health and Safety: 805-756-6662

If you need to report an emergency the location of the building is as follows:

“I AM IN THE CAL POLY LIBRARY, BUILDING 35”

The more information you can give the emergency contact the faster the emergency will be tended to.
Introduction

This fire life safety plan is established for the Robert E. Kennedy Library (Building 35) on the California Polytechnic State University campus, in accordance with the requirements of the California State Fire Marshal (SFM) and the 2010 California Fire Code (CFC).

Building 35 is a mixed-use building with approximately 64 percent dedicated to business occupancy (offices and study areas), 30 percent dedicated to assembly occupancy, and 6 percent to storage and utility rooms. Building 35 has business occupancy as established by section 304 of the 2010 CBC.

Per CFC Section 404.2, an approved fire safety and evacuation plan shall be prepared and maintained for a Business occupancy building with an occupant load of 500 or more persons. Furthermore, Section 404.5 requires that fire safety and evacuation plans shall be available in the workplace for reference and review by employees, and copies shall be furnished to the fire code official for review upon request. The distribution of fire safety and evacuation plans shall be distributed to the tenants and building service employees by the owner or owner's agent. Tenants shall distribute to their employees applicable parts of the fire safety plan affecting the employees' actions in the event of a fire or other emergency.

Fire Safety and evacuation plans shall be reviewed or updated annually or as necessitated by changes in staff assignments, occupancy or the physical arrangement of the building (Section 404.4).

Fire Evacuation Procedures and Plans

The following procedure is established by the Cal Poly Environmental Health & Safety department.

This procedure has been prepared to ensure the orderly and complete evacuation of campus buildings in the event of an emergency and/or the activation of the alarm system.

The primary objectives of this evacuation plan are to ensure:

5. Everyone leaves the building safely;
6. A procedure is in place to safely evacuate individuals who cannot negotiate stairs;
7. Building occupants are accounted for after an emergency evacuation, and
8. Personnel (Building Coordinators) are selected from among building occupants, with functions to ensure plan objectives are met.
The following are emergencies for which a total or partial evacuation of a building may become necessary:

a. Fire
b. Explosion
c. Bomb threats
d. Building air contamination
e. Weather related emergencies
f. Earthquake (Note: an earthquake alone is not necessarily a reason to evacuate. Evacuation is indicated if the earthquake causes apparent structural damage or creates a secondary hazard such as flooding, hazardous materials release, exposed electrical conductors, etc.)

**Emergency Egress Routes**

Egress from floor levels above ground level shall be via the enclosed stairwells. Egress from the first floor shall be through ground level exit doors to the exterior.

See floor plans for exit locations.

**DURING AN EMERGENCY EGRESS SHALL NOT BE VIA ELEVATORS.**

**Employee Procedures**

Every employee should be prepared to care for themselves and help others in the event of an emergency. During an emergency, all employees should remain calm. A successful outcome in an emergency situation always depends on the thoughtful and cooperative response of campus personnel working as a team. When you hear the evacuation alarm (fire alarm) or if the conditions in the building appear to warrant it, evacuate the building immediately. Your safety and the safety of others is the ultimate priority.

- Do not use an elevator.
- Take small and easily accessible personal belongings and secure any sensitive documents or valuables, if it is safe and expedient to do so.
- **While you evacuate, carefully look for anyone injured or trapped.**
- Direct everyone to the nearest exit.
- Assist persons with disabilities or injuries in exiting the building.
- Exit the building in the quickest way possible.
- Keep away from the building and any emergency operations. Keep streets and walkways clear for emergency vehicles and personnel.
• Move away, and assist others to move away, from all exits after leaving a building. This allows others to get out of the building without crowding or pushing.
• Move away from the building until you are a safe distance away.
• Rescue personnel will search all rooms to ensure they have been cleared. Do not lock doors when evacuating unless it is necessary to protect sensitive documents or valuables.
• Do not return to the evacuated building until the area is declared safe by authorized personnel.
• Employees: Following your exit from the building, immediately report in to the Building Coordinator for your group. Report any people that were unable to leave the building due to injury, disability, or being trapped. If multiple building evacuations are occurring, proceed to your pre-assigned outdoor assembly area and report in there to your Building Coordinator. Everyone should stay in their assembly area to await further instructions, if it is safe to do so. Do not go home without approval from management.

ASSEMBLY AREA FOR THE CAL POLY LIBRARY (BUILDING 35) IS THE PLAYING FIELDS NORTH OF HIGHLAND DRIVE.

Building Coordinators

Building Coordinators serve a dual purpose. In the event of a drill or an emergency situation, Building Coordinators are responsible for assisting in the safe and orderly evacuation of campus buildings, for reporting injuries and probable locations of trapped individuals to campus authorities, and, if the EOC is activated, situation reporting. In non-emergencies, Building Coordinators serve as a liaison between building occupants and Facility Services. The coordinator should be familiar with personnel normally in the area, such as handicapped persons requiring special assistance during an evacuation and the applicable University Emergency procedures.

During an Emergency

• Remain calm.
• As soon as it is safe to do so, assess your immediate area for injuries and hazards.
• If safe to do so, retrieve the roster of employees in your area of responsibility, a Building Assessment form, and your Building Coordinator vest.
• Put on your Building Coordinator vest.

Assisted Rescue

*Evacuation chairs available on every floor of the library in the corridor leading to the*
Evacuation chairs are used to move people with disabilities or are injured down stairways quickly and safely during an emergency.

An individual may require assistance during an emergency because of a disability or injury. When assisting an individual during an emergency, first assess how immediate the emergency is and communicate the nature of the emergency to the person. Second, ask the person how s/he would like to be assisted. If the individual has a mobility device, evacuate the device with the person, if possible.

In some cases, you may require assistance from rescue personnel to be evacuated and the following procedures are recommended:

- Identify your exact location and have an evacuee report it to the Building Coordinator or emergency personnel when they are outside the building.
- If a telephone is available, call 911, and describe the emergency and your location.
- Wait for rescue personnel to make their primary search and come to your aid.

It is suggested that individuals with permanent disabilities should prepare for emergencies ahead of time by instructing a classmate, instructor, or fellow staff member on how to assist them in case of emergencies.

In general, the following assistance is recommended for individuals with visual and hearing impairments and for those who use wheelchairs:

- Visual impairments - Offer your elbow to these individuals, and guide them to a safe area. Make sure that they are fully informed of the situation and what they are to do.
- Hearing impairments - Communicate with a short written message or speak slowly or directly to them. Use gestures to guide them toward the nearest exit.
- Wheelchair Users - Consult with the individual to establish the best course of action. Lifting these individuals without proper consideration for their medical needs may be dangerous to their well-being as well as the possibility of injury to the rescuer. When there is doubt if the situation is life threatening, wait for trained emergency personnel to respond with the proper evacuation equipment.

**Accounting for Building Occupants**

It is the building coordinator’s responsibility to account for the employees within the
building. Occupants of building shall let the building coordinator know about people trapped or mobility impaired in the building. The building coordinator shall relay the information of occupants within the evacuated building to emergency personnel (i.e., police and fire department)

Emergency Aid

Emergency aid will be available at the designated occupant assembly area in the playing field north of Highland Drive. If the medical need the person needs impairs the person from walking or being moved to the designated occupant assembly area, s/he shall wait near the library for emergency personnel (i.e., police and fire department) to administer medical aid.

See the site plans for more detail on the location of the designated occupant assembly area.

Occupant Notification of Fire or Emergency

The primary means of notification to building occupants of a pending emergency or fire will be via the emergency alarm system. The alarm will sound with a temporal scheme where a three tone pulse will sound, followed by a pause, followed by a three tone pulse. The diagram below illustrates the temporal scheme:

![FIRE ALARM EVACUATION SIGNAL]

3 PULSE TONE FOLLOWED BY PAUSE

The campus also utilizes other emergency and communications methods which include
Campus telephone emergency communication system, radio station 1610 AM and the campus news hotline.

The campus telephone emergency communication system includes outdoor speakers.

The campus news hotline phone number is 805-756-NEWS (6397).

**Reporting Fires and other Emergencies**

Personnel who can be contacted for further information or explanation of duties under the plan are listed on page three of this fire life safety plan.

**Fire Prevention**

The following are general procedures to take to prevent fires and/or to safely extinguish a manageable fire:

- Note the location of alarms and extinguishers.
- Clear obstructed corridors, aisles and room exits.
- If a door is permanently blocked, label it as no access.
- Use only grounded electrical outlets.
- Do not use an extension cord for permanent use.
- Do not use mechanical rooms, or utility rooms, or stairwells for storage or block the entrance to these rooms.
- Know the location of the emergency exits and stairwells and have a strategy for evacuating.
- In laboratories, teach students about fire safety first thing.
- Practice. During a fire drill, immediately evacuate the building you are in.
- Report strange smells which could be smoke or electrical overload.
- Practice and familiarize yourself with all escape routes.

**State Fire Marshal Requirements for Bulletin Boards In Corridors**

Section 3.11, Title 19, California Code of Regulations restricts combustible material in exit corridors. The following are the campus-wide requirements bulletin boards and postings in corridors for all buildings owned and/or operated by the campus:

a. Existing notice boards up to 3.5 square feet will not be required to be removed or be covered providing there are no more than two single layer sheets of paper which are secured at all four corners. Violation of this policy will result in covering or removal of the boards.
b. New notice boards for faculty offices, etc., may not be larger than 1.5 square feet. Only two single layer sheets of paper which are secured at all four corners may be posted.

c. For new bulletin boards larger than 1.5 square feet and existing bulletin boards larger than 3.5 square feet the following shall be provided:
   1. Bulletin boards will be enclosed with glass or lexan fronts in a wood or metal frame.
   2. They shall not protrude more than 3" into the corridor.
   3. Locking mechanisms for the glass front are required on bulletin boards exceeding 3' x 6'.

d. All display cases shall protrude into the corridor a maximum of 4" and shall be enclosed with a glass or lexan front in a wood or metal frame.

e. All display cases shall be provided with locking mechanisms for the glass or lexan front.

**Cal Poly Safety Inspection Check List- Office Area Safety**

The campus Injury and Illness Prevention Program, Section 10.1, requires departments to conduct regular safety inspections of areas under their control. This safety inspection checklist for office areas has been developed to assist departments in fulfilling this responsibility.

If a particular operation or item does not exist in your office, please note this on the inspection form by one of the following methods:

- Write "N/A" in the comments section for that item.
- Draw a diagonal line through the item description(s) for the item or for the entire section, if not applicable to your operations.

It is important to document that an item has been reviewed and found to not apply to your office environment, please do not just leave items blank if they do not apply. Departments should feel free to modify and customize these forms for their operations. The Environmental Health & Safety (EH&S) Office can provide the original Word file for modification. If your office has operations, equipment, or processes not covered by this checklist, EH&S will assist you in developing a checklist tool for the office.

The checklist is designed so that each applicable inspection item should be answered with a "yes."

Inspected items, which are checked "no", require corrective action. Corrections to noted problems may be by:
Fixing it yourself.
Issuing a work order to Facility Services to repair an item. Work orders may be issued via phone at x65555 or via an online web form at: http://www.facsrv.calpoly.edu/fac_serv/form_mnt.html.

If these methods cannot correct the problem, contact the Environmental Health & Safety Office at x66662 for assistance.

After the problem is corrected, the date of correction should be entered in the "comments" section next to that inspection checklist item.

After completion, all safety inspection checklists should be kept by the department for at least three (3) years. The C.S.U. Board of Trustees performs periodic audits of these records.

Questions regarding safety inspections can be directed to the Environmental Health & Safety Office at extension 66662 or dragsdal@calpoly.edu.

A COPY OF THE SAFETY CHECKLIST IS ATTACHED AS AN APPENDIX TO THIS FIRE LIFE SAFETY PLAN.

What to do When a Fire Occurs

- Activate the nearest fire alarm pull station.
- Feel doors for heat. If cool, exit carefully. If hot, do not open the door. Stay where you are until help arrives. If a telephone is available, call 911 and describe the emergency and your location. Place cloth material around the bottom of the door to prevent smoke from entering. Close as many doors as possible between you and the fire. Be prepared to signal from a window, but do not break glass unless necessary since outside smoke could enter your room.
- If caught in smoke, drop to your hands and knees and crawl as you exit. Hold your breath as long as possible. Breathe shallowly through your nose and use clothing as a filter.
- If you see fire, confine it by closing doors and windows.
- Start an orderly evacuation (even for small fires, a closed room can reach 1500 degrees within three minutes).
- From a safe location call 911 from a campus telephone.
- Use extinguishers on small fires only if it is safe to do so and when there is no personal risk. When operating a fire extinguisher, remember P-A-S-S: Pull the pin; Aim at the base of the fire; Squeeze the lever; Sweep from side to side.
- Never use an elevator during a fire.
- In laboratories, follow the fire safety training provided by the instructor or other department personnel.

If your clothing catches fire - STOP, DROP AND ROLL to extinguish the flames

Fire safety plans

Site Plans
Occupancy Assembly Point and Areas of Refuge

[Map showing different areas and assembly points]
Normal Routes of Fire Department Vehicle Access
Manual Fire Alarm Boxes
Occupant-use Hose Stations

NO OCCUPANT – USE HOSE STATIONS ARE ACTIVE

There are occupant-use hose station boxes located in various location throughout the library. They do not contain hoses and are inactive hose stations. Portable fire extinguishers have been installed within the hose station glass boxes.

Fire Alarm Annunciators and Controls
Appendix

Cal Poly Safety Inspection Checklist
Office Area Safety

Date: __________ Department: ____________ Building: __________ Room(s): __________

Person Performing Inspection: ________________________________

Yes  No  N/A

Are exit ways clear of obstructions?  —  —  —

Are extension cords ONLY used to supply temporary power to portable equipment (does not include power strips with built-in circuit breakers)?  —  —  —

Are fire extinguishers charged with current (within 1 year) tags?  —  —  —

Are first aid supplies readily available to employees in the area?  —  —  —

Is storage well organized with adequate, clear aisles?  —  —  —

Is there at least 18 inches of clearance between the ceiling and stored materials?  —  —  —

Are stored materials clear (at least 24 inches) from lamps, heaters, hot pipes, etc.?  —  —  —

Is furniture over 42 inches tall attached to the floor or wall to prevent tipping in an earthquake?  —  —  —

Are emergency phone numbers posted prominently?  —  —  —

Are power, telephone, and computer cables arranged and routed so as not to be a trip hazard?  —  —  —

Are self-closing fire doors in good operating condition and not held open with wedges or other means?  —  —  —

Are doors which are blocked on one side clearly marked on the opposite side: “No Access Through This Door”?  —  —  —

Are doors, passageways or stairways, that are neither exits nor accesses to exits and which could be mistaken for exits, appropriately marked with, “Not An Exit”, “To Storeroom”, etc.?  —  —  —