Single Exit Stairway Apartments

Technical Advisory Group Meeting 1

- Introductions
- Background & Objectives
- Approach
- Q&A
- Discussion Topics
- Final Thoughts

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Opening Statement

Minnesota DLI / Construction Codes and Licensing

(5 Min)

Technical Advisory Group Introductions

Minnesota DLI / Construction Codes and Licensing

(15 Min)

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Background & Objectives

Minnesota DLI / Construction Codes and Licensing

(25 min)

Scope of Project

- Task 1. Initial meeting (Today)
- Task 2. Data collection, analysis and scenario development
- Task 3. Conduct and document interviews with Stakeholders
- Task 4. Scenario analysis
- Task 5. Draft report
- Task 6. Prepare final report

Overstory

- No building can ever be considered risk free or 100% safe.
- A risk-informed approach, which considers fire loss data, fuel loading, and system efficacy and reliability data is also critical to developing appropriate scenarios for fire effects modeling and evacuation modeling.
- Obtain consensus on what needs to be studied further.
- Obtain consensus on what success looks like.
- We look forward to listening and learning from you.

Approach

Consulting Team (45 min)

Preliminary Literature Review

Consulting Team

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Preliminary Literature Review

Pew Foundation Report

- U.S. faces housing shortfall of 4M to 7M homes, affordability crisis
- Second stair for 4 – 6 story buildings can be cost prohibitive
- Smaller overall footprint increases flexibility, density
- Increased safety due to active and passive fire protection

Source:
https://www.pewtrusts.org/en/research-and-analysis/reports/2025/02/small-single-stairway-apartment-buildings-have-strong-safety-record#:~:text=A%20first%2Dever%20analysis%20of,as%20other%20types%20of%20housing.

Preliminary Literature Review

NFPA Single Stair Symposium – September 2024

- Egress system design
- Fire department operation issues
- Construction of the building
- Elevator considerations / capabilities

Source: https://www.nfpa.org/forms/single-exit-stair-symposium-report

Preliminary Literature Review

Seattle Building Code §1006.3.4 Themes

- Not more than 5 stories R-2 served by a single stair
- No more than 4 dwellings on each floor
- No less than 1-hour rated construction with sprinklers throughout
- Pressurized stairwell and elevator
- Maximum of 20 feet from the dwelling door to reach the stair entry
- Travel distance shall not exceed 125 feet

Source: Building Code - SDCI | seattle.gov

Preliminary Literature Review

British Columbia Building Code 2024 Themes

- Up to 6 stories
- No more than 24 persons/4 dwelling units on each floor
- Travel distance restrictions (floor area to an exit less than 25 m; dwelling unit to an exit less than 6 m)
- Sprinklered throughout
- Smoke management / pressurization systems

Source: https://www.bccodes.ca/index.html

Risk Informed Approach

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Risk Informed Approach

What is Engineering Risk?

$$Risk = Probability * Consequence$$

Risk Informed Approach

- Quantitative versus qualitative decision-making
- Deterministic approach
  - Independent of likelihood
- Risk-informed approach
  - Evaluate likelihood of occurrence versus consequence
  - Included in building code for structural design, and the energy industry

Risk Informed Approach

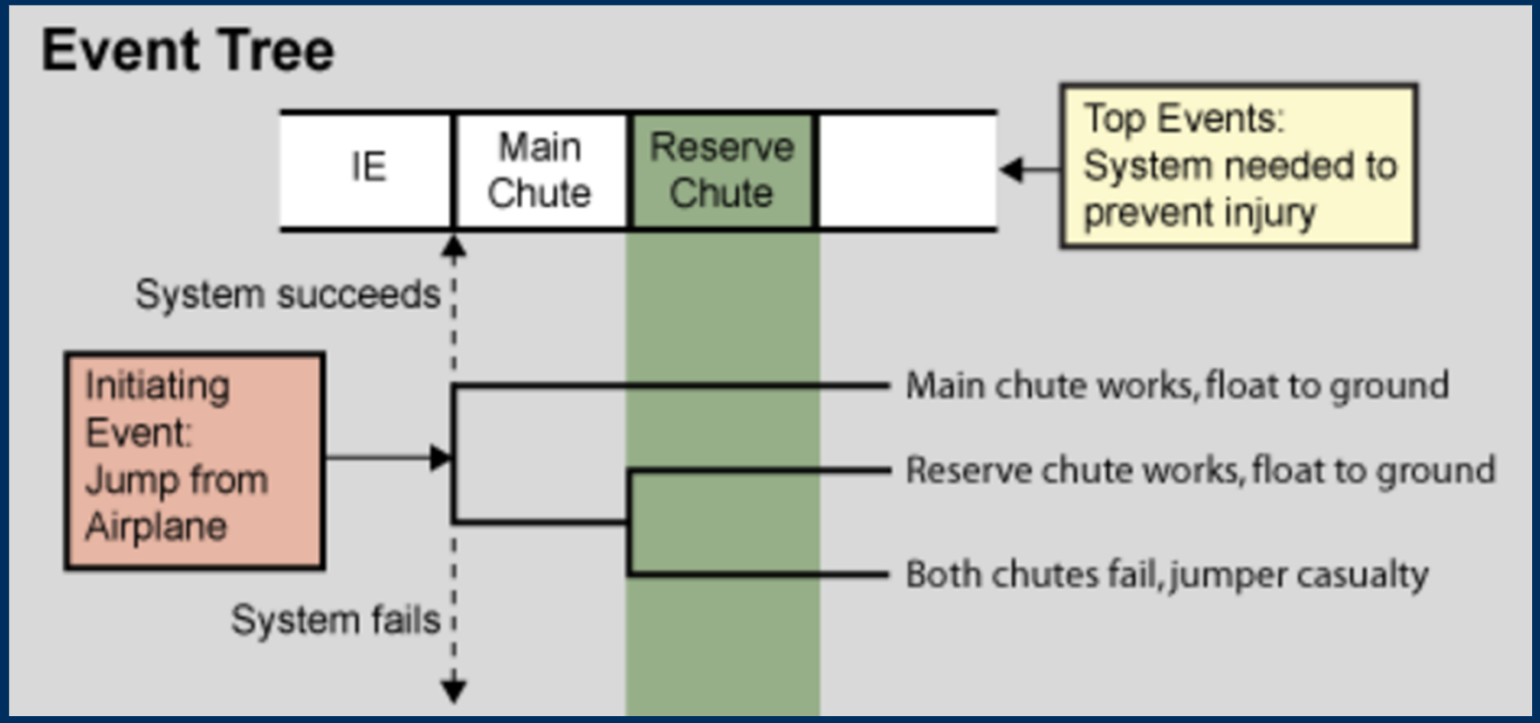
- People accept risks daily
  - Driving a car, investing in the stock market, working at a job site
- Impossible to eliminate risk entirely
- Apply measures to mitigate / manage risk to acceptable levels
- Tool to inform decision making

Risk Informed Approach

Components of Fire Scenario Selection

- Stakeholder input
- Fire frequency data
- Past / present / future ignition sources and fuel loads
- Reliability and operability data
- Fire department response

General Event Tree



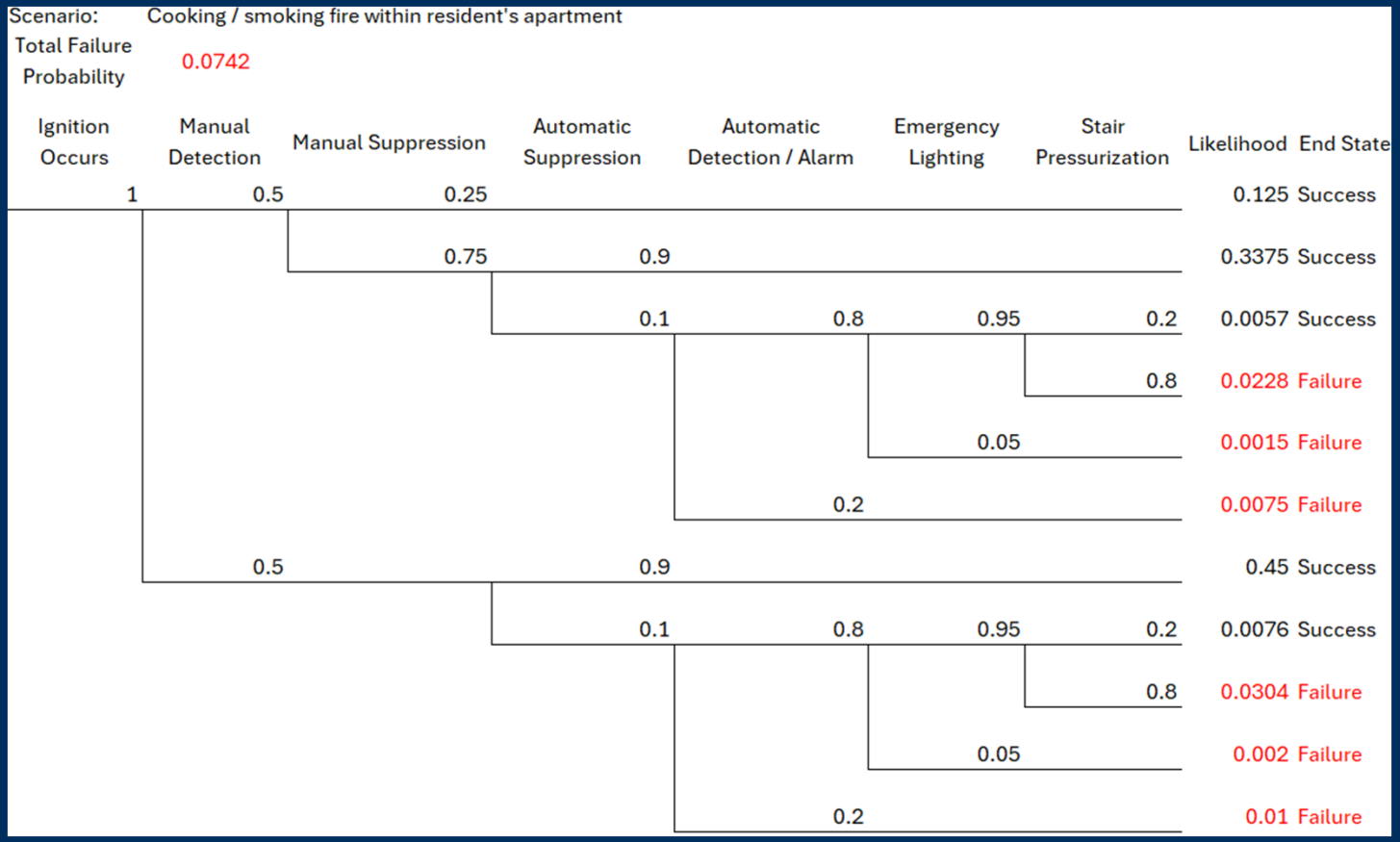
Source: https://www.nrc.gov/about-nrc/regulatory/risk-informed/pra.html

Event Tree

Risk Informed Scenario Evaluation Process

- Inform successful outcome
- Identify systems that mitigate consequences
- Assign probabilities of success / failure for each system
- Calculate likelihood of each end state occurring
- Understand risk-significant mitigating systems

Sample Fire Event Tree



Approach

- What risk exists / is permitted by the adopted building codes?
- Establish risk tolerances
  - What is an acceptable risk for the proposed design(s)?
- Comparative risk assessment
- Modeling and sensitivity analysis
  - What are the impacts of changing design(s) inputs on risk?
- Review outcomes with Stakeholders and consider possible changes

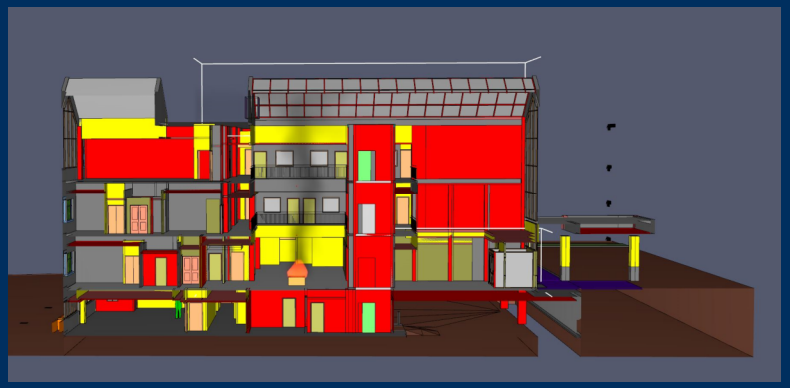
Modeling

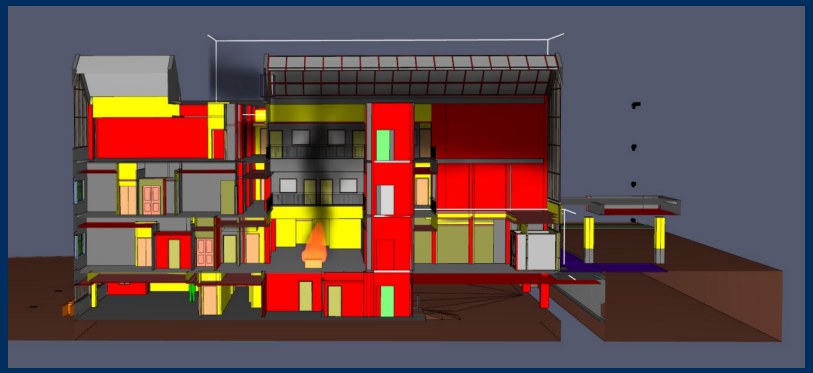
Consulting Team

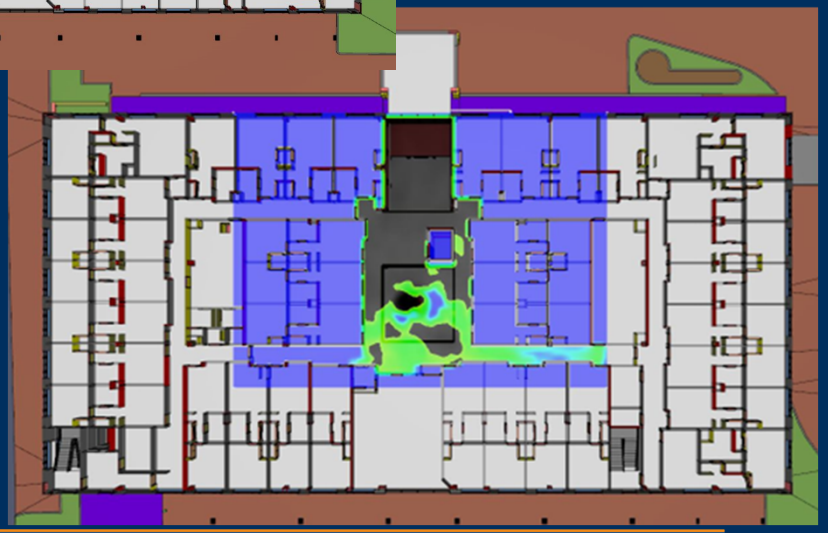
Modeling Background

- Use of fire modeling and egress modeling to evaluate scenarios developed through risk analysis & input from TAG
- Modeling software to be used has been verified and validated
- Fire Modeling: PyroSim with Fire Dynamic Simulator (FDS)
  - https://pages.nist.gov/fds-smv/
- Egress Modeling: Pathfinder
  - https://www.thunderheadeng.com/pathfinder/

Fire Modeling







Egress Modeling

Crowd Movement Simulation and Egress Modeling Software: Pathfinder | Thunderhead Engineering

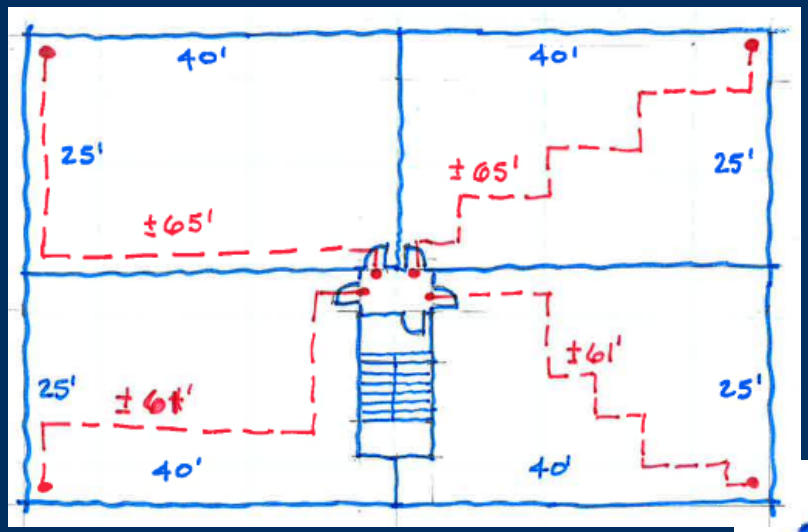
Preliminary Housing Information

- FLOOR AREA
- Studio = 457 SF
- One Bedroom = 735 SF
- Two Bedroom = 1,097 SF
- Three Bedroom =1,336 SF
- National Average = 908 SF
- Average for St. Paul MN = 761 SF
- Average for Minneapolis MN = 766 SF

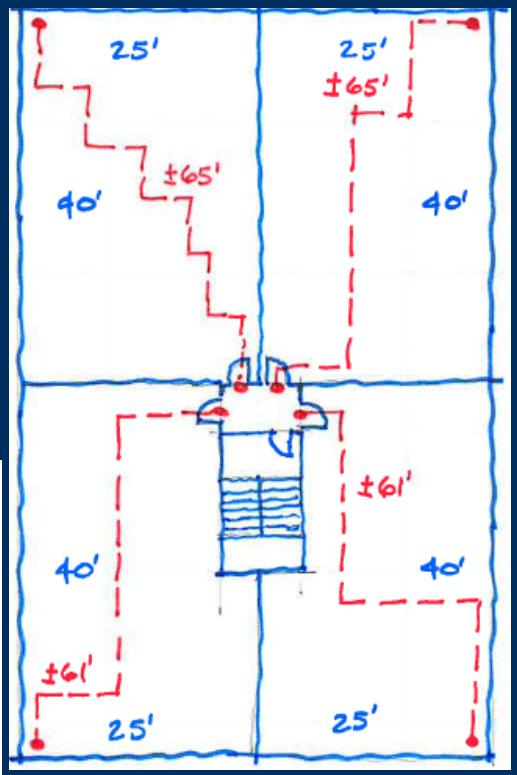
- APPROXIMATE PERCENT OF NEW APARTMENTS BY UNIT TYPE THE MARKET IN THE LAST TEN YEARS:
- Studios = 5.1%
- One Bedroom = 48.2%
- Two Bedroom = 38.3%
- Three Bedroom = 6.6%

Source: https://www.rentcafe.com/

Single Stair Sketch



- STAIR AND LOBBY "MODULE" IS ABOUT 9' x 20' = ± 180 SQ.FT.



- ± 4,000 SQ.FT. FLOOR PLATE MAXIMUM
- FOUR DWELLING UNITS EACH ±1,000 SQ FT OR LESS.
- SAME "MODULE" OF STAIR AND COMMON LOBBY.
- ORIENTATION OF STAIR TO UNIT ORIENTATION GENERALLY DOES NOT CHANGE TRAVEL TO UNIT ENTRY DOOR, BUT UNIT SIZE CAN.
- TYPICAL FLOOR INDICATED. GROUND FLOOR REQUIRES CORRIDOR TO EXTERIOR DOOR.

Next Steps

Consulting Team

Upcoming Tasks

- Interviews / calls with Stakeholders
- Data collection
- Fire scenario definition
- Reliability / operability of mitigating system
- Model geometry
- Analysis
- Reporting

Questions and Comments

(40 min)

Discussion Topics

All (Facilitated by Consulting Team)

Discussion Topics

Group Discussion of the Below Topics (15 minutes each)

1. Approach to acceptable risk
2. Approach for event tree / risk-informed analysis

Anything else?

Final Thoughts

Minnesota DLI / Construction Codes and Licensing

Questions/Comments