FACT SHEET

ANALYSIS OF CHANGING RESIDENTIAL FIRE DYNAMICS AND ITS IMPLICATIONS ON FIREFIGHTER OPERATIONAL TIMEFRAMES

SUMMARY

The residential fire environment has been steadily changing over the past several decades. These changes include larger homes, different home geometries, increased synthetic fuel loads, and changing construction materials. UL conducted several experiments to compare the impact of different fuel loads and construction materials in residential houses. Six room fire experiments were conducted to examine the difference between modern and legacy living room furnishings. Furnace experiments were conducted to quantify changes in wall linings, structural components, windows and interior doors. Overall, these experiments examine how these changes affect fire dynamics and operational timeframes.

FINDINGS

- While the average home size has increased 56% since the 1970s, the fire service resources available to respond have not increased proportionally in many areas of the United States.
- Newer homes tend to incorporate features such as taller ceilings, open floor plans, two-story foyers, and great rooms. All of these features remove compartmentation, add volume, and can contribute to rapid smoke and fire spread.
- Larger homes have more air available to grow and sustain fires.
- As homes become more energy efficient and fuel loads increase, fires will become ventilation-limited, making the introduction of air during a house fire extremely dangerous.
- If ventilation is increased through tactical action of firefighters, or through unplanned events such as window failure or a neighbor opening a door, heat release will increase and potentially result in flashover conditions.
- The modern room flashed over in 3:30 to 4:45 and the legacy room flashed over in 29:30 to 34:15.
- Modern fires convert from room-and-contents fire to structure fires quickly due to failure of modern building components.
- Modern construction materials are lighter weight than traditional materials and have a shorter time to structural collapse. The engineered wood I-joist collapsed in 6 minutes and the unprotected 2” x 10” lumber, legacy floor system collapsed in 18 and a half minutes.
- Over time, home contents have transitioned from being comprised mostly of natural materials to synthetic materials. The legacy sofa made of cotton and wood has a peak heat release rate of 370 kW at a little over 15 minutes. The modern sofa with polyolefin fabric and other plastics has a peak heat release rate of 1990 kW at four and a half minutes.
- All these issues add up to shorter escape times for residents.

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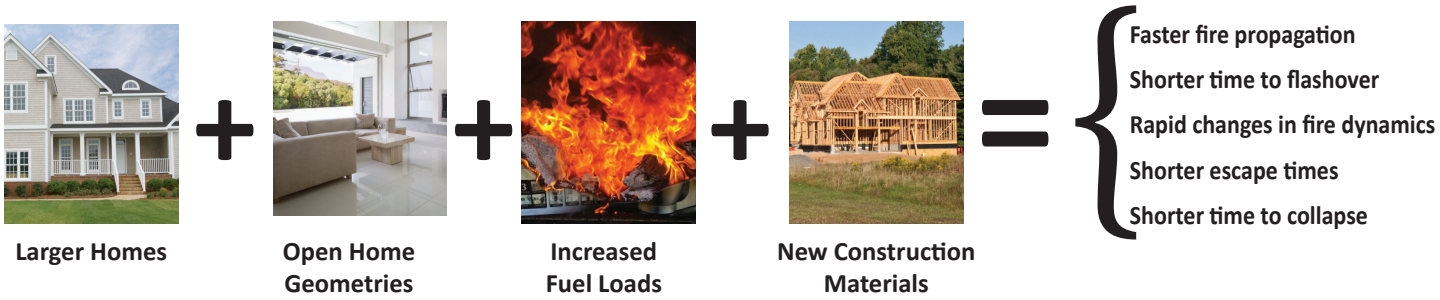
TAKEAWAYS

As illustrated in the below graphic: Larger homes, open home geometries, increased fuel loads, and new construction materials are leading to faster fire growth, quicker times to flashover, more ventilation-limited fires, shorter times to structure collapse, and shorter residential escape times.



- Fire conditions can change rapidly due to the under ventilated fire conditions, and floor systems can collapse quickly and with little warning. Operating conditions need to be constantly monitored to understand the impact of the tactics used and the potential need to change them.
- Ultimately, as the fire environment changes, there needs to be reevaluation of firefighting tactics to have the greatest opportunity to be most effective on today's fires.

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FIRE STATION TALK

Start a discussion at your station about the changes in residential fire dynamics and how they impact the timeframe of firefighting operations.

Faster fire propagation

- Changes in modern drywall linings now allow for more "room-and-contents" fires to grow into structure fires.
- The larger size and open geometries of newer homes result in fewer compartments and barriers to stop the spread of a fire.

Faster flashover

- In laboratory experiments, modern rooms had flashover occur in less than five minutes. The shortest timeframe for a legacy room to transition to flashover was over 29 minutes.
- These ventilation induced fire conditions are sometimes unexpectedly swift, providing little time for firefighters to react and respond.
- These experiments demonstrated that in most cases, the fire will have transitioned to flashover prior to arrival of fire service, or at the very least, crews will encounter a ventilation-limited fire.

Shorter times to collapse

- Modern home construction techniques have removed components that had prolonged the time-to-collapse.
- After unit arrival at eight minutes from ignition, collapse is possible as soon as 1 minute 30 seconds later; the legacy room fire collapse hazard begins at 40 minutes after arrival.

Shorter resident escape times

- The impact of ventilation (flow paths) is the key to the fire development in structures.
- Fire departments must reexamine their tactics to ensure they are still relevant within this evolving fire environment.

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CONSIDERATIONS FOR CHIEFS

Department leaders should consider the following:

- Require a 360 degree size-up to identify possible starting points for an offensive exterior attack; this is the quickest and safest way to stop the attack on the structures by the fire, preserving the structural integrity needed for an interior attack.
- Using one member to deliver water from the exterior to the targeted seat of the fire can also reduce the thermal threat and chances for flashover, while the remainder of the crew prepares for an interior attack.
- Emphasize the effects of ventilation. Venting a ventilation-limited fire can induce flashover, but at the least will cause fire growth and increase the Heat Release Rate (HRR).
- Synthetic materials with a significant fuel load have reduced residential escape times. Make sure your members are aware that in today's fires, victims have the greatest chance of survivability behind closed doors.

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STAY IN THE KNOW

Read the research, start the discussion.

Additional resources and tools for this study can be found at www.fstaresearch.org/resource/?FstarId=11513.