

Furniture Flammability

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This is your chair



This is your chair on fire



<http://fire.nist.gov/bfrlpubs/fire01/PDF/f01070.pdf>

Any questions?



This is your mother's chair



This is your mother's chair on fire



Any questions?

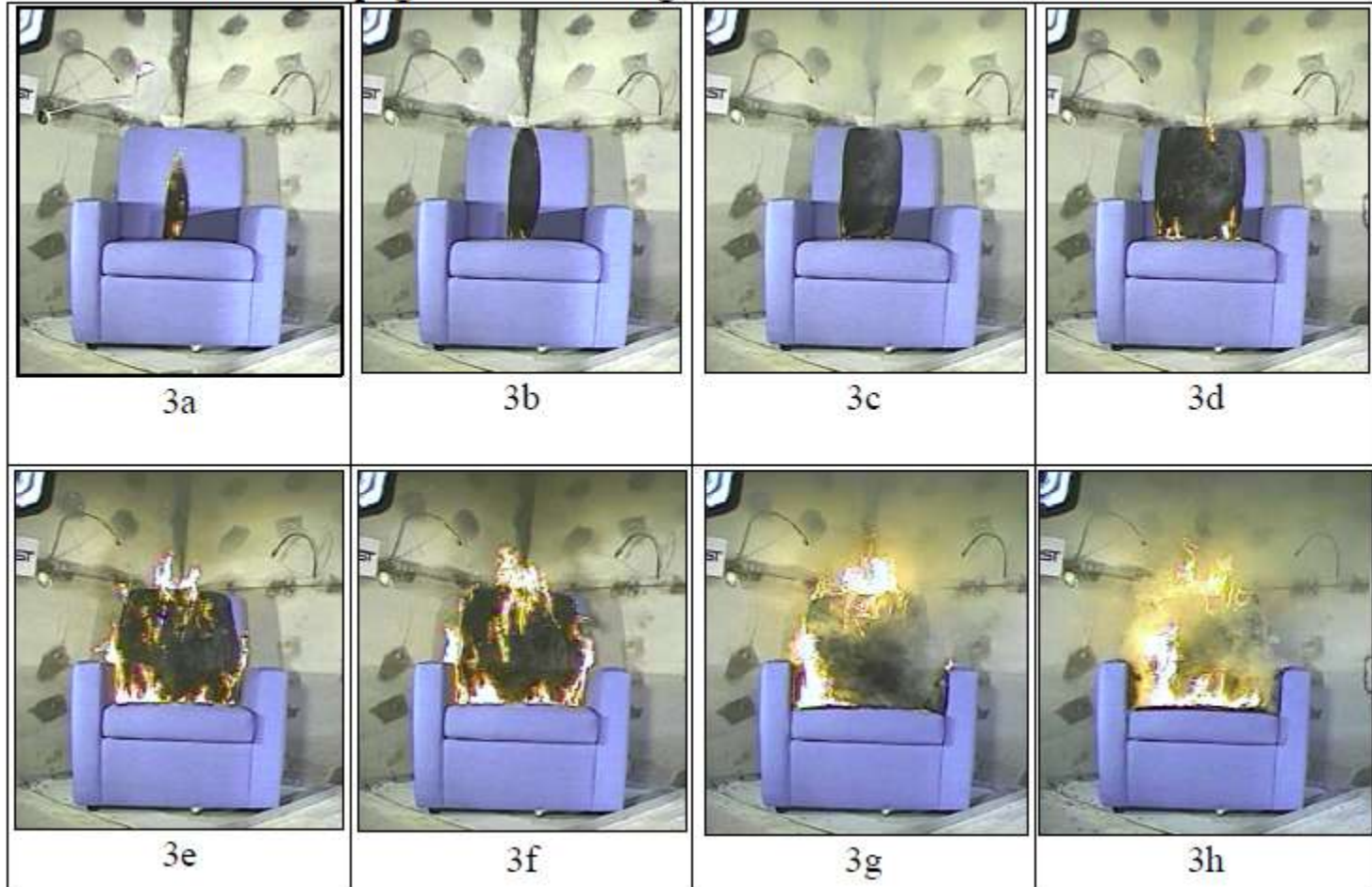


This is your grandmother's chair



This is your grandmother's chair on fire





Table 3. Propagation of Burning on a Chair with a Fire Barrier



Any questions?

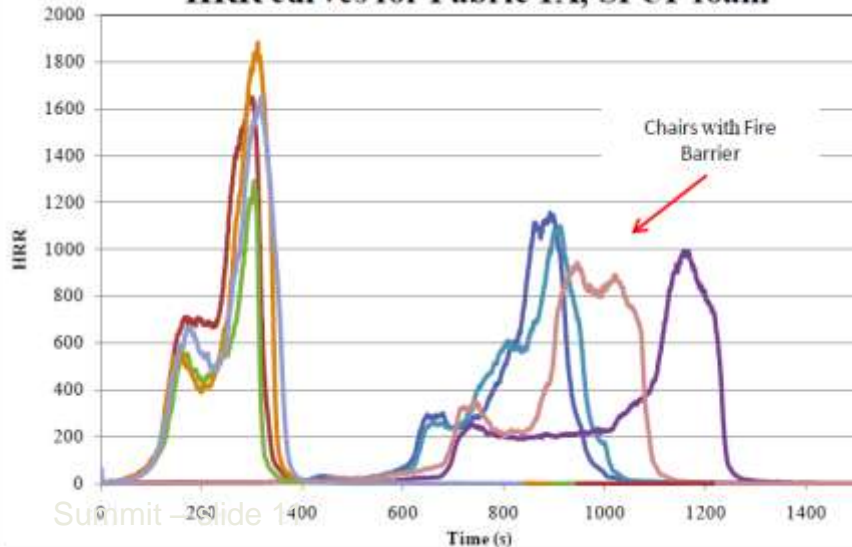
- ▶ The point is:
- ▶ Furniture flammability is not a new problem
 - It has been an issue since the conversion from horsehair and cotton to polyurethane foam and polyester in 1960s
- ▶ What has changed
 - “Tight building syndrome” / light frame construction
 - Fire service recognition of legacy vs modern furnishings and construction

TB or not TB, that is the question

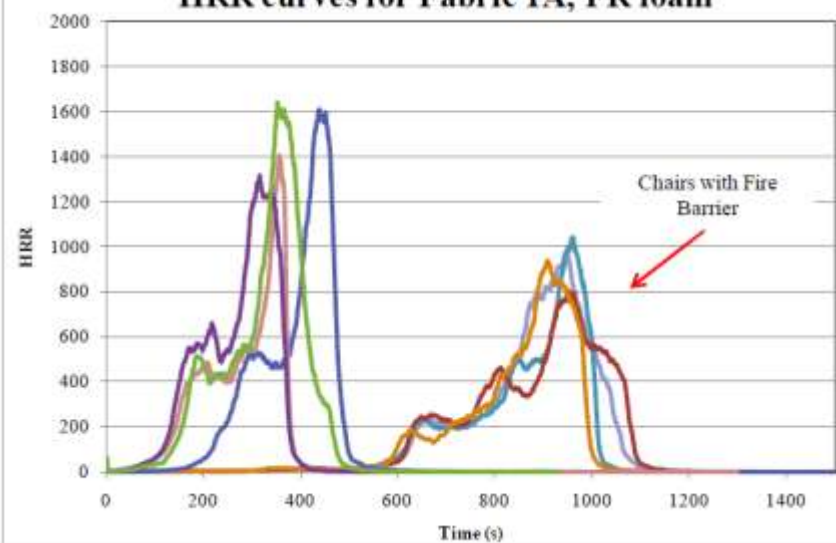
Nonfire Barrier, SPUF	Nonfire Barrier, FR	Fire Barrier, SPUF	Fire Barrier, FR
 <p data-bbox="233 768 444 801">Combination 2</p>	 <p data-bbox="656 768 867 801">Combination 4</p>	 <p data-bbox="1081 768 1292 801">Combination 1</p>	 <p data-bbox="1505 768 1715 801">Combination 3</p>

<http://www.cpsc.gov/PageFiles/93436/openflame.pdf>

HRR curves for Fabric 1A, SPUF foam



HRR curves for Fabric 1A, FR foam



1970s

- ▶ Brady Williamson, UC Berkeley
 - “The impact of contents on building fires”
- ▶ FTC complaint and consent agreement
 - Misleading representation of foam plastic flammability
- ▶ Fire Safety Aspects of Polymeric Materials
 - National Academy of Sciences
- ▶ Vyto Babrauskas, Full-scale burning behavior of upholstered chairs, Nat. Bur. Std. (U.S.) Tech. Note 1103 (1979)
- ▶ Are we losing our institutional memory of these issues?



1980s

UPHOLSTERED FURNITURE HEAT RELEASE RATES: MEASUREMENTS AND ESTIMATION

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ABSTRACT

A new instrument, termed a furniture calorimeter, has been constructed and placed into operation for measuring furniture heat release rates based on oxygen consumption. Using the furniture calorimeter, burning rate information has been obtained on a series of 13 chairs, love-seats, and sofas, most of them specially built to permit direct comparisons of construction features. A quantitative assessment is made of the effect of fabric types, padding types (cotton batting, ordinary polyurethane foam, and California-requirements foam), and frame types. The advantages of furniture calorimeter testing over normal room fire testing are discussed. Based on these measurements, a rule is presented for estimating the heat release rate based on design factors. Finally, implications for achieving both good flame resistance and good cigarette ignition resistance are discussed.

Key words: burning rate; chairs; flammability tests; furniture; heat release rate; plastics flammability; textile flammability; upholstered furniture.

INTRODUCTION

FURNITURE FIRES ACCOUNT FOR ROUGHLY HALF OF ALL THE FIRE deaths in the United States. These are primarily divided into upholstered furniture fires and bed fires, with about half the losses in each category. Thus, efforts in reducing upholstered furniture fire losses can have a significant effect on the over-all fire problem.

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Fire Behavior of Upholstered Furniture

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November 1985



U.S. Department of Commerce
Makoto Nakagaki, Secretary
National Bureau of Standards
Euseb Ambler, Director

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VYTENIS BABRAUSKAS

Table 1. Test specimens

Chair	Tests	Mass (kg)	Padding Material	Fabric	Frame
F21	T19,T45	28.3	Calif. Foam	Polyolefin	Wood
F22	T24	31.9	FR Cotton Batting	Cotton	Wood
F23	T23	31.2	FR Cotton Batting	Polyolefin	Wood
F24	T22	28.3	Calif. Foam	Cotton	Wood
F25	T29	27.8	Non-Calif. Foam	Polyolefin	Wood
F26	T25	19.2	Calif. Foam	Polyolefin	Wood (Min. Weight)
F27	T26	29.0	Foam, Cotton, Polyester	Cotton	Wood
F28	T28	29.2	Foam, Cotton, Polyester	Cotton	Wood
F29	T27	14.0	Non-Calif. Foam	Polyolefin	Polypropylene
F30	T30	25.2	Non-Calif. Foam	Polyolefin	Polyurethane
F31	T31,T37	40.0	Calif. Foam	Polyolefin	Wood (Loveseat)
F32	T38	51.5	Calif. Foam	Polyolefin	Wood (Sofa)
F33	T18	39.2	Foam, Cotton	Cotton	Wood (Loveseat)

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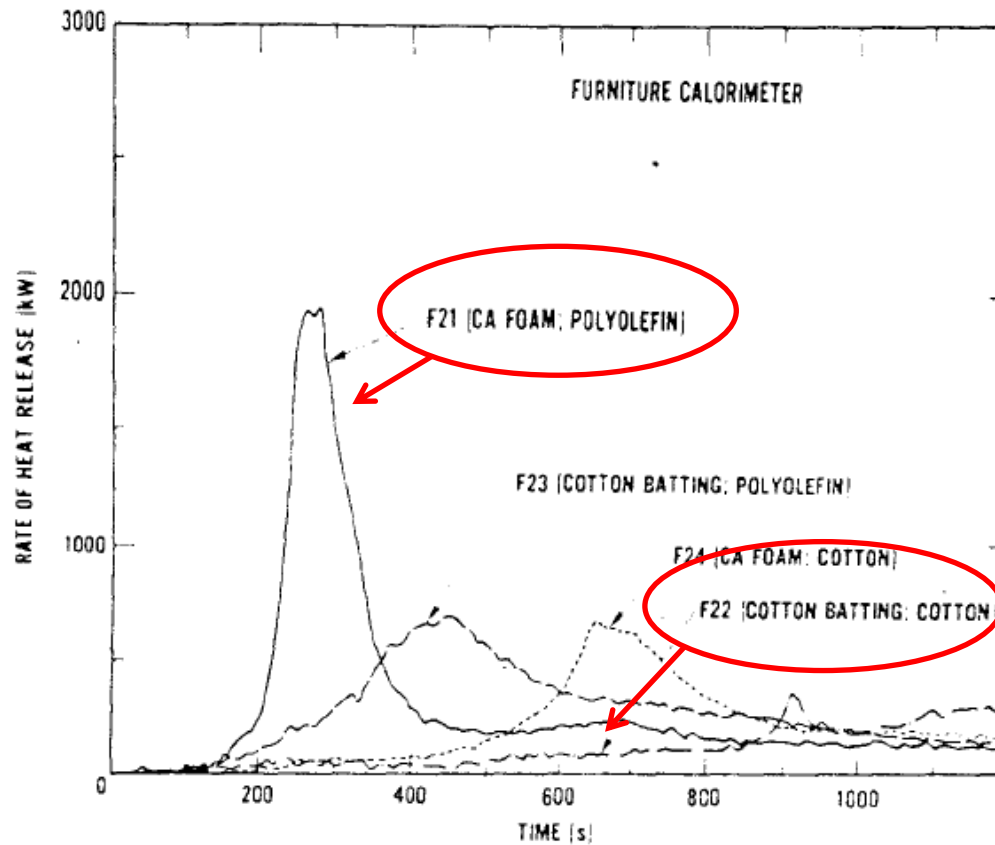
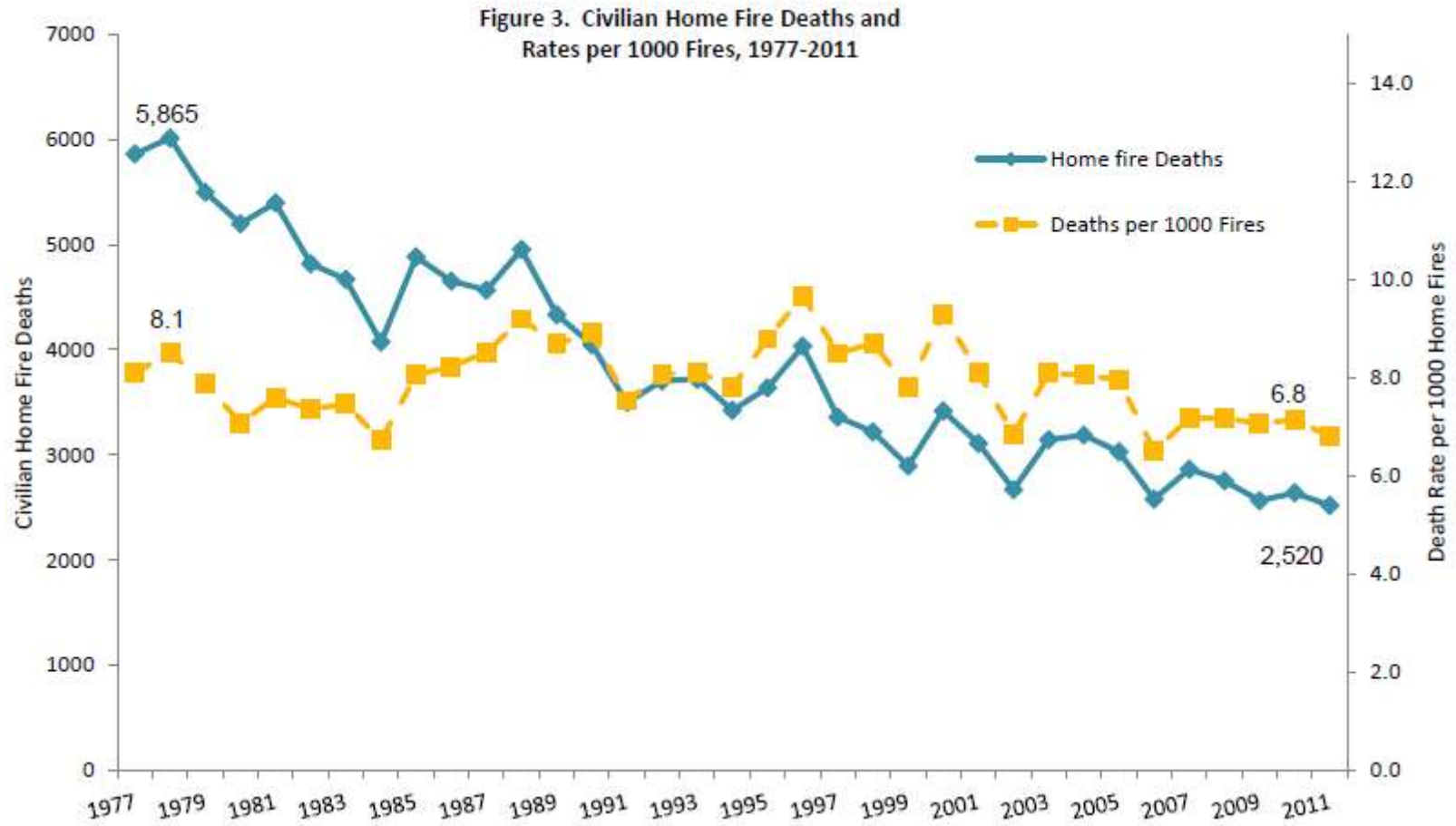


Figure 11. Effect of specimen padding and fabric on rate of heat release

Perspective on the US fire problem



Reference: Michael J. Karter, Jr., FIRE LOSS IN THE UNITED STATES DURING 2011, NFPA, September 2012

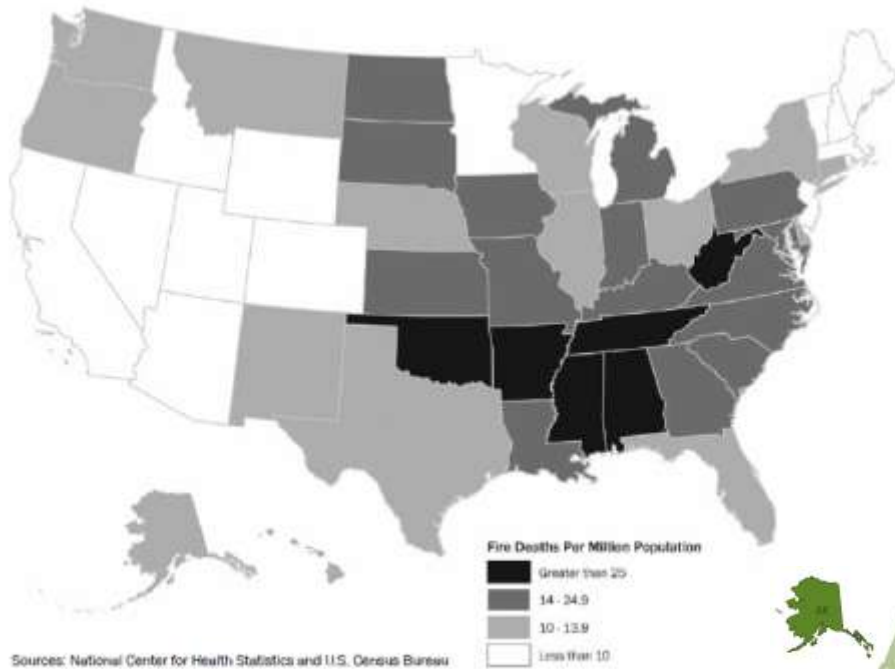
Perspective on the US fire problem

- ▶ Normalized by US population
- ▶ Early 1900s
 - ~12,000 deaths / ~100 million people = 120×10^{-6}
- ▶ 1980
 - ~5,200 deaths / ~227 million people = 23×10^{-6}
- ▶ 2011
 - ~2,520 deaths / ~312 million people = 8.1×10^{-6}

Reasons for reduced fire fatalities

- ▶ Enhanced fire safety codes and standards
 - Building construction / utilities / appliances
 - Flammability of furnishings / finishes / consumer products
 - Smoke alarms
 - Automatic sprinklers
- ▶ Reduced prevalence of indoor smoking
 - ~40% of adults smoked in 1980 (~5200 home fire deaths)
 - ~20% of adults smoke today (~2600 home fire deaths)
- ▶ Other
 - e.g., fire safety education

Fire death rates vs smoking rates



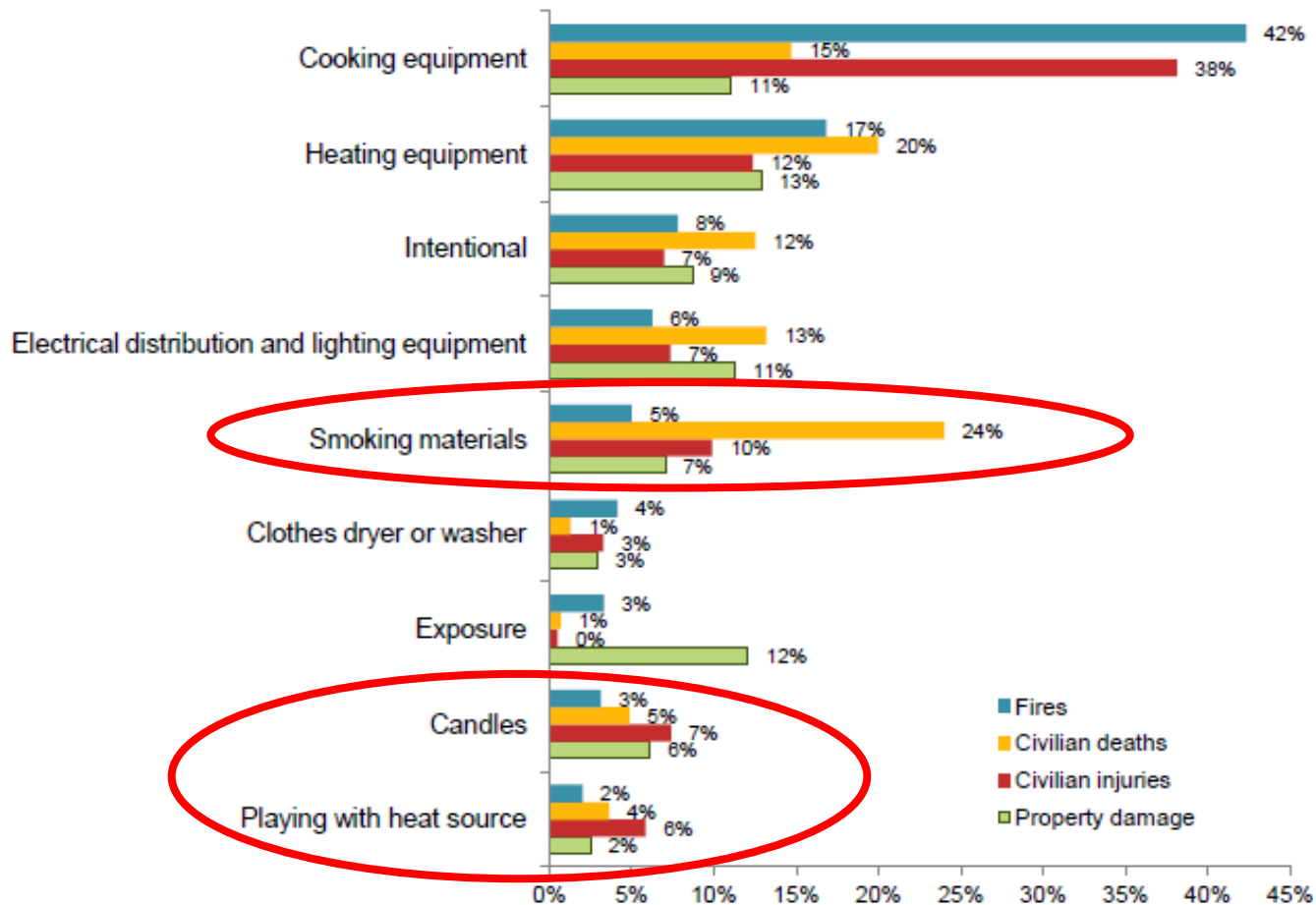
Source: USFA, Fire in the US, 14th ed. (2004 data)

Source: CDC VitalSigns, Sept. 2011



Leading causes of home fires

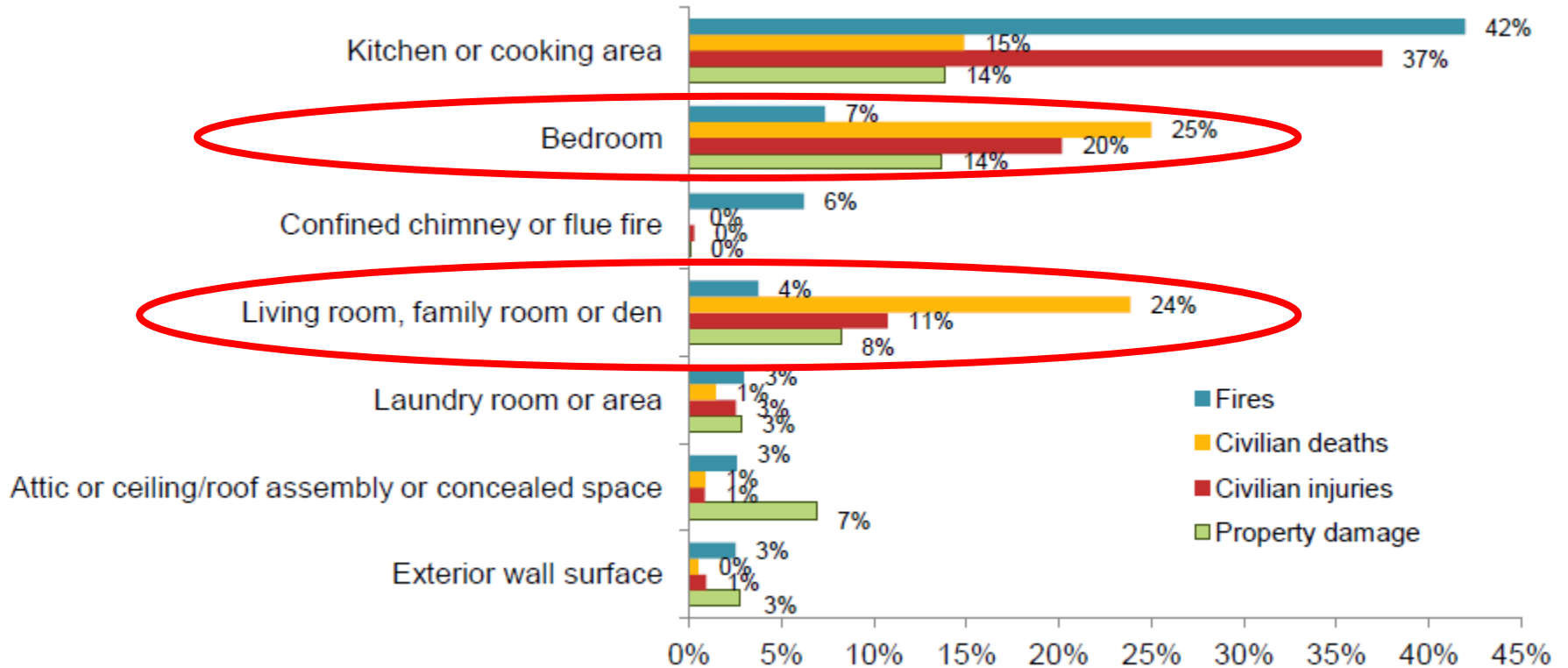
Figure 9. Leading Causes of Home Structure Fires: 2006-2010



Reference: Marty Ahrens, Home Structure Fires, NFPA, August 2012

Leading areas of origin

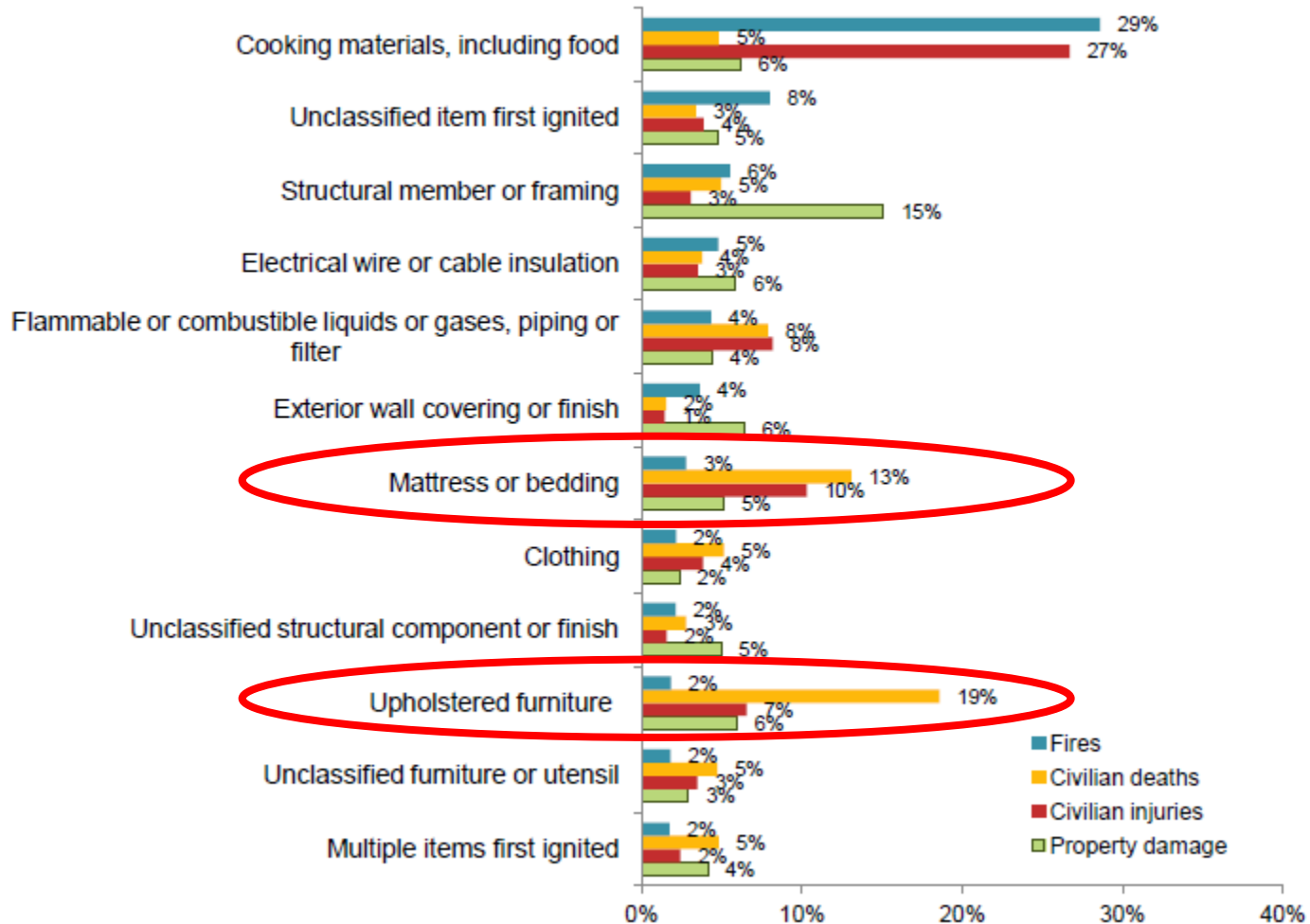
Figure 11. Leading Areas of Origin in Home Structure Fires: 2006-2010



Reference: Marty Ahrens, Home Structure Fires, NFPA, August 2012

Leading items first ignited

Figure 12. Leading Items First Ignited in Home Structure Fires: 2006-2010



Summary

- ▶ By area of origin
 - 7% start in bedroom – result in 25% of deaths
 - 4% start in living areas – result in 24% of deaths
 - **11% of home fires – result in 49% of deaths**
- ▶ By first item ignited
 - 3% start in bedding/mattresses – result in 13% of deaths
 - 2% start in upholstered furniture – result in 19% of deaths
 - **5% of home fires – result in 32% of deaths**
- Reference:
 - Marty Ahrens, Home Structure Fires, NFPA, August 2012

Flammability of upholstered furniture

- ▶ Ease of ignition

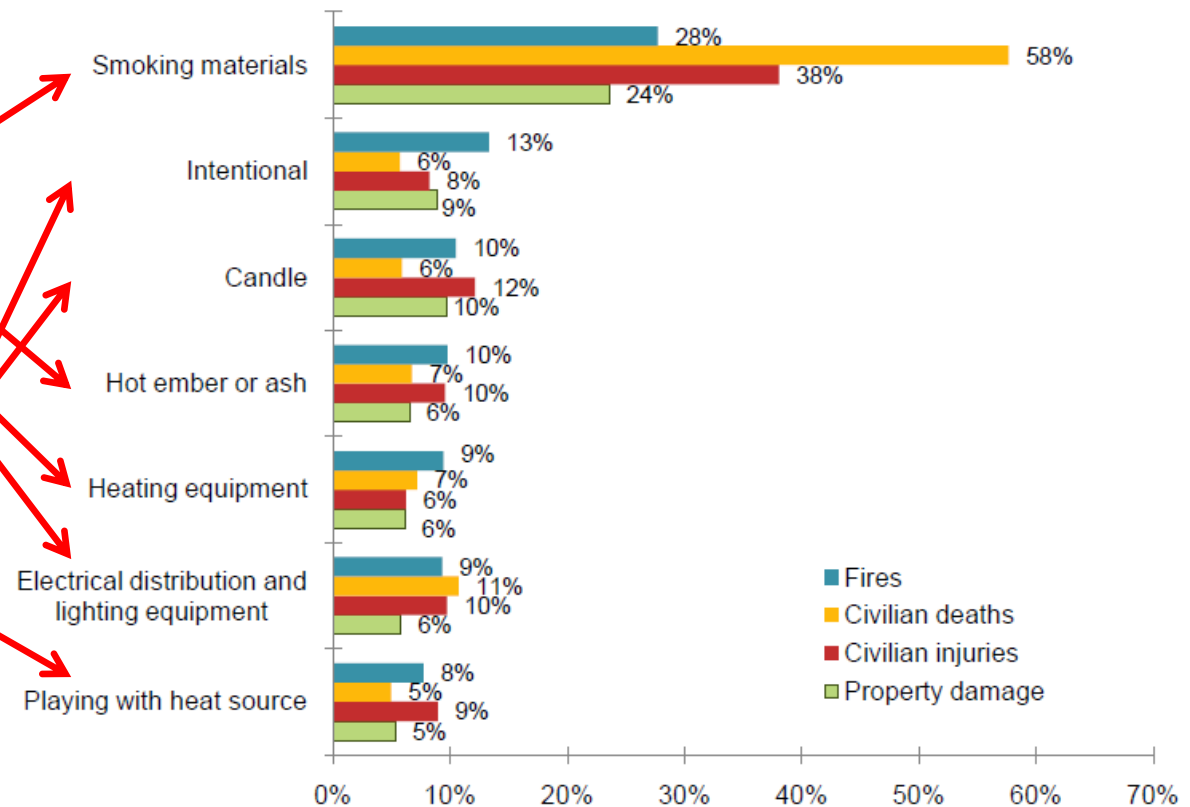
- ▶ Smoldering

- Small-scale
- Large-scale

- ▶ Flaming

- Small-scale
- Large-scale

Figure 4. Major Causes of Home Structure Fires that Began with Upholstered Furniture: 2005-2009



Flammability of upholstered furniture


- ▶ Summary
- ▶ Ignition by smoking materials dominates
 - 28% of upholstered furniture fires
 - 58% of upholstered furniture deaths
- ▶ Ignition by flaming sources not insignificant
 - 23% of leading causes of upholstered furniture fires
 - 17% of deaths associated with these causes
- Does not consider upholstered furniture as secondary fuel

Mitigation strategies

- ▶ **Systems approach – some combination of:**
- ▶ **Alternative flammability performance?**
 - Prevent ignition vs reduced rate/magnitude of fire development
- ▶ **Improved fire detection**
 - **38% of fire deaths in homes without detectors**
 - **24% of fire deaths in homes where detectors did not operate**
 - Marty Ahrens, Homes Structure Fires, NFPA, August 2012
- ▶ **Automatic fire suppression**
 - Potential long-term impact, but questionable impact in short term

Potential research topics

▶ Furniture flammability

- Should we trade off increased smoldering propensity for better flaming performance and enhanced sustainability?
 - PU foam / polyester  Cotton / wool / natural fabrics
 - How do we participate in movement towards eliminating fire retardants – furniture, appliances, insulation ...
- ## ▶ Enhanced smoke detection in older residences
- **62% of deaths occur without functional detection!**