Fire and Safety Risks Posed by Large Wood Frame Residential – An Evidenced Based Review

What are the stated concerns and what does the data show?

First Wood Design Seminar

February 2014

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Copyright Materials

Large Wood Frame Residential

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Challenging the *Implicit* Assumption

The instinctive response from the fire service with respect to 6-storey wood frame buildings…

50% taller…

Therefore…

50% more risk for fire and safety…

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Three Takes on Wood Frame Construction

- Developers
- Public
- Fire service

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1. What the Developer Sees…

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2. What the Public Sees…

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3. What the Fire Service Sees…

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Understanding the Benefits

- Increase demand for local wood products
- Create jobs and stimulate the economy
- Increase housing affordability ≈ 12% - 15%
- Lower carbon foot print
- More intensive land use

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Fire Service Concerns Raised

- Science
  - Expressed lack of research and/or evidence to support
- Harmonization
  - Not consistent with other building codes
- Consultation
  - Stakeholders outline a number of issues
    - Response times
    - Resourcing
    - Inspections
    - Construction site safety

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Code Changes in BC 2009

- Compartmentalization
- Fire resistant assemblies
- More stringent sprinkler protection
- Control of moisture content
- Construction risk mitigation

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Research Relating to these Concerns

1. National Research Council simulation modeling
2. Retrospective analysis of fires in BC
3. Case studies from other jurisdictions that have these buildings
4. Shake-table research examining earthquake impacts

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FiRECAM™ Sprinkler Study #1

- Two variables of interest
  - Civilian / Firefighter Injuries
  - Sprinkler protection
  - Additional fire departments

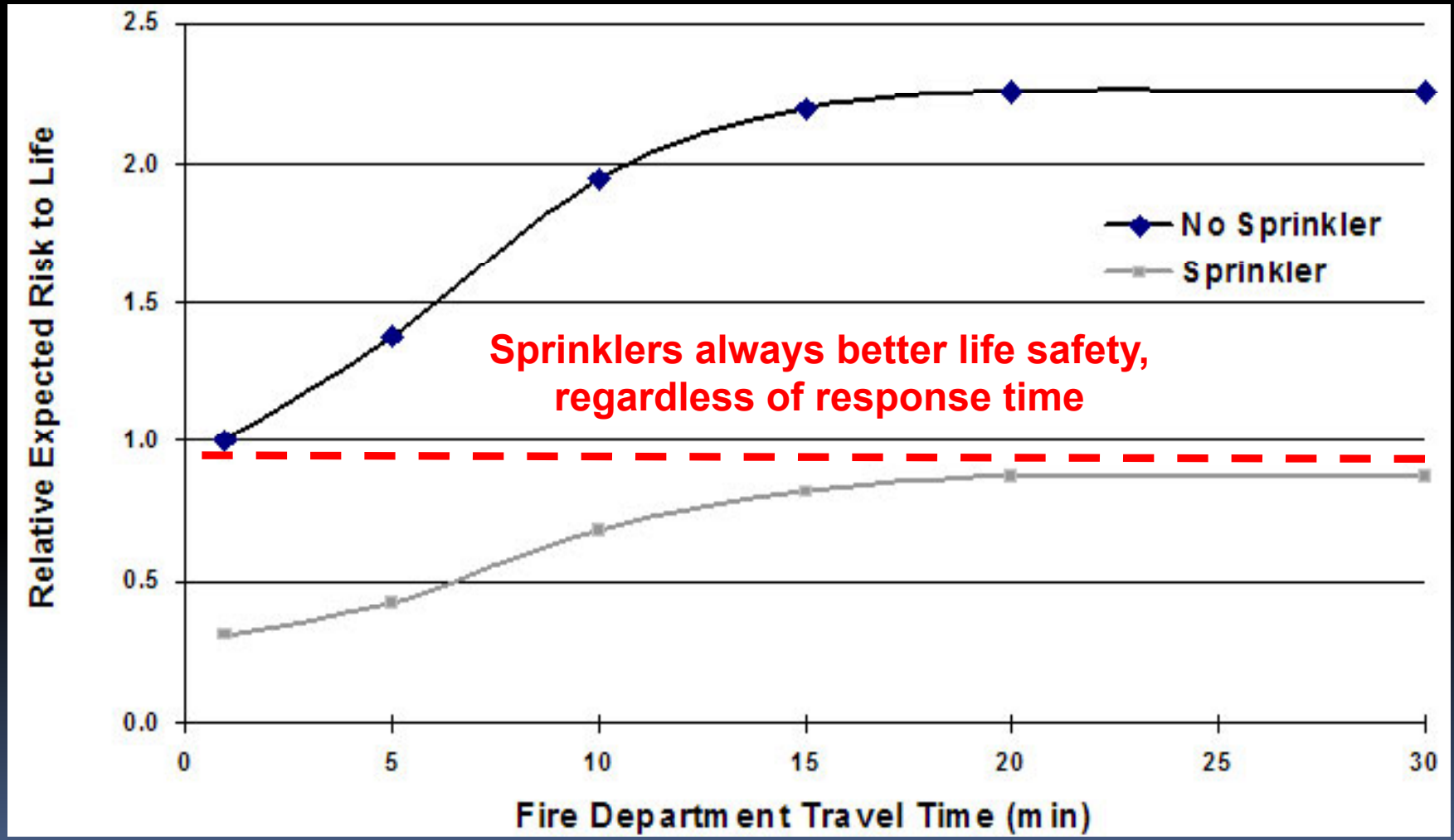
Civilian / Firefighter injuries

Severity of injuries	Civilian injuries (n=608)		Fire fighter injuries* (n=88)	
	No sprinkler protection (n=571)	Sprinkler protection (n=37)	No sprinkler protection (n=84)	Sprinkler protection (n=4)
< 1 day in hospital/off work	55.0%	67.6%	56.0%	75.0%
1-2 days in hospital and/or off work 1-15 days	30.5%	24.3%	36.9%	25.0%
≥ 3 days in hospital and/or off work > 15 days	14.5%	8.1%	7.1%	0.0%
Total	100.0%	100.0%	100.0%	100.0%
Injury rate per 1,000 fires	63.6	43.0	9.4	4.7

* The OFC data codes this as fire fighter/police/RCMP combined.

N = (9,841 Fires / 144 Deaths / 696 Injuries)

FiRECAM™ Sprinkler Study #1



Research Part 1 – NRC Modeling

- Fire Separations , Calculated the relative expected risk to life and expected losses for five different options:

1. 60-min wall/flooring/ceiling assembly without sprinklers
2. 60-min wall/flooring/ceiling assembly with sprinklers
3. 45-min wall/flooring/ceiling assembly with sprinklers
4. 60-min wall and 45-min floor/ceiling assembly with sprinklers
5. 30-min wall/flooring/ceiling assembly with sprinklers

- Sprinklers modeled at NFPA13R

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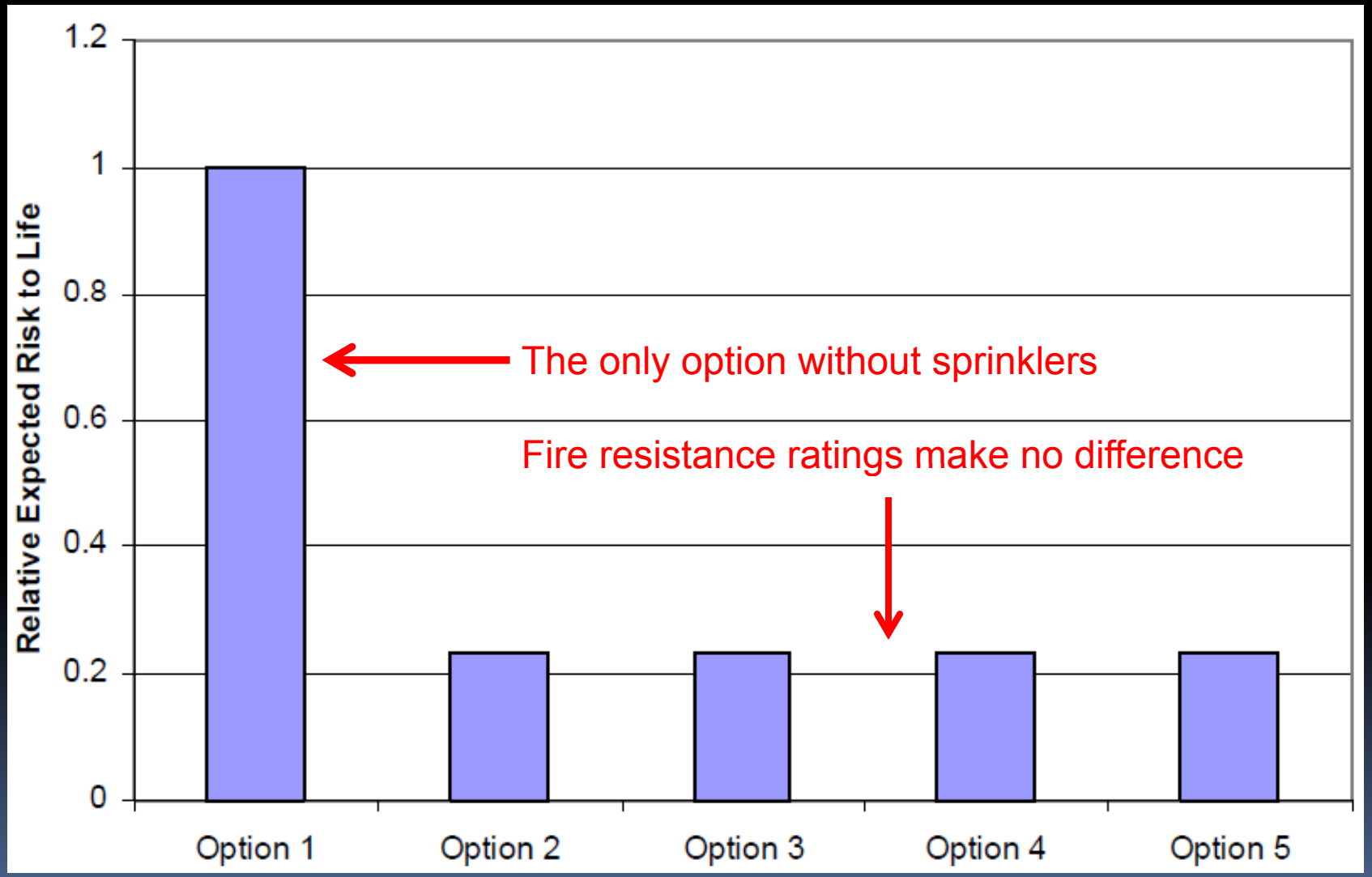
FiRECAM™ Sprinkler Study #1



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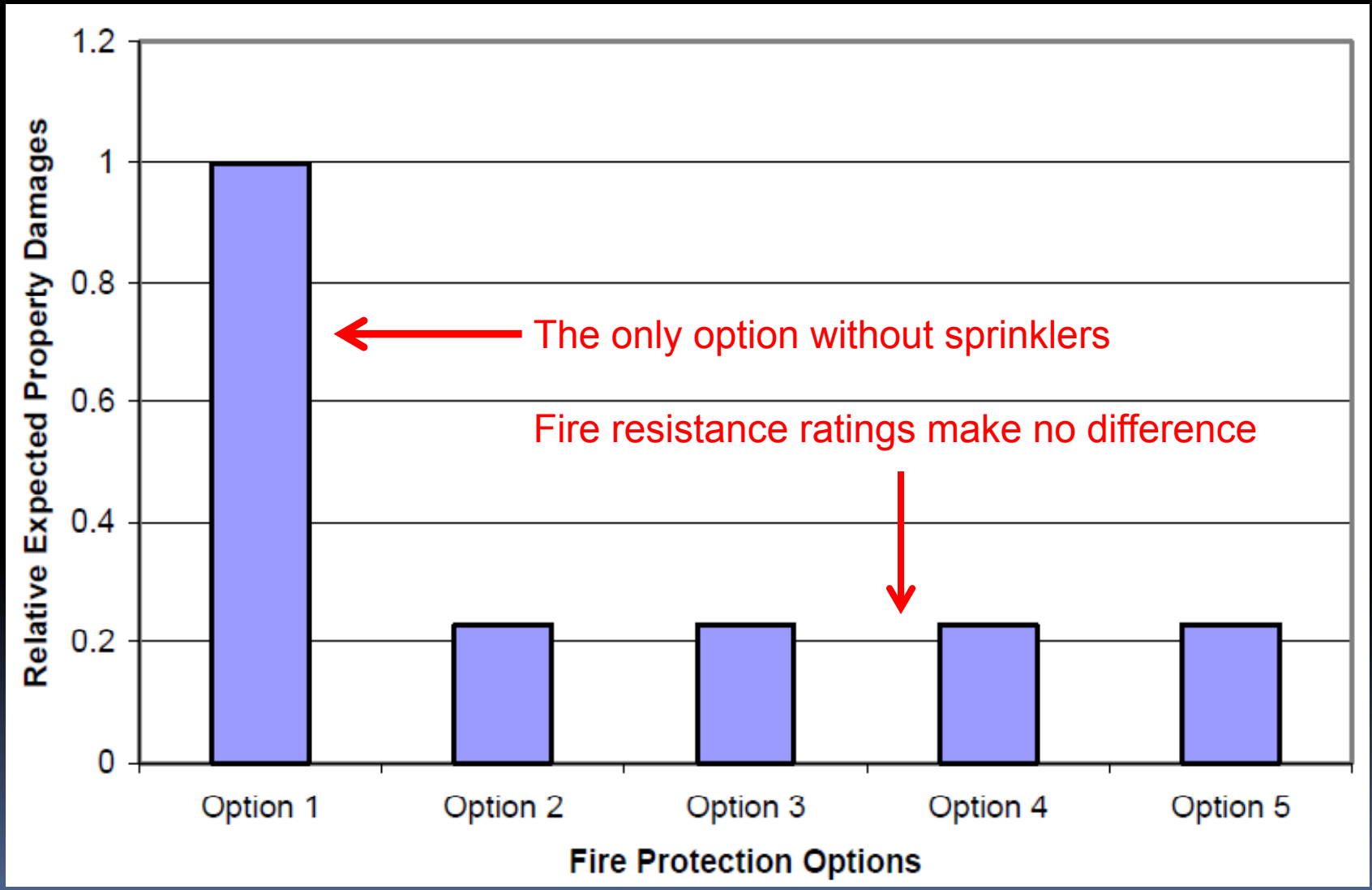

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Research Part 2 – BC Data

- Set of 1,942 fire incidents that occurred in apartments
  - Occurred in BC
  - October 2006 to October 2011
  - Compared fires in completely sprinkler protected buildings (n = 565)
  - With fires in buildings without any sprinkler protection (n = 1,377)
- Looked at
  - Initial detection
  - Extent of fire spread
  - Method of fire control

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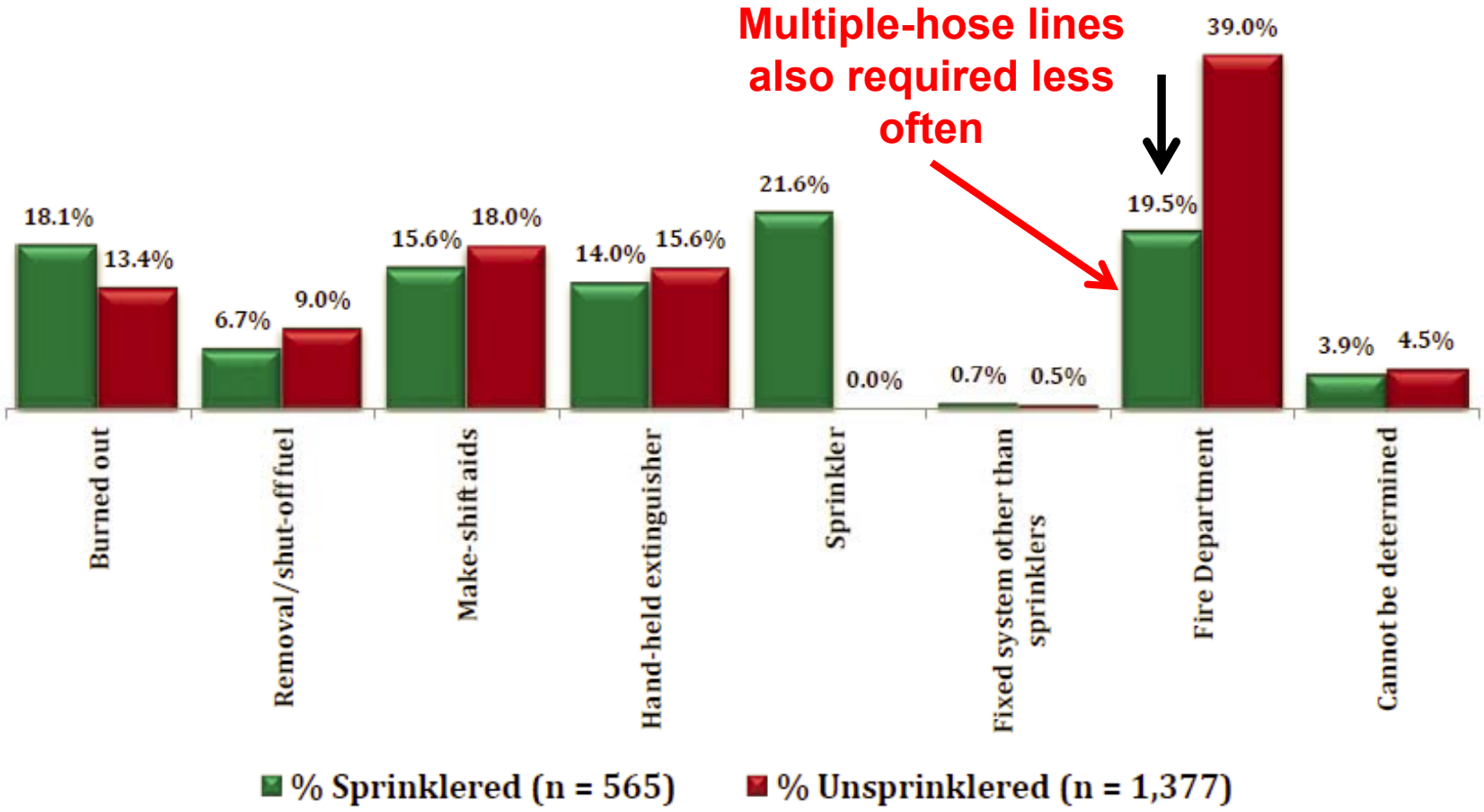
Method of Fire Control by Sprinkler Status

FIGURE 1: WITHIN-GROUP PERCENTAGES OF BROADLY GROUPED METHODS OF FIRE CONTROL BY SPRINKLER PROTECTION STATUS



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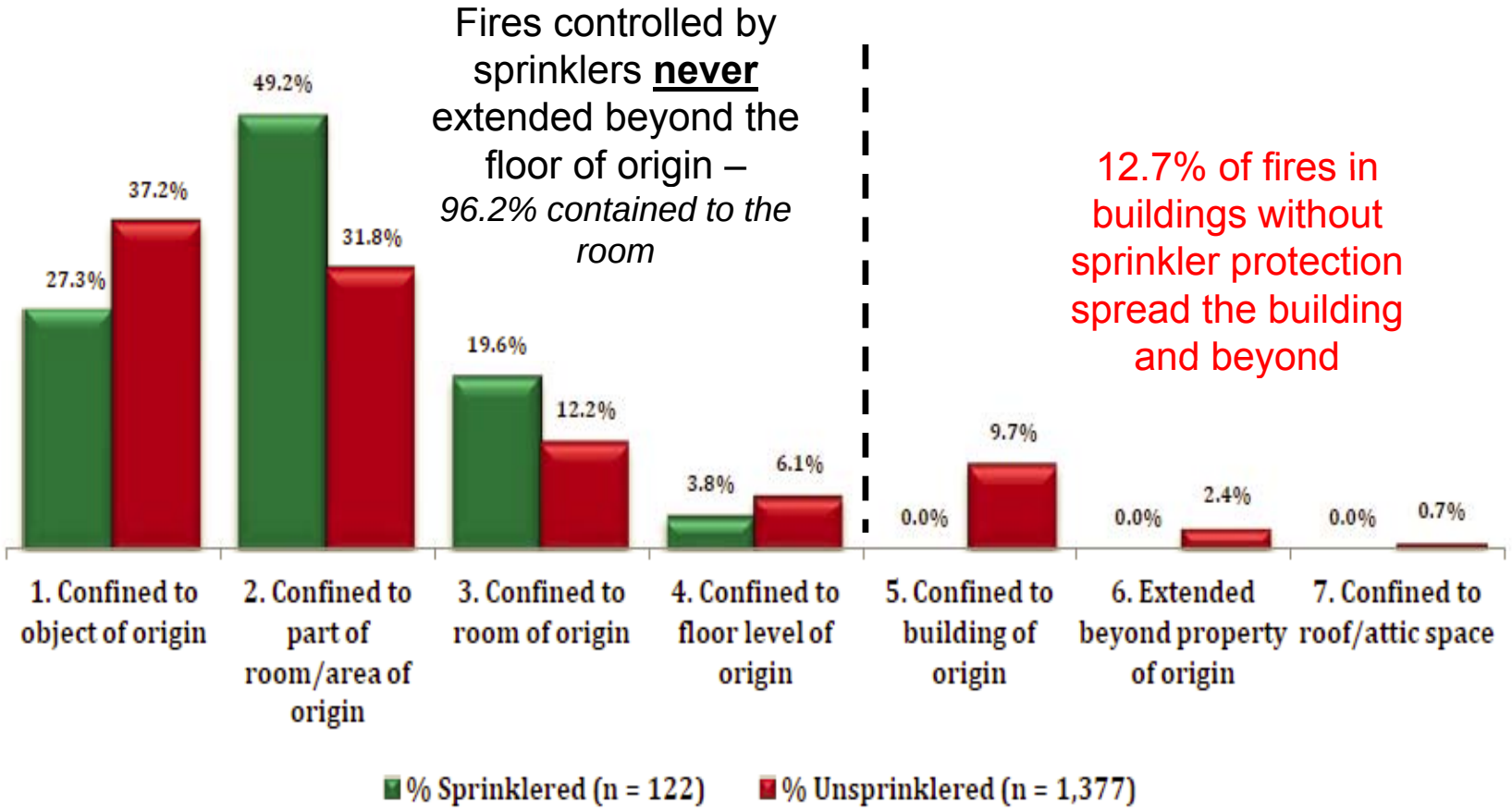
Extent of Fire Spread by Sprinkler Status

FIGURE 2: PERCENTAGE (AND CUMULATIVE PERCENTAGE) OF EXTENT OF FIRE SPREAD BY SPRINKLER PROTECTION STATUS



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Timing of Fire Safety Inspections

- Set of 4,084 fire incidents that occurred in inspectable properties
  - Occurred in BC
  - 1999 to 2003 (when inspection form changed)
  - Examined date since last inspection (more or less than 1 year) and fire outcome
    - Property loss
    - Fire-related casualty

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Timing of Fire Safety Inspections

- Majority of fires (74%), injuries (81%), and deaths (74%) occurred within 1 year of most recent inspection
  - No meaningful increase in risk with duration since last inspection
- Timing had no influence on extent of fire spread
  - Buildings inspected at least every 3 years performed equivalently
- Injury rates were greater for residential vs. non-residential properties
  - No influence of timing that indicated increased risk with increased time

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Research Part 3 – Case Studies

- Seattle Fire Service, WA
- Protects an area that has had 6-storey multi-residential wood frame buildings for 20 years
- Deputy Fire Chief Fire Marshal

  "We have been allowing this in Seattle for roughly 20 years and although we may have hundreds of buildings like this we have not seen large losses…"
- Seattle Battalion Chief

  "The fires I have had in these buildings have been controlled by sprinklers and confined to the room of origin…"

  "The Seattle Fire Department mandates fast response residential sprinklers in these kinds of occupancies and they are very effective…"

Research Part 4 – Shake Tables

- van de Lindt et al. examined the outcomes of controlled, shake-table research
  - Examine structural performance of wood frame buildings in response to extreme seismic activity
  - Full-scale mid-rise light-frame 6 story apartment model
  - World's largest shake table, in Miki, Japan
  - 1,350 m^2 of living space with 23 apartment units
  - Exposed to once in every 72 years events to once in every 2,500 years events (equated to the 1994 LA earthquake)

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Research Part 4 – Shake Tables

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Research Part 4 – Shake Tables

- Overall, the researchers concluded
  - The buildings performed excellently under simulation conditions
  - Sustained little damage across all trials

- It is estimated that only 2 of Japan's 500 wooden pagodas – some as tall as 19 stories – have collapsed during the past 1,400 years
  - Despite being one of the world's most active earthquake zones

The Economist (1997)

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Vulnerability #1 – External Origin Fires

- Fires that commence on the outside of the building:
  - Exterior balconies
  - Court/patio/terrace area

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Analyzing the Risk with Balcony Fires

- Set of 2,638 fire incidents that occurred in apartments/ townhomes
  - Occurred in BC
  - October 2006 to October 2011
  - Initially looked at sprinkler protection status – not predictive
  - Compared fires that started on balconies and court/patio/terrace (n = 255)
  - With all other apartment/townhome fires (n = 2,383)
- Looked at
  - Initial detection
  - Extent of fire spread
  - Method of fire control

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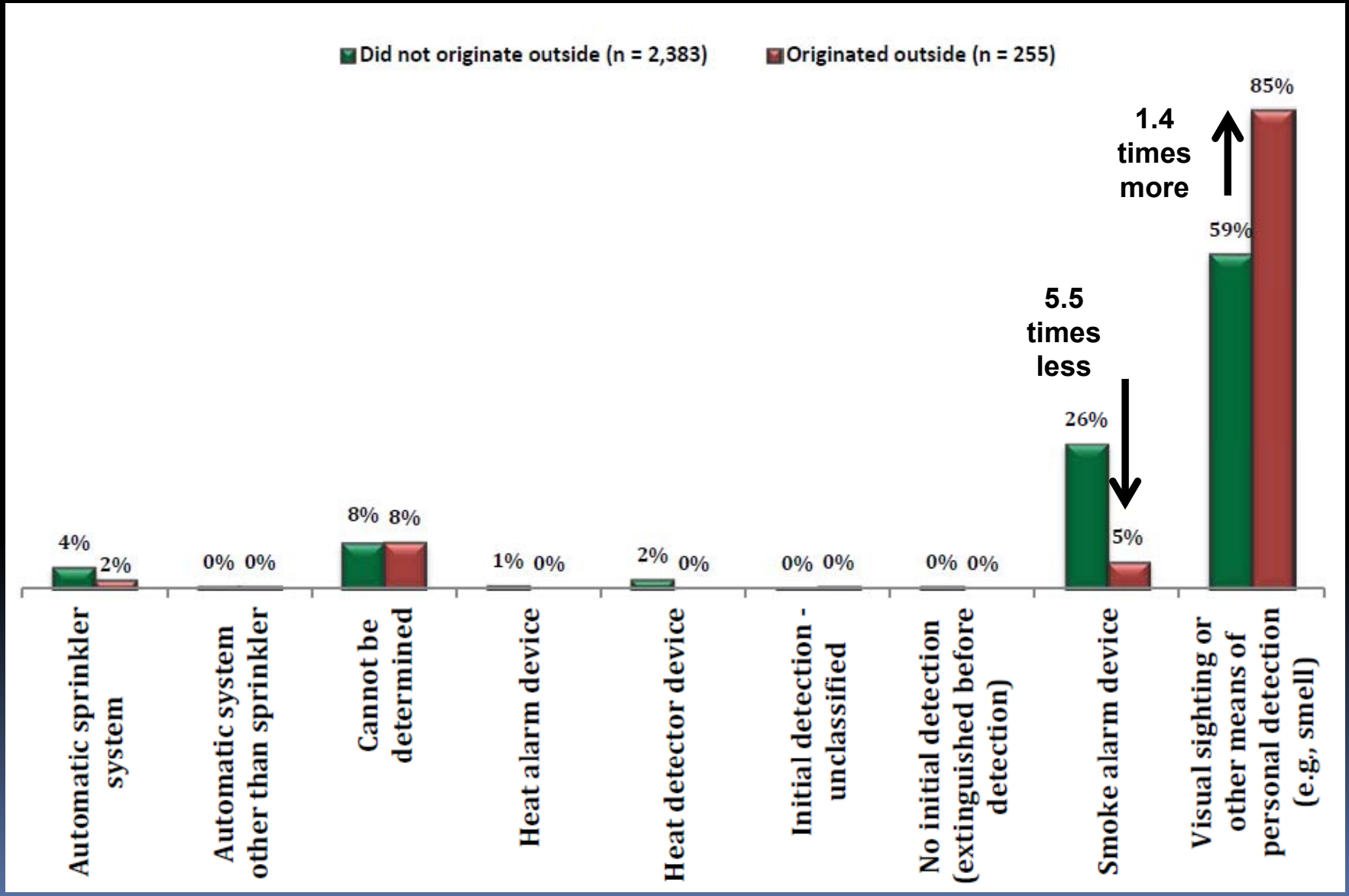
Initial Detection for Balcony Fires



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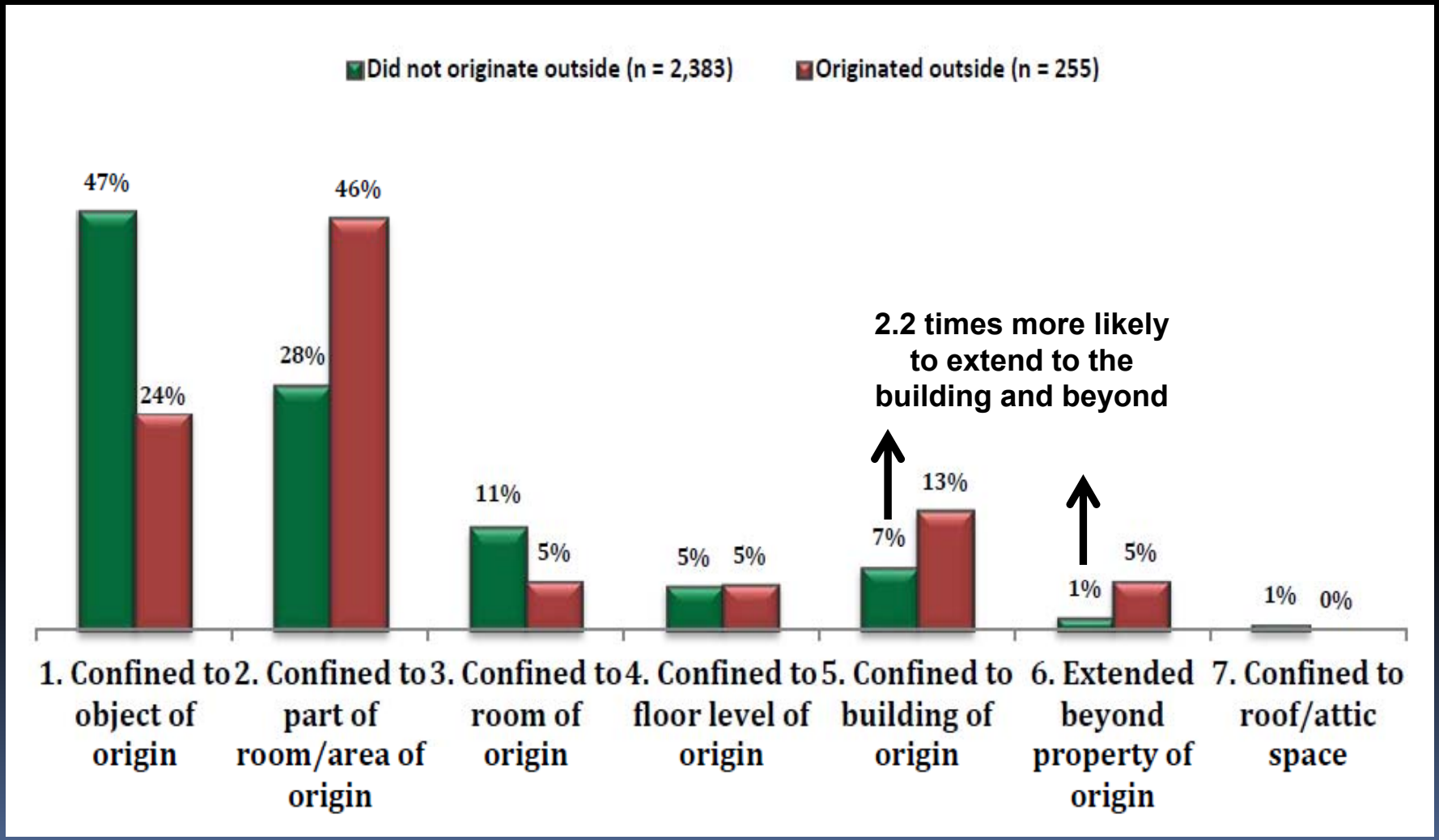
Extent of Fire Spread for Balcony Fires



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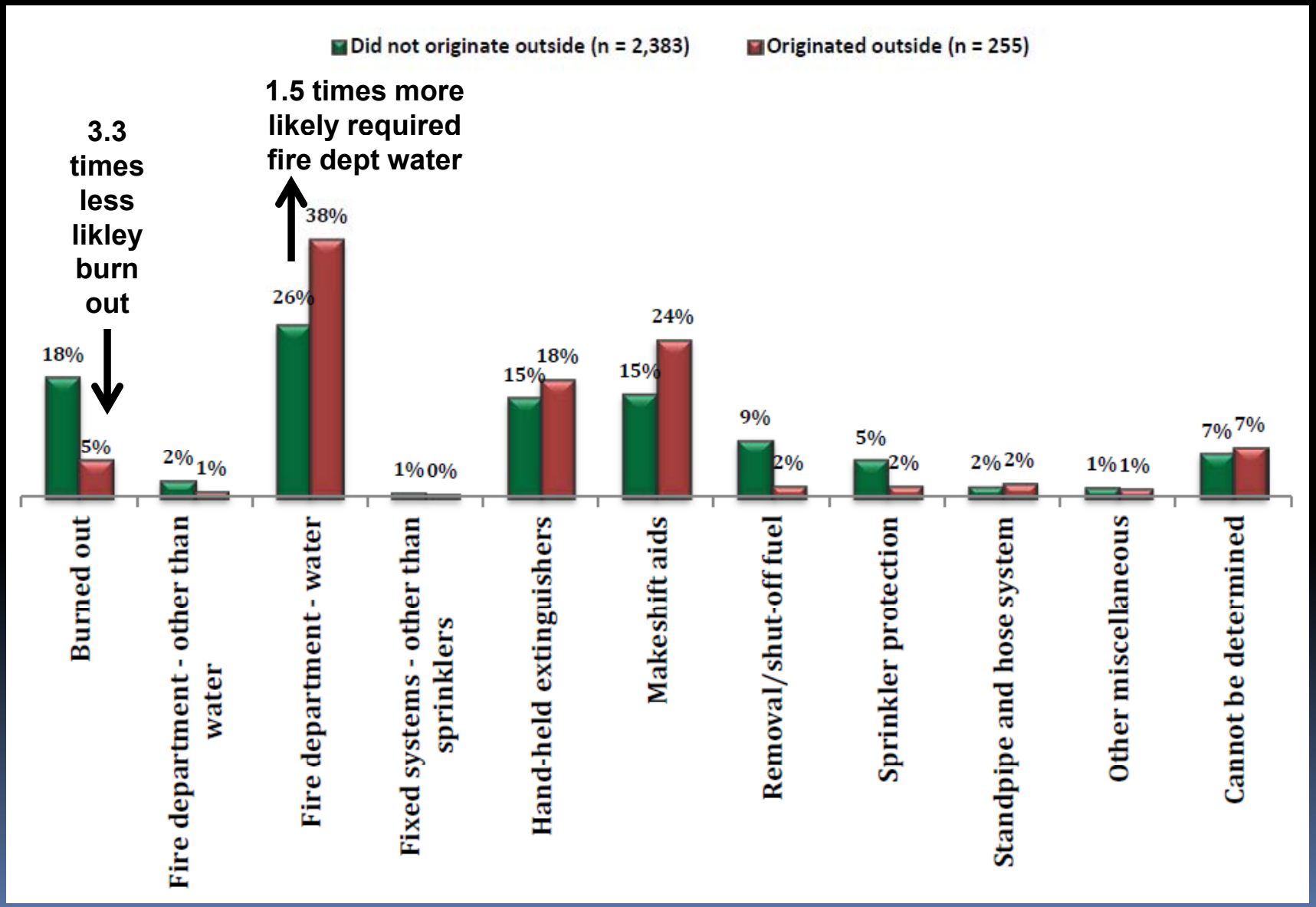
Method of Fire Control for Balcony Fires



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Vulnerability #2 – Buildings Under Construction

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What Causes Fires when Under Construction?

- Leading causes for fires when under construction:
  - Incendiary / suspicious events
  - Smoking on site
  - Open flames/ embers
  - Heating equipment

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Construction Fire Safety Plans

SURREY FIRE SERVICE

Construction Fire Safety Plan Bulletin

CITY OF SURREY
FIRE SERVICES

The B.C. Fire Code requires building owners/contractors to comply with the requirements of the BC Fire Code 5.6 Construction and Demolition Sites

CITY OF SURREY FIRE SERVICE

8767 132 Street Surrey B.C., V3W 4P1
Fire Prevention: 604-543-6780
Fax: 604-594-1237 www.surrey.ca

Revised July 29, 2011

This bulletin is provided by the Surrey Fire Service to assist owners, contractors, and workers on the requirements of a Construction Fire Safety Plan (CFSP). The document is intended to provide a brief overview of existing information that has previously been developed. Each site and construction project will have site specific issues that will need to be addressed in the CFSP.

During the construction phase, a building is at its most vulnerable state. A CFSP is a part of a system that is intended to protect the building during this vulnerable stage. Once a building is completed, there are a number of life safety systems in place to protect the building and its occupants. These include fire alarm systems, sprinklers, and fire compartmentalization. During construction these fire safety measures may or may not be installed or fully operational. Therefore, the CFSP must address hazards that could be present during construction.

The leading causes of fire in buildings under construction or demolition are:

- Incendiary/suspicious events.
- Smoking on site.
- Open flames/embers.
- Heating equipment.

While minimizing the fire hazards at a construction site, the CFSP must also take into account the impact a fire would have on the neighboring building(s).

It is the owner's responsibility to develop a Construction Fire Safety Plan that meets the requirements of the BC Building and

Construction Fire Safety Plans

- Fire safety plan requirements:
  - Fire safety training for onsite staff
  - Enforcement of best practices
  - Features co-ordination – fire wall construction – fire doors
  - Site security – active watchman service

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How Much does Protection Fire Cost?

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What's Driving the Total Cost of Fire

- The most recent estimates for the total cost of fire in the US was produced by Hall in 2010.
  - Economic loss (property damage) due to fire (direct and indirect, reported and unreported) estimated at $18.6 billion
  - **13% decrease** compared to 1980 estimates (CPI adjusted)

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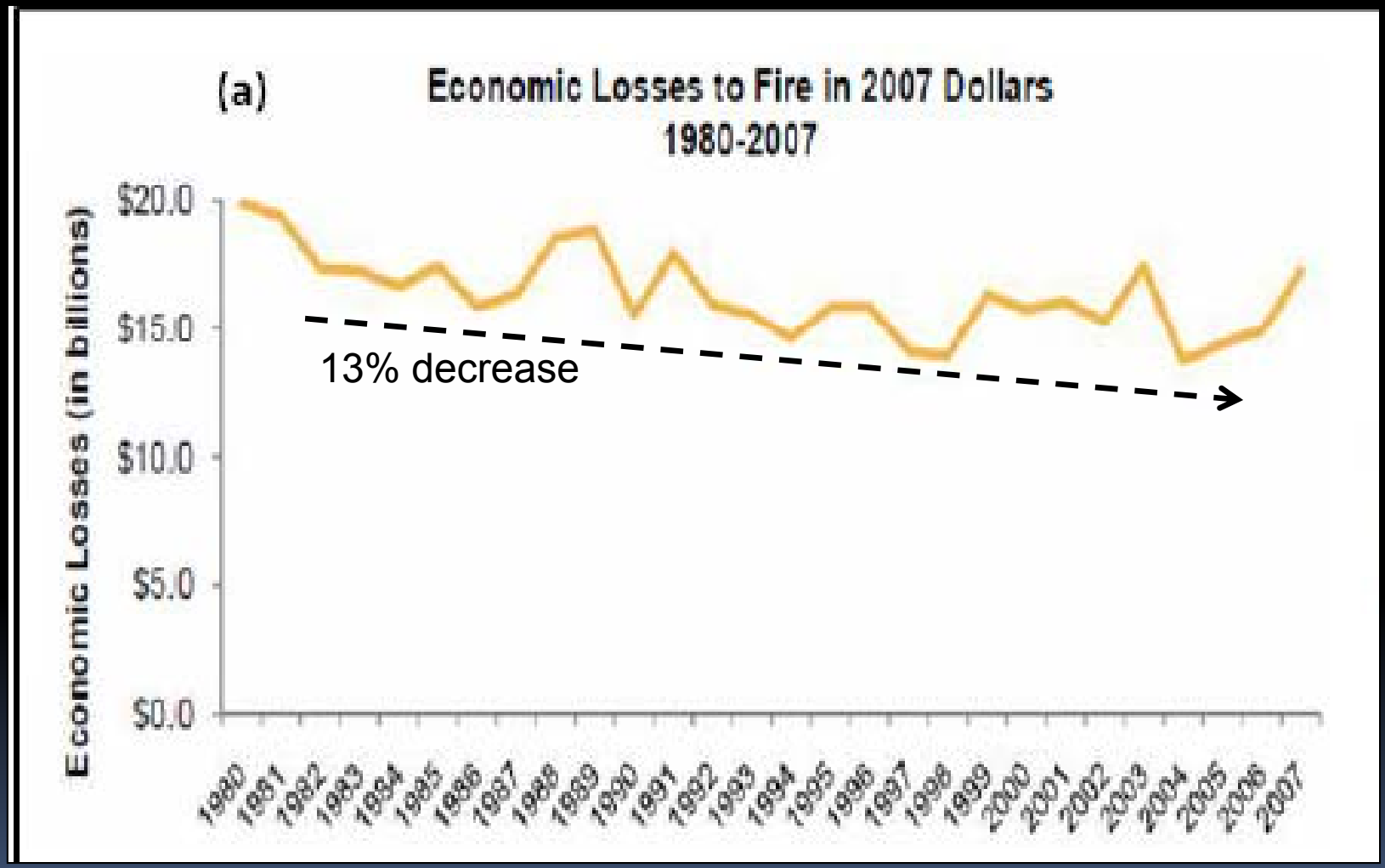
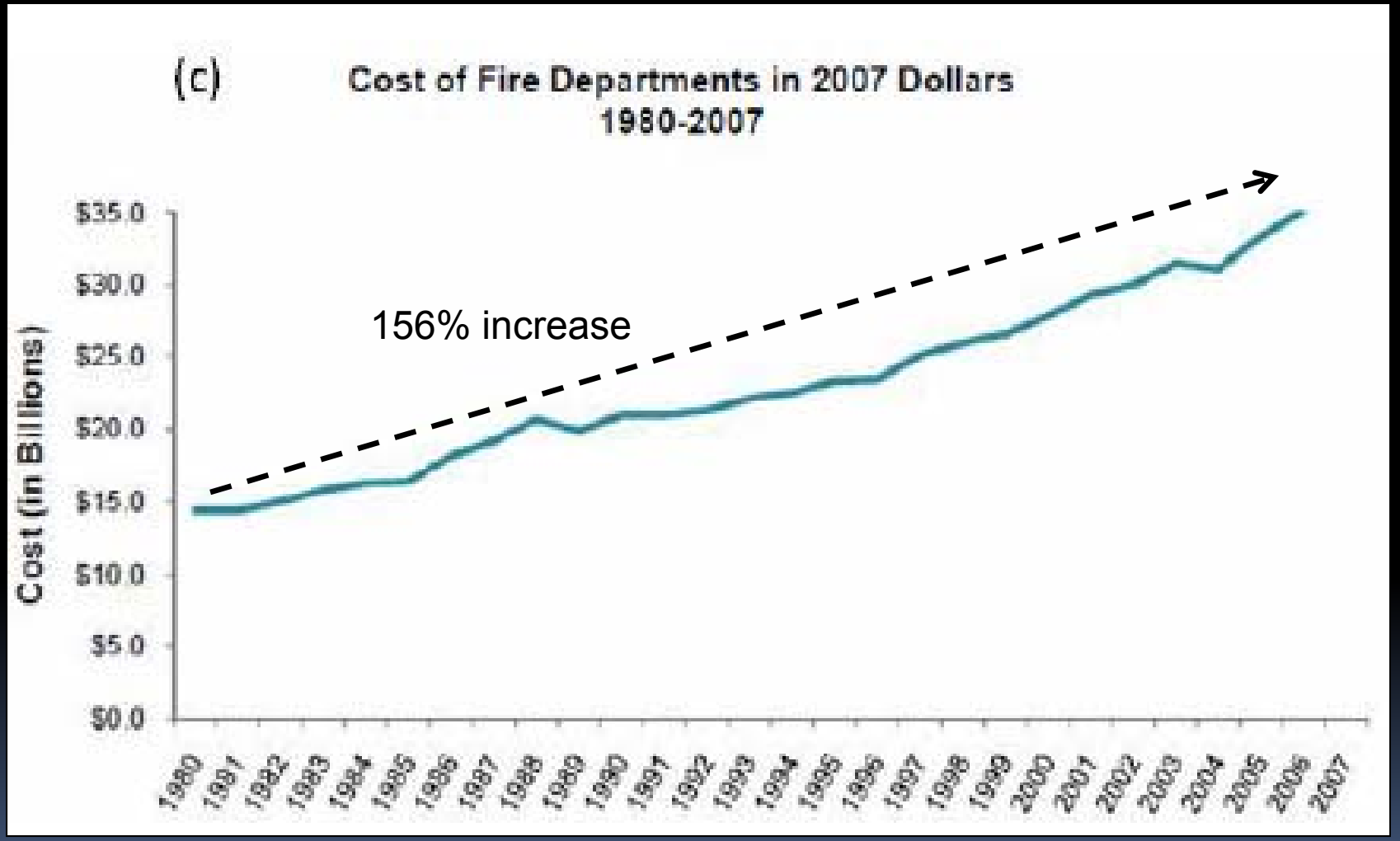
Summarizing the Trends for Cost of Fire



J.R. Hall Jr., *The total cost of fire in the United States*, 2012, National Fire Protection Association, Fire Analysis and Research Division: Qunicy, MA. p. 31.

Summarizing the Trends for Cost of Fire



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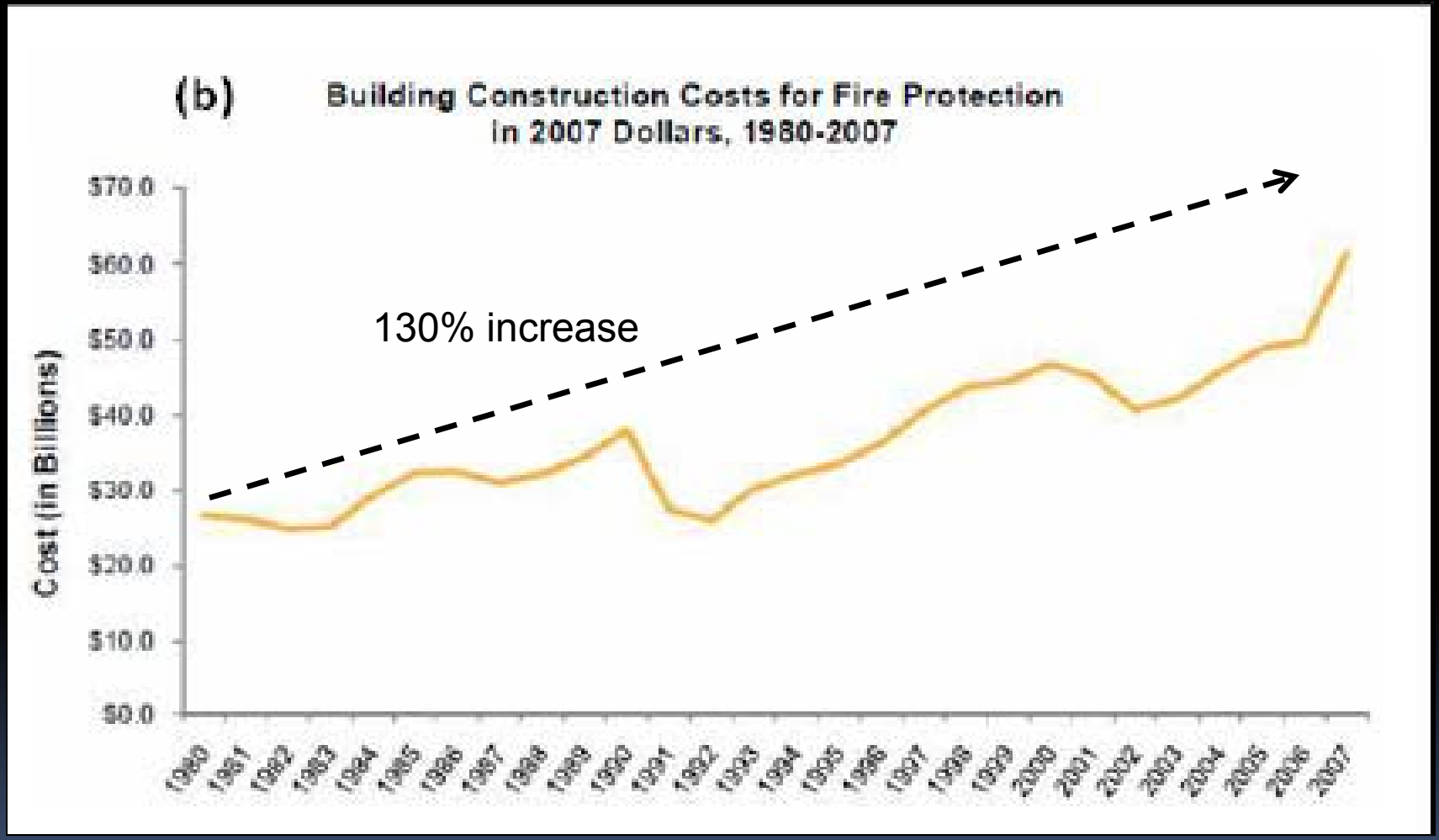

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At What Cost Was the 13% Decrease?

- **156%** increase in the cost of career fire department
- **67%** increase in the net difference between fire-related insurance premiums paid and estimated insurable economic losses
- **130%** increase in the costs of new building construction for fire protection
- "These building construction costs include passive protection, such as compartmentation, and active protection, such as detection and sprinkler systems"

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- **Hall discusses that these trends clearly indicate there is a need for product innovations and other programs (including education) that can simultaneously improve fire safety but at a lower cost.**

Conclusions

- Extensive examination
  - Simulation, retrospective quantitative analysis, case study
- Overwhelmingly consistent theme that emerges
  - Although fire services typically have responded to these types of proposed changes with concerns
  - Available information suggests these structures will perform at least as well from a safety perspective as those that are already permitted
- Existing code changes make provisions to address the weaknesses for
  - Buildings while under construction.
  - Fires that originate from the exteriors of these buildings (most typically from balconies).

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The Future?

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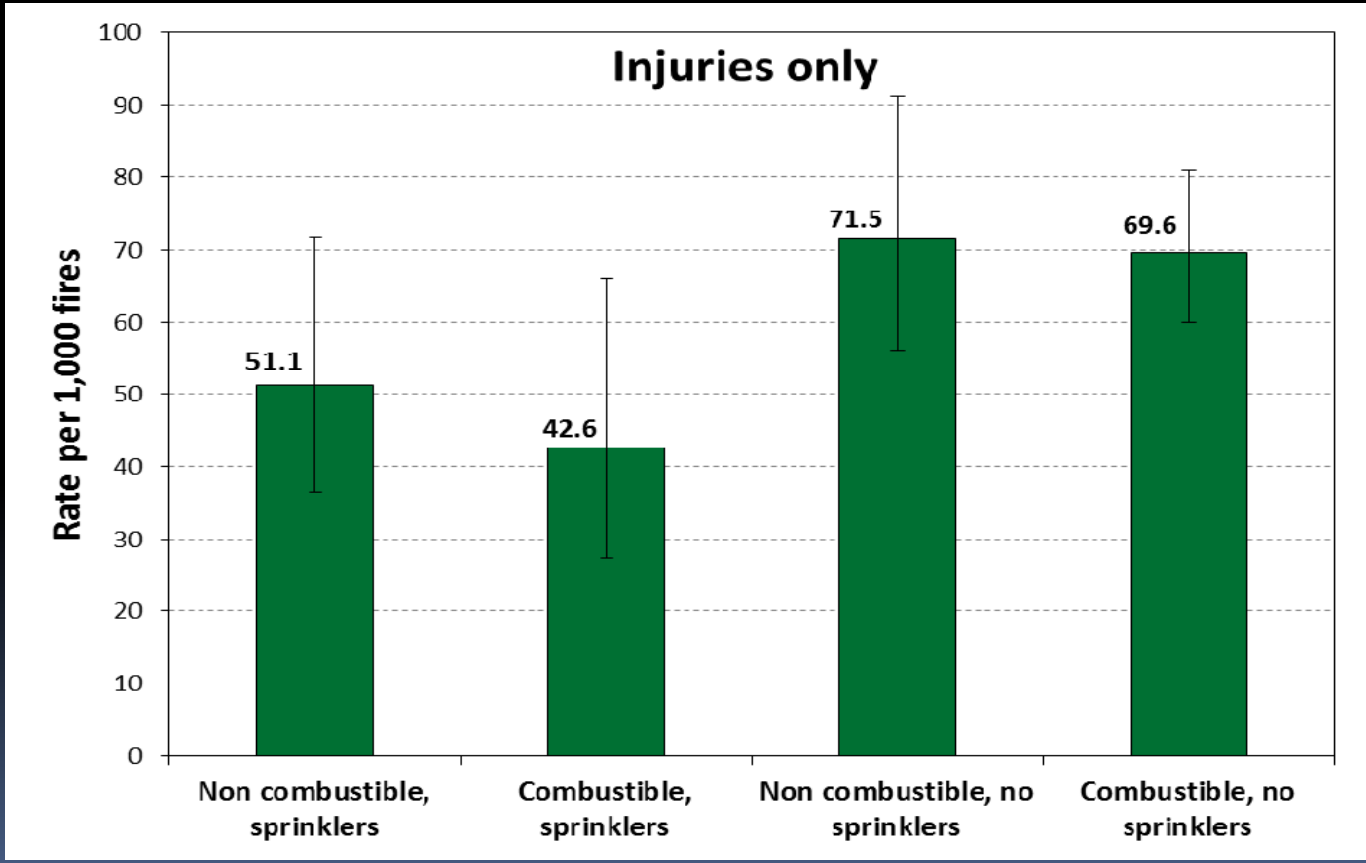
Is the FUTURE going to be Safe?

- The best available data so far says “Yes”
- No difference between the “Two construction materials”



Source: Richardson (2007) *Fire and Materials*, *31*, 97-123

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Not Just Talking About Smoke Alarms

- US Fire Administration research (2008)
  - Fire sprinklers alone – chances of dying in a fire decrease by 69% (compared to no sprinklers)
  - Smoke alarms alone – chances decrease by 63% (compared to no alarm)
  - Sprinklers AND smoke alarms – chances decrease by 82%
- Fire risk is non-random
- Not advocating for blanket approaches – more thoughtful and risk driven

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Building use and occupancy appear to be the key

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Questions/ Comments?

This concludes the:

- ***American Institute of Architects***
- ***Architectural Institute of British Columbia***
- ***Engineering Institute of Canada***

Continuing Education Systems Program

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