What are the Concerns and How Can we Mitigate

Fire & Safety Risk Posed by Large Wood Frame Residential Buildings

Len Garis, Fire Chief City of Surrey, Adjunct Professor - School of Criminology and Criminal Justice & Associate to the Centre for Social Research University of the Fraser Valley , Affiliated Research Faculty - John Jay College of Criminal Justice, and The Christian Regenhard Centre for Emergency Response Studies, New York

Canadian Wood Council

Fire and Safety Risks Posed by Large Wood Frame Residential Buildings

Professor / Fire Chief Len Garis

September 29, 2015

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Len Garis, the Fire Chief for the City of Surrey, Professor at the University of the Fraser Valley, Affiliated Research Faculty, John Jay College of Criminal Justice , New York, will discuss research undertaken in partnership with Dr. Joe Clare and will examine stakeholder concerns with the fire and safety risks posed by wood frame residential construction. The talk will commence by discussing the background to the concerns from the fire service with respect to these structures, and how these contrast with the benefits that have been identified for these buildings. The specific nature of the concerns that have been raised by the key stakeholders will be outlined and then discussed with respect to research findings that have examined these issues, including an overview of the National Research Council work that has contributed to the safety margins relied on in the new building codes, and a retrospective analysis of recent fire outcomes for relevant structures in BC. Vulnerabilities with previous constructions that have been identified will be discussed, along with an explanation as to how the amended building code addresses these. The talk will conclude by explaining that, based on available simulation and retrospective data, and acknowledging the amendments that have been made to the building code to protect these new, taller wood frame buildings, there does not appear to be data-driven support for the concerns raised by key stakeholders with respect to these structures. In addition, the rate-of-return on the increasing demands for fire protection relative to the reduction in fire losses will be explained, with the intent of demonstrating that the ever-growing total cost of fire requires all stakeholders to be more mindful of adding additional costly safety components without considering their effectiveness.

At the end of the this course, participants will be able to:

- The specify the nature of the concerns that have been raised by the key stakeholders in reference to tall wood construction will be outlined and then discussed with respect to research findings that have examined these issues, including an overview of the National Research Council work that has contributed to the safety margins relied on in the new building codes, and a retrospective analysis of recent fire outcomes for relevant structures in BC. Vulnerabilities with previous constructions that have been identified will be discussed, along with an explanation as to how the amended building code addresses these.
- The talk will conclude by explaining that, based on available simulation and retrospective data, and acknowledging the amendments that have been made to the building code to protect these new, taller wood frame buildings, there does not appear to be data-driven support for the concerns raised by key stakeholders with respect to these structures.
- discussing the background to the concerns from the fire service with respect to these structures, and how these contrast with the benefits that have been identified for these buildings.
- the rate-of-return on the increasing demands for fire protection relative to the reduction in fire losses will be explained, with the intent of demonstrating that the ever-growing total cost of fire requires all stakeholders to be more mindful of adding additional costly safety components without considering their effectiveness.

This concludes The American Institute of Architects Continuing Education Systems Course

Canadian Wood Council www.cwc.ca
Wood *WORKS!* Alberta www.wood-works.org

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Challenging the *Implicit* Assumption

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

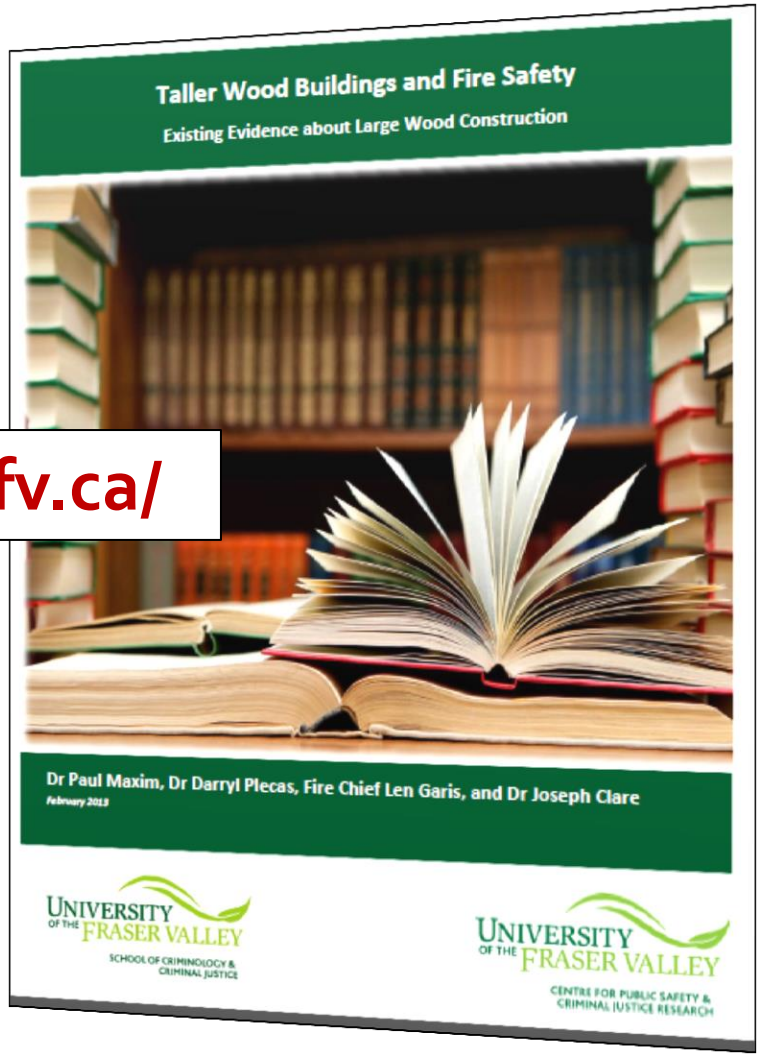
taller…

Therefore…

more risk for fire and safety…

Challenging the *Implicit* Assumption

http://cjr.ufv.ca/



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Large Wood Frame Residential

Challenging the *Implicit* Assumption

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

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Three Takes on Wood Frame Construction

- Developers
- Community
- Fire Service

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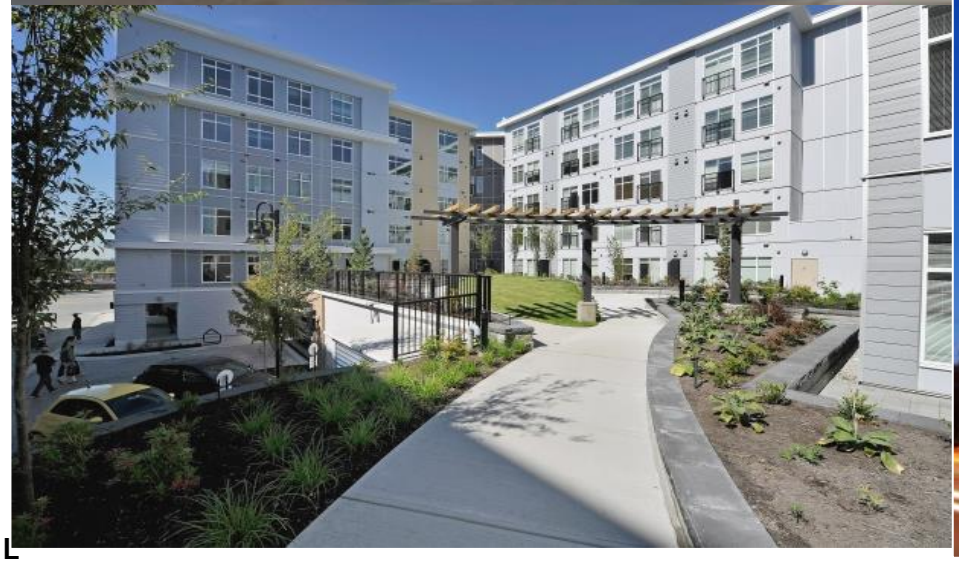
1. What the Developer Sees…

2. What the Public Sees…



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 ≈ 15% - 20%
- Lower carbon foot print
- More intensive land use

L

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
    - Construction site safety

L

Code Changes in BC 2009

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

L

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

J

FiRECAM™ Sprinkler Study #1

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

Civilian / Firefighter injuries

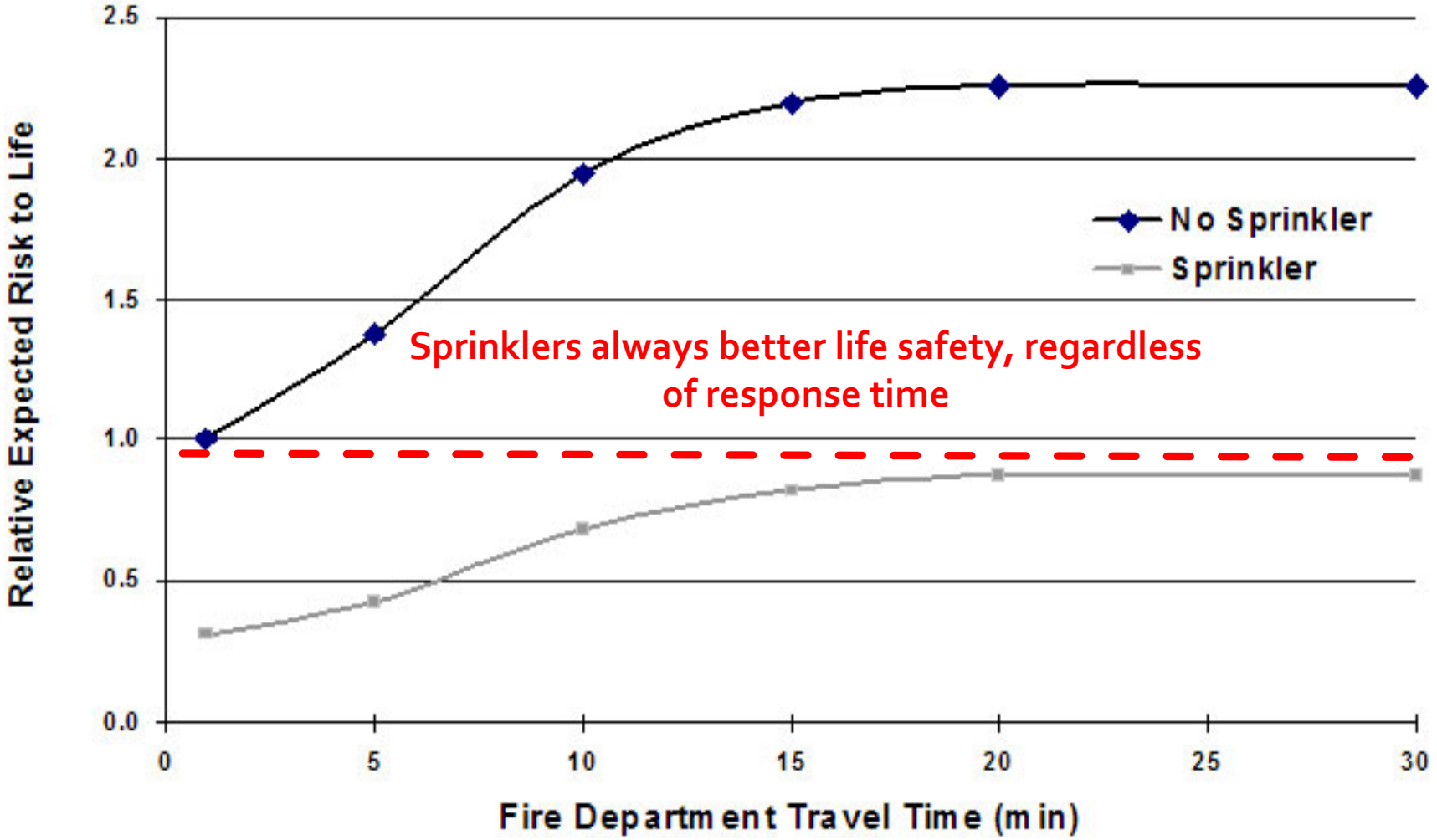
- Fire Fighters 2 times greater to be injured w/o Sprinklers
- Civilians 9.3 times greater to be injured w/o Sprinklers

Severity of injuries	Civilian injuries (n=6[illegible])		Fire fighter inju[illegible] (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

N = (9,841 Fires / 144 Deaths / 696 Injuries) (Oct 2009 - 2011)

FiRECAM™ Sprinkler Study #1

"Predicts lessor Risk to life"



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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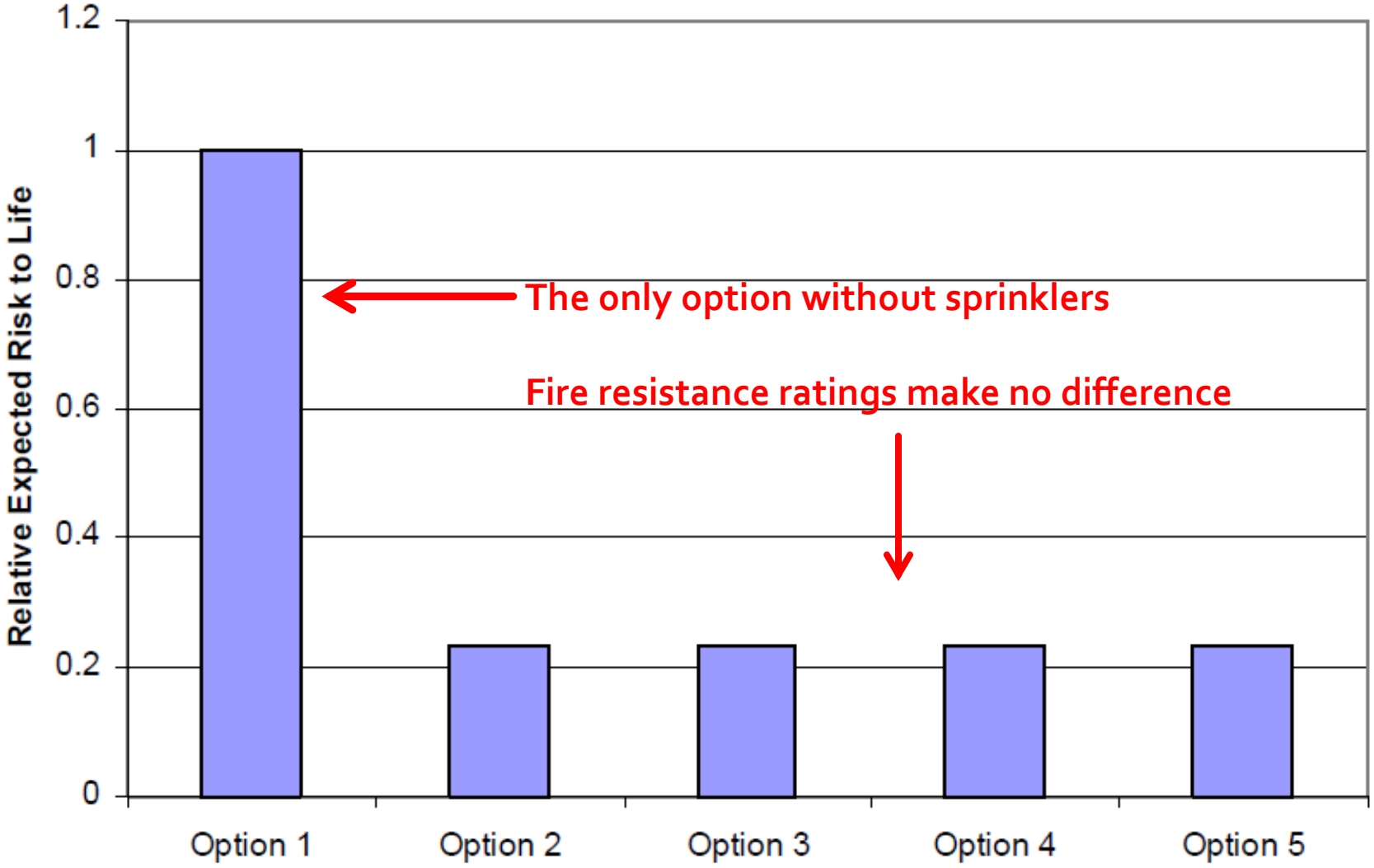
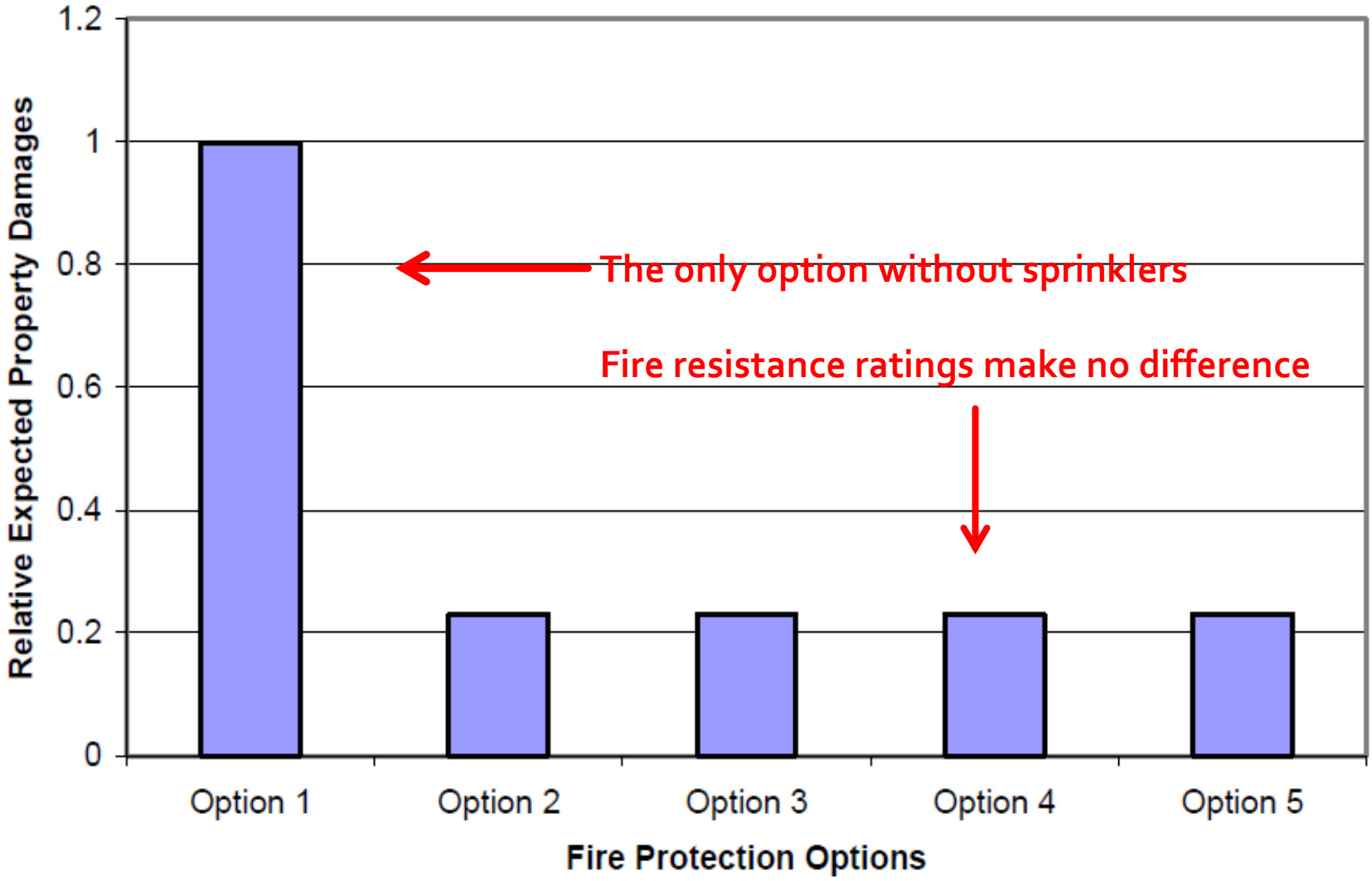
FiRECAM™ Sprinkler Study #1

"Predicts lessor Risk to life"



FiRECAM™ Sprinkler Study #1

"Predicts lessor Risk to Damage"



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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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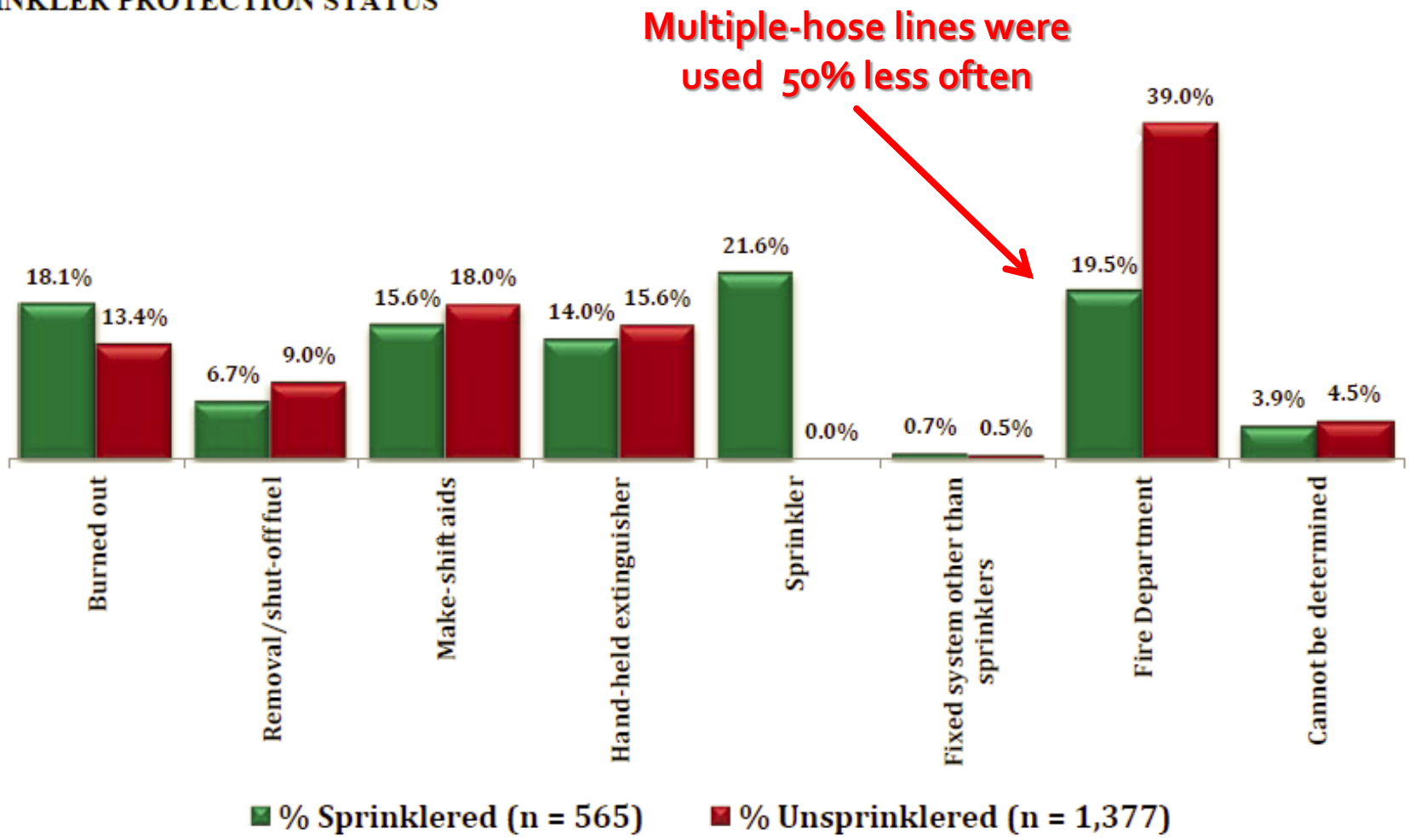
Method of Fire Control by Sprinkler Status

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



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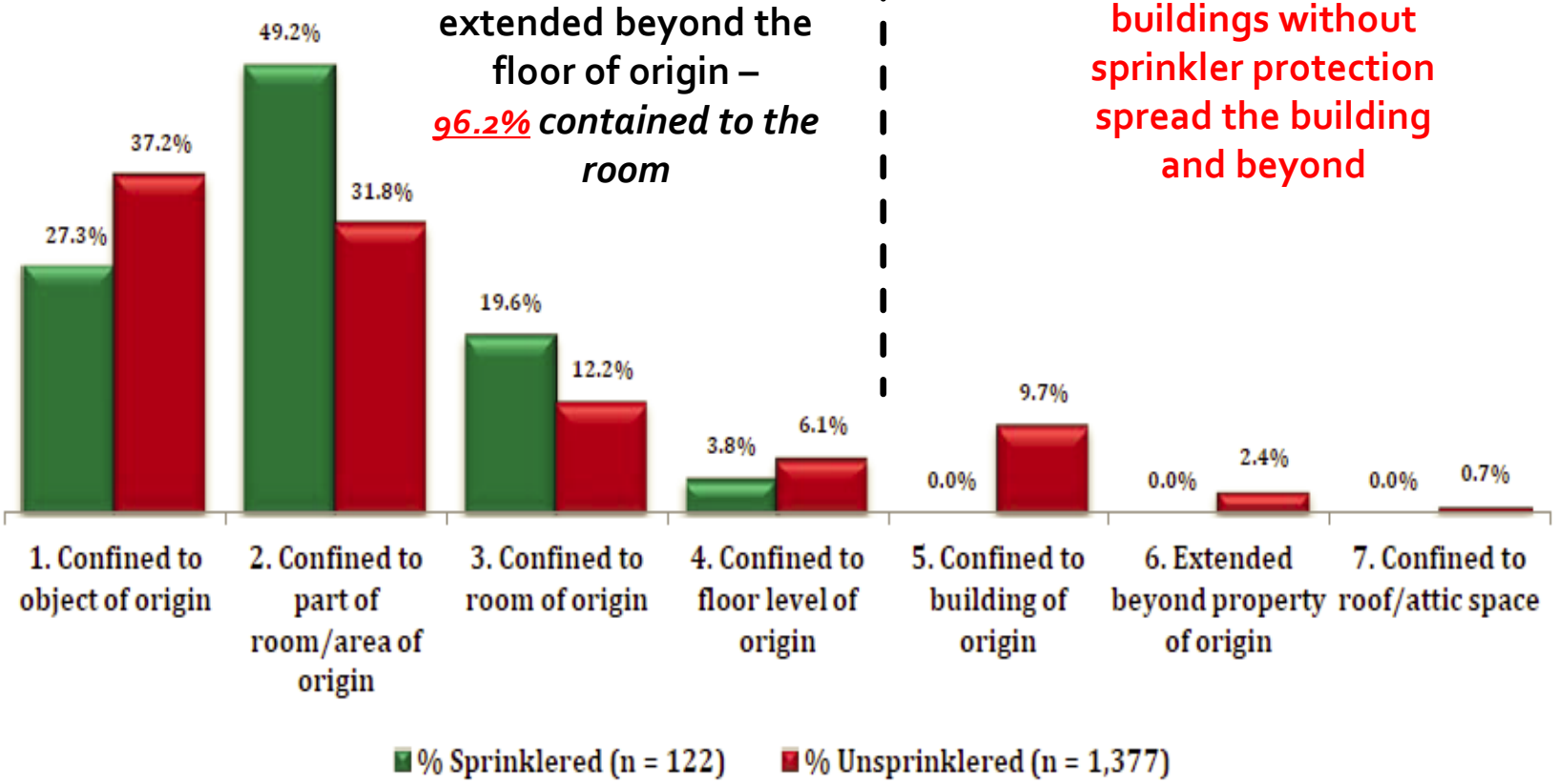
Extent of Fire Spread by Sprinkler Status

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

Fires controlled by sprinklers never extended beyond the floor of origin – *96.2% contained to the room*

12.7% of fires in buildings without sprinkler protection spread the building and beyond



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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…"

J

Vulnerability #1 – External Origin Fires

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

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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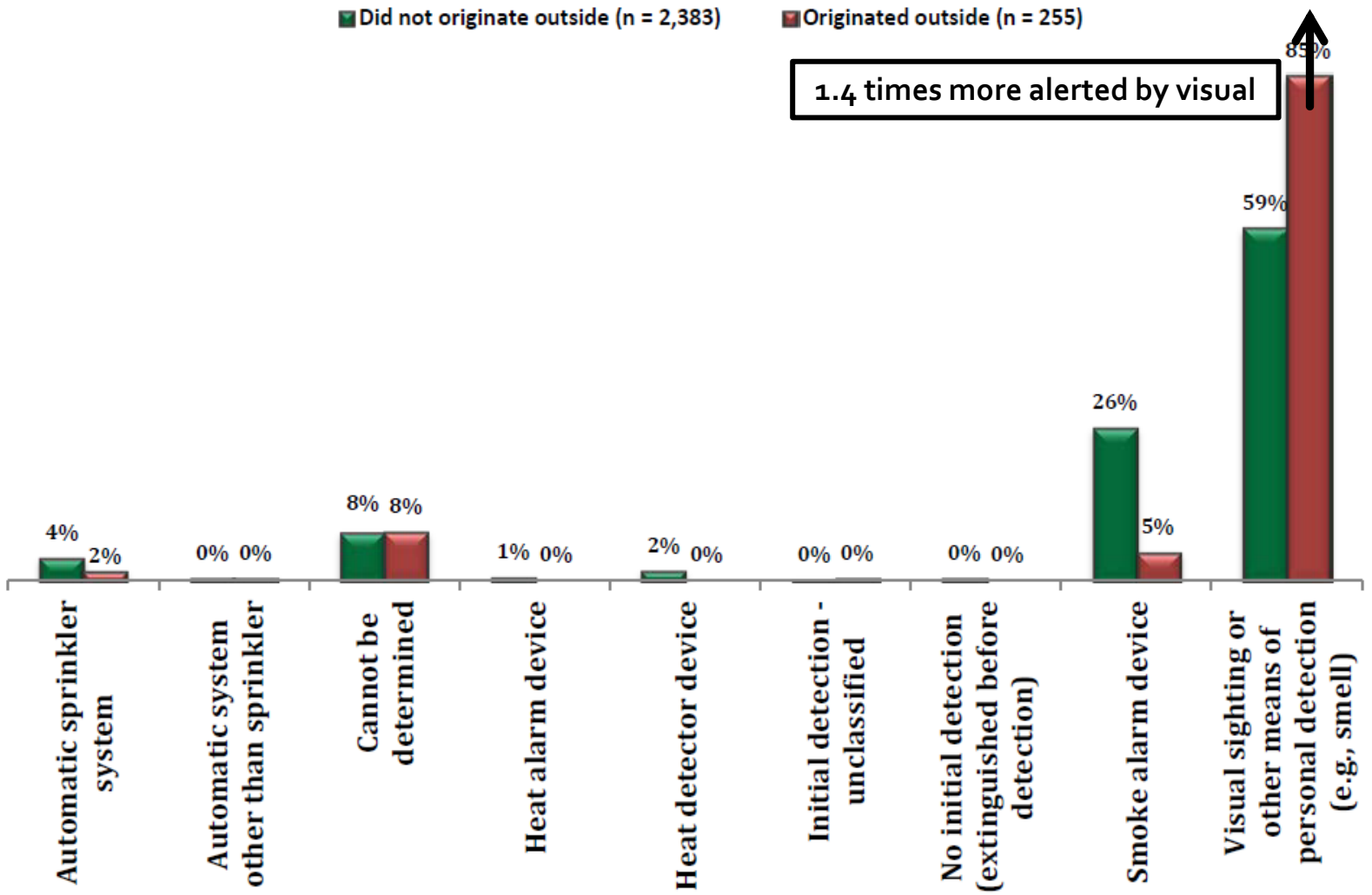
Initial Detection for Balcony Fires



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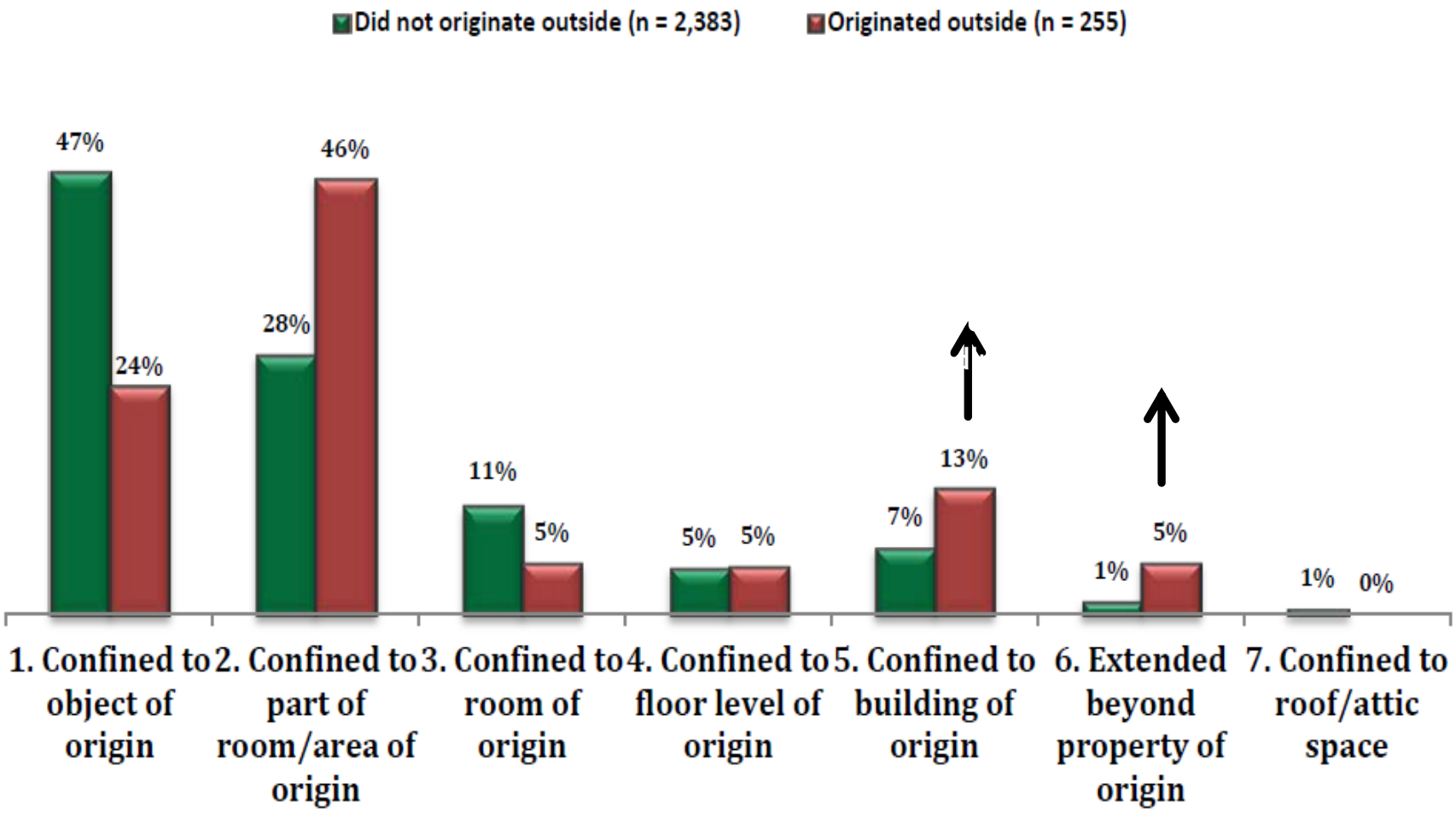
Extent of Fire Spread for Balcony Fires



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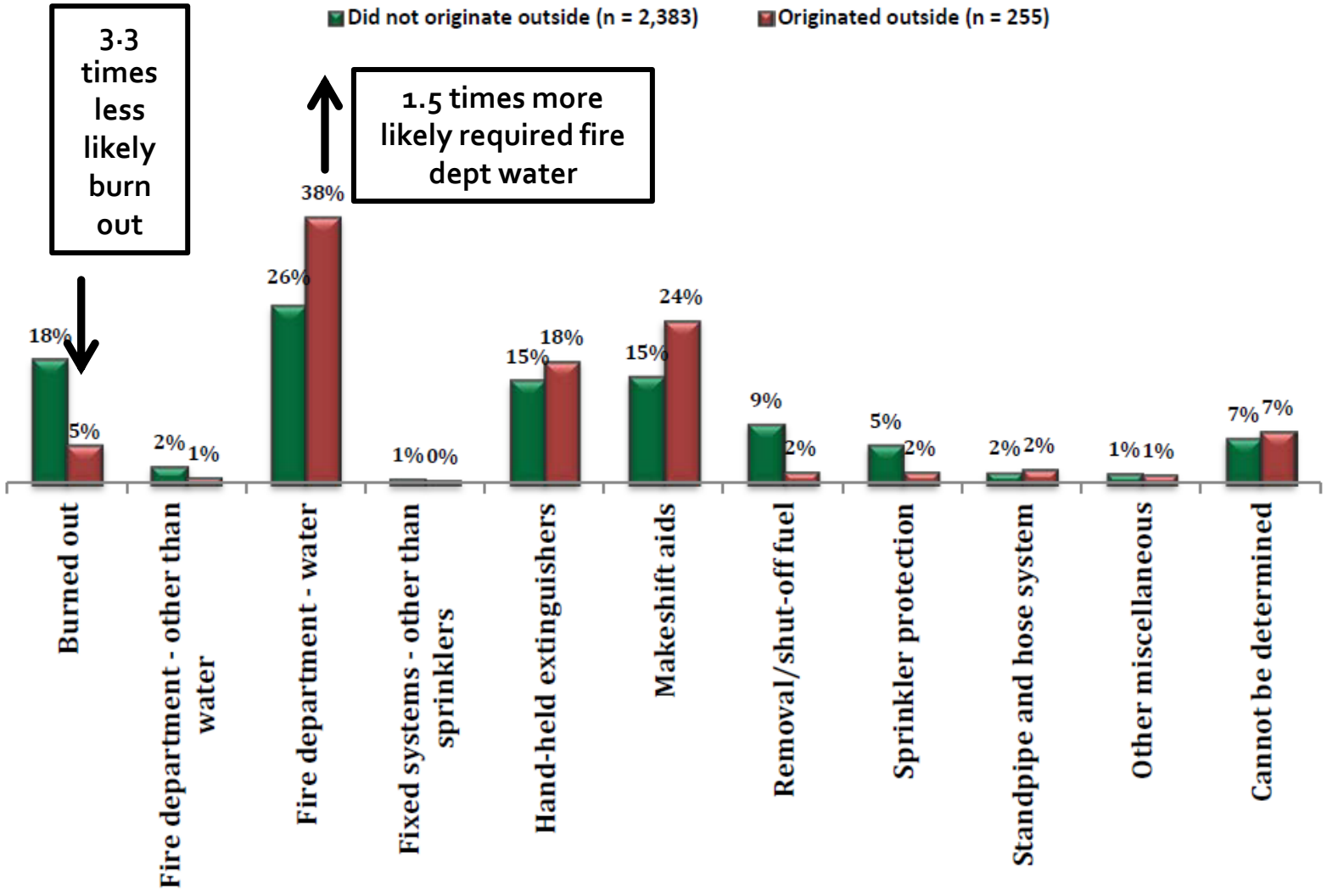
Method of Fire Control for Balcony Fires



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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

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

CITY OF SURREY
FIRE SERVICES

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

Construction Fire Safety Education

http://cjr.ufv.ca/

L

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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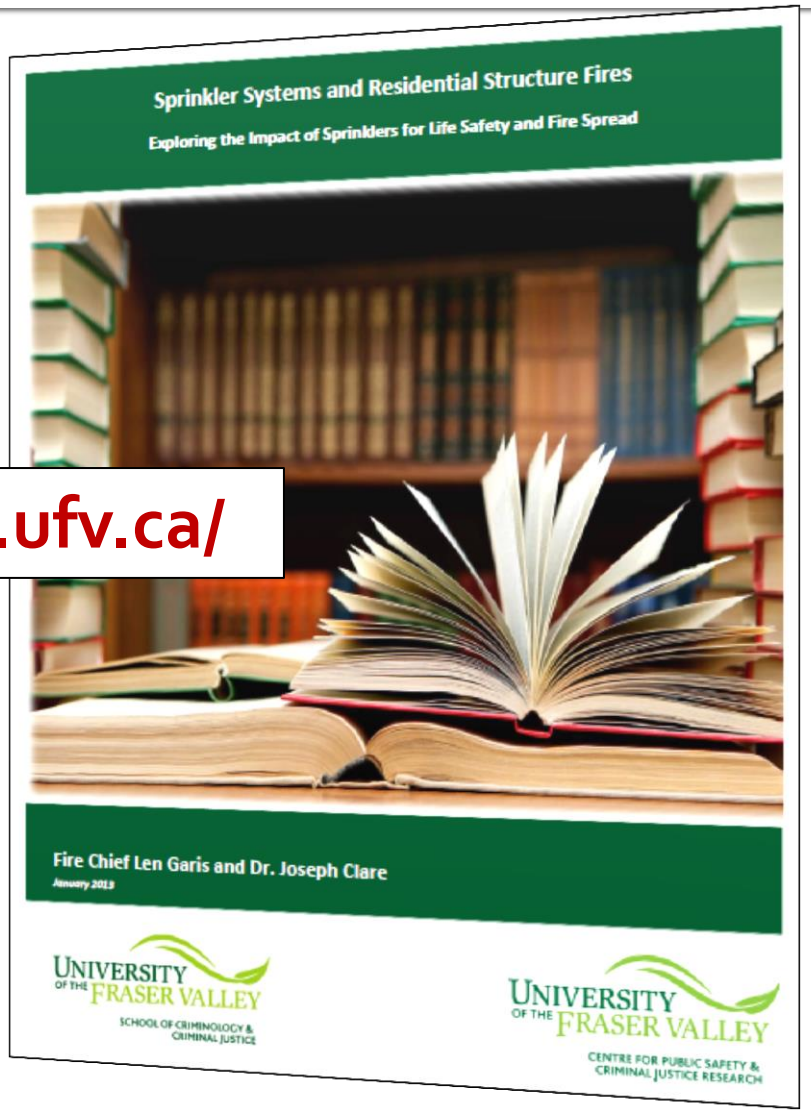
The Question posed:
Does Construction Type make a difference ?

http://cjr.ufv.ca/



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The Question posed:
Does Construction Type make a difference ?

- In the first part we reviewed reported fires in British Columbia, 2008 – 2013 in the second part we looked at 2006 to 2014
  - 11,875 / 20,110 were retained for subsequent analysis
  - There were 107 / 254 deaths and 772 / 1,376 injuries
- Looked at fires that occurred in the following five construction types:
  - Combustible construction – open wood joist
  - Protected combustible construction – wood protected by plaster/gyproc
  - Heavy Timber construction
  - Non-combustible construction exposed steel
  - Protected non-combustible construction - protected steel or concrete

J

Does Construction Type make a difference ?

- Looking at (n = 11,875)
  - Frequency of fires , deaths and injuries by general construction type
  - Extent of fire spread by general construction type
  - Frequencies of fires, sprinkler protection, smoke alarm activation and injury rate general construction type
  - Extent of fire spread by general construction type and protection type
  - Method of fire control by general construction type
  - Fire related causalities by general construction type
  - Fire Related causalities by construction type in the presence of a working smoke alarm and sprinkler protected

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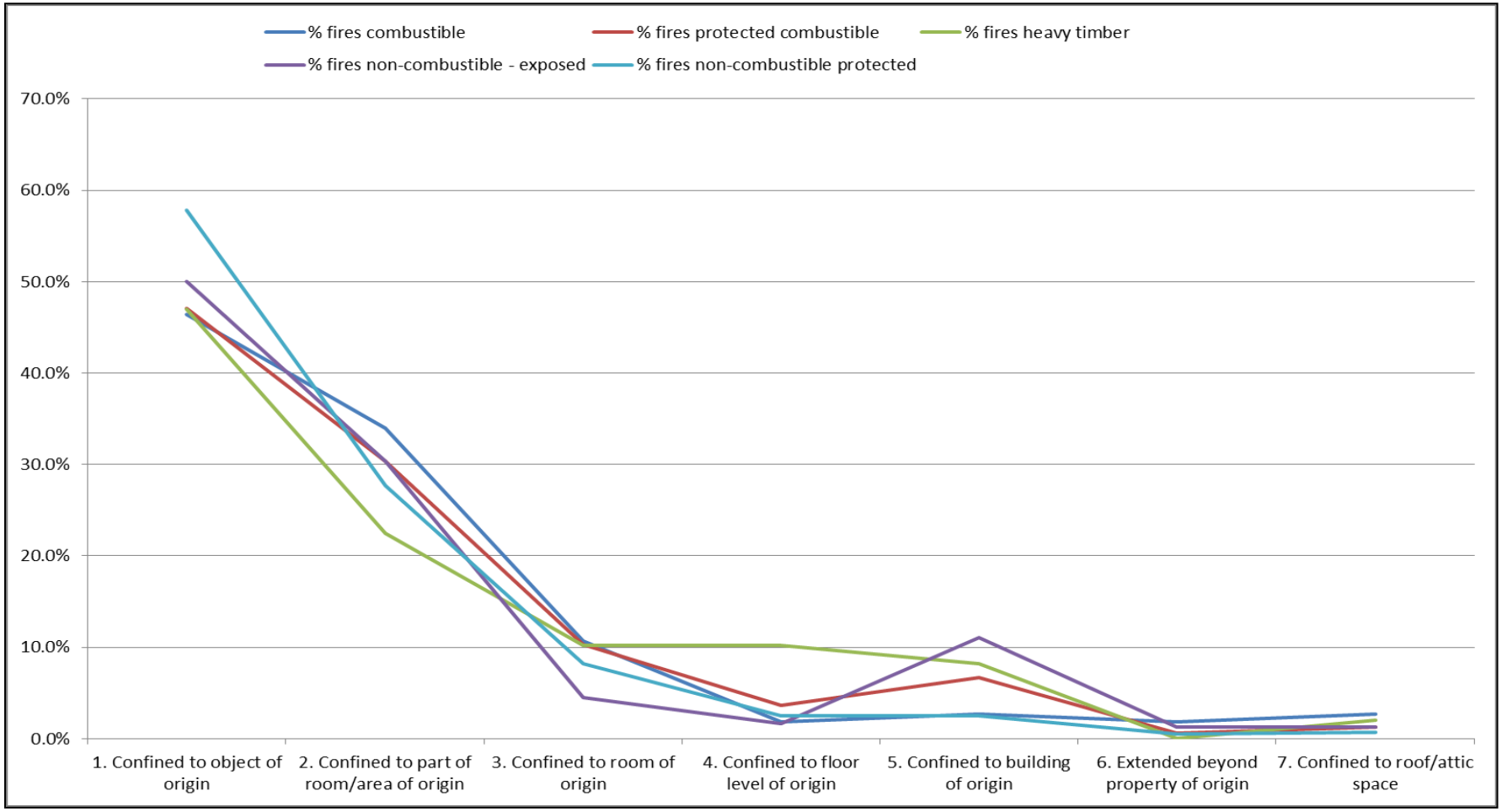
Does Construction Type make a difference ?



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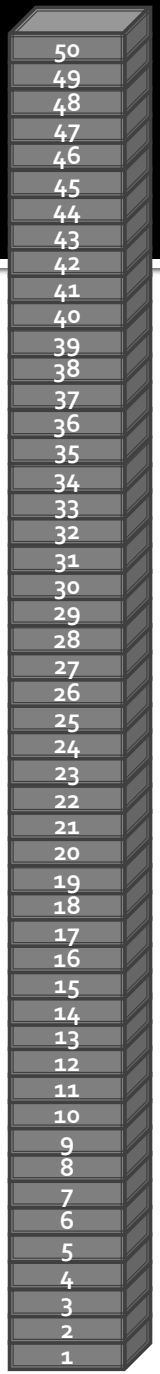

The Question posed:

Does Construction Type make a difference ?

Between 2006 & 2014:

- **66,594 Fires**
- **27,787 Structure fires**
- **20,126 Residential Structure Fires**
- **1,376 Residential Injuries**
- **254 Residential Deaths**

The Question posed:

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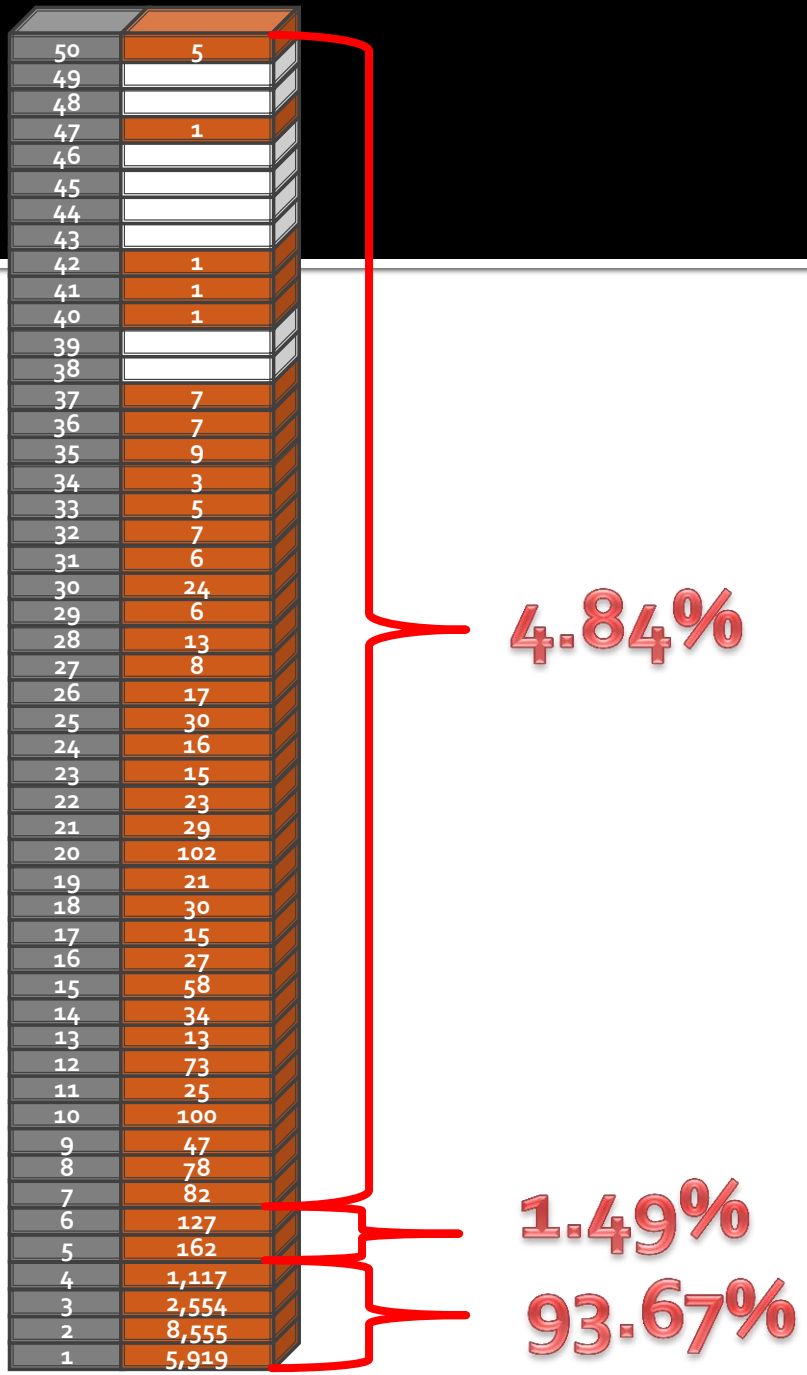

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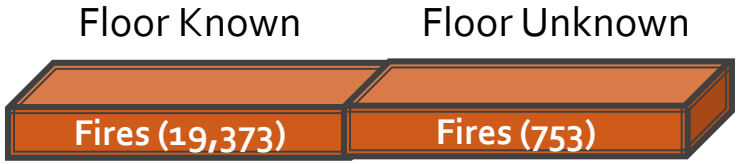

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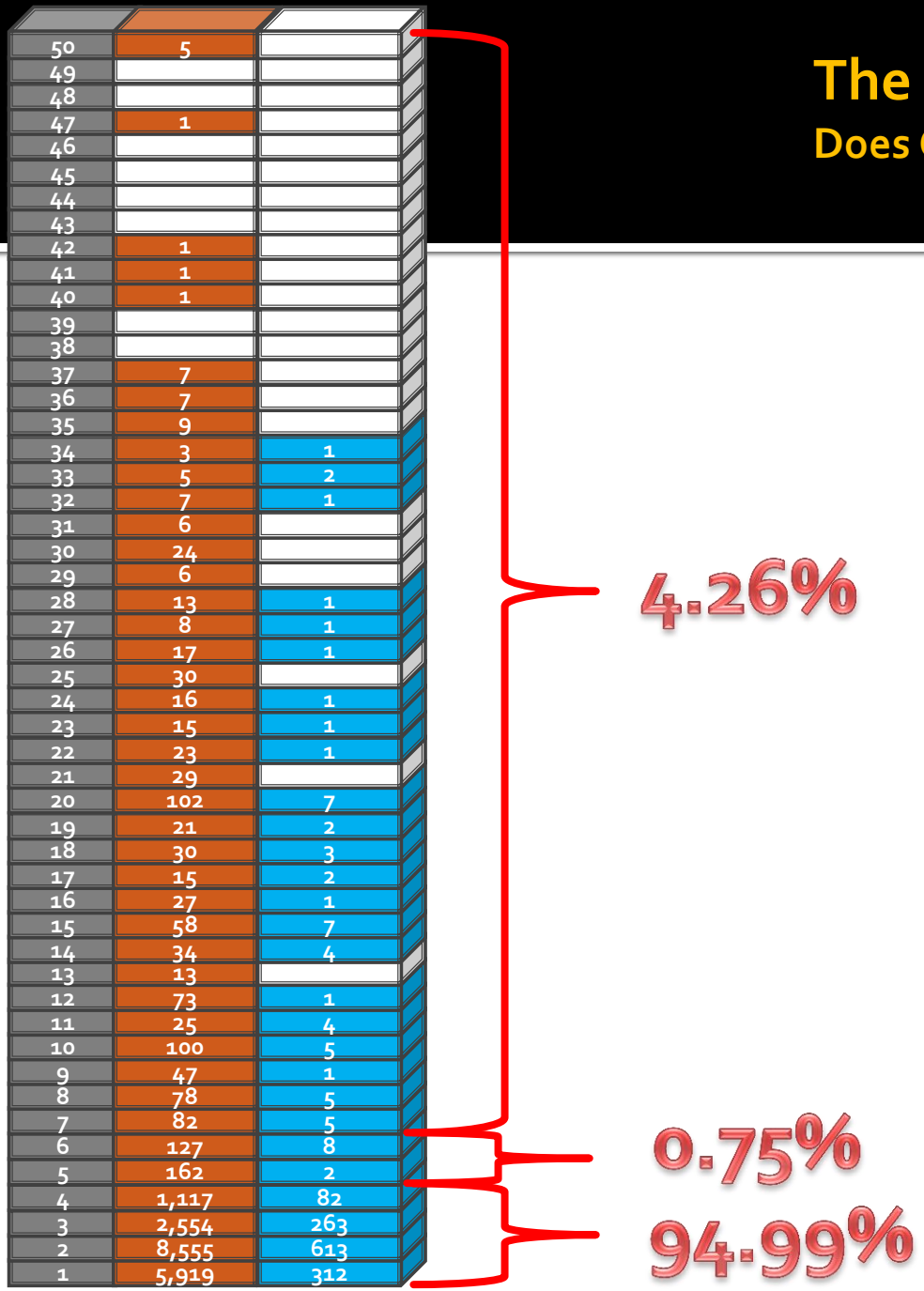

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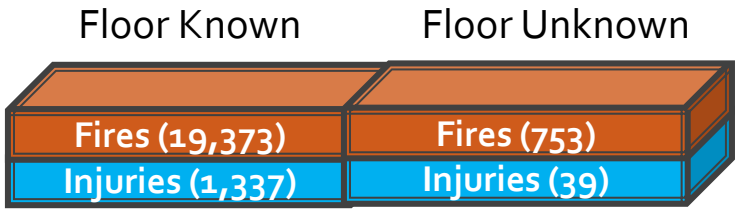

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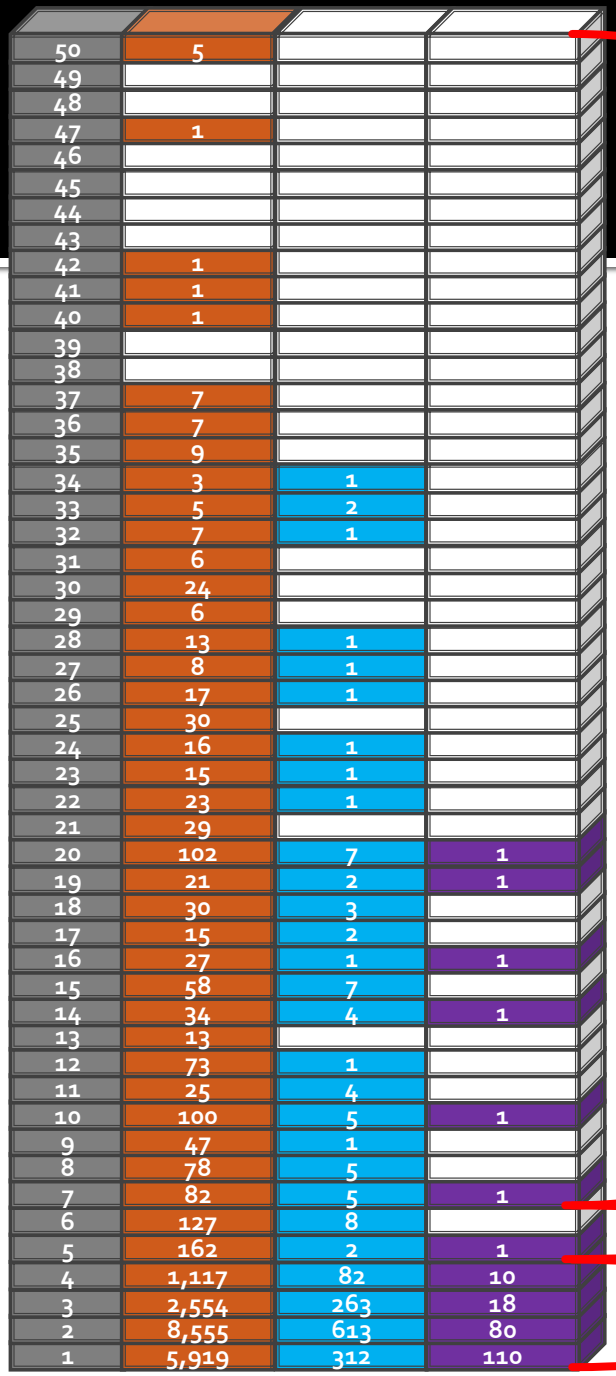

2.67%

0.44%

96.89%

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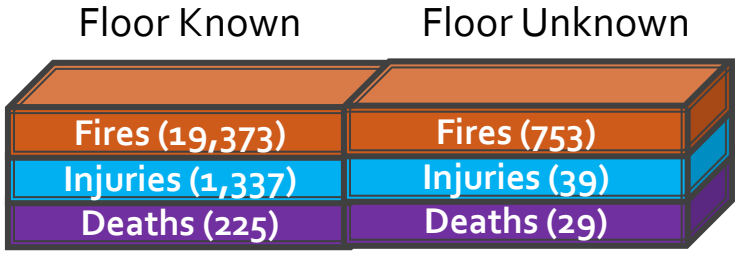

The Question posed:

Does Construction Type make a difference ?

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41	1						41
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36	6	1					36
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34	3						34
33	5						33
32	7						32
31	3	1	2				31
30	17	3	4				30
29	6						29
28	13						28
27	8						27
26	15	1	1				26
25	27	1	2				25
24	14	2					24
23	13		2				23
22	18	3	1				22
21	25	1	3				21
20	70	4	15	5	4		20
19	16		3	1			19
18	22	1	6	1			18
17	12	1	2				17
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9	30	2	9	5			9
8	41		27	3	2		8
7	24	1	34	12	5		7
6	46	2	44	14	11	3	6
5	33	3	82	23	10	4	5
4	65	7	799	107	105	5	4
3	50	3	1,913	239	280	17	3
2	40	2	6,559	628	1147	92	2
1	29	16	3,727	576	1399	71	1

Residential Structure Fires by Building Floor and Construction Type (2006-2014)

Between 2006 & 2014:

- 66,594 Fires
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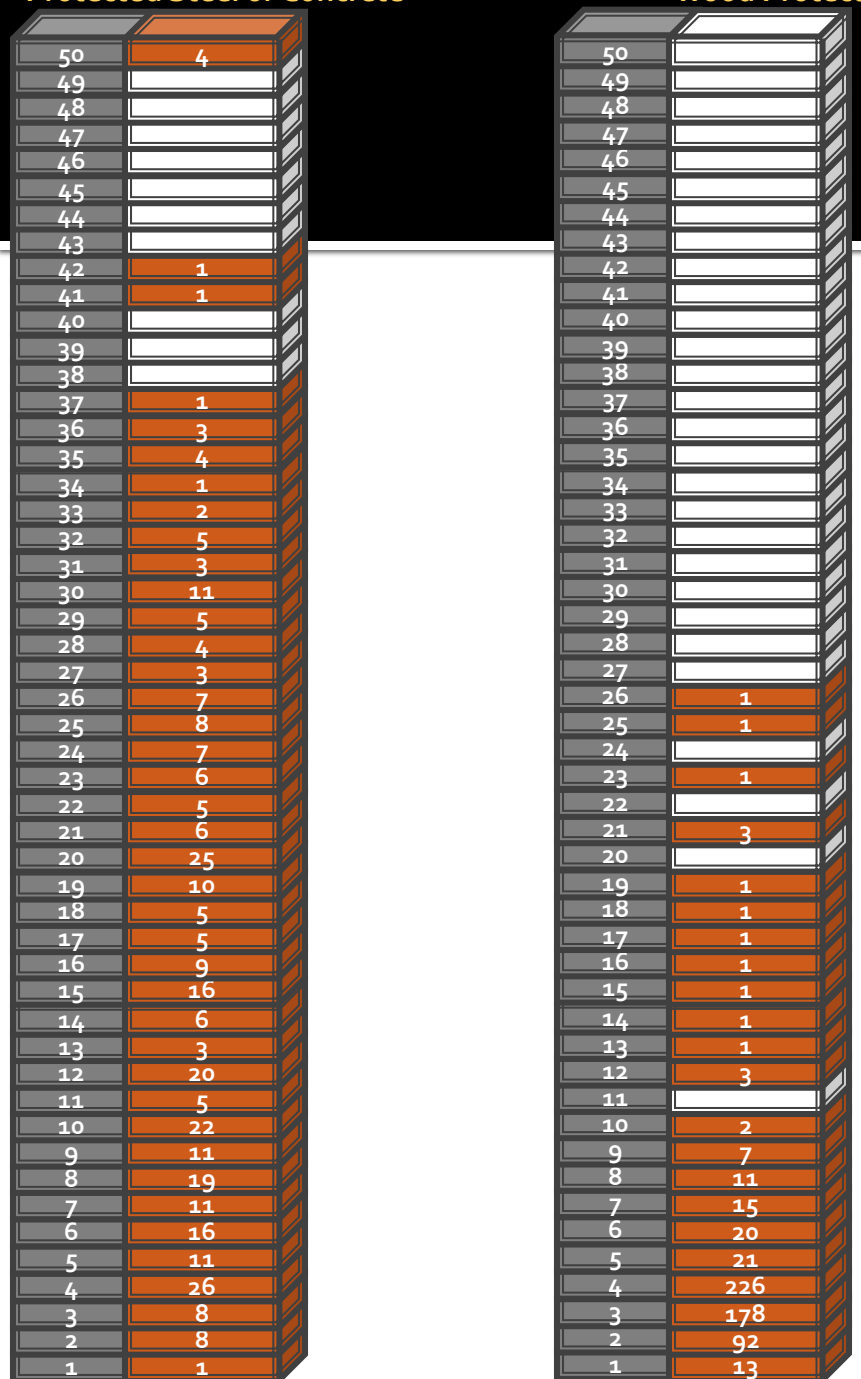


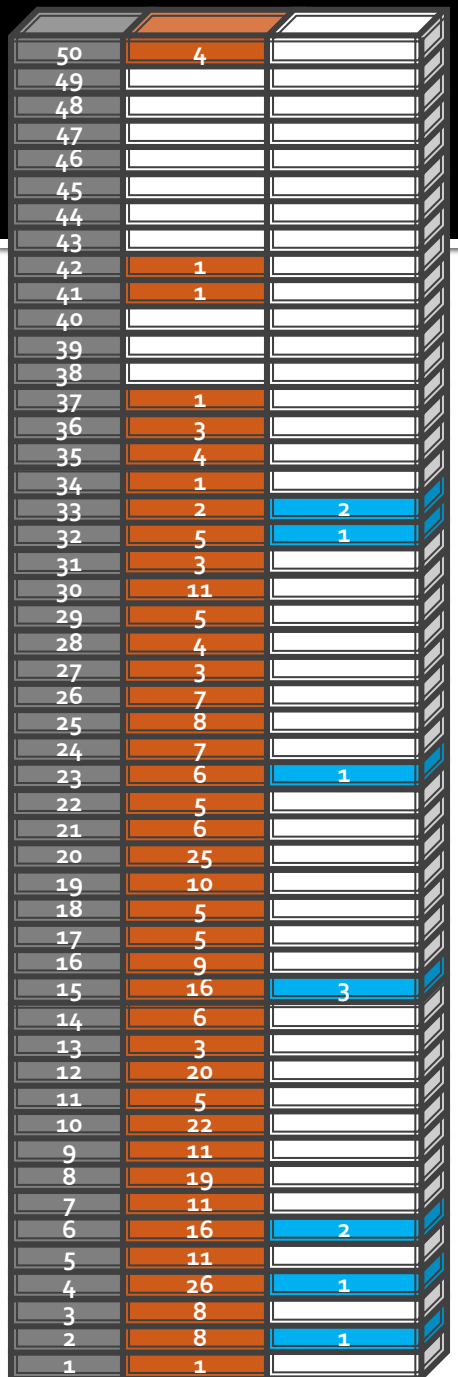
Residential Structure Fires by Building Floor and Construction Type (2006-2014) with Complete Sprinkler Protection and Working Smoke Alarm

	Non-Combustible	Combustible
Fires	332 (8 Unspecified)	602 (1 Unspecified)

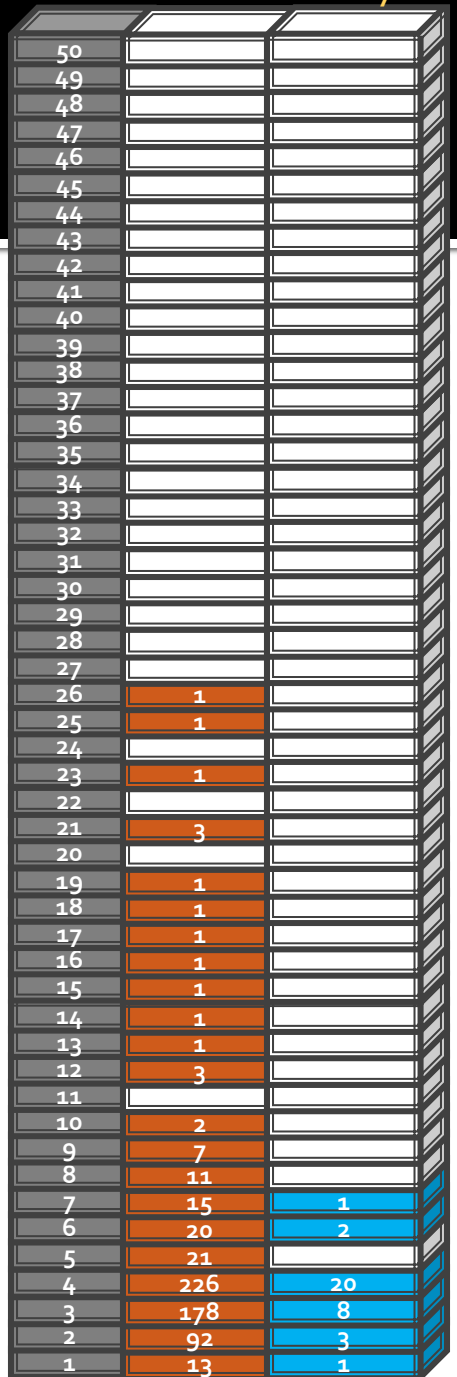
Between 2006 & 2014:

- 66,594 Fires
- 27,787 Structure fires
- 20,126 Residential Structure Fires
- 1,376 Residential Injuries
- 254 Residential Deaths

Protected Non-Combustible Construction – Protected Steel or Concrete



Protected Combustible Construction – Wood Protected by Plaster/Gyproc



The Question posed:

Does Construction Type make a difference ?

Residential Structure Fires by Building Floor and Construction Type (2006-2014) with Complete Sprinkler Protection and Working Smoke Alarm

	Non-Combustible	Combustible
Fires	332 (8 Unspecified)	602 (1 Unspecified)
Injuries	11	35

Between 2006 & 2014:

- 66,594 Fires
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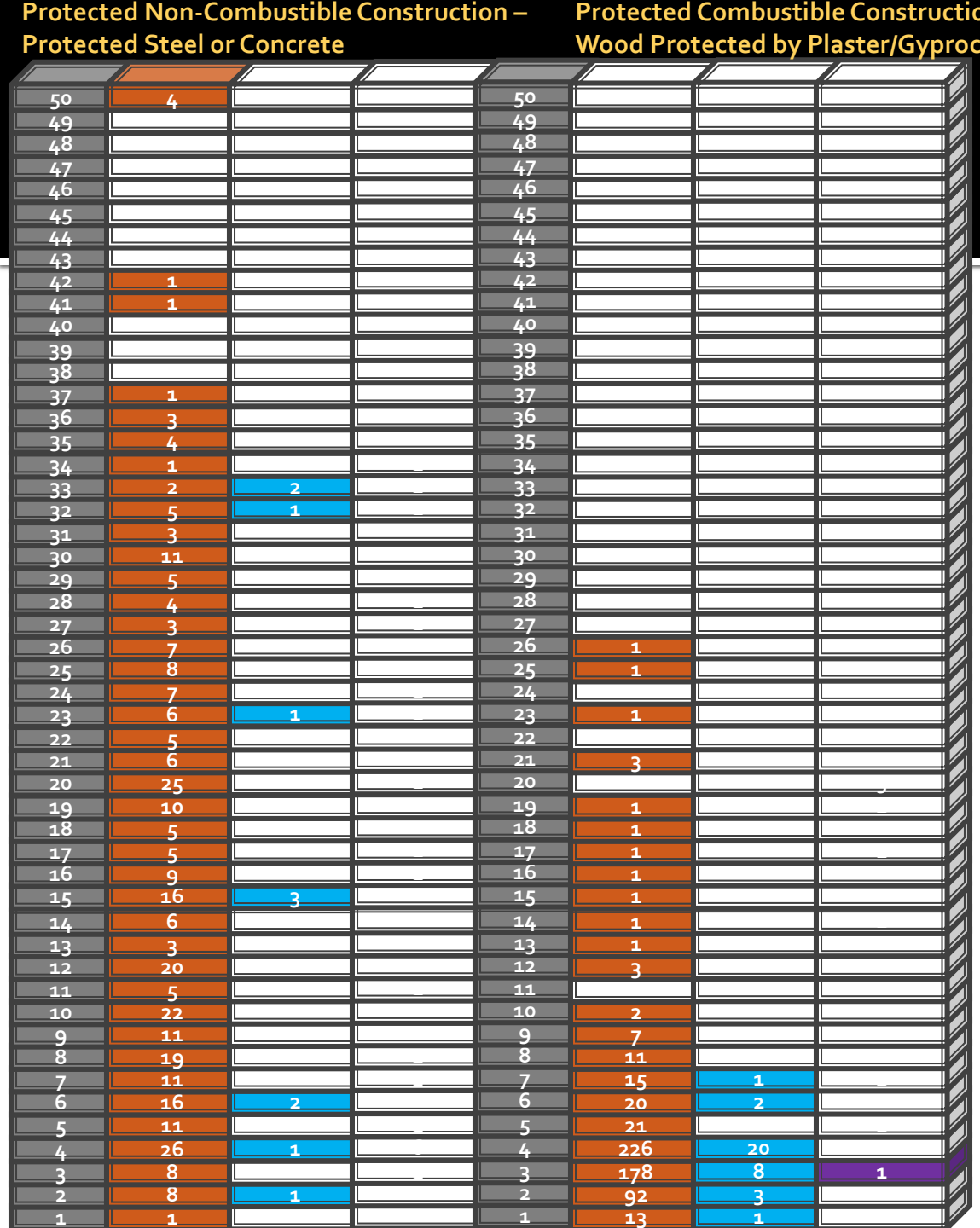

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Does Construction Type make a difference ?

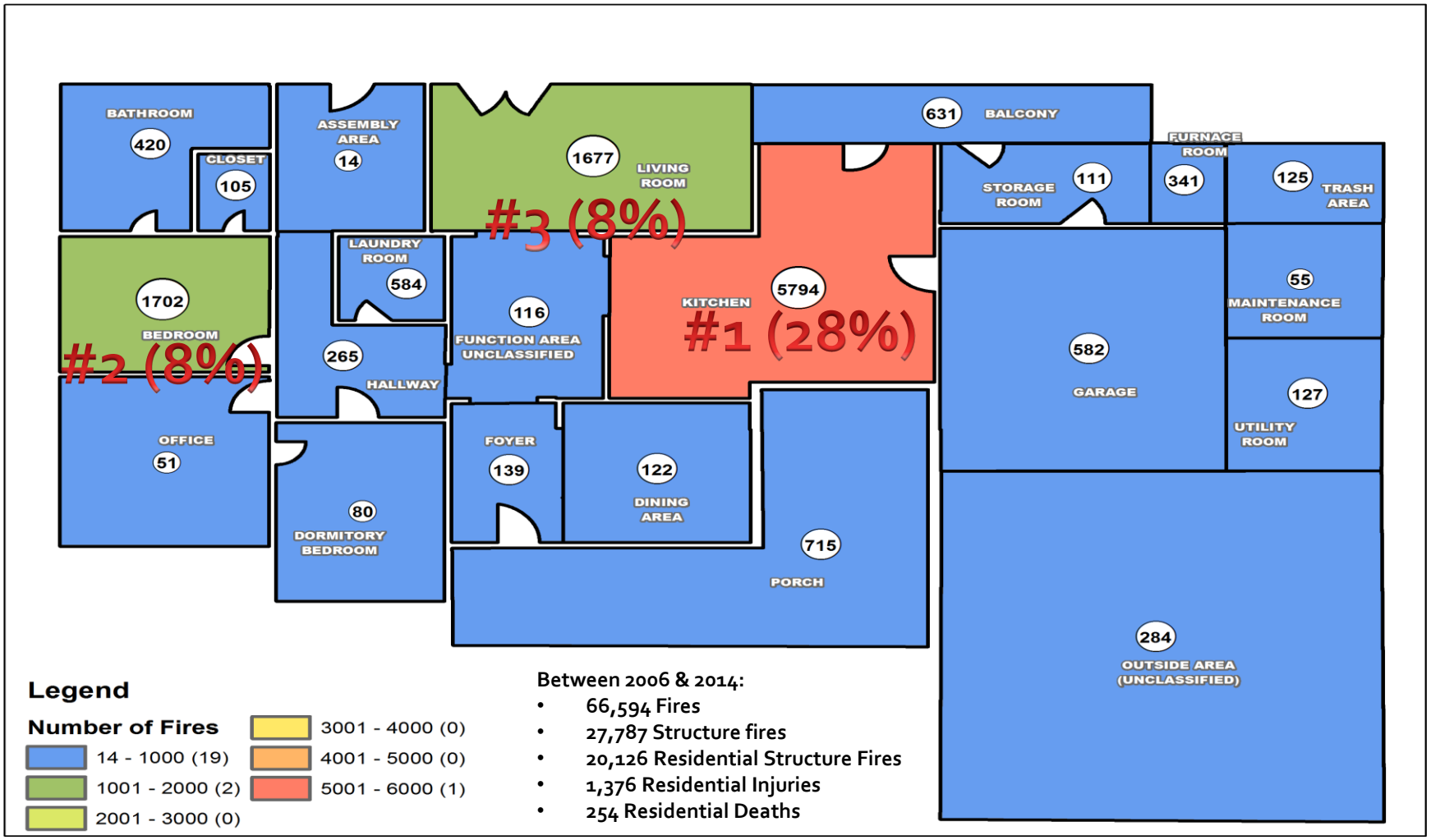
Residential Structure Fires by Building Floor and Construction Type (2006-2014) with Complete Sprinkler Protection and Working Smoke Alarm

	Non-Combustible	Combustible
Fires	332 (8 Unspecified)	602 (1 Unspecified)
Injuries	11	35
Deaths	0	1

Between 2006 & 2014:

- 66,594 Fires
- 27,787 Structure fires
- 20,126 Residential Structure Fires
- 1,376 Residential Injuries
- 254 Residential Deaths

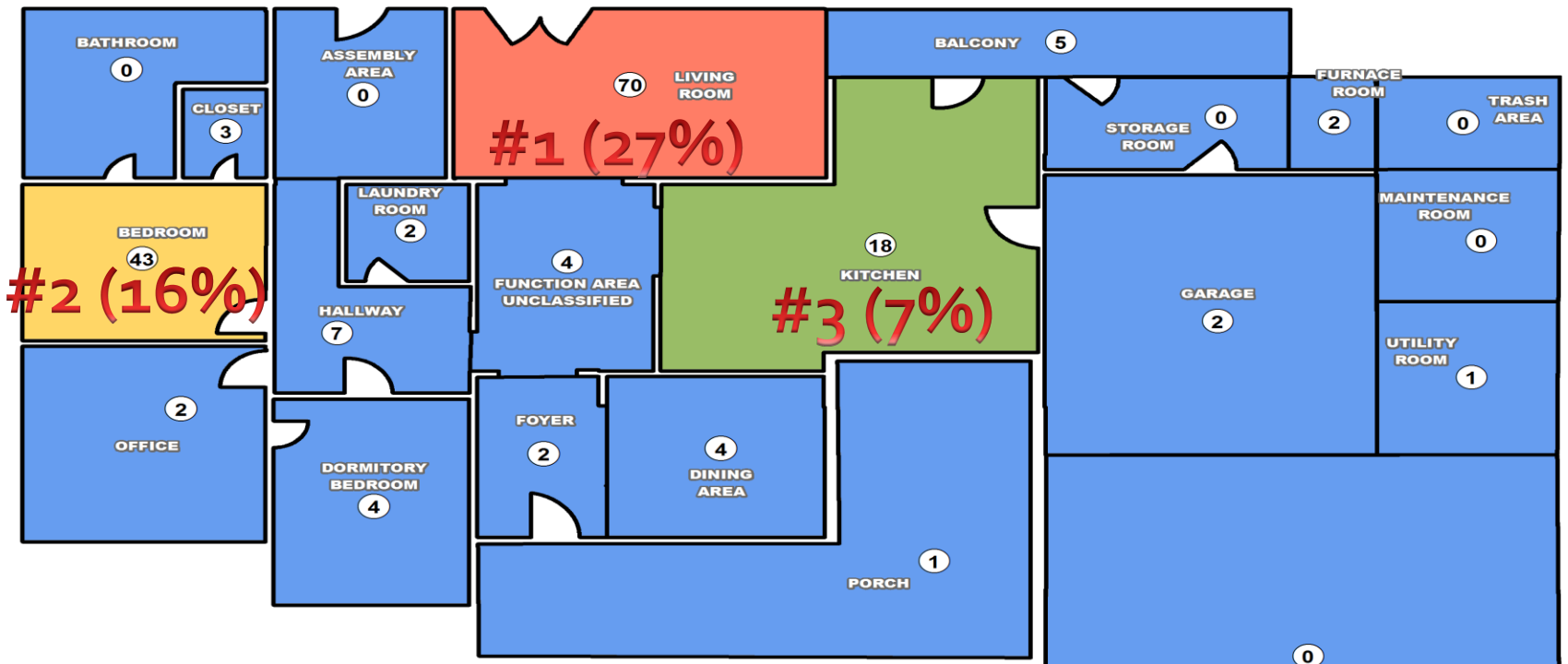
Number of Fires by Area of Origin Within a Typical Residential Structure (2006-2014)



Between 2006 & 2014:

- 66,594 Fires
- 27,787 Structure fires
- 20,126 Residential Structure Fires
- 1,376 Residential Injuries
- 254 Residential Deaths

Number of Deaths by Area of Origin Within a Typical Residential Structure (2006-2014)



Legend

Deaths

0 - 10 (19)	31 - 40 (0)
11 - 20 (1)	41 - 50 (1)
21 - 30 (0)	51 - 60 (0)
	61 - 70 (1)

Between 2006 & 2014:

- 66,594 Fires
- 27,787 Structure fires
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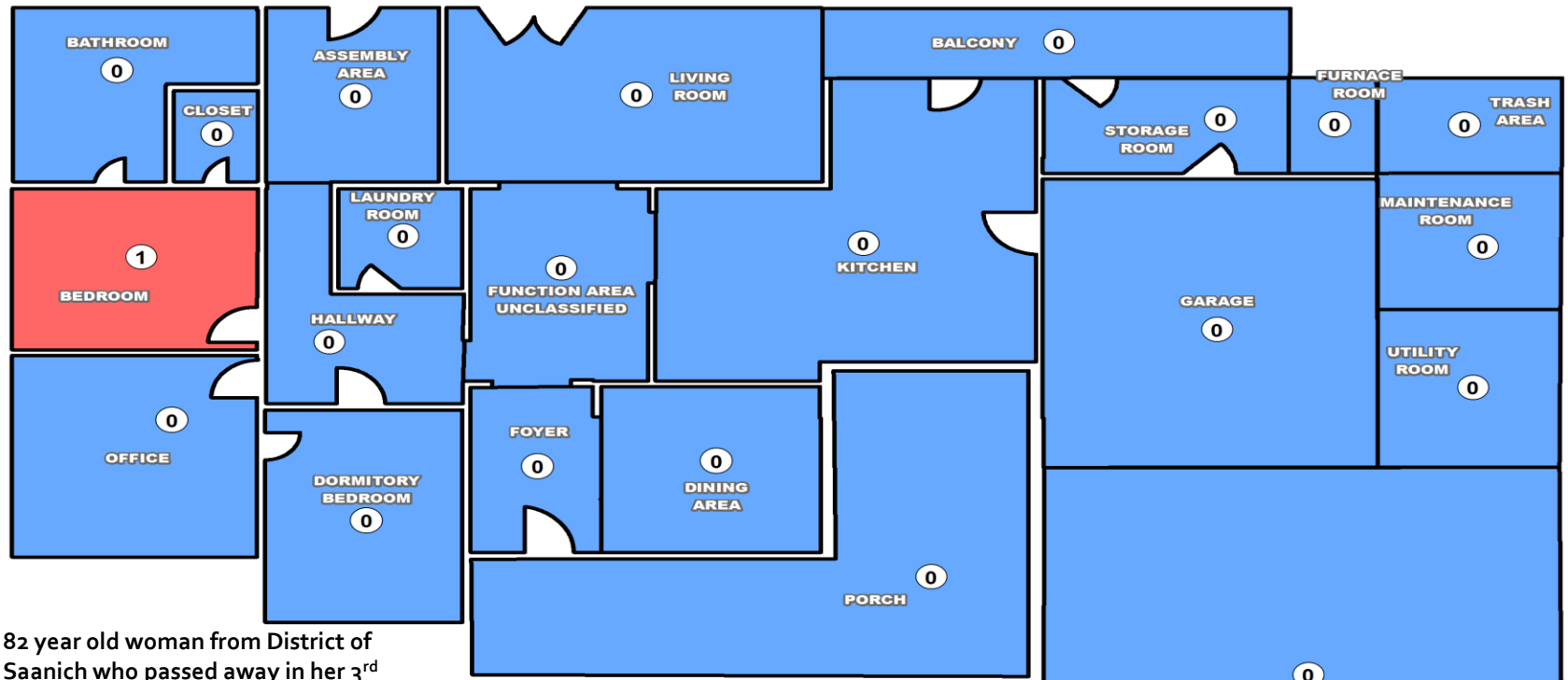
Number of Deaths by Area of Origin Within a Typical Residential Structure (2006-2014)



- 82 year old woman from District of Saanich who passed away in her 3rd floor residential apartment bedroom in 2014.

Legend

Working Smoke Alarm & Sprinkler Deaths

- 0 (21)
- 1 (1)

Between 2006 & 2014:

- 66,594 Fires
- 27,787 Structure fires
- 20,126 Residential Structure Fires
- 1,376 Residential Injuries
- 254 Residential Deaths

Does Construction Type make a difference ?

Conclusion- Short Answer No!

We found causalities by construction type in the presence of a working smoke alarm and sprinkler protected

- **Had one death across all construction types**
- **Had an Injury rates that were similar**
- **The fires spread were remarkable similar with no distinguishable differences by construction type, most fires were confined to the room of origin.**

J

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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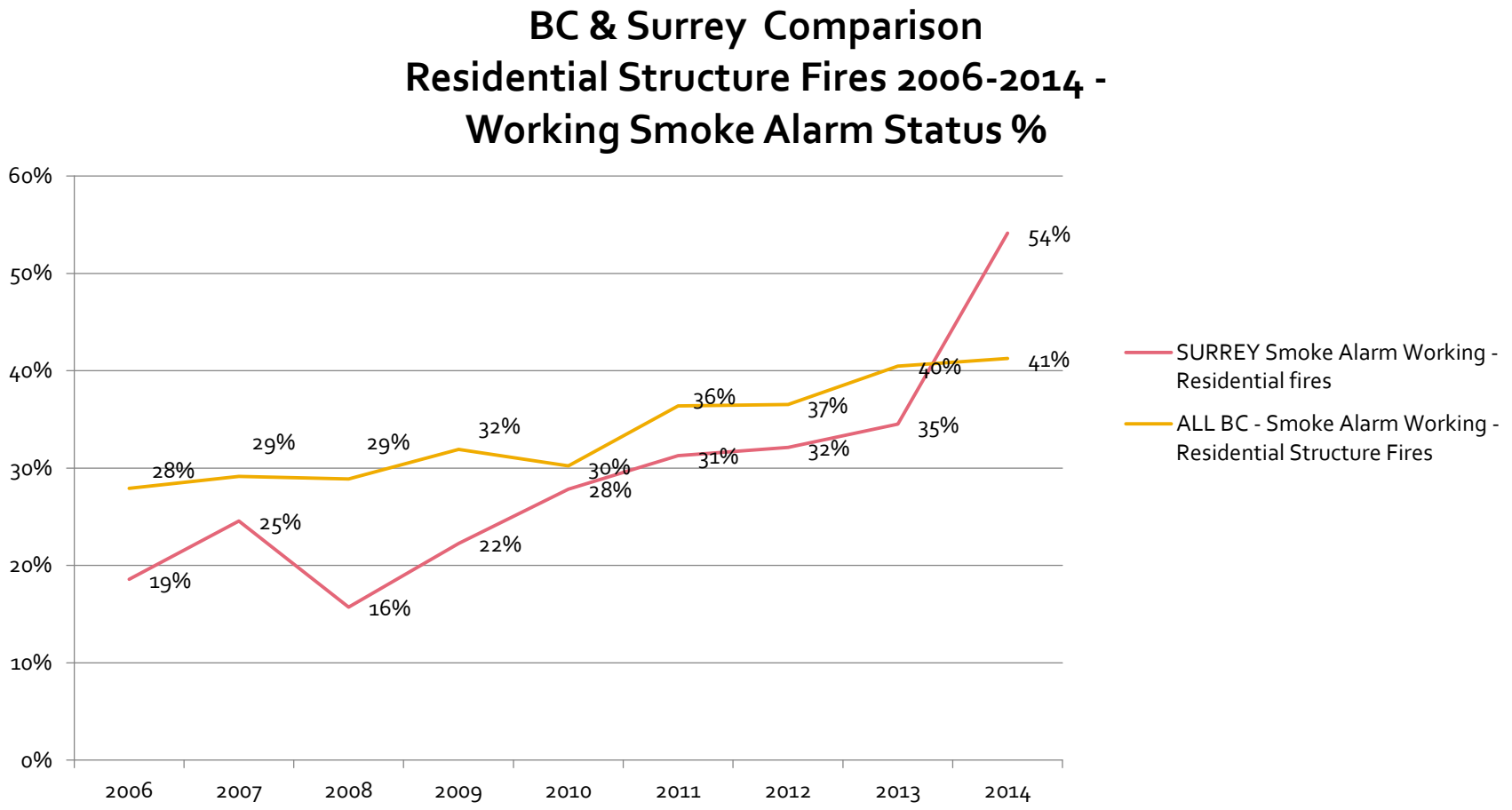
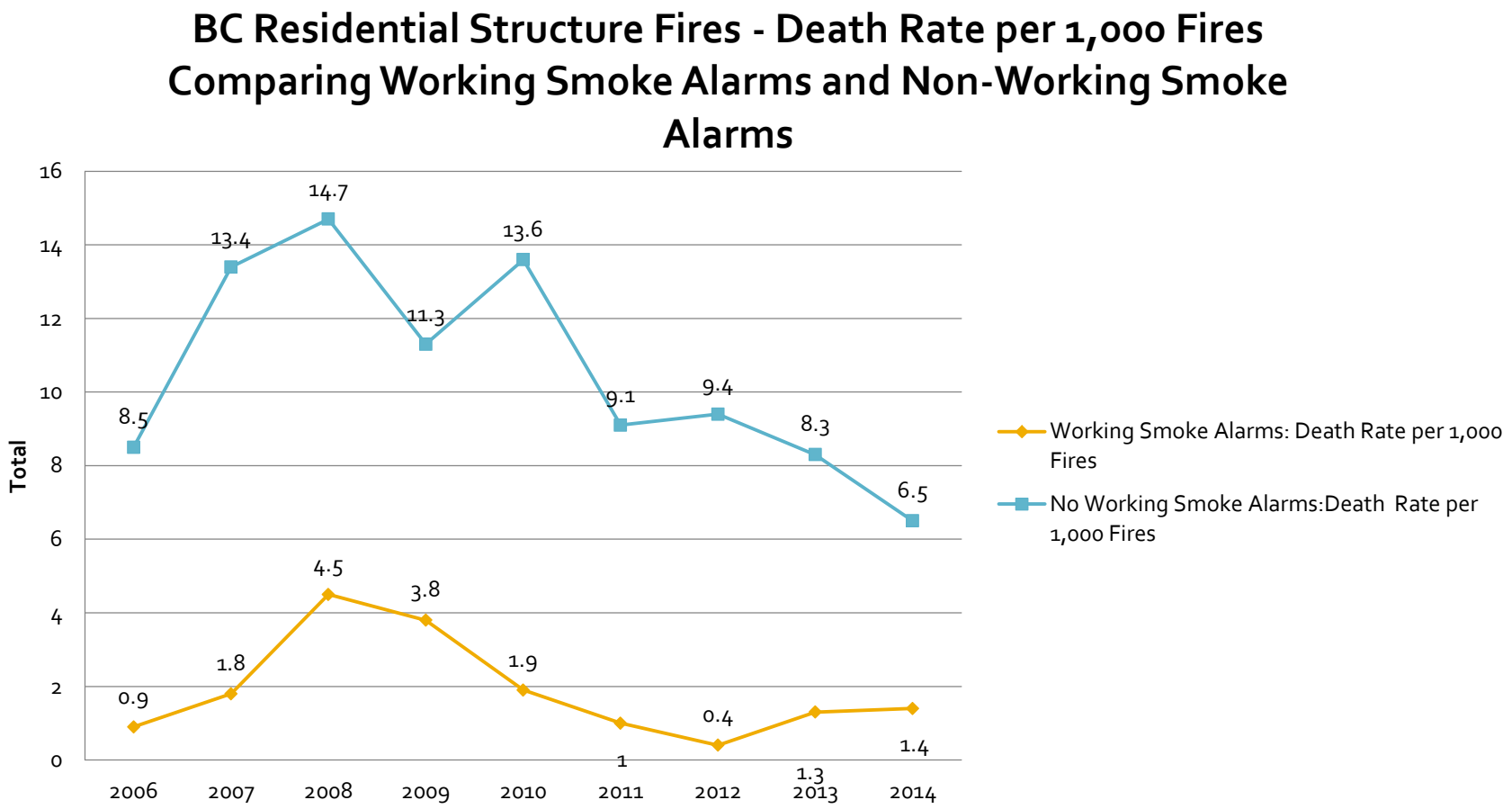
BC & Surrey Comparison



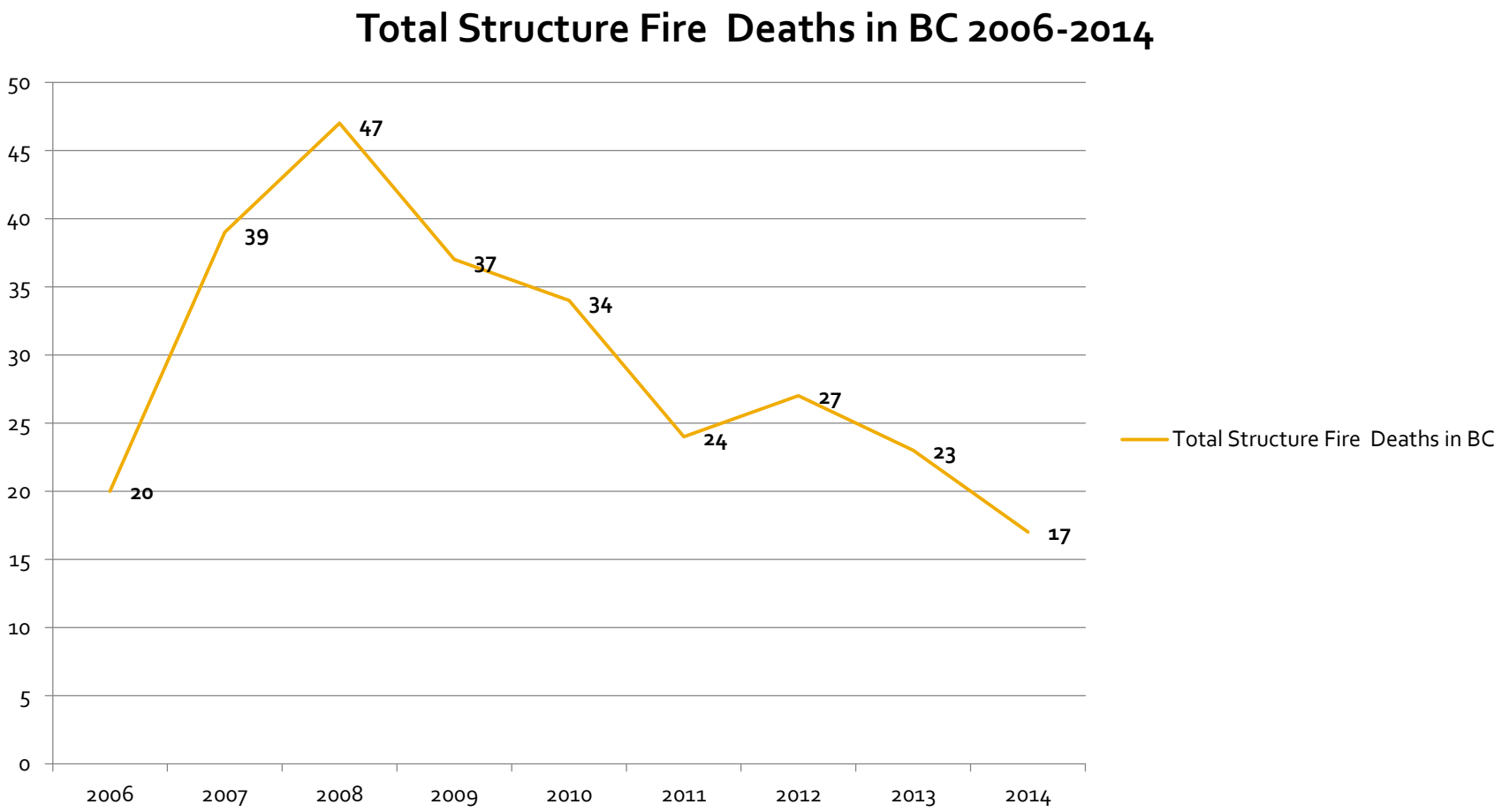
Source: Office of the Fire Commissioner accessed March 19, 2015

Death Rates Based on Status of Smoke Alarm 2006-2014

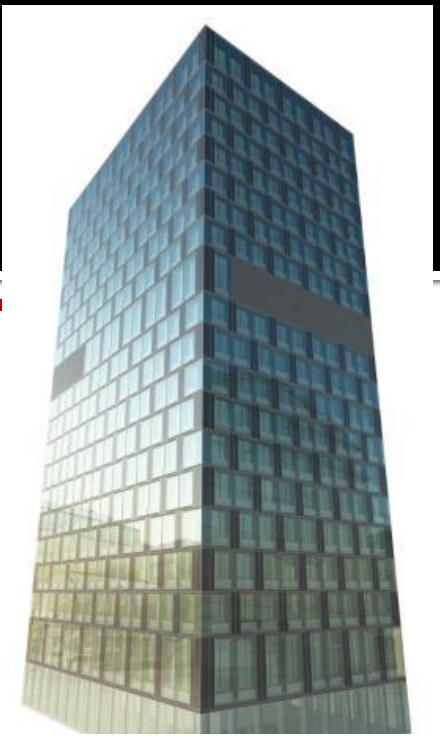


Source: Office of the Fire Commissioner accessed March 19, 2015

Structure Fire Deaths in BC 2006-2014 (n=268)



The Future?



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Building Taller from Wood is it safe ....

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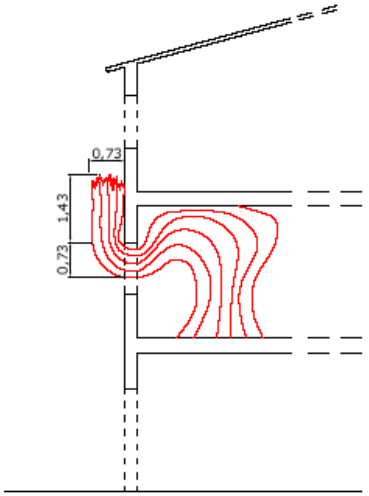
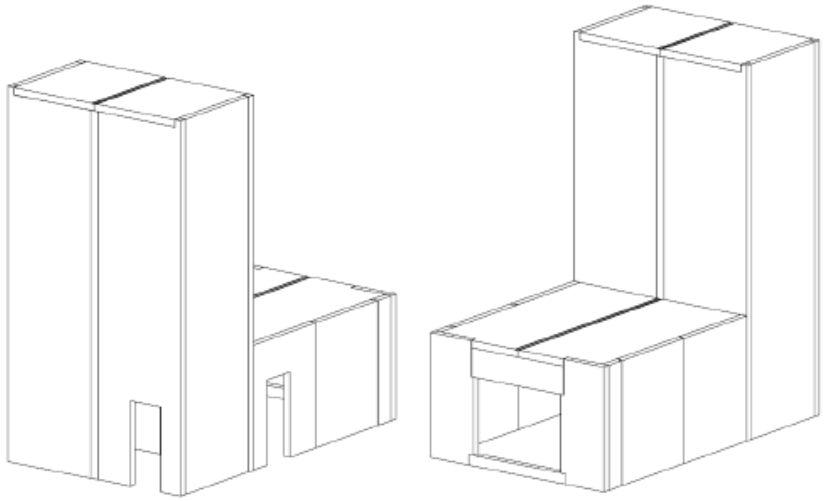
IVALSA


0,73
1,43
0,73


75

April 8, 2015

Client Report: A1-006010.1

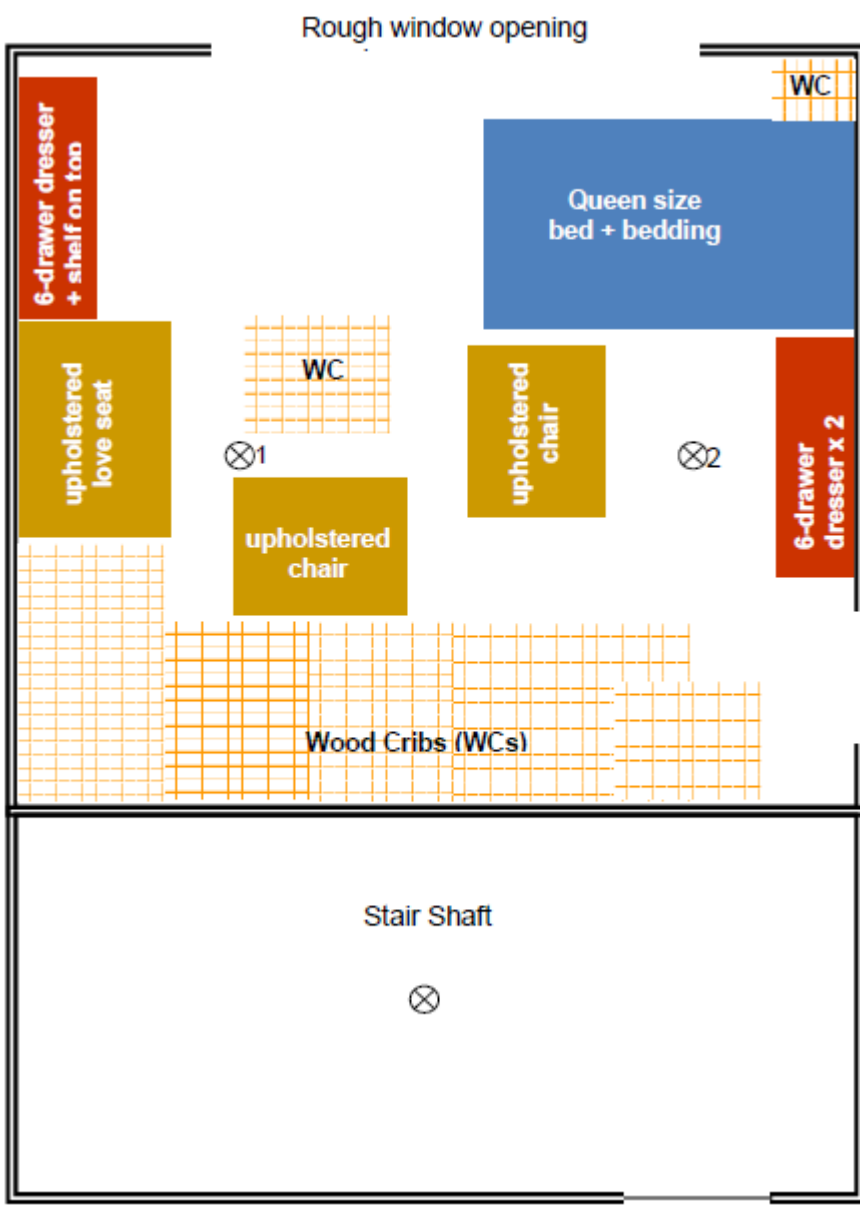


NATIONAL RESEARCH COUNCIL CANADA

Fire Demonstration –

Cross-Laminated Timber Stair/Elevator Shaft

For
FPInnovations


Rough window opening
WC
6-drawer dresser + shelf on top
Queen size bed + bedding
upholstered love seat
WC
upholstered chair
6-drawer dresser x 2
1
2
upholstered chair
Wood Cribs (WCs)
Stair Shaft


0:00
1:00
95:00
100:00
2:00
2:35
105:00
110:00
3:00
4:00
115:00
120:00

Figure 32. Inside of the fire compartment after the fire demonstration.

6 CONCLUSIONS

The demonstration results have demonstrated that the severe, high-intensity fast growing fire in the adjacent apartment had no impact on the mass timber stair/elevator shaft; the conditions inside the stair/elevator shaft were unchanged before, during and after the fire.

Total Cost of Fire NFPA

L

What's Driving the Total Cost of Fire

- The most recent estimates for the total cost of fire in the US was produced by John 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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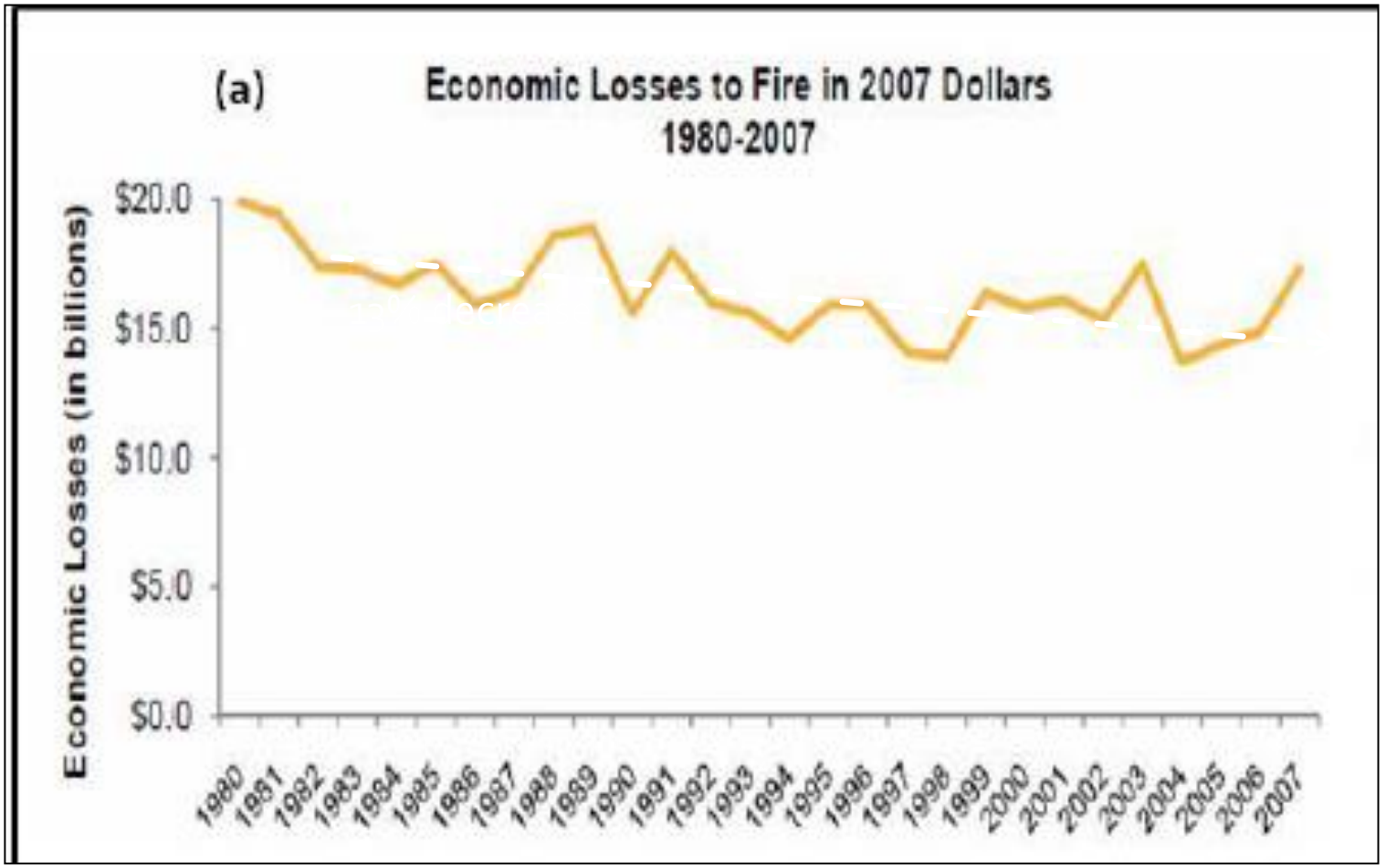
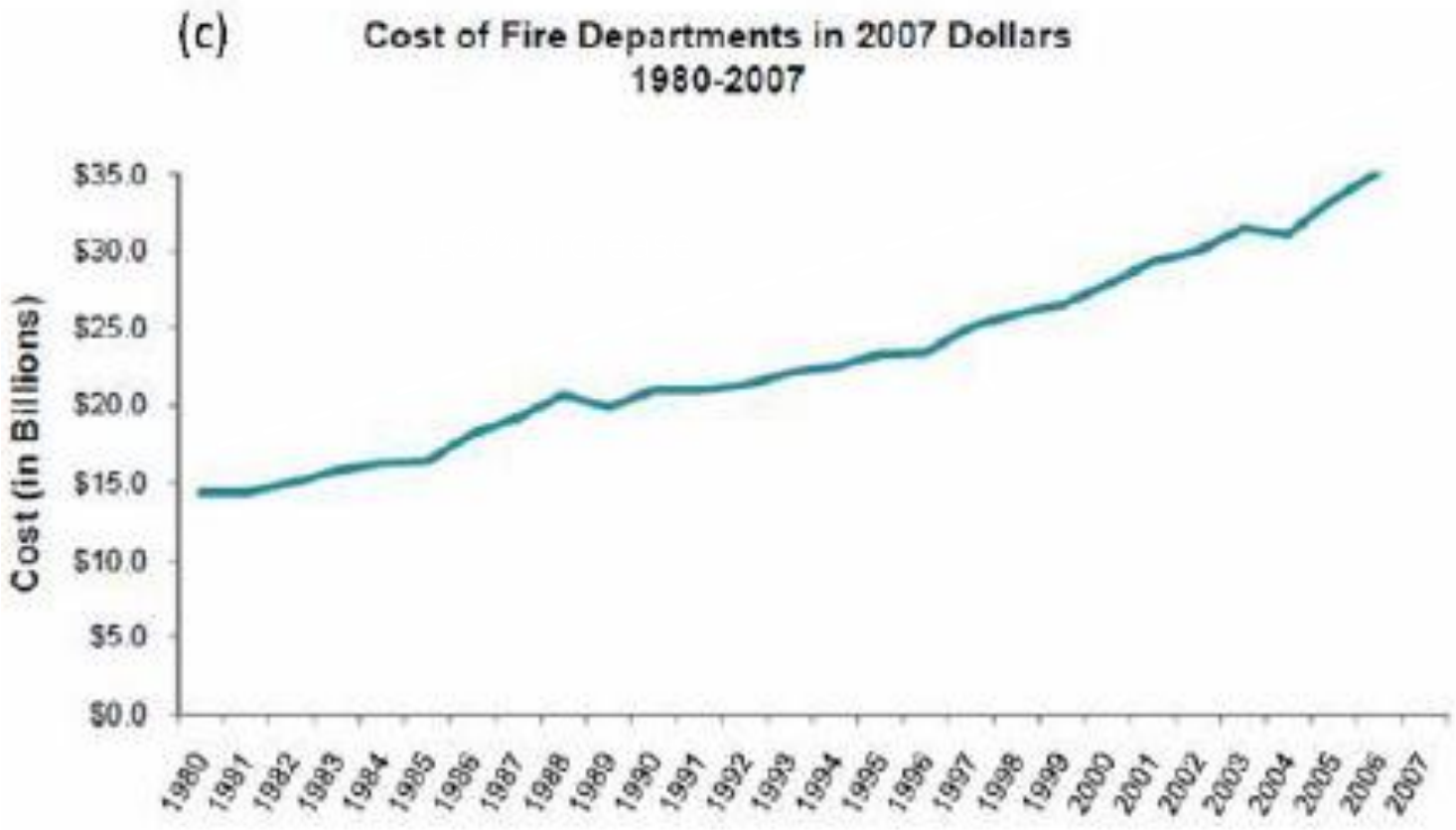
Summarizing the Trends for Cost of Fire



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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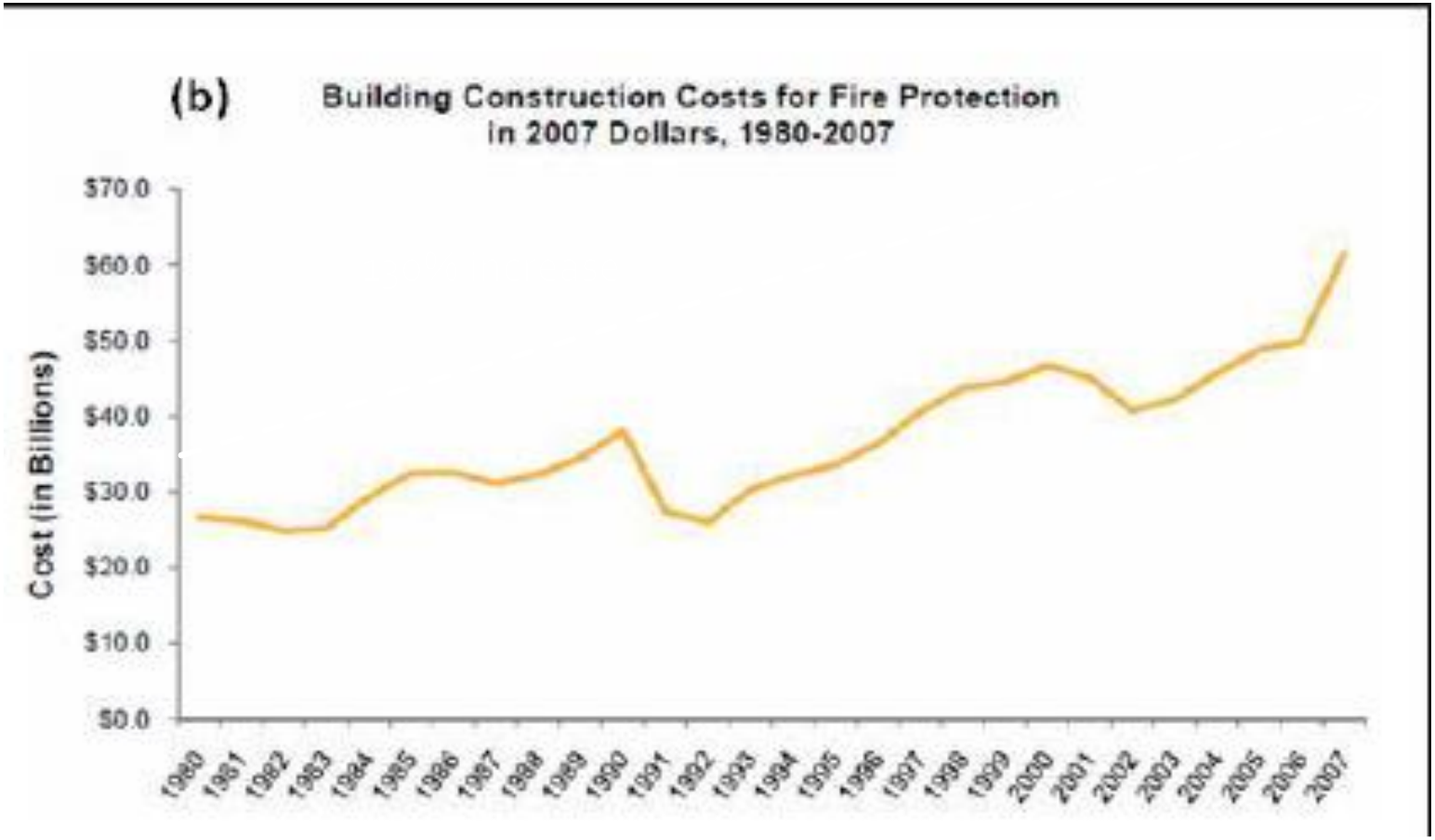
Summarizing the Trends for Cost of Fire



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.

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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"

L

- **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.**

Questions?

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(604) 543-6701