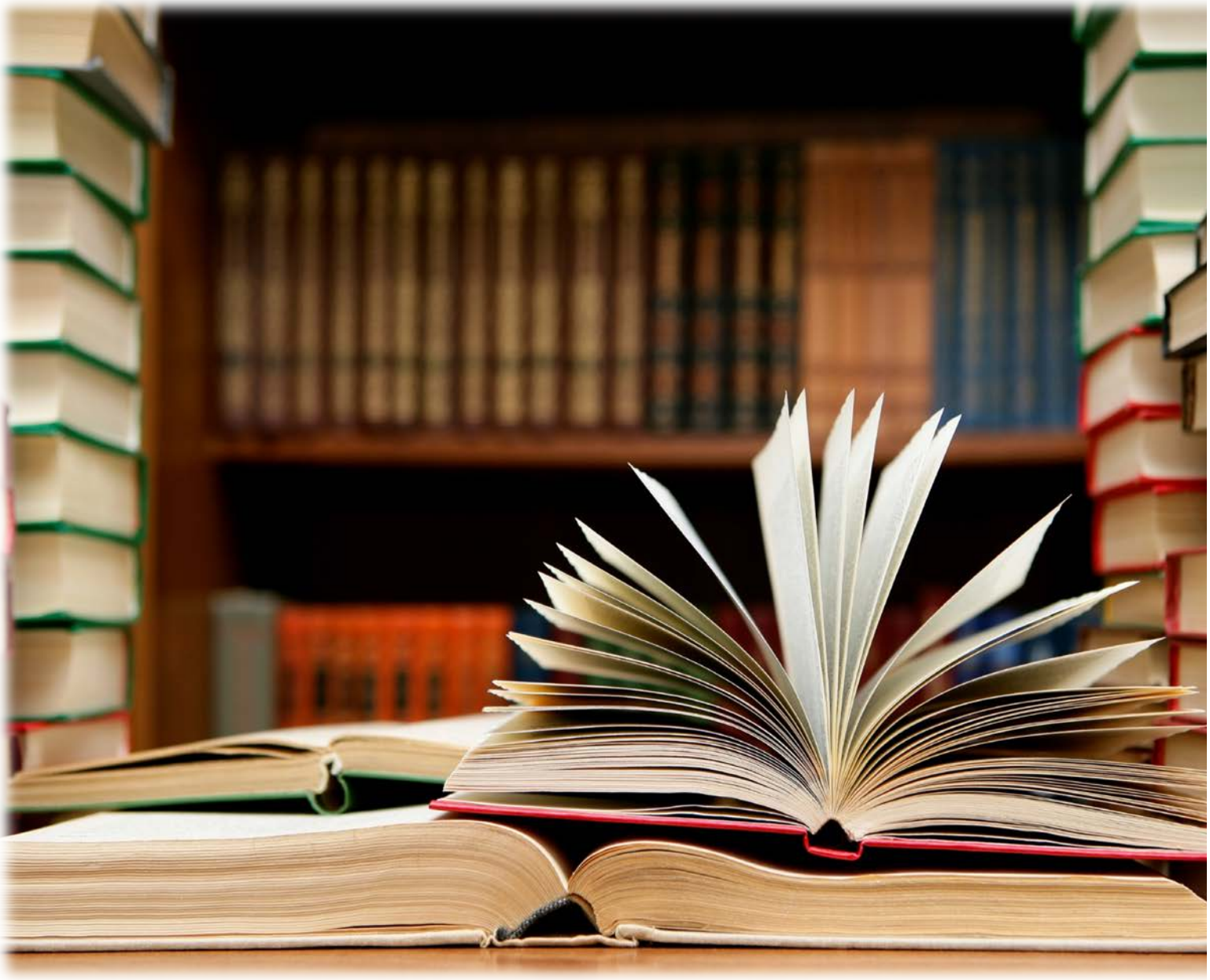
Fires in the Basements of Single-Detached Residential Property

A Retrospective Analysis of British Columbia Residential Fires Reported 2008 to 2013



Fire Chief Len Garis and Dr. Joseph Clare

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UNIVERSITY OF THE FRASER VALLEY
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UNIVERSITY OF THE FRASER VALLEY
CENTRE FOR PUBLIC SAFETY & CRIMINAL JUSTICE RESEARCH

Overview of this Research

This report examines the fires that occurred in basements of British Columbia (BC) single-detached residential properties, reported to the BC Office of the Fire Commissioner (OFC) between October 20 2008 and October19 2013. The data included in this analysis was provided by 296 reporting agencies across the province, sampled from first nations band areas, non-municipal areas (with and without fire protection), and municipal areas. These fires that originated in the basement[1] (n = 715) were compared with all other fires that occurred in single-detached residential properties over this period of time (n = 5,481). The analysis revealed the following main findings with respect to fires that originated in the basement level of these buildings:

- They were more likely to have been ignited as a result of appliances, electrical equipment, and heating equipment;
- They were more likely to have been detected as a consequence of a smoke alarm activating and were less likely to have been without a smoke alarm;
- They were more likely to have been confined to at least the room of origin and less likely to extend beyond the building of origin;
- There was little in the way of meaningful difference in the method by which the fires were controlled as a function of the level of the building from which they originated;
- There was no difference in the rate of fire-related death as a function of the level of origin for the fire within this sample;
- Fire-related injuries were found to be more frequent for fires that originated in the basement level – a pattern consistent with the increased frequency of smoke alarm activation for this sample of fires, as demonstrated by prior research by the authors; and
- There was no obvious pattern indicating a variation in the frequency of fires by floor of origin as a function of building age. However, fire-related deaths were disproportionally higher for buildings constructed pre-1971.

These findings are discussed with respect to the BC Building Code [1] and the legislated requirements for built-in fire protection for secondary suites, which are regularly located in the basement areas of single-detached residential properties. No specific policy or practice recommendations are made as a consequence of these findings, as this is a retrospective study and there are limitations with the data that prevent specific conclusions being drawn about secondary suites in isolation. This said, in light of the combination of findings presented here, a review of the policy governing building code improvements as they relate to secondary suites would be warranted, with a view to determining if any changes would be appropriate.

Recent History for Residential Suites in BC

In 1995 the BC Building Code [1]was amended to add requirements focused specifically on secondary suites. Secondary suites are "a form of rental housing that is typically affordable, ground-oriented, and market-based… [and] can provide many benefits to homeowners, tenants, and the community" [2: 1]. As it stands,

[1] As will be explained, this includes 'sub-basements', and it was not possible to distinguish which of these fires occurred in finished basement suites (as opposed to occurring in the basement area of a house that was either a non-finished basement suite or a basement without a suite).

Part 9 Section 9.36 of the BC Building Code [1] outlines numerous restrictions and specific construction requirements relating to secondary suites, including (but not restricted to) the following:

- The secondary suite cannot exceed 40% of the total living area of the building it is located in, to a maximum area of 90 m^2 in finished living area;
- The secondary suite must be located within a building of residential occupancy containing only one other dwelling unit;
- The secondary suite must be located in, and part of, a building that is a single real estate entity;
- The ceiling height of the secondary suite can be a minimum of 2.0 m;
- Exit stairs from the secondary suite must have a minimum width of 860 mm;
- Fire separations with a fire resistance rating are required between residential suites, exits, public corridors, and storage garages, unless the building has sprinkler protection;
- Each dwelling unit shall have a second means of egress where the egress door from either dwelling unit opens to a space used by both suites with only one exit;
- Heating, ventilation, and air conditioning (HVAC) systems that serve both suites are to be equipped to prevent the movement of smoke when detected by duct-type smoke alarms;
- Independent smoke alarms are required in each suite; and
- An additional smoke alarm is required to be interconnected between both suites where a 30 min fire separation is proposed.

There are a complex set of issues and challenges associated with secondary suites, as captured in this quote from BC Ministry of Community, Aboriginal and Women's Services [2: 10]:

> *Given the history of illegal secondary suite housing, there continues to be debate in many communities about whether to legalize. On one hand, legalizing existing suites is difficult due to factors such as health and safety concerns, neighbourhood concerns, and the need to avoid closures of affordable housing stock. On the other hand, the option of continuing to prohibit suites does not stop them from being built, thus deepening the scale of the problem.*

Some of the major challenges and issues [2], in point form, include: (a) community acceptance; (b) fairness of utility billings; (c) fairness of property taxes; (d) standards of health and safety; (e) parking; (f) impact on built form; (g) bylaw enforcement; (h) administrative costs; (i) suite registration and licensing; (j) local government liability; (k) variability in the definitions of 'single family'; and (l) security of tenure.

The findings of this report should be interpreted with respect to the fire-specific health and safety concerns that are relevant to secondary suites. Prior to introducing the findings, however, it is important to emphasize that there are caveats associated with the use and interpretation of these findings. The data analysed here covers fires from across the province, but the state of compliance with the BC Building Code standards and the local government bylaws is unknown. As a result, this research is not designed to make any recommendations. Instead, it is a retrospective analysis of the recent outcomes of fires that occurred in the basement areas of residential buildings.

The Scope of the Dataset

The 6,196 fires in single-detached residential properties reported in BC between October 20, 2008 and October 19, 2013, were taken from a larger set of 34,708 fires reported to the BC OFC, 10,640 of which occurred in residential properties.[2] Therefore, the sample of fires included here represents 58.2% of all residential fires reported during this time period. Overall, this sample included fires that resulted in 403 fire-related injuries and 83 deaths. The final data set was created by selecting fires that occurred in single-detached residential properties (PC3400) and then the origin level of the fire was separated into basement (including '*sub-basement*', LV1000) [3] versus all other potential levels of origin. The frequencies of fires, deaths, and injuries across these two groups are presented in Table 1. As explained above, 296 reporting locations across the province submitted reports for fires that were included in this data set.

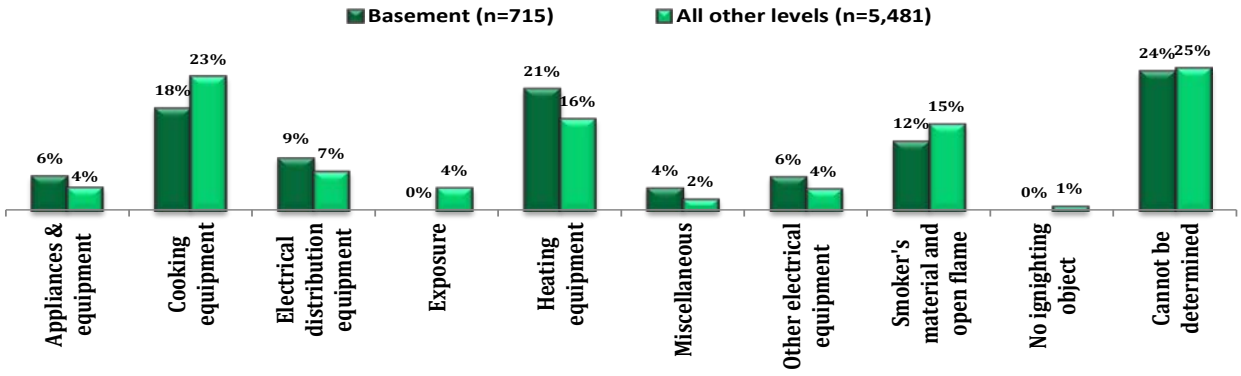
TABLE 1: FREQUENCIES OF FIRES, DEATHS, AND INJURIES BY LEVEL OF FIRE ORIGIN WITHIN SINGLE-DETACHED RESIDENTIAL PROPERTIES

Single-detached residential fires, level of fire origin	# fires	% fires	# deaths	% deaths	# injuries	% injuries
Basement, sub-basement	715	11.5%	10	12.0%	67	16.6%
All other levels	5,481	88.5%	73	88.0%	336	83.4%
Total	**6,196**	**100.0%**	**83**	**100.0%**	**403**	**100.0%**

The Igniting Object that Caused the Fire

The relationship between the broad categories of igniting objects that caused the fires and the level of the fire origin was examined, with results displayed in Figure 1. Throughout this report, the differences that are discussed can all be considered to be statistically significant,[3] expect where it is clearly specified that this is not the case. Although the percentages in Figure 1appear relatively close in some cases, given the sample size involved here, meaningful differences were observed between groups for all of the categories. Basement fires were more frequently caused by appliances, electrical distribution equipment, heating equipment, other electrical equipment, and miscellaneous sources. The frequencies for all other broad categories of igniting objects were greater for fires that did not originate from the basement level of these buildings.

FIGURE 1. BROAD CATEGORIES OF IGNITING OBJECTS BY FIRE ORIGIN LEVEL



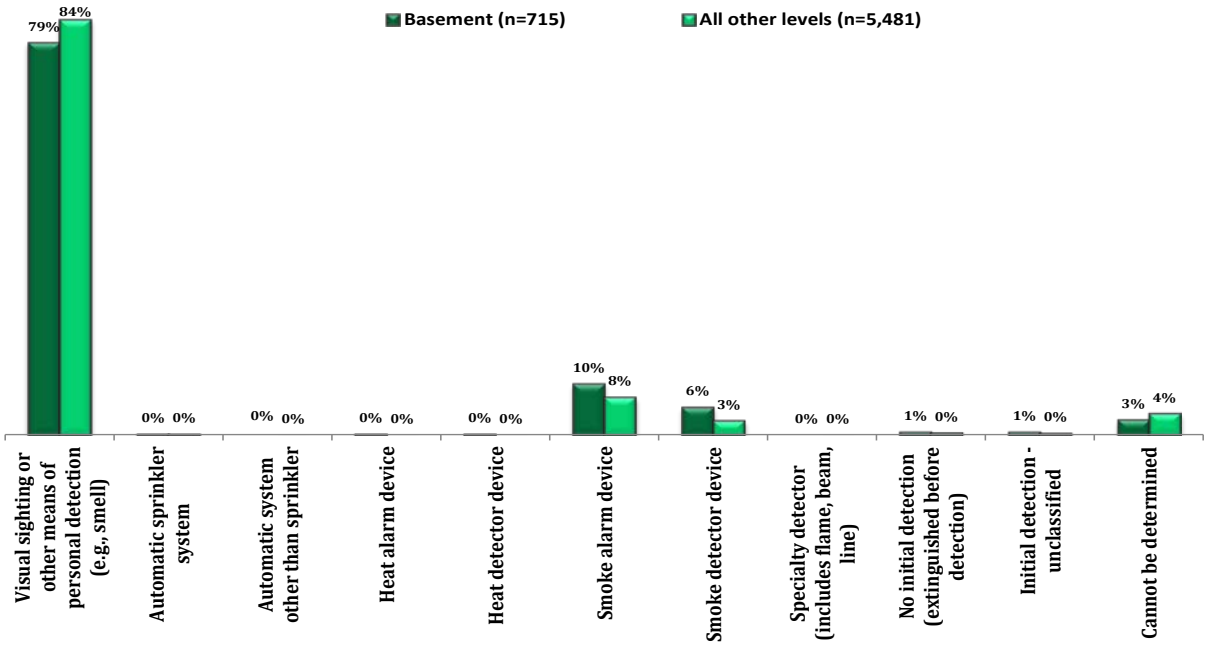
[2]Property complex coded for "residential use" (PC3100 to PC3900, inclusive), BC Fire Reporting Manual.

[3] Statistically significant differences describe a relationship between two variables that is deemed to be too large to have occurred by chance alone, and thus represents a real difference. Conventionally this is deemed to be the case if the probability of a difference of the observed size would have occurred by chance less than 5% of the time. The majority of differences discussed within this report were planned *Z*-comparisons, designed to compare the relative distributions of non-parametric data within categorical groups.

The Method of Initial Fire Detection

Next, the process by which the fire was initially detected was compared, as a function of the fire origin level within the building (results displayed in Figure 2). The only differences of note between the relative frequencies of these detection methods were: (a) fires that originated in basements were less likely to have been detected by visual sighting or other means of personal detection (79.4% vs. 84.1%), and (b) in aggregate (across smoke alarms and smoke detectors), fires that originated in basements were more likely to have been detected by some type of smoke alarm (15.9% combined, compared with 10.5% of fires in all other areas of the buildings).

FIGURE 2. THE INITIAL PROCESS BY WHICH THE FIRES WERE DETECTED BY FIRE ORIGIN LEVEL



Additional analysis into the smoke alarm functionality indicates this increased detection by working alarms is the result of an increased rate of present, functioning alarms in basements (see Table 2). The frequency at which smoke alarms in basements that experienced fire were present and functioning was significantly greater than for fires experienced in all other areas of these residential buildings, and there was significantly less cases where no smoke alarm was installed in basements that experienced fire (with *Z*-scores indicated in the table).

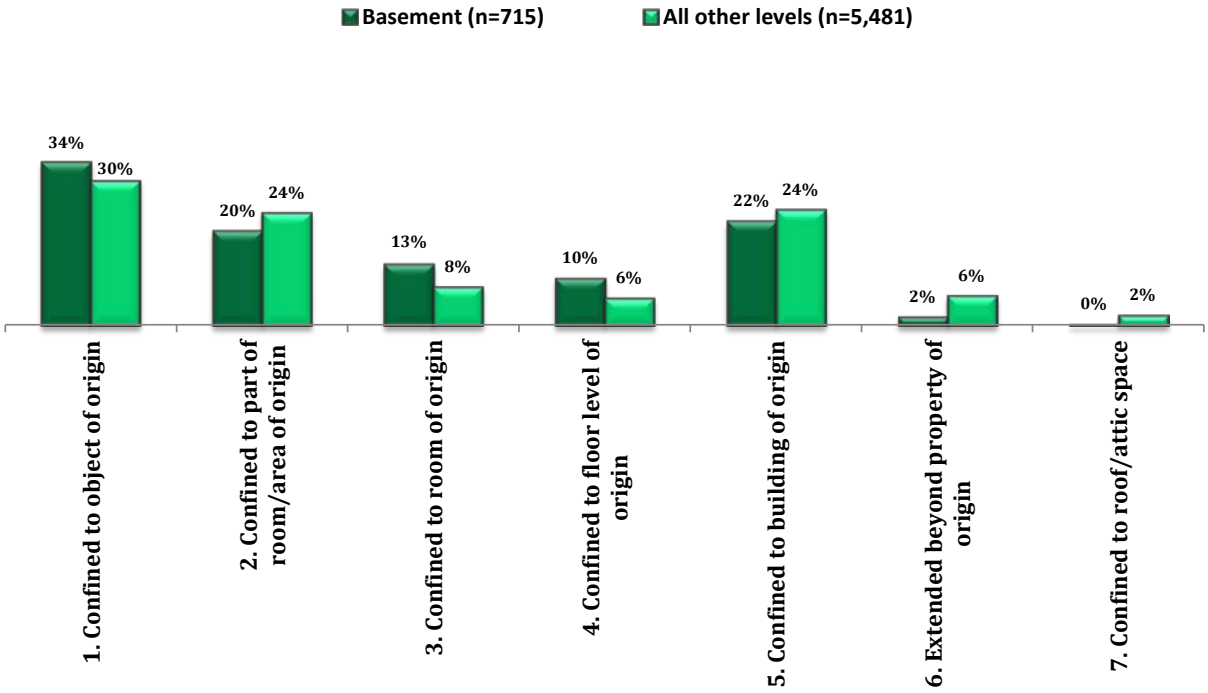
TABLE 2. THE INITIAL PROCESS BY WHICH THE FIRES WERE DETECTED BY FIRE ORIGIN LEVEL

	Basement		All other levels		
Smoke alarm status	**# fires**	**% fires**	**# fires**	**% fires**	**Significance (*Z*)**
Alarm activated	214	29.9%	1,315	24.0%	3.29*
Alarm not activated	179	25.0%	1,348	24.6%	*ns*
No smoke alarm installed	104	14.5%	1,147	20.9%	−4.47*
Cannot be determined	218	30.5%	1,671	30.5%	*ns*
Total	**715**	**100.0%**	**5,481**	**100.0%**	

The Extent of Fire Spread as a Function of Fire Origin Level

The extent of fire spread from the point of origin was also examined as a function of the fire origin level within the buildings, with the results displayed in Figure 3. In combination, fires that occurred in basements were more likely to have been confined to at least the room of origin (66.6% of fires, compared to 61.9% of fires in all other areas of the buildings). In contrast, fires that occurred outside of the basement area were significantly more likely to extend beyond the building of origin (1.7% for basements compared to 6.2% for all other locations).

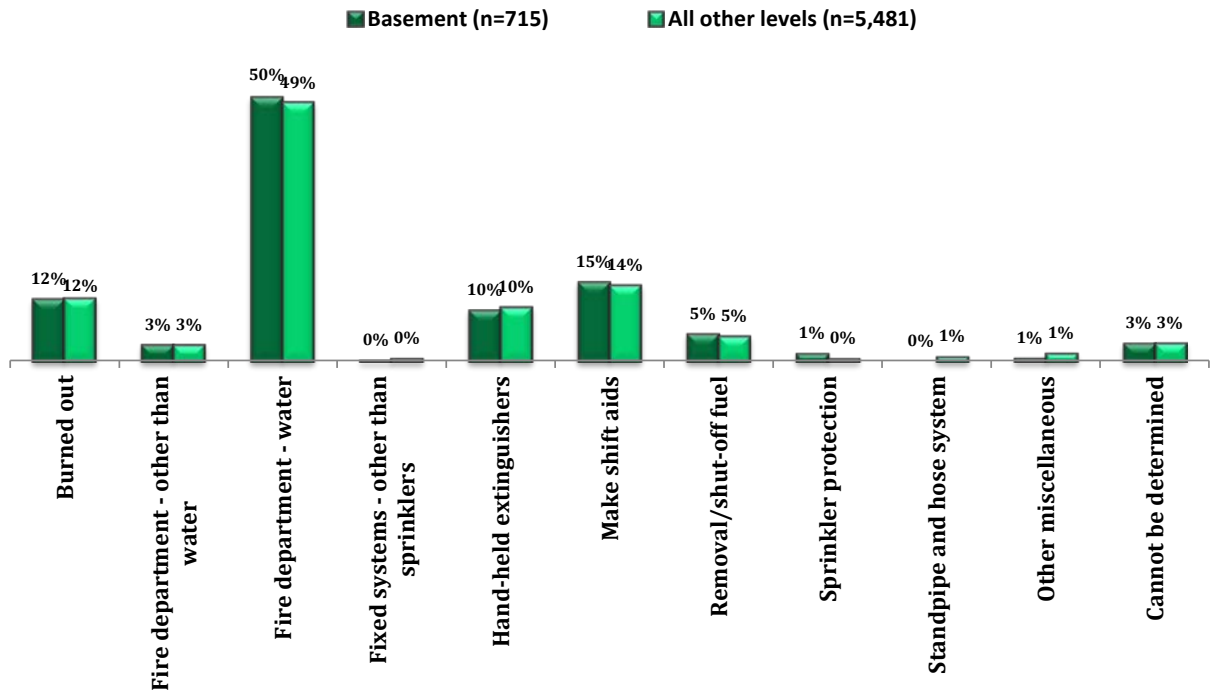
FIGURE 3. THE EXTENT OF FIRE SPREAD BY FIRE ORIGIN LEVEL



The Method of Fire Control as a Function of Fire Origin Level

The various frequencies of the methods of fire control used are displayed in Figure 4, as a function of the origin level of the fire within the buildings. As can be seen from the patterns in this frequency, there is very little meaningful difference between the methods used to control the fires when the patterns for these two groups are compared. The only statistically significant differences showed (a) a small increase in frequency of sprinkler protection in basements (1.4% of fires controlled this way, compared with 0.4% of all other fires); and (b) small increases in the frequencies at which fires that originated in areas other than basements were controlled by fixed systems other than sprinklers (0.1% vs. 0.5%), standpipe/hose systems (0.0% vs. 0.8%), and other miscellaneous methods of control (0.1% vs. 0.5%).

FIGURE 4. THE METHOD OF FIRE CONTROL BY FIRE ORIGIN LEVEL



Fire-Related Casualties as a Function of Fire Origin Level

The overall patterns for fire-related casualties (injuries and deaths) are displayed in Table 3, separated out by the fire origin level within the buildings. The rate ratio for deaths per 1,000 fires demonstrated a non-significant result (14.0 deaths per 1,000 fires in basements, compared to 13.3 deaths per 1,000 fires in other areas), indicating no difference in the rate of deaths for fires between these two groups. There was, however, a significantly greater rate of injuries per 1,000 fires when the fires originated in the basement level of these residential properties (93.7 injuries per 1,000 fires in basements, compared to 61.3 per 1,000 fires in other areas). This pattern is consistent with the increased activation of smoke alarms for fires that originate in the basements – an issue that has been explored in previous work by these authors [e.g., 4, 5].

TABLE 3. FIRE-RELATED CASUALTIES BY FIRE ORIGIN LEVEL

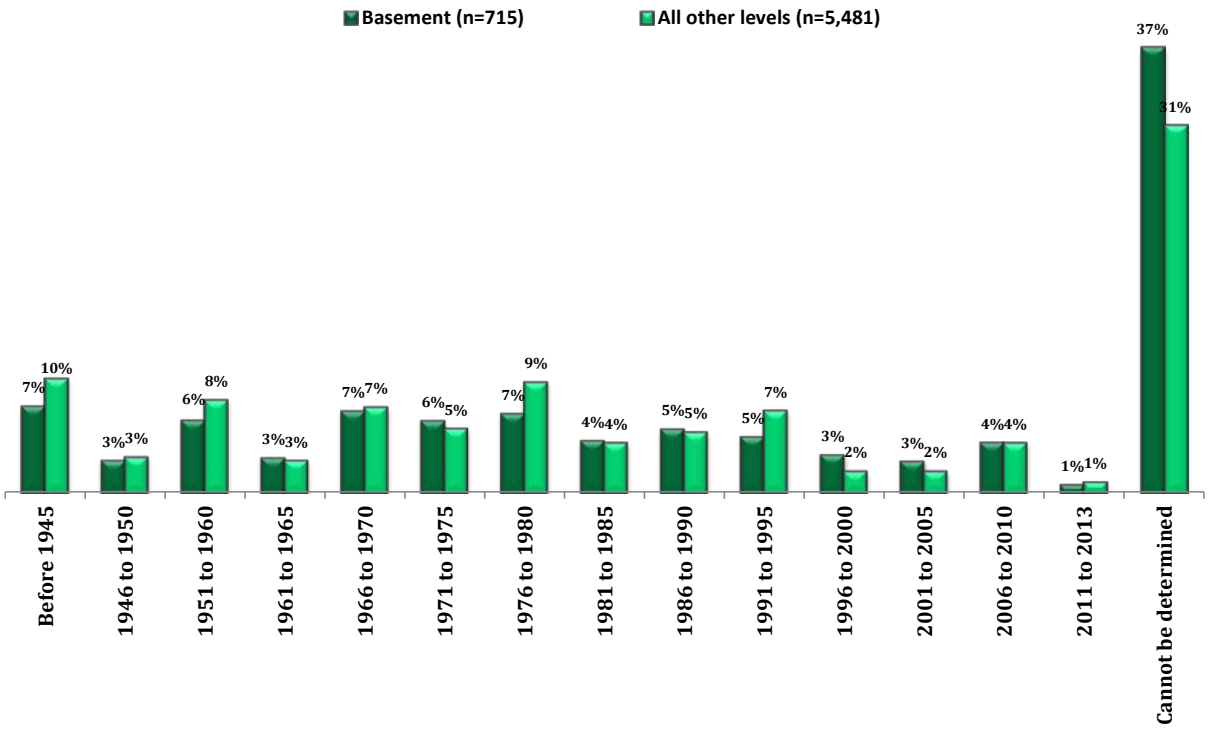
Single-detached residential fires, level of fire origin	# fires	# deaths	deaths per 1,000 fires	# injuries	injuries per 1,000 fires
Basement, sub-basement	715	10	14.0	67	93.7
All other levels	5,481	73	13.3	336	61.3
Total	**6,196**	**83**	**13.4**	**403**	**65.0**

Exploring the Relevance of Building Year of Construction for Fire Origin Level

Given the recent history with respect to the amended legislation regarding secondary suites, as discussed above, the patterns for fires as a function of the year of construction was also explored (with findings displayed in Figure 5). It should be noted that this variable is not always completed within the fire incident reports that are submitted to the BC OFC, as demonstrated by the large percentages of fires in both groups for

which the building year of construction could not be determined. Ostensibly, the patterns across these groups appear fairly similar. Interestingly, when the building age was known, regardless of the floor within the building at which the fire originated, 72.9% of all the deaths occurred in buildings that were constructed prior to 1971 despite these buildings making up only 26.8% of the total sample that experienced fires.

FIGURE 5. THE YEAR OF BUILDING CONSTRUCTION (GROUPED) BY FIRE ORIGIN LEVEL



General Summary of Findings and Conclusion

Overall, as explained from the outset, this analysis demonstrated that fires in basements were: (a) more likely to have been ignited as a result of electrical appliances and heating equipment; (b) more likely to have been detected as a consequence of a present, functioning smoke alarm; (c) more likely to have been confined to at least the room of origin; and (d) controlled in much the same way as fires that commenced in other areas of these buildings. In addition to this, there was no difference in the rate of fire-related death as a function of the level of origin for the fire within this sample. This said, injuries were more frequent for fires that originated in the basement level, but thisfinding is consistent with the increased presence of functioning smoke alarms. Finally, although there was no clear interaction between the frequency of fires, the floor of origin, and the building age, fire-related deaths were disproportionally higher for buildings constructed pre-1971 (regardless of the fire level of origin within the building).

As suggested previously, this paper is not designed to make any specific policy or practice recommendations to building owners, managers, local authorities, or the fire service. Instead, it just acts to retrospectively analyse the available information into fires that occur in the basement levels of residential buildings relative to fires that occur in all other areas of these types of properties. While the findings of this report should be interpreted with respect to the fire-specific health and safety concerns that are relevant to secondary suites, it is important to restate the major caveat associated with the use and interpretation of these findings: the state

of compliance with the BC Building Code standards and the local government bylaws for the fires analysed here is unknown. This research is not intended to address any other issues associated legalizing suites, as discussed above. Its intention is to provide insight into how these occupancies are generally performing when fires occur.

References

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Author Biographical Information

Len Garis is the Fire Chief for the City of Surrey, B.C. and is an Adjunct Professor in the School of Criminology and Criminal Justice at the University of the Fraser Valley and a member of the Institute of Canadian Urban Research Studies, Simon Fraser University. Contact him at LWGaris@surrey.ca.

Dr Joseph Clare was the Strategic Planning Analyst for the Surrey Fire Service (BC) between 2010 and 2013, and is also an adjunct professor in the Crime Research Centre, University of Western Australia, and a member of the Institute of Canadian Urban Research Studies (ICURS), Simon Fraser University. Contact him at joe.clare@uwa.edu.au.

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