KCB Kelton, Chertow & Boyd Inc.

Calgary Fire Department

Review of the Calgary Fire Department's Service Level and Response Time Targets and Related Implications of Installing Residential Sprinkler Systems in New Development Areas

January 19, 2018

Final Report

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1. Executive Summary

The City of Calgary is charged with the provision of municipal services in areas of new growth and is faced with the reality that growth does not pay for itself, where it occurs in most Canadian municipalities. New development can be a costly exercise, and that cost can take many forms. It can take many years for the tax base to grow to a point where it catches up with the budget impacts that new growth imposes.

With respect to the provision of emergency services, growth poses particular challenges because the provision of these services typically cannot be delayed. It is not practical to wait until the development reaches a point where the new tax base will support the service. However it is also expensive to provide these services before the community reaches a funding neutral position. For the purpose of this report the discussion has, and will, focus on emergency response services provided by the Calgary Fire Department in the City of Calgary.

Within this context it is also worth referencing the POLICY FOR THE INTEGRATION OF EMERGENCY SERVICES IN THE CITY OF CALGARY LAND USE, INFRASTRUCTURE AND MOBILITY PLANNING (2010)(Ref.1)

"Through further emergency services involvement in The City's planning processes, The City will contribute to emergency services safe communities that enhance societal safety by promoting and maintaining safe and healthy behaviours, supporting effective emergency responses and offering protection to people and their property. It is part of a broader complete community planning approach and respects, complements and supports the other factors that make up Calgary's vibrant, safe communities".

The level of timely and adequate response was established in 2008 with the Council approved Service Level and Response Time Targets (SLRTT) (Ref.2) At that time, the fire service was identified as "leading infrastructure" in new developments by City Council, meaning that Council's direction for development included ensuring fire service in new areas. This is part of the assessment used to indicate whether or not an approval will be granted.

The key consideration for any city when determining what level of emergency response to provide is the assumption of risk. In Calgary's case, any development that is permitted to occur in an area where the requirements of the SLRTT cannot be met will require The City to assume the associated risks. The question is; how much risk is The City prepared to assume?

The Fire Department typically cannot meet the SLRTT in areas of proposed new development, with existing infrastructure and staffing. Therefore, if development is to proceed in areas that cannot be serviced within the 7 and 11-minute time frames of the SLRTT, The City must decide whether to: i) strictly adhere to the SLRTT requirements, ii) amend the SLRTT requirements iii) ignore the requirements altogether or iv) implement mitigation measures to reduce the need for Fire's timely response.

A thorough analysis of the 4-options was undertaken, examining the validity of the SLRTT with respect to the need for emergency response targets and what those targets should be. Secondly, mitigation efforts were studied to determine if the response time needs can be amended on either a temporary or permanent basis, to permit development without the corresponding investment in infrastructure and

staffing. The following is a brief summary of our findings. A more thorough explanation of the analysis and key findings are contained within the body of the report.

a) Response Time Targets:

It is important to note that all Fire Department emergency responses were considered in the analysis.

The SLRTT established a first response time target of 7-minutes (7:00), to the 90th percentile for all emergencies and an Effective Response Force response of 11-minutes (11:00) to the 90th percentile. The National Fire Protection Agency (NFPA) established targets for fire and medical response under its NFPA 1710 standard. (Ref.3) NFPA 1710 is a standard widely endorsed by the Fire industry, internationally. The 1710 standard sets the first response time at 6-minutes and 24-seconds (6:24) and the first initial full alarm assignment at 10-minutes and 24-seconds (10:24), both to the 90th percentile. Both SLRTT targets fall within 10% of the NFPA 1710 targets, so they are a reasonable standard for Calgary, with respect to response time and compare favourably to other major Canadian municipalities.

It is important to note that the Service Level Response Time Targets have not been achieved at the 7 minute and 11 minute targets. Based on the response time statistics for 2016, first response arrival was seven minutes and thirty-nine (7:39) seconds to the 90th percentile. Of particular concern is the response time of assembling an Effective Response Force in eleven minutes. The eleven-minute target was not achieved. The response time was thirteen minutes and eleven seconds (13:11) to the 90th percentile. This response time is problematic in providing an effective firefighting force to mitigate any incident effectively.

While we find that the response time targets established in the SLRTT are reasonable, the same cannot be said for the staffing requirements. While the SLRTT establishes the ERF at 12-personnel, the 1710 standard requires 14 at a residential fire and 15 where aerial operations are undertaken. (Ref.4)

b) Mitigation Strategies

A breakdown of the analysis undertaken to consider various strategies that may mitigate the need for strictly adhering to the SLRTT is included in the body of the report. For summary purposes, it is important to understand that we believe that the only effective mitigation strategy would be to require all buildings (residential and non-residential buildings where sprinklers are not required by code) in a newly developed area to be sprinklered, until sufficient resources are located in the new community to satisfy the response time requirements of the SLRTT. We appreciate that non-residential is outside the Notice of Motion. Note: There are other risk mitigation options available such as increasing spatial separation between new homes, however consideration of this and other options is outside the scope of this review.

Sprinklers will not eliminate the need for fire response to a building in which they have been installed. They will contain fires and allow the inhabitants to escape safely. Therefore, firefighting crews are less likely to be required to enter a burning building to affect a rescue upon their arrival. They do not, however, effectively control an exterior fire or prevent those fires from spreading to other buildings. Therefore, a delay in the arrival of the ERF may be less of a risk with respect to the safety of the inhabitants and the fire fighters, but the potential for property loss risk is not

significantly reduced where the fire involves the outside of buildings beyond the current HIRF benefits. The CFD response statistics reported that 42% of all fires were exterior fires of all categories. (Ref. 5)

Any recommendation regarding amending the SLRTT in a sprinklered community will involve assuming added risk. Though the risk of lives lost is normally reduced, the risk of property loss is still very real.

The City cannot force builders to install sprinklers in buildings within newly developed areas simply because they fall outside the 7-minute response time area. The Alberta Building Code (ABC) (Ref.6) requires additional building design and development considerations to mitigate the risk of having a response time of more than 10-minutes, and a municipality cannot supersede that Provincial requirement. The City can require sprinklers in areas outside of a 10-minute response but not for anything less than that.

The installation of residential sprinklers provides many benefits, as outlined in the report, but only for an emergency that involve fires starting within sprinklered structures. They in no way to mitigate the need for Fire's timely response to other emergencies such as motor vehicle collisions, medical calls, hazardous materials and technical rescues. Therefore, the associated risks for these other incidents must be a consideration when approving development in new areas, without considering the need for Fire resources.

c) Recommendations

It is our opinion that the best approach to providing Fire Department service to areas of new growth is to adhere to the SLRTT by providing new fire infrastructure and staffing, concurrent with development.

However, we were tasked to indicate whether or not there are acceptable ways to mitigate risks in growth areas. Our findings indicate that there are other options but all involve the assumption of risk by the City of Calgary. It is, unfortunately, impossible to provide a one-size-fits-all solution to the question regarding Calgary Fire's response into new developments. There are too many factors that are site-specific. (The example of South Shepard is outlined in the report.)

We offer the following general recommendations.

1. The City should not amend the citywide first-response target time requirements in the SLRTT in any way that would expand the current response time target in serviced areas.
2. Encourage growth in areas currently serviced by Calgary Fire that already meet the response time requirements of the SLRTT.
3. Development in presently un-serviced areas must be contiguous with areas presently serviced by Calgary Fire.
4. New development must only be permitted in areas where future Fire Department servicing is planned in the foreseeable future.
5. When approving growth in an area where the SLRTT cannot be met, establish firm points that trigger new, staffed fire stations. The trigger points will be area specific and will be based on number of factors such as occupied buildings (tax base), road networks in place, availability of fire response from adjacent areas and distribution and concentration of buildings.

6. If growth is permitted in areas where the SLRTT cannot be met, sprinklers must be required in all buildings, not just homes, which fall outside of a 10-minute first response time, in accordance with the Alberta Building Code.
7. The pace of growth within new areas should be considered prior to issuing approvals for development. A rapidly growing area will acquire the tax base necessary to support emergency services more quickly.
8. Distribution of growth should be considered when issuing permits. Concentrated growth is easier to service than growth allowed to progress in a "patchwork" fashion.
9. The City of Calgary may wish to propose an amendment to the Alberta Building Code to mandate residential sprinklers for all new construction for developments where fire department response time is less than 10 minutes.
10. The City should encourage builders and developers in growth areas, where response times fall between the SLRTT and the 10-minute threshold covered under the ABC, to install sprinklers in all buildings.
11. The City should undergo a new Fire Underwriters Survey. Any potential costs to the residents and businesses as a result of amending the SLRTT in growth areas, in the form of increased insurance premiums, will be identified in the resultant report.
12. The Calgary Fire Department and the City of Calgary 911 Centre must enter into a service level agreement to ensure all time benchmarks are accurately captured for the Calgary Fire Department.
13. The current SLRTT call handling time should be increased from 60 seconds to 64 seconds to align with the latest revision to NFPA 1221. (Ref.7)

2. Purpose Statement/Objective of Report

Mandate Objectives

The objective of this mandate is to provide The City with a comprehensive report resulting from a review of the Calgary Fire Department's SLRTT with an emphasis on growth areas and in consideration of the effect on fire risk reduction that residential sprinklering could have on those growth areas.

Project Scope

The scope of this engagement included, but was not limited to:

a) Conducting a review of the current fire department Service Level and Response Time Targets to determine if they are still relevant and in alignment with industry standards and best practices, achievable in new growth areas of the City, and in alignment with the direction from Fire's Zero-Based Review for resource allocation, including planning for new growth areas, to include a greater focus on risks and outcomes.

b) Analysing Costs and Benefits: Identify what, if any, benefit there is in sprinklering a new community in terms of fire safety with a specific emphasis on analysing the cost/benefit to the fire department to provide fire protection for that same community,

while also assessing the impact on the many other types of emergencies the fire department responds to and the additional services and risk mitigation provided by emergency response resources in that community. Indicate whether or not there are acceptable ways to mitigate risks in growth areas, considering the unique characteristics of the city of Calgary (risks, resources, community expectations, policy direction, etc.)

c) Maintaining relevance to the Canadian city environment: Wherever possible the context of information gathered and reported will be in the context of a Canadian municipality of similar size to Calgary.

d) The consultant leading engagement with the development and sprinklering industries, as well as leading public engagement.

e) Consideration of related Council policies, including ensuring alignment and/or identifying restrictions or non-compliance issues.

Methodology

a) Data Collection & Review

Included i) literature reviews, ii) benchmarking, iii) response time performance analysis, iv) incidents profile data analysis, v) interviews with all key stakeholders, vi) studies of sprinklered systems in the US and Canada and vii) related Council policies. Review our findings formally through weekly progress update meetings and more informally as required with key stakeholders.

b) Conduct Engagement Sessions with the Public and Developers/Builders.

c) Recommendations & Options.

Summarize our findings and recommendations and options for review by the Fire Chief and Director of Building Services.

d) Draft and Final Report Preparation.

Prepare a draft report for review by the Fire Chief and the Director of Calgary Building Services. Agreed changes and enhancements to the report were incorporated into a Final report for review and report out.

e) Communications:

Weekly 1-hour face-to-face progress meetings. Participants included the Fire Chief, Director of Building Services, and other key CFD stakeholders (as required), Bill Stewart and Sean Pearce

- Bi-weekly written progress reports
- Met and liaised with regulatory bodies, stakeholder groups, and other personnel as designated by the Fire Chief and the Director of Building Services
- Provided copies to The City of all correspondence related to the project

3. Current State

a) City Policies and Bylaws re: Growth Management

Land costs in Calgary are increasing. These increases are partially due to the lack of land being made available for new growth. While the city and BILD Calgary have what appears to be an amicable working relationship; they differ in their opinions on this topic. Members of BILD Calgary that were engaged during the development of this report were clear that the lack of development in greenfield areas would limit their ability to help grow Calgary by creating affordable housing for first time homebuyers. They also believe that this is vital to the city's growth as other neighboring communities will provide greenfield areas for growth and Calgary will lose out on these potential home buyers. One present example of greenfield development selling quite well is Livingston. Based on the comments from the builder group, one might assume that the release of other areas for growth will drive down costs in currently approved areas and spark competition.

Understanding that City officials are trying to make more efficient use of current infrastructure and reduce urban sprawl is also an important consideration. There is a general recognition that too little supply drives up the cost of housing, which can affect affordability, reduce competition and discourage innovation. Too much supply leads to unwarranted investment in infrastructure, which in turn ties up capital, and in subsequent operating costs to service the capital, and slows the build out of existing communities.

Currently within legislation, the developer per hectare fee covers water servicing, sanitary servicing, major roads and storm water facilities. Outside of the legislation, developers have contributed to fire halls, recreation facilities, libraries, police stations and transit.

Having engaged with both City staff and developers and builders, the goals of balancing growth from an expense perspective and growth from an economic development position, appears to be the sticking point in Calgary. The current level of collaboration is an example for other communities and should continue to be expanded so that development can continue to occur in a well thought out way.

City of Calgary staff are currently developing a separate document on how other communities manage their growth as it relates to the fire service and the input from that document should be considered as part of the review of this report.

b) ABC Requirements Summary (including STANDATA) (ref.8)

Alberta Building Code Requirements Summary

The Province of Alberta Building Code has a specific definition for fire department response time as it pertains to the construction requirements it triggers only. It does not define what a fire depart response time should be. Ten minutes is the defined response time requirement before additional requirements for limiting fire spread need to be met. That is, any structure built outside of a 10-minute response from a fire hall needs to meet the following requirements;

Alberta Building Code References

KCB Consulting Final Report

CODE REFERENCES

1. Sentence 3.2.3.1. (8) states: 3.2.3.1. Limiting Distance and Area of Unprotected Openings … 8) A limiting distance equal to half the actual limiting distance shall be used as input to the requirements of this Subsection, where a) the time from receipt of notification of a fire by the fire department until the first fire department vehicle capable of beginning suppression activities arrives at the building is greater than 10 minutes in not less than 10% of all calls to the building, and b) any storey in the building is not sprinklered. (See Appendix A and A-3.2.3.1. in Appendix A)
…
2. Article 9.10.14.3. states: 9.10.14.3. Limiting Distance where Firefighting Facilities are Inadequate 1) Except for the purposes of applying Sentences 9.10.14.4. (2), (8) and (9), and Sentence 9.10.14.5. (8), A limiting distance equal to half the actual limiting distance shall be used as input to the requirements of this Subsection, where a) the time from receipt of notification of a fire by the fire department until the first fire department vehicle capable of beginning suppression activities arrives at the building is greater than 10 minutes in not less than 10% of all calls to the building, and b) any storey in the building is not sprinklered. (See A-3.2.3.1. and A-3.2.3.1. (8) in Appendix A) Page 2 of 3 06-BCI-025

3. Article 9.10.15.3. states: 9.10.15.3. Limiting Distance where Firefighting Facilities are Inadequate 1) Except for the purposes of applying Sentences 9.10.15.5. (11), a limiting distance equal to half the actual limiting distance shall be used as input to the requirements of this Subsection, where a) the time from receipt of notification of a fire by the fire department until the first fire department vehicle capable of beginning suppression activities arrives at the building is greater than 10 minutes in not less than 10% of all calls to the building, and b) any storey in the building is not sprinklered. (See A-3.2.3.1. and A-3.2.3.1. (8) in Appendix A)
In October of 2009 a Standata Building Code Interpretation was released related to Fire Department Response Time and how it is calculated, included below are related excerpts from this Standata.

This measurement of fire department response time is solely for the purpose of applying the appropriate development and building design criteria to comply with the Alberta Building Code 2006. Other measures, outside the regulatory framework of the Safety Codes Act and within the policy authority of municipal councils, must be used to address issues of fire department performance measures. This includes the use of standards provided by the National Fire Protection Association and other such standards development organizations or advisory bodies.

INTERPRETATION: The terminology as noted in Sentences 3.2.3.1. (8), 9.10.14.3. (1) and 9.10.15.3. (1) is interpreted to have the following meanings:

- *"receipt of notification of a fire" - means the point in time that the fire dispatcher (who may or may not also be the 911 call taker) first receives the request for fire suppression assistance. The fire dispatcher is the person who directly notifies fire crews of the need to respond and whose actions are within the control of the fire department through direct employment, a shared services agreement or contract. Note: this timeframe does not include any call handling or call transfer time by 911 operators or alarm monitoring company personnel.*

- *"arrives at the building" – means the point in time that a rated fire department engine (i.e. pumper) capable of beginning exterior exposure protection and*

suppression activities arrives at the scene of the fire staffed with a crew of firefighters in accordance with local municipal policy. In situations where the time from the point of fire department notification to the point of fire department arrival at the structure will be greater than 10 minutes more than 10% of the time, the Code stipulates that either additional protection (i.e. fire resistance or suppression) or additional spatial separation must be provided. The timeframe may be calculated and mapped by the fire department using a combination of response data, timed trials and/or traffic modeling. These calculations must be based on the existing firefighting facilities and resources of the municipality, not upon future plans. It is therefore necessary for the building safety codes officers within the municipality to work with the fire suppression and development authorities of the municipality to delineate the 10-minute response area(s). Such mapping will need to be updated as changes in infrastructure and fire suppression capacity occur. This INTERPRETATION is applicable throughout the province of Alberta.

This interpretation is somewhat unique to Alberta and varies slightly from NFPA 1710, which is the standard that most urban fire services use to determine the response time they will use. NFPA 1710 suggested response time is for all emergency responses delivered by a fire department, not just fire responses. It is expected that an urban fire service will set its own benchmark/target response time in conjunction with its municipal council to achieve the highest level of public safety the corporation can afford.

An internet review of response time was conducted of municipalities that have publically adopted 3.2.3.1. (8) in Alberta. It was found that the City of Wetaskiwin, Leduc County and Fort Saskatchewan have all published documents related directly to the expected response time from the ABC and the requirements for building outside of 10 minutes. In 2010 a report was given to Calgary City Council on the high intensity fire issue and the provincial 10 minute response: CPS2010-61 Protection Against Residential Fires and Fire Spread in The City of Calgary. This document clearly establishes the provincial rules with regards to response time for dwellings outside of 10 minutes from a fire station.

The 10-minute response was introduced into the 2010 National Building Code (NBC) and retained in the 2015 NBC. (Ref.9) Various provinces have adopted this in different ways. In Ontario they have amended it slightly to include a definition of Fire Department abilities. The City of Burnaby has adopted the Alberta version. The rest of BC has the 2010 NBC version. Based on a web search, Manitoba, Saskatchewan, Quebec, Newfoundland, New Brunswick and Prince Edward Island all have some form of the regulation, but the actual application has not been confirmed.

The application of this code requirement is governed by the Safety Codes Act (SCA) (Ref.10). The ABC is the minimum requirement and the SCA in section 66 prevents a municipality from creating a bylaw that may exceed or reduce a code requirement.

SCA Bylaw 66:

(1) Except as provided in this section, a bylaw of a municipality that purports to regulate a matter that is regulated by this Act is inoperative.
(2) Notwithstanding subsection (1), a municipality may make bylaws

(a) to carry out its powers and duties under the Forest and Prairie Protection Act;
(b) respecting minimum maintenance standards for buildings and structures;
(b.1) in the manner and to the extent authorized by the regulations, respecting private sewage disposal systems;
(c) respecting unsightly or derelict buildings or structures.
(3) Notwithstanding subsection (1), an accredited municipality may make bylaws
(a) respecting fees for anything issued or any material or service provided pursuant to this Act, and
(b) respecting the carrying out of its powers and duties as an accredited municipality.

c) CFD SLRTT Overview (specifics in appendix)

Service Level Response Time Targets (SLRTT) Review

Introduction

Response Times

The effectiveness of any municipality's Fire Service can be measured by the quality of service delivered to its citizens. Two key measurements of performance quality are the time required to react and respond to emergencies and the number of firefighting personnel on the scene.

The response of a Fire service to emergencies involves a complex series of variables and a number of constants. For the person experiencing an emergency, the clock starts ticking when the emergency event occurs and ends when the emergency is mitigated or closed. However, currently, measurement of response time against the target starts when the 911 call is answered, and it ends when emergency personnel arrive on scene. The variables are time to discovery of the event, reactions of the people involved, amount of time to react, access to a communication device, weather and traffic conditions. The constants include the emergency services' infrastructure, staffing capabilities and the road network.

The response time is calculated to the 90th percentile for all emergency incidents responded to by a fire department. A target threshold is the time required to meet on 90% of responses. In other words, the target will be met 9 out of 10 times.

NFPA 1710

The National Fire Protection Agency (NFPA) is an international body that establishes standards for the fire service. The industry benchmark to measure urban response capability is NFPA Standard 1710 (1710). The title is "Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments". This standard specifies requirements for effective and efficient organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by career (i.e. not volunteer) fire departments to protect citizens and the occupational safety and health of fire department employees. 1710 sets out specific

benchmarks for the 3 stages in fire response that add up to the total response time: time, chute or turnout time and travel time.

It is important to note that 1710 is not regulatory and municipal fire departments can choose to accept 1710 as their response time target, set their own target or not set targets at all. It is also worth mentioning that NFPA 1710 is based in a 2000 square foot home with no basement or exposures, which is very different to our experience in growth communities.

A synopsis of the NFPA revisions is included in Appendix 4.

Flashover

Flashover is the transition phase in the development of a contained fire in which surfaces exposed to the thermal radiation, from fire gases in excess of 600° C, reach ignition temperature more or less simultaneously and fire spreads rapidly through the space. This is the most dangerous stage of fire development.

Source: National Institute Standards Technology - USA

The potential for flashover in a structure fire has increased significantly in the past fifty years. Scientific experiments conducted by Underwriters Laboratories in the United States have confirmed the timeline to flashover in modern homes has been reduced to less than five minutes. NFPA states flashover can occur within 8- 10 minutes. It must be noted that flashover varies, depending on the contents of the building and other factors. The fact that flash over may now occur prior to fire service response does not reduce the need for rapid intervention, as post flashover conditions will rapidly lead to fire spreading within the involved structure as well as to adjacent structures with associated risk to occupants of those structures.

Source: Underwriters Laboratories – See Appendix

City of Calgary Service Levels and Response Time Targets (SLRTT)

The City of Calgary Council has approved the Fire Department's SLRTT. The SLRTT, like 1710, sets benchmark times for the 3 stages of response for the first responding unit as well as the total response time for the initial full alarm assignment, the Effective Response Force (ERF) to residential fires. The SLRTT first unit arrival target, unlike 1710, applies to all emergency responses.

The type of emergency incident will generally dictate the resources to be deployed. The determination will be based on the information received by the Emergency Communications Officer taking the call at Calgary 911. In the case of a fire emergency, the critical time frame of assembling an effective firefighting force is essential to emergency scene operations and the deployment of fire crews for search and rescue, firefighting, ventilation, protecting exposures to protect the surrounding properties. Assembling the appropriate type and number of resources is equally as critical for emergencies not involving fires.

KCB focused on our review of the 2008 Calgary City Council approved Calgary Fire Department response time standards (SLRTT). The review included a comparison to NFPA 1710.

First-In Unit Response Comparison

NFPA 1710 establishes the following first response time benchmarks:

1. Alarm Handling (Dispatch) Time: 64 seconds
2. Chute Time (Time for Vehicle to Leave Station After Call Received): 80 seconds
3. Travel Time (From Station to Event): 240 seconds
4. Total response Time: 6-minutes, 24-seconds

Calgary's **SLRTT** establishes the following first response time benchmarks:

1. Alarm Handling Time: 60-seconds*****
2. Chute Time: 90-seconds
3. Travel Time: 270-seconds
4. Total response Time: 7-minutes

(***** The NFPA changed their call handling target time from 60-seconds to 64-seconds to account for the added time to deal with cell phone calls. We recommend that the SLRTT be changed accordingly)

Table 1: NFPA 1710 vs. SLRTT

COMPARISON - NFPA 1710 vs. SLRTTFIRE AND MEDICAL FIRST RESPONSE			
	NFPA 1710	SLRTT - FIRE	SLRTT - MEDICAL
ALARM HANDLING TIME	64 seconds	60 seconds	60 seconds
CHUTE TIME	80 seconds	90 seconds	90 seconds
TRAVEL TIME	240 seconds	270 seconds	270 seconds
TOTAL RESPONSE TIME Minutes/Seconds	6:24	7:00	7:00
% DIFFERENCE to NFPA	N/A	+ 9.4%	+ 9.4%

Source: Calgary Fire Department

The SLRTT established a seven-minute response time to the 90th percentile for the first in fire apparatus to a fire call, alarm of fire, and other emergencies requiring the response of the CFD.
The industry standard for fire department response time is NFPA 1710. NFPA 1710 specifies as a benchmark six minutes and 24 seconds, 90% of the time, for first-in fire apparatus. The standard reflects fire emergency response, medical and other incidents requiring the response of the fire department. The 7-minute Calgary target is within 10% of the NFPA standard. Therefore, the current SLRTT benchmark established by Calgary City Council in January 2008 and amended in 2009, and subsequently amended in 2014, is a justifiable target.

The current seven-minute response standard has not been met over the past five years. The 2016 response time results, to the 90th percentile, for all first-in vehicle responses was seven minutes and thirty-nine seconds.

Target Medical Response Time Comparison

NFPA 1710 establishes the total response time standard for medical response at 6-minutes and 24-seconds.

The SLRTT sets 7-minutes as the target total response time. 9.4% longer than NFPA 1710

Medical response in 2016 was seven minutes and three seconds to the 90th percentile.

ERF/Initial Full Alarm Assignment Comparison

NFPA 1710 establishes the initial full alarm assignment as 10-minutes and 24-seconds.
The **SLRTT** sets 11-minutes as the target total response (ERF) time.

COMPARISON – NFPA 1710 vs. SLRTT EFFECTIVE RESPONSE FORCE		
	NFPA 1710	SLRTT - ERF
ALARM HANDLING TIME	64 seconds	60 seconds
CHUTE TIME	80 seconds	90 seconds
TRAVEL TIME	480 seconds	510 seconds
TOTAL RESPONSE TIME Minutes/Seconds	10:24	11:00
% DIFFERENCE to NFPA	N/A	+ 5.7%
PERSONNEL ASSEMBLED	14	12
PERSONNEL ASSEMBLED –AERIAL OPERATIONS	15	12

Source: Calgary Fire Department

The eleven-minute response time standard for ERF, also established by City Council in 2009, is still relevant today for fire department response in the City of Calgary. Our review has noted that the Calgary Fire Department has not met the current eleven-minute response time target over the past five years. The response time in 2016 was thirteen minutes and eleven seconds to the 90th percentile.

While we find that the ERF response time targets established in the SLRTT are reasonable, the same cannot be said for the staffing requirements. While the SLRTT establishes the ERF at 12-personnel, the 1710 standard requires 14 at a residential fire and 15 where aerial operations are required. The City of Calgary, in consultation

with the Fire Chief, must review the current effective firefighting response to assemble sufficient staff on scene to perform firefighting operations.

Calgary 911 Fire Dispatch Review

Calgary 911 utilizes NFPA 1221 to benchmark their standards as a Public Service Answering Point (PSAP) for emergency calls in the city and surrounding municipalities under contract to Calgary 911 for emergency communication services.

Calgary 911 and the Calgary Fire Department do not have a service level agreement in place presently. The times currently captured by Calgary 911 do not meet the needs of the SLRTT, nor NFPA 1221. Therefore a service level agreement should be negotiated to ensure the CFD is receiving the necessary data for every incident responded to by the CFD. CFD senior staff has noted time delays in the current call handling process between Calgary 911 and the CFD to date. The service level agreement would benefit the corporation from a risk management perspective and future potential liability.

d) Emergency Medical Response

The following is an excerpt from the Alberta Medical First Response website:

Medical First Response (MFR) agencies are key partners with Emergency Medical Services (EMS). They provide timely aid to patients during emergencies and support EMS when requested.

Alberta Health Services (AHS) has a responsibility to ensure patients receive safe care and that medical first responders are trained, prepared and supported to provide that care.

AHS and Alberta Health, in collaboration with an expert advisory panel, have developed a provincial model for Medical First Response. It formalizes the standards of medical care provided by MFR's across the province, building on the good work our partner providers are already doing to help patients.

Communities will decide what level of response is offered by their local Medical First Response agency. While agencies must meet program standards, registration with the Alberta College of Paramedics is not required. Municipalities and agencies can choose if they wish to participate in the MFR program based on community interest, resources and ability to respond to medical calls.

We understand that having local medical response is vital, no matter how big or small a community is. Our priority is to work with and support response agencies and enhance the services they are capable of providing to ensure Albertans get the best care possible.

As it is written, while Alberta Health Services (AHS) has a responsibility to ensure patients receive safe care, communities will decide what level of response is offered by their local medical response agency. In Calgary, the Fire Department serves as the local medical first response authority. The City of Calgary has been in negotiations with the Alberta Health Services with regards to participating in the Alberta MFR program. However, no agreement has been reached at the time of writing this report.

Although the City of Calgary is not currently participating in the Alberta MFR Program, the Fire Department still responds to the most critical medical calls: Codes Delta and Echo. Fire's response to EMS calls assists AHS in providing patient care. No funding for EMS services is provided to The City by AHS. Calgary's response to medical calls is provided as a service to the citizens of Calgary. Call volume data for the past 5 years shows that 52.4% of Calgary emergency responses are for medical calls.

Alberta Health System's response time data is shown in Appendix 2

As illustrated in the chart in Appendix 2, AHS's response to Code Echo and Delta calls to the 90th percentile has fallen to between 11 and 14 minutes from April 2015 – September 2017. Fire's response times to the same Echo and Delta calls, to the 90th percentile has been 7 minutes and 3 seconds (7:03). The value of having Fire respond lies in the ability to provide critical medical life-saving interventions 4 to 7 minutes faster than AHS in Code Echo and Delta situations. Echo and Delta calls are the most critical call types for medical intervention.

Further, the seven-minute SLRTT target for the first-in vehicle response for medical emergencies should be maintained. Biological death occurs in four to six minutes after respiration and the patient's pulse has stopped. The Sudden Cardiac Arrest Association states that with every minute without CPR and defibrillation, the victim's chance of survival decreases by 7-10%. (Ref.11)

The response by the CFD provides medical intervention to provide initial medical life support prior to the arrival of the Provincial ambulance. Emergency medical response is a service that has been provided by all major metropolitan fire departments across North America for decades.

The current level of medical training for CFD members fully supports the response intervention to Echo and Delta calls received from AHS. In many instances, CFD crews are the first line of critical medical intervention prior to the arrival of AHS paramedics. The CFD members are certified and trained under the direction of the Medical Director for the Calgary Fire Department, Dr. Kevin Hanrahan MD,CCFP (EM),DMM, Emergency Physician. He is also a Clinical Lecturer at the University of Calgary as well as an Associate Medical Director for the Alberta Health Services EMS. Dr. Hanrahan is former member of the Calgary Fire Department serving in the role as a firefighter for the city.

e) Rationale

The scope of the this project tasked the consultants with determining if the SLRTT target response times are achievable in new growth areas of the City, as well as emergency response resource allocation in new growth areas with a focus on risk and outcomes.
Future growth and development across the city will require emergency response by the Calgary Fire Department. The CFD provides an all-hazards emergency response to the citizens of Calgary and all response needs must be considered as part of the growth approval process. The particular response requirements will vary by type of emergency. Those requirements will determine the level of response, with respect to equipment, number of staff and specialized staff particulars. Response time considerations, for both initial response and ERF must be taken into account when planning for new development.

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Our scope of work for this project did not include a risk assessment for the City of Calgary. However, the city has a number of risks that are similar to comparator cities across Canada. The downtown core of the city is comprised of commercial high-rise buildings, hotels, commercial establishments, transit, stores and restaurants. Further, Calgary has major highways, waterways, railways, manufacturing, industrial, hazardous material facilities, refineries and an international airport within the city. Residential housing is a mixture of single, semi-detached, multifamily-family low rise and high-rise buildings.

The residents of Calgary expect prompt response by the CFD to assist them when they are faced with an emergency, regardless of where they may be located within the City, as outlined in the Citizen Survey (Ref. 12) section of this report. The response time standard of seven minutes must be maintained in existing serviced areas to service the needs of the citizens of Calgary. The decision with respect to the level of risk the citizens of Calgary are willing to accept is that of City Council.

Future fire station locations must be determined as part of the growth strategy for the proposed new developments as the city expands into the current green field areas. The proximity of existing stations, and their access to the new areas is also an important factor, as apparatus from those facilities will comprise an essential part of the ERF within the new development.

The City of Calgary has a long history of steady growth through annexation. The increase in land mass has contributed significantly to the Fire Department's current response time challenges. The Belvedere, Shepard, Keystone, Macleod, Rangeview and Haskayne areas have all been annexed since 1989 and future fire stations are planned for each area to deal with new growth, though there is no Capital or Operating budget funding assigned for any of the areas with the exception of MacLeod. In the MacLeod case, temporary funding on the West side has been cut as a result of the Workforce Planning work.

The "bolt on" nature of some of the annexed areas has created particular challenges with regards to fire coverage. Their location, outside of the ring road (Stoney Trail), has essentially landlocked the South Shepard area, for example. Fire response into the area from existing stations is hampered by Stoney Trail SE and the interchange with Highway 22X in the Southeast.

Current response into a large portion of the South Shepard area specifically is well outside 7-minute SLRTT target. While locating a single fire station within the area will address the first response requirements, the challenge in providing the ERF within the 11-minute target time will still exist. Therefore, the long-term impacts of proposed development must be considered. Regardless of the first-in response time,
the delayed response of the entire ERF will put the safety of citizens and the first responding fire crews in jeopardy. Additional mitigation efforts should be implemented. Residential sprinklers will control fires and decrease risk to citizens and firefighters.

With respect to the ability for the City to mandate residential sprinklers to mitigate risk, the current provincial law, under the Alberta Building Code (ABC), sets specific requirements for construction including the option of providing fire mitigation provisions in areas that fall outside of a 10-minute fire department first-in response.

The city cannot mandate such mitigation in areas where response times less than ten minutes are achievable. The Alberta Building Code is a min/max code and as such

cannot be superseded. For future growth areas in excess of a ten-minute fire department response time, there are provisions for mitigating fire risk through increased spatial separation of homes, installation of residential sprinklers and building construction alternatives, which limit fire spread.

For the purpose of this report, an analysis of sprinklers is provided. Fire sprinklers have a direct impact on occupant and firefighter safety. There has not been an accidental fatality in a residential occupancy where fire sprinklers have been present, and the addition of fire sprinklers greatly reduces fire risk to first responders. There is a dramatic reduction in property damage in sprinklered dwellings, meaning that overall costs for health and safety, health care and reconstruction are reduced when fire sprinklers are present. There is also reduced environmental impact from reduced release of products of combustion and contaminated firefighting water runoff.

Currently, residential sprinklers are being used in the Livingston community in the north portion of Calgary. All building stock in this community is fully sprinklered. It is imperative that all buildings, not just residential buildings, be sprinklered if sprinkler protection is to be considered a stop gap measure, making up for a lack of a fire station and crew in the area. It is also imperative that from a water supply position, communities that begin to sprinkler to expedite their approvals, complete the entire project regardless of the construction of a fire hall, as the sprinklering will affect the fire flow calculations for the area.

While sprinklering a community that falls outside of the 10-minute ABC target does help mitigate some of the overall fire risk it has no impact on the other emergencies to which CFD responds. Fire stations must still be considered within the sprinklered developments to respond to emergencies such as life-threatening medical interventions, motor vehicle collisions, hazardous materials incidents, rescues, structural collapses, and many others. Some fire response time flexibility may be considered for a community fully protected by residential and commercial sprinklers, however, this is complicated by the fact that Fire provides many more services than response to fires that require rapid intervention. The community protected by residential sprinklers provides time for the occupants of the home to safely escape by slowing down the spread and growth of the fire, and therefore normally holds the fire in check until the fire department arrives to fully extinguish the fire. The Livingston project utilizes NFPA 13D (Ref.13) sprinklers, which allow for occupant escape time and should be considered for future developments as the city grows.

Still, the current zero lot line construction in residential development creates a potential for fire spread beyond the current protection provided by the HIRF requirements. If residential sprinklers protect the housing development, if an exterior fire penetrates the envelope of the structure the sprinkler system will help to control the spread in the interior of that building. Residential sprinklers are not designed to control fires starting externally to a property. Given the zero lot line, and limited lot line construction of residential homes, the fire department response time of seven and eleven minutes is warranted.

A number of factors will contribute to the need for, and timing of, a new fire station in a new growth area. During the planning process, the pace of incremental population growth, population distribution and density are all factors that impact the associated fire risk and must be considered. If new communities are developed contiguous with existing developed areas, existing fire stations may be able to service the new home construction, albeit with longer response times. If these longer response times are not

acceptable, temporary fire stations then must be considered to meet the service demands in the interim until a fire station is constructed in the new community as part of an integrated civic facility. Operating and Capital budgets will have to be considered by City Council in approving future developments based on how the new development policy lays out emergency response service provision in new areas.

The period of construction also presents considerable risks. Framed buildings, with no cladding are very vulnerable to rapid fire spread. Developments often have street networks that are unfinished, making access for fire vehicles very difficult. Consideration for fire servicing during construction must be planned for.

f) Current Performance

The current Service Level Response Time Targets are not currently being met by the CFD. Mitigating factors include: road conditions, time of day, traffic congestion, weather conditions and distance travelled to an emergency scene. Emergency response to areas outside the downtown core tends to be longer given current station locations.

However, it is our opinion that current SLRTT times of seven and eleven minutes approved by City Council remain relevant today. Performance with respect to actual response time data for the ERF requires review by the City and the CFD as it significantly exceeds the eleven-minute target.

Suppression and Other Emergency Response

In 2016 the Calgary Fire Department met the SLRTT response time target for the arrival of the first in vehicle to fire suppression and other emergency incidents 84.5% of the time. The SLRTT benchmark was not achieved for fire suppression and all other emergency incidents.

However, the CFD response based on the SLRTT target has improved significantly over the past five years. The 90th percentile response time achieved in 2016 was seven minutes and thirty-nine seconds.

In 2016 the Calgary Fire Department met the NFPA 1710 response time target for the arrival of the first in vehicle to fire suppression and other emergency incidents 76.3% of the time.

In 2016 the Calgary Fire Department met the SLRTT time standard of 11 minutes for a full first alarm assignment (ERF) 76.5% of the time. In comparison, the Calgary Fire Department met the NFPA 1710 response time target for the arrival of the initial full alarm assignment on 66.8% of responses.

With respect to a full effective firefighting force of twelve firefighters, arriving in eleven minutes (11.0) to a high-risk incident is problematic. The CFD statistics in 2016 indicate the department did not meet the standard. In fact the CFD achieved the travel time in 13 minutes and eleven seconds (13:11). The CFD has improved response times over the past five years and achieved a benchmark of 76.3% based on 2016 SLRTT requirements. Assembling a full effective firefighting force is critical to effectively managing a fire scene and MUST be reviewed to reduce the response time for the health and safety of the residents and firefighters attending at the incident.

Reference detailed SLRTT performance data, provided by Calgary Fire, in the Appendix.

h) Calgary 911 Centre Performance

Note: Calgary Fire and the Calgary 911 Centre provided all response data contained within this report.

Alarm Handling

Calgary 911 is the Public Service Answering Point (PSAP) for emergency calls received through 911. Calgary 911 receives emergency calls from customers and dispatches emergency services in the city as well as to contracted agencies outside of the city. An Emergency Communications Officer (ECO) receives the initial emergency call of an incident and utilizes a predetermined set of questions to determine the appropriate level and type of emergency response for the incident, based on the information provided by the caller. Specific questions are asked utilizing the Emergency Fire Dispatch (EFD) system, which gives the Officer information about the emergency so they can send the call to a dispatcher to mobilize the required resources of the appropriate emergency service. The initial ECO stays on the line to provide the customer with pre-arrival and post-dispatch instructions.

With Calgary Fire, the call flow is seamless as the ECO answering the call from the customer at the PSAP is trained to evaluate calls for fire service. This means there is no transfer within Calgary 911 for fire calls to a secondary PSAP. The CFD is dispatched through a computer aided dispatch (CAD) system that determines the level of response, closest available resource/s using Automatic Vehicle Location, and notifies the appropriate fire station/apparatus closest to the incident for emergency response.

Calgary 911 utilizes the National Fire Protection Standard 1221 to report on their ability to meet the standard to the 90th percentile for emergency call handling. The title of the standard for emergency communications centres operations is "NFPA 1221 – Standard for the Installation, Maintenance, and Use of Emergency Service Communications Systems".

Highlighted in Appendix 2 is the status of some of Calgary 911's most important performance measures. Some performance measures may be indicated as on track although they are not meeting the current target. This is because employed strategies have been effective in improving performance and are anticipated to continue doing so. If performance plateaus or gets worse, that status will be changed to off track.

Calgary 911 triages the emergency call to determine if there is a need for a fire department response to a medical emergency. The time to triage the emergency call and determining the need for fire department response has been provided by Calgary 911 in the Appendix. The data provided for 2016 measures the time taken to dispatch the CFD to an emergency medical incident by Calgary 911. Based on the information received the benchmark has not been met at the 90% target in 64 seconds or the 95% target in 106 seconds.

Source: Calgary 911 Centre

Reference detailed alarm handling performance data, provided by the Calgary 911 Centre, in the Appendix.

4. Industry Scan

a) Other Cities

Canadian Fire Service Comparators

KCB's research has shown that comparator Canadian cities have variations to benchmarks against the NFPA 1710 Standard. The Standard is voluntary and as such, each municipality determines the level of risk tolerance based on the decision of City Council. The standard may be accepted as a target or goal to achieve compliance in the interest of public safety to the community. The municipalities may alter the standard, and/or set mandatory targets, as is the case in the City of Calgary. Comparator data is provided in section 7 – SLRTT Review.

There is not a mandatory requirement for fire departments to report response times on an annual basis. Based on the Internet search for Fire Department Annual Reports in Canada we noted that very few municipalities prepare and release response time data to the public. The decision to prepare and release the information is dependent on each municipality. Currently there is not a national reporting system in Canada to capture fire department data and reports at the national level. The Federal government continues to be lobbied by the Canadian Association of Fire Chiefs to establish a national reporting information system for the Canadian Fire Service.

The data provided in the various tables below represent response performance for several large urban cities across Canada as well as Chute and Travel times for nine Western Canada communities.

Table 9: 2016 Performance (min/sec.)

Total Response time from notification to the arrival of **1st truck** on scene		
City	NFPA Standard 6:24 to 90th percentile	% of Standard achieved
Edmonton	NA	85.3 *
Winnipeg	8:46 ****	NA
Vancouver	6:46	NA
Ottawa	7:39 **	NA
Toronto	7:03	83
Montreal	6:55 ***	84

Source: Annual Reports and by request to individual Fire Services.

* Edmonton provided their performance data as a percentage of targets achieved. Edmonton Fire and Rescue Services has an approved Council time standard based on 7 minutes for the first in vehicle and 11 minutes for a full ERF. Their standard is similar to NFPA 1710 as they measure their response time to the 90th percentile.

** Ottawa uses historical data to validate baselines for the Ottawa Fire Service Standards of Cover. The data provides a foundation for selected fire response benchmarks to the 90th percentile, which are in line with NFPA 1710.

***Montreal calculates response time to the previous edition of NFPA 1710. The former standard had a benchmark at 6:20 for the first in vehicle and 10:20 for a full ERF to be assembled on scene.

**** Winnipeg calculates from station notification to arrival on scene and is in line with NFPA 1710.

Table 10: 2016 Performance (min/sec.)

Total Response time from notification to arrival of the **full ERF**		
City	NFPA Standard 10:24 to 90th	% of Standard achieved
Edmonton	NA	81.7
Winnipeg	10:41	NA
Vancouver	NA	NA
Ottawa	11:03	NA
Toronto	10:47	87.72
Montreal	10:24	NA

Source: Annual Reports and by request to each Fire Department.

Table 11: Provides a comparison to Benchmarks for various cities across Canada

Actual 90th Percentile Fire Station Notification Response Time (Min./Sec.) Each Municipality has a different mix of vehicle types and staffing modes, reflecting its fire & community risks.			
City	2014	2015	2016
Calgary	6:44	7:05	6:52
Hamilton	6:55	6:52	6:52
London	6:03	5:59	6:08
Montreal	6:20	6:18	6:16
Regina	NA	NA	5:45
Sudbury	NA	NA	9:34
Thunder Bay	6:46	6:38	6:40
Toronto	6:38	6:34	6:28
Windsor	7:15	7:21	6:36
Winnipeg	6:55	6:51	6:57
Median	6:45	6:44	6:38

Source: 2016 MBN Canada Performance Measurement Report
FIRE405 (Customer Service)

Chute (Turnout) and Travel Response Time (min:sec) – Effectiveness

Table 12 below provides a comparison of response times from 2012 – 2014 for nine (9) Western Canadian Municipalities

This chart shows the time to respond to a residential fire emergency incident; illustrating the time from when a dispatch call is received to arrival of fire suppression personnel/equipment at the site of the incident. Municipalities are in order from lowest to highest time based on the average of 2012, 2013, 2014 results

Table12: Response Time Data

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Municipality	Year	Response Time (min:sec)	Fire Suppression Trucks (#)	Firefighters for First Response (#)
Airdrie	2012	5:08	1	4
	2013	5:38	1	4
	2014	5:43	1	4
Banff	2012	12:44	1	7
	2013	12:26	1	7
	2014	12:51	1	7
Canmore	2013	10:07	1	4
	2014	12:36	1	4
Cochrane	2012	6:21	1	4
	2013	7:56	1	4
	2014	8:41	1	4
Lethbridge	2012	7:56	1	3
	2013	7:22	1	3
	2014	8:39	1	3
Medicine Hat	2012	8:44	1	4
	2013	8:09	1	4
	2014	7:30	1	4
Okotoks	2012	8:30	1	4
	2013	7:48	1	4
	2014	7:12	1	4
Red Deer	2012	5:25	1	4
	2013	5:51	1	4
	2014	5:34	1	4
Wetaskiwin	2012	13:37	1	4
	2013	16:26	1	4
	2014	12:28	1	4

Source: Fire Services Report – Alberta Municipal Benchmarking Initiative (Dec. 2016)

Note:

Fire Suppression Guidelines are referenced in the NFPA 1710 Standard for the "Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments, 2016 edition". Underwriters Laboratories, National Institute of Standards and the National Fire Protection Association Standards and Guidelines have undertaken further industry best practice studies. The National Institute of Standards, an agency of the United States Federal Government conducted scientific validation studies. The NIST study referenced is a scientific document that has tested deployment to operational time and tasks undertaken by a fire crew based on crew size. This" Landmark Residential Fire Study Shows How Crew Sizes and Arrival Times Influence Saving Lives and Property" is provided for reference and is contained in the appendix of the report.

b) Fire Underwriter's Survey (Ref.14)

Fire Underwriters Survey

Fire Underwriters Survey (FUS) is a national organization that represents more than 90 percent of the private sector and casualty insurers in Canada. FUS provides data to program subscribers regarding public fire protection for fire insurance statistical and underwriting evaluation. The current Calgary FUS report on file was completed in 2009 and the previous study was completed in 1990. For example, should there be a decision to reduce the number of in-service fire companies or increase response times a study must be considered given the potential impact to insurance rate increases that may occur prior to moving forward with an implementation plan.

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Reference the Fire Underwriters Survey dated September 29th, 2009

The FUS report graded the City under the following headings:

Public Fire Protection Classification (PFPC)
- Class 2 for hydrant protected areas (HPA)
- Class 9 for non-hydrant protected areas

Dwelling Protection Grade (DWP)
- Grade 1 for hydrant protected areas (HPA)
- Grade 3B for non-hydrant protected areas

The Public Fire Protection Classification is based on a 1 – 10 scale with 1 being the highest, which rates the city fire protection service with respect to the capability to prevent and control major fires that could occur in multifamily residential, commercial, industrial and institutional buildings.

The Dwelling Protection Grade is a numerical system scaled from 1 to 5. One (1) is the highest grading possible and 5 indicates little or no recognized public fire protection. This grading reflects the ability of a community to handle fires in small buildings (e.g. single family dwellings).

The following information has been downloaded from the Fire Underwriters Survey, pertaining to the grading conducted in evaluating a municipality.

Fire Department (40% of overall PFPC Grade)

The Fire Department review contributes to approximately 40% of the overall PFPC Grade. Areas of Fire Department review include:
- Type and number of apparatus
- The condition and age of fire apparatus and fire suppression equipment
- Pumping capacity
- The type of staffing (i.e. career Firefighters vs. paid-on-call)
- The distribution of companies relative to fire risk
- Response to alarm protocols
- Management of emergency services
- The quality of training programs for the fire fighter including specialized training
- Pre-incident planning

Water Supply (30% of overall PFPC Grade)

The Water Supply review contributes to approximately 30% of the overall PFPC Grade.

An adequate and reliable water supply is an essential part of the firefighting facilities of a community or municipality. A water supply is considered to be adequate if it can deliver the Basic Fire Flow for the appropriate duration while simultaneously providing domestic water supply at the maximum day demand. If this delivery is possible under certain emergency or unusual conditions, the water supply is also considered to be reliable.

In most municipalities, due to structural conditions in some areas, the possibility exists that a combination of unfavourable factors, such as the delayed receipt of an alarm of

fire, high winds, or an explosion, will result in a fire becoming large enough to tax the ability of the fire service to confine the fire using the normally available water supply.

If, at the same time, the water supply is lacking or is considerably curtailed due to the failure of essential equipment (reliability); any fire, even if relatively small upon the arrival of the fire department, could rapidly expand and extend to adjoining buildings, becoming a conflagration. The FUS water supply criteria recognize the positive impact fire sprinklers have on a community and it provides for a reduction in fire flow in areas that are protected by fire sprinklers.

In order to provide reliability, duplication of some or all parts of a water supply system is important, the need for duplication being dependent upon the extent to which the various parts may reasonably be expected to be out of service as a result of maintenance and repair work, emergencies, or some unusual condition. The introduction of storage, either as part of the supply works or on the distribution system, may partially or completely offset the need for duplicating various parts of the system; the value of the storage depends upon its amount, location and availability.

Gravity Systems and Pumping Systems

Gravity systems delivering supply from the source directly to the community or municipality without the use of pumps is advantageous from a fire protection standpoint because of its reliability, but the reliability of a pumping system can be developed to such a high degree through redundancies and back-up power supplies that no distinction is made between the two types.

Storage

In general, storage reduces the requirements of those parts of the system through which supply has already passed. Since storage usually fluctuates, the total normal daily minimum maintained or 80 percent of capacity is the amount that is considered as available.

Pump Capacities

As part of the grading analysis of pumps for Fire Insurance Grading the capacities of pumps are de-rated by 25 percent to factor in age and reliability.

Fire Prevention and Fire Safety Control (20% of overall PFPC Grade)

The Fire Safety Control review contributes to approximately 20% of the overall PFPC Grade.

A substantial degree of safety to life and protection of property from fire should be provided by provincial and municipal control of hazards. Control can be best accomplished by the adoption and enforcement of appropriate codes and standards for manufacture, storage, and use of hazardous materials and for building construction, as well as through training, advisory and education programs for the public.

This grading item reviews the general fire prevention, inspection and investigation activities of the fire department. The official in charge of fire prevention activities, in cooperation with the Chief of the fire department, should establish an inspection procedure for correction of: obstructions to exits which interfere with emergency

egress or with fire department operations; inadequate or defective automatic or other fire alarm/fire extinguishing equipment; or conditions in buildings or other structures which create a severe life hazard potential. Provisions should be made for the investigation of fires.

The fire prevention program should include visiting and inspection of dwellings on an occupant voluntary basis and the continuous education of the public. The fire department should maintain a highly visible profile in enforcement, education, training, and advisory services.

While each community will have their own risks and reduction programs, prevention will be more and more viewed as a frontline service and not a support service.

Emergency Communications (10% of overall PFPC Grade)

The Emergency Communications review contributes to approximately 10% of the overall PFPC Grade.

Equipment for the receipt and transmission of alarms should be housed securely and be protected against fire or damage from other sources, including flooding, vandalism, and earthquakes. Emergency communication centres should be of non-combustible construction with one to three hour protections from exposures depending on complexity of the installation. Most importantly, there should be protection from ignition sources and rapid initial fire spread through control of such sources as flammable furnishings and building finish materials.

The above functions are measured against recognized standards of fire protection. Insurance ratings directly impact part of the cost borne by the taxpayers of Calgary for fire damage protection through insurance premium costs. The total costs associated for fire protection to individual taxpayers and building occupants represents the cost of the fire service portion of their municipal tax and insurance premium costs for fire.

There can be a direct impact by the factors considered in a FUS report and the ratings given to a municipality. The FUS Report prepared for the City of Calgary specifies the requirements to maintain a conditional grading

The current FUS report must be reviewed to ensure the sub headings identified have not been impacted by significant changes:

Pre Incident Planning

- Development of a Pre Incident Planning Program

Fire Risk Levels

- Major developments
- Annexations

Fire Protection Service Levels

- Staffing changes
- Fire Station Changes (closures, new stations etc.)
- Fire Apparatus Changes (number of in service fire companies)

In discussions with senior staff of OPTA Information Intelligence, formerly CGI Insurance, the current rating for Calgary applies based on the risk assessment completed in 2009. Should the city alter the current response of the CFD, or limit fire protection services, an updated review should be undertaken. The grading given by FUS has a direct impact on commercial and residential insurance premiums. The rates may increase dependent on a reduction of service considered by City Council impacting water supply or fire department services to a community.

We believe the Corporation should consider having an FUS conducted in consultation with senior administration staff and the Fire Chief prior to implementing any significant change to emergency response coverage for the City of Calgary.

5. Citizen and Industry Perspectives

a) Engagement results

Engagement Sessions:

Engagement sessions were scheduled and conducted with the assistance of the City of Calgary staff. Sessions were planned and scheduled with the following groups:

1. Developers and Builders
2. Calgary Water Services
3. Calgary Firefighters Association Local 255
4. Public (Insufficient Numbers of Public – Meetings Cancelled)
5. Calgary 911 Centre Staff
6. Calgary City Manager Jeff Fielding

The following subsections provide a summation of the discussions.

Developer/Builder Engagement Sessions

City of Calgary staff arranged two Developer/Builder sessions, which were conducted on Thursday, December 7th and Tuesday December 12th at the Calgary Municipal Building. KCB Associates Andy MacDonald, Sean Pearce, and Bill Stewart facilitated the meetings.

The meetings were established to seek input and dialogue on future development across the City. The meeting attendees were asked a number of questions to seek their input and insight and to generate discussion. The consultants documented the comments raised through the two scheduled sessions. City staff was in attendance at both sessions. Each session was approximately two hours in duration. Based on the responses received, it was agreed that the KCB draft report would be reviewed at future engagement sessions to be conducted in January 2018 by city staff in consultation with the builders and developers.

The following points have been documented from the Developer/Builder Engagement Sessions:

Developers

The Builders and Developer representatives were active participants in both sessions' discussions. Their interests generally focused on a number of specific topics.

There were a number of points raised regarding the response time criteria established by the City of Calgary and the Alberta Building Code. In particular, the Calgary Fire Department's Service Level Response Time Targets, with respect to new development and the potential development restrictions was discussed in detail. The participants wanted to know what types of responses required the strict targeted times and why that's so.

Much of the discussion centred on residential sprinklers and their ability to mitigate the need to meet the 7, 10 and 11-minute response criteria. The sprinkler discussion also explored the cost of installing residential sprinklers and the regulations related to the installation in Calgary residences.

The participants related the need for new development in Calgary, in their opinion, and expressed interest in working with the City to enable that to happen. There was extensive discussion on what needs to be done on their part.

Public

Public engagement sessions were scheduled but not held, due to the very low number of available participants and were cancelled by City staff. The information received through the developer sessions will be used to establish the recommendations contained in the final report to be tabled on January 21st, 2018.

Water Services Division

The KCB team met with Maggie Zhang, Project Lead for the Water Services Business Unit on Wednesday, December 6th to discuss the water main sizes and fire flows to support the use of residential fire sprinklers now and in future developments citywide.

Ms. Zhang identified that the City of Calgary uses the 1999 Fire Underwriters Survey (FUS) standards Water Supply for Public Fire Protection to calculate fire flows in both greenfield communities and infill construction. The FUS standard sets requirements for fire flows, water supply and all aspects of pumping station operation. The document also sets out requirements for record keeping and inspection. The document states *"The Protection of buildings by automatic sprinklers is a significant contribution to the fire protection of the community and should be encouraged, not penalized by onerous service charges or metering requirements".* Further, the document provides a guide for calculating water supply that states, *"the value obtained in No. 2 above may be reduced by up to 50% for complete automatic sprinkler protection depending on the adequacy of the system".*

This reference confirms Ms. Zhang's comment that reductions in pipe sizes are available to communities with fire sprinklers, however the City of Calgary increases the required pipe size by one size to help provide water for potential future development. The decreased pipe size also has a positive impact on water treatment costs and helps to reduce turbidity.

We also discussed the potential of using residential sprinklers for infill housing projects. Ms. Zhang stated that sprinklering these projects could help to reduce the water supply issues for infill construction. Based on the current water main sizes, residential fire sprinklers are supported for use by the Water Services Business Unit. The largest benefit would come if all buildings were sprinklered, as the pipe size reduction could then be applied to all structures and not one specific occupancy type, eliminating the possibility of a different occupancy driving pipe size increases. Ms. Zhang supported the 2009 Council motion for residential fire sprinklers, as it would reduce water supply demands for the city and as a result decrease water supply costs. Ms. Zhang noted that there is a potential for increased costs for larger water meters to accommodate increased fire flows for fire sprinkler protected buildings.

IAFF (International Association of Firefighters) Local 255

KCB Associates Bill Stewart and Sean Pearce met with IAFF Local 255 President Mike Carter and Vice President Mike Henson of the Calgary Firefighters Association on Wednesday, December 6th 2017 at the Firefighters Association office. Bill Stewart provided an overview of the scope of work being undertaken and confirmed the review did not include staffing or fire station locations. The review of SLRTT, response time and the future use of residential sprinklers are the focus and mandate of the KCB report for the CFD. He further stated the CFD current response time would be benchmarked against NFPA 1710 as a comparator.

The President of the Association stressed that residential fire sprinklers were in fact supplemental to an effective fire department response. He was supportive of residential sprinklers from a public and firefighter life safety perspective but stated that sprinklers do not replace fire department response.

The proposed South Shepard project was also briefly discussed, as the Association had been present at the July 31, 2017 Council meeting and witnessed the debate and information presented to members of Council. Reference was also made to the former growth management overlay policy.

The Association also stated they were not aware of the Livingston project details. Sean provided an overview of the project development.

The Association President also commented on the Standata and the ABC 10-Minute response time clause versus the fire SLRTT response time. He also commented on response time in relation to medical calls. CFD fire crews also discussed the AHS 12 minute response time standard, in relation to medical response performance.

Calgary 911 Centre Staff

The meeting on December 12th was held with the Acting Commander of Calgary 911 and his senior staff. Assistant Deputy Chief Tyler Pelke attended the meeting, representing the CFD. The meeting was informative regarding the call handling process and dispatch protocols for all emergency calls in the city. Calgary 911 utilizes NFPA 1221 as their target measurement for emergency calls handled within the center.

The 911 Centre staff expressed their commitment to providing excellent service to Calgary Fire, referring to Fire as their partner.

During our discussions the KCB team noted that not all benchmarks for NFPA 1710 were being captured for CFD statistical reporting purposes. Further, the Pre Alert to a fire station provides limited information for the response of the CFD based on the call they are responding to. Presently there is not a service level agreement in place between Calgary 911 and the CFD, which will form a recommendation in this report.

Calgary 911 also provides emergency communications and call handling for other municipalities under contract.

City Manager Jeff Fielding

KCB Associates, Sean Pearce, Andy MacDonald and Bill Stewart met with the City Manager on Tuesday, December 12th for half an hour. The City Manager provided an overview of the current financial impacts to the economy and the past economic drivers related to the oil and gas industry in past city developments undertaken by the City. Given the current fiscal climate, the City is not in a position to fund operating expenses for various city projects at this time. From the capital perspective the city is in a positive cash position. Our discussions focused on future development, as the City requires the developments to move forward. The Calgary economy is dependent on future development, citywide.

b) Citizen Surveys

Public Perception of the CFD

The City of Calgary is proactive in polling the citizens on the level of service provided by all divisions of the Corporation. The 2017 Citizens Expectations and Perceptions Study was reviewed by KCB to understand the perception of the citizens, in response to the survey, with a focus on the Calgary Fire Department. Leger The Research Intelligence Group conducted the survey from November 28 to December 20, 2017. Staff from Leger polled 502 residents city wide using a predetermined set of questions based on the city service being reviewed.

The final report findings provided an overview of the city services and the satisfaction by the residents for the services delivered. The following are the key headings referenced in the report for the Calgary Fire Department:

I. Desired Investment in Fire Department
II. Reasonable Time for Fire Department to Respond
III. Importance of Responding to Medical Incidents
IV. Residential Fire Sprinklers
V. Awareness of Relationship between Insurance Rates and Fire Suppression Performance
VI. Support of Mandatory Fire Sprinklers

In each of the headings the survey respondents rated the Calgary Fire Department. The rating for the "Desired Investment in Fire Department" achieved a rating of 52%, to invest more in the Fire Department, 41% to remain the same, 1% stated less and 5% did not know.

Under the heading of "Reasonable Time for Fire Department to Respond" the average time identified was 7.6 minutes to an emergency. The study also queried the reasonable time to respond to a scene of an emergency for a community with automatic fire sprinklers. The study identified an average response time of 8.5 minutes. The majority expect a response within 10 minutes.

The "Importance of Responding to Medical Incidents" was rated at 92% by the citizens for the continued response by the CFD. Further, 70% of Calgarians stated it was very important.

Under the heading Residential Fire Sprinklers, 74% of the citizens will ask about installing residential sprinklers the next time they build a new home or renovate.

Support of Mandatory Fire Sprinklers received a rating of 58% for all new homes being constructed.

Under the heading of General Opinions about the Calgary Fire Department Trends over time, the following key points are noted:

97% of Calgarians are comfortable knowing the CFD is there when needed.

95% of respondents believe the city is safer because of the quality of service provided by the CFD.

94% of respondents stated the CFD should be resourced to keep pace with developments and growth of the city now and in the future.

91% believed the CFD should be involved early in the community planning process.

91% believe the CFD should assist surrounding municipalities if they need assistance providing the needs of Calgary are met first.

75% of respondents believed a fire station should be built in a community prior to any major development surrounding it to ensure fire protection of new home construction as well as future residents. The survey results were 74% in 2014 and 2015. The 2017 survey rating was 75% indicating support for the construction of new fire stations for future developments in the City.

The survey also noted under the heading Overall Measures Fire Department Trends over time:

I. "Importance to Quality of Life" received a rating of 98%
II. "Perceived Quality 92%
III. "Perceived Value" 86%

The 2017 survey clearly indicates the satisfaction the residents have for the work undertaken by the Calgary Fire Department and the services provided to the citizens of Calgary. The CFD is an all hazards response service that is respected by the citizens in response to their emergency service requirements citywide. There is also a clear understanding by the citizens in supporting future growth of the CFD based on new developments to protect the future residents.

The following table is contained in the 2017 Citizen Expectations and Perceptions Survey conducted by Leger.

Source: 2017 Leger Citizen Expectations and Perceptions

6. Proposed Options for Future State

a) Residential Sprinklers

Residential fire sprinklers are defined as being installed to either NFPA 13D or NFPA 13R (Ref. 15) standards. The need for these standards was realised in 1973 with the release of the report "America Burning". That same month NFPA appointed a subcommittee-committee to develop the NFPA 13D standard, Installation of Sprinkler Systems in One and Two Family Dwellings and Manufactured Homes. The focus of the standard was on life safety rather than property protection; however, property preservation has been extensively realized through the use of this standard. Over the years many new developments and studies have been done on the value of residential fire sprinklers. They have been proven to save lives and prevent injuries in occupants and first responders. Letters of support for residential sprinklers from the Canadian Association of Fire Chiefs, International Association of Fire Chiefs and Metropolitan Fire Chiefs Association are provided in Appendix 6 (Ref.16)

Much of the technology advancements have come in the last 10 years with manufacturers investing time and money into creating fire sprinkler heads specifically for the residential market. These heads operate faster than traditional heads, have a bigger coverage area and tend to operate at lower pressures. Each of these advancements has improved the life safety benefits of residential fire sprinklers and in turn the property preservation of the dwelling that have them installed. They have also made the installation of residential fire sprinklers more affordable.

Currently, the Livingston community in Calgary is North America's first ground-up fully sprinklered community. The cost of installing a fire sprinkler varies from less than 1% of the cost of a home to 1.5%. In each case the standard is applied slightly differently. Both NFPA 13D and NFPA 13R have certain allowances for areas of a residence where research has dictated that fewer fires begin. In Alberta, these reductions have been removed for the NFPA 13R standard but the reduced design requirement is still available.

In 2010 Dr. John Hall of NFPA conducted a comprehensive study into the effectiveness of fire sprinklers. Dr. Hall found that sprinklers activated in 91% of all reported structure fires large enough to activate sprinklers. When the sprinklers operate, they were found to be effective 96% of the time. The leading cause for sprinkler failure from the report was the water being shut off before the fire began.

It is essential to note that in Calgary, to reduce the probability of fire sprinkler shutdown prior to a fire, the residential fire sprinkler systems being installed in the Livingston Community are using a passive purge system. This system connects the fire sprinkler system to a single potable water outlet. In this case it is the master en-suite toilet. The system also does not have a control valve on the fire protection side

of the system. The only way to shut off the water to the sprinklers is to shut off water to the entire home. The domestic water supply has an isolation valve and it can be shut off, effectively isolating the domestic water only.

Understanding that fire sprinklers have a limited mechanical failure history is only part of the equation. Factory Mutual (FM) conducted a series of tests in 2010. The results were recorded in a report called "The Environmental Impact of Automatic Fire Sprinklers". The tests were conducted at FM Global's research facility using modern furnished rooms for each test. The research facility had the ability to capture and analyze 123 species of air emissions, water usage and water toxicity. These tests concluded that the use of automatic fire sprinklers reduced emissions by 97.8%. It was also noted that a combined fire sprinkler discharge and firefighting hose stream application was 50% less than in the non-sprinklered test. The research then expanded these results and extrapolated that in a full-size home a 91% reduction in total water consumption could be realized in case of a fire. Due to the early intervention of fire sprinklers, it was noted that less fire damage occurred. This factor contributed to the fact that in the sprinklered test runoff water showed fewer persistent pollutants, such as heavy metals and fewer solids, due to less material being burned.

The next component of the equation is the actual effectiveness of fire sprinklers in a residential home. In 2008, Canada's National Research Council began conducting a series of tests to examine the Fire Performance of Houses.

Phase 1 was the Study of Unprotected Floor Assemblies in Basement Fire Scenarios. These were full-scale fire tests designed to examine various construction types and the impact on occupant safety, as well as the ability of occupants to escape a fire in each situation. If results were extrapolated, a determination for first responder safety and acceptable response time to an incident could be developed.

The same fuel package was used in all but one test in Phase 2 and the fire was always a basement fire situation. The tests produced results in occupant tenability on the first and second floors, including time to incapacitation. In these tests it was found that the average time to incapacitation on the second floor was 224 seconds, (3:44). The type of construction had little impact on this number. The average time to incapacitation on the first floor was 201 seconds, (3:21). Time to structural collapse varied by construction type and ranged from 325 seconds (3:45) to 740 seconds (12:20) for solid wood joists.

The results clearly demonstrated that response times needs to be in the 180 sec. (3:00) to 200 sec. (3:20) range for a first responder to have a lifesaving impact. Noting that in the tests, the time of ignition is easily measured, and therefore it is simple to determine how long the fire has been burning. However, in real life scenarios, it is almost impossible to determine time of ignition. As it relates to first responder safety, any response time after 382 seconds (4:22) is potentially life threatening and the exposure to various products of combustion might increase one's potential exposure to other toxins.

Phase 1B of this study tested the same structure assemblies in the identical way with the addition of a residential fire sprinkler system. Using the same fire load and the same assembly types, the addition of a residential fire sprinkler system eliminated visual obscurity, loss of tenability on any floor and structural collapse. In these tests, the complete lack of damage to the assembly from the fire allowed for the same assembly to be used for multiple tests, including tests where the fire sprinkler head

was moved to a more remote location from the fire load. In each case the results were the same and ultimately the same assembly was used for other tests.

Understanding that residential fire sprinklers dramatically interrupt the science of fire growth correlates with historical data from areas that have used residential fire sprinklers for a period of time. The Bucks County report from Pennsylvania reviewed six municipalities in the region and found that 88% of all fire deaths occurred in a residential setting. Over the period used for the report, 90 people perished as a result of residential fires in un-sprinklered dwellings and 0 people died in sprinklered dwellings. The average cost for repair to un-sprinklered dwellings was $179,896 per unit and the average cost for repair in a sprinklered dwelling was $14,000. Water consumption to extinguish a fire in an un-sprinklered dwelling was 5974 gallons and in the sprinklered dwelling it was 340 gallons.

In February of 2014, Fraser Valley University in British Columbia conducted a similar but more detailed examination of fires by construction type in B.C., titled: Fire Outcomes by General Construction Type. This report examined fires in B.C. from 2008 through to 2013. The results again align with the NRC research results and showed that, in 2241 fires without sprinklers, 772 people were injured and 107 perished, in 112 fires with sprinklers 60 people were injured and 0 perished.

In 2010 UL released data from their research on Understanding Fire Behaviour in Residential Structures. This report reviewed multiple tests designed to examine firefighter safety as it relates to modern fire growth. UL conducted several full-scale tests and room tests. The room tests examined the impact modern furnishings have on a fire load verses furniture from approximately 25 years ago. These tests showed that flashover in buildings with modern furniture occurred in 4 minutes as compared to 29 minutes for the rooms with legacy furniture. This research tends to show that contents rather than construction, is the leading cause for the rapid-fire growth we are experiencing today.

The full-scale tests examined firefighter loss of tenability. It showed that within 8 to 10 minutes after ignition, firefighters had 100 (1:40) to 200 (3:20) seconds to apply water to a fire or they would have to leave the structure due to a loss of tenability. These times align very closely with the NRC findings from Fire Performance of Houses. It is important to note that in both of these tests the clock started from time of ignition and did not include an allowance for time of call, dispatch, response and turnout time. If these factors were included in a response model, a modern fire service would have to be on scene within 4 minutes from time of ignition, which could easily be the time it takes for a witness to make the call to 911, and would not consider dispatch, response and turnout time.

In the study "Sprinkler Systems and Residential Structure Fires Exploring the Impact of Sprinklers for Life Safety and Fire Spread"which was conducted by Fraser Valley University, they reviewed fire losses, deaths and resources used in fires over 5 years. They found similar fire loss, injury and mortality rates as the above referenced research, but they also looked at fire department resources used at both fires with sprinklers and those without. Fire service resources and intervention was required 2.9 times more often for a fire in an un-sprinklered dwelling. It was also required to a greater extent. In dwellings with sprinklers, the fire was confined to the room of origin in 96.7% of the fires and no fire in a sprinklered building ever extended beyond the building of origin. In dwellings without fire sprinklers, a large fire services attack force was required to fight the fire using multiple hose streams 5.7 times more often.

The FUS rating for water services used by the City of Calgary allows for a reduction in main size where areas are fully protected by fire sprinklers. This allows for a reduction in cost while not impacting fire safety. FUS appears to recognize the impact that fire sprinklers have on fires and has reduced fire flows in these communities.

The results of all of the research and reporting has shown clearly that residential fire sprinklers all but eliminate fire deaths in residential occupancies and dramatically reduce injuries to both civilians and first responders. In several Canadian municipalities, the use of residential sprinklers as a temporary alternative to meeting target fire services response time has been accepted. It should be noted that the solution in Livingston in Calgary is the best model as it incorporates fire sprinklers in all structures, not just residential dwellings. This provides a broader level of protection to the entire area. Fire service and water resources are far less taxed in communities that are fully protected by fire sprinklers.

Toronto's Sunnybrook hospital is currently conducting a study into the cost benefit of fire sprinklers to the healthcare system. Phase 2 was released and showed that *"the economic burden of premature mortality due to burn injuries in Canada was estimated to be $290 million annually"*. The study looked at a time frame from January 1998 to March 2012 in Ontario. It also calculated that over this time frame more than 23,000 years of potential life were lost and the statistical cost of these lives lost in Canadian dollars is $7,598,500,000. This study was conducted by the Hospital in conjunction with the University of Toronto and was subject to all of the rigors that come with the generation of a report from this facility.

Understanding that fire sprinklers decrease fire load and control the development of combustion products is clear. The fact that they have an effective impact on firefighter safety both during a response and after, when the true effects of exposure are most dangerous, is also very clear. Many provinces have acknowledged that exposure is the leading cause of fire fighter job related cancers. If fire sprinklers reduce the exposure and increase workplace safety; than it can be assumed that job related illness and injuries will be reduced.

This point is confirmed by the Scottsdale Arizona report and many more like it where an examination of fires in dwellings with fire sprinklers showed that of the 109 fires that had occurred in sprinklered buildings in Scottsdale, 44 were residential fires. In over 90 percent of the incidents, the fire was controlled with one or two sprinklers activated. The average amount of water flowed by the sprinklers was 299 gallons per fire versus an estimated manual suppression usage of approximately 6000 gallons per fire.

We have developed the following analysis of the costs and benefits of residential sprinklers in a new community, without a fire station, versus the costs and benefits of a fire station in a new community without residential sprinklers.

i. Real Cost Savings: The average cost for post-fire water damage repair to un-sprinklered dwellings was $179,896 per unit and the average cost for repair in a sprinklered dwelling was $14,000.

i. Limit of Fire Spread: In dwellings with sprinklers, the fire was confined to the room of origin in 96.7% of the fires and no fire in a sprinklered building ever

extended beyond the building of origin, according to our research. They have a positive impact preventing flashovers, resulting in lower property damage

ii. Infrastructure Cost Savings: The FUS rating for water services used by the City of Calgary allows for a reduction in main size where areas are fully protected by fire sprinklers. This allows for a reduction in cost for The City, while not impacting fire safety.

ii. Life safety Risk Reduction: In 2241 fires without sprinklers 772 people were injured and 107 perished, in 112 fires with sprinklers 60 people were injured and 0 perished. (Reference Buck County report in section 12 of this report and 2014 Fraser Valley University report) There has not been an accidental fatality in a home where fire sprinklers have been present

iii. Fire Fighter Safety: In sprinklered homes firefighter tenability is greatly increased, because of the decrease in smoke and production of toxic fire by-products, improving the overall safety of an emergency scene. Increased workplace safety will lead to a reduction in job related illness and injuries.

iii. Reduced environmental impact. The use of automatic fire sprinklers reduced emissions from the products of combustion and runoff by 97.8%. (Ref. Factory Mutual Tests). The reduction of emissions decreases the air toxicity in the area of the fire and the level of contamination in the firefighting runoff.

iv. Sprinklers will satisfy the requirements of the Alberta Building Code where the 10-minute response time cannot be met.

iv. Sprinklers will mitigate some of the risks associated with delays in amassing an Effective Firefighting Force that are caused by restricted access from existing serviced areas. The access may be compromised because of incomplete road networks in new developing areas or the fact they are cut off by existing roads. e.g. South Shepard and Stoney Trail.

v. The addition of fire sprinklers increases resident safety by providing them added time to escape from fires in their homes.

vi. Property preservation has been extensively realized through the use of the NFPA 13D standard

vii. The cost of installing fire sprinkler varies from less than 1% of the cost of a home to 1.5%. In Livingston's case the cost to install a sprinkler system ranged from $3000 - $4000 per dwelling.

viii. When sprinklers operate, they are found to be effective 96% of the time. (The leading cause for sprinkler failure was the water being shut off before the fire began). (ref. Factory Mutual Tests)

ix. The combined fire sprinkler discharge and firefighting hose stream application was 50% less than in the non-sprinklered test, with a potential reduction of 91% in total water consumption (ref. Factory Mutual Tests)

c) Alternative Solutions:

KCB Consulting Final Report

The concept of residential fire sprinklers being used as a means to a delay fire department response has been examined in the past. The Canadian Mortgage and Housing Corporation (CMHC) completed a research report in 1998 on the topic. It examined six potential high greenfield growth communities in Canada; Pitt Meadows, BC, Edmonton Alberta, Kawacatoose First Nations, Saskatchewan, Burlington, Ontario, Barrie, Ontario and Gatineau, Quebec. The scope was defined was to examine the cost of residential fire sprinklers and estimate the impact mandatory sprinklers would have on the cost of providing municipal fire protection.

This project was completed in conjunction with a parallel study on the impact on risk that potential changes in the level and types of municipal fire protection services, which might result from the introduction of mandatory sprinklers. This study was limited in scope but did come to the conclusion that for a single family home "*the risk to life is significantly reduced by the use of sprinklers and is not increased by longer fire department response times*". It is important to note that in the past much research has been done on residential fire sprinklers but in reality all structures must be sprinklered or you negate the potential municipal reductions.

The study has several unidentified gaps that could be examined in today's market. These gaps significantly inflated the cost of sprinklering and Alberta now has Livingston, in Calgary as an example of true costs. The industry standard for average home lifespan is forty years, not thirty years as calculated in the study. This is the first gap. The second cost gap was the identification that there are increased home maintenance costs for the sprinkler system. This in fact is not the case. NFPA 13D has no inspection test requirements for sprinklers installed to this standard.

The systems being installed in Livingston represent a passive purge system. In this case the system is connected to a single toilet in the home, normally in the ensuite bathroom. Each time that toilet is used, water is moved through the system, in effect purging the system, testing the back flow preventer and ensuring that water is in the fire protection piping. There is no additional cost for this system. In fact it represents approximately a $400.00 savings from standalone type systems. This version also negated the need for annual backflow inspections and reduces the impact on the municipal government for inspections.

Additionally the average cost to sprinkler a home was calculated using $1.70 dollars per square foot. This is not accurate and not a fair method of calculation as sprinkler design is not based on square footage but actual home design and obstructions. Livingston represents a similar cost per square foot but it is almost impossible to create a fair average price as the designs differ from model to model. The cost for sprinklering at Livingston currently represents less than 1% of the cost of the home.

The last unidentified gap is the insurance savings. The study used a 5% average reduction. Today many insurance companies have identified savings in the average range of 10%.

The study also identified five additional gaps: health care costs, lost time for first responders as a result of fire ground injuries, reduction in claims time, water damage, reduction in deaths and injuries. Each of these gaps can now be quantified using new research.
The last component, and arguably the most important, has been recently dissected by Sunnybrook Hospital and the University of Toronto. They examined cost related to fire injuries and deaths, on a much deeper scale than ever before. This research included

following victims to the hospital from the fire scene and tracking actual fire deaths, including those post-transport. These numbers have been otherwise unknown and inflate the annual death rate in Canada due to fire over the study period. It also looks at the true financial health care costs from burn patients and calculated a number for loss of time. It would be advisable that this research be used in the potential review of this report for Calgary's own purposes. The study also recognizes the potential for increased medical response time and the potential impact that would have on provincial ambulance and paramedical services.

The City of Edmonton is the closest municipality to Calgary that was represented in this study. It was determined, using the criteria from the study that over a 30-year period, that Edmonton could reduce their fire services growth by six stations, related staff, vehicles and equipment. It is important to note that this did not take into consideration other response types. It can be assumed that the criteria could be expanded and other models could be implemented based on this base research. The premise of this research could be used specifically in Calgary to help identify risks and gaps.

Another area that should be examined in Calgary going forward, in conjunction with the Province is the concept of building code changes to include fire sprinklers. The recognition of the positive impact fire sprinklers provide from every study conducted in Canada should be a consideration.

The position of one in one out for building code change could be difficult to achieve but the ability to logically identify areas were fire sprinklers provide alternative solutions to existing building code requirements is important to the overall development of building code. For example, the International Code Council (ICC) in the US identifies fire sprinklers as providing a two-hour fire separation where an existing wall is built to the building code standards.

Examination of the ABC and the adoption of fire sprinkler specific requirements as alternative solutions could provide both developers and builders with a cost benefit that make fire sprinklers cost neutral. This would create broader adoption and generate water supply savings for the municipality. This concept should be expanded upon and using the skills of the various building code, safety code and fire officials in Alberta. The use of alternative solutions to achieve this is an interim solution but not a practical long term one.

c) Mutual Aid agreements

Mutual Aid Response

In emergency services, mutual aid is an agreement among emergency response agencies to lend assistance across municipal and jurisdictional boundaries. This may occur due to an emergency response that exceeds the capability of local resources, such as a large fire or disaster.

Mutual aid, by definition, is not meant to provide primary response in a neighboring municipality where services are non-existent. Mutual aid agreements are typically reciprocal and no fee arrangements are attached.
The City of Calgary (The City) is bounded on its West, North and East borders by Rocky View County (The County) and on the South by the Municipal District of Foothills No.

31. The City of Calgary does not have a formal, written mutual aid agreement with either neighboring municipality.

The City of Calgary does have a formal service agreement with the Rocky View County Fire Service in the form of the Secondary Emergency Response Fire Services Agreement (The Agreement), effective October 1, 2016. The Agreement clearly stipulates the terms under which each fire service responds to the other's response area and all matters are addressed, including a detailed fee structure. While The Agreement is reciprocal, in the sense that it does acknowledge that on occasion The City may request assistance from The County, it appears to be written primarily for the benefit of The County.

The County's response into The City under this agreement would not be sufficient to effectively contribute to The City's first-in emergency response or ERF needs and/or requirements.

d) Impact to FUS and Public/Property Safety Risk from Proposed Options

A reduction in overall response time performance, due to increased response times in growth areas that do not meet the SLRTT requirements, will potentially lead to a lower Fire Underwriters Survey rating. A lower rating may lead to higher residential, commercial and industrial property insurance rates.

The installation of sprinklers may lead to a reduction in insurance rates for property owners. The current industry annual reduction in insurance rates is typically between 5 and 10%.

Predictive Modeling/Dynamic Staging

The City of Calgary has been proactive by supporting, through the previous zero based review, the adoption of predictive modelling software in Calgary Fire. The predictive modelling software has been installed and is now operational for the city. Extensive testing of the system was completed prior launching the Deccan application by Calgary Fire Department and the vendor. The application will use historical call data to determine the potential for an emergency call across the city.

Predictive modelling will assist the department in determining a) optimal distribution of resources on the demand for service, b) future station locations, c) type of fire apparatus to be deployed, and, d) potential fire target areas. In the future, Calgary 911 in consultation with Calgary Fire will be implementing an additional software package, Move Up Module, to enhance the existing dynamic deployment of resources. It is anticipated that this software is expected to be implemented in 2019.

7. Detailed Recommendations

Growth does not pay for itself where it occurs in most Canadian municipalities. New development can be a costly exercise, and that cost can come in many forms.

With respect to the provision of emergency services, growth poses particular problems because provision of services typically cannot be delayed until the development reaches a point where the new tax base will support the service. For the purpose of

this report the discussion has, and will, focus on the emergency response service provided by the Calgary Fire Department in the City of Calgary.

New greenfield development proposed for areas that fall outside of the existing residential development area with few exceptions also fall outside of the current 7-minute response areas for emergency response in Calgary. In some cases the proposed development also falls outside of the Alberta Building Code (ABC) 10-minute threshold where additional design and development considerations need to be taken into account to mitigate the risk of having firefighters more than 10 minutes away.

Building and staffing new Fire facilities in developing areas which are able to respond to emergencies within the times laid out in the current SLRTT before allowing a citizen tax base to develop in that area is very expensive for developers and the City, who are respectively responsible for capital costs of building a new station and the operating costs of staffing a new station. Conversely, waiting until the homes are built so that a tax base can be established to cover the cost of building and staffing a new fire station puts the lives and property of the new inhabitants at risk during that waiting period. In some cases, that may take years and create a high level of risk.

One possible solution to this issue is to build and staff a station at a point after the first home goes into the ground and when enough homes are occupied to achieve financial stability. While that may seem like a reasonable compromise, the question becomes, when? Is the timing dependent on number of homes occupied, or the amount of time that has passed? How do we acknowledge the additional risk to residents created by this approach and how can we mitigate as much of that risk as possible? Variables such as the pace of development can grossly impact that decision.

Another complicating factor to consider is the proximity of the new growth to existing Fire resources. While one new strategically located station in a new area of growth will aid in meeting the current 7-minute first unit response target, meeting ERF requires a number of crews from different stations to respond. The response times from those stations to ensure effective response to fires are an important consideration when designing the growth pattern within the new development. The arrival of those secondary crews is essential for the safety of citizens as well as the first-in crew.

Other options include mitigation efforts provided for in the Alberta Building Code; one of which is residential sprinklers. Sprinklers will allow ABC requirements to be satisfied. They will provide protection for the residents of the new development, allowing them to escape safely from their homes. Sprinklers will also provide a safer working environment for the first responding firefighters. However, they have limited ability to mitigate the spread of fire between closely spaced homes in an exterior fire situation. They will also not reduce the need for meeting the 7-minute response time target for other life-threatening emergencies.

In some jurisdictions, mutual aid from neighbouring Fire services can provide secondary response assistance in newly developed areas. In Calgary's case there are no Mutual Aid agreements in place with neighbouring municipalities so it is not possible at this time to qualify their level of response, and/or aid.

Unfortunately, in Calgary's case, there is no risk-free solution, other than not approving new development. If new development is going to be approved, the risks need to be identified as they have been in this report. They then need to be mitigated in a fashion, and at a cost, that Council is willing to accept.

Approving development in areas that fall outside of the 7-minute SLRTT response target without the provision of fire protection in the form of a staffed Fire facility, at some point in the development, is not recommended. It is recommended that development only be approved in areas that have been identified as those slated for a fire station in the future. Also it is recommended that any growth outside of the 7-minute SLRTT response target should be contiguous with areas of the city with existing fire service.

However, notwithstanding our recommendation in the previous paragraph, should approvals be given for developments that fall outside of the 7-minute target, the risk-mitigation efforts that may be implemented under these circumstances must be very site specific. The variables will depend on actual response time projections, geography, proposed road networks, potential call volumes, call type predictability and distance to existing Fire facilities. With each development proposal, the City of Calgary will have to weigh the risks and balance that against the mitigation potential of sprinklers and capital and operating budgets. Therefore, there is no trigger point that can be set for all future development that falls outside of the SLRTT response times.

The City of Calgary has a great opportunity to move forward with future growth, citywide. The issue is to ensure an updated development policy is presented to City Council in 2018 for consideration. The safety of the residents of Calgary is paramount in drafting the new policy. The policy must meet the fiscal needs of the corporation, while mitigating risks to its citizens, while aligning with the approval process for future development applications.

Summary:

1. The City should not amend the citywide first-response target time requirements in the SLRTT in any way that would expand the current response time target in existing serviced areas.
2. Encourage growth in areas currently serviced by Calgary Fire that already meet the response time requirements of the SLRTT.
3. Development in presently un-serviced areas must be contiguous with areas presently serviced by Calgary Fire.
4. New development must only be permitted in areas where future Fire Department servicing is planned.
5. When approving growth in an area where the SLRTT cannot be met, establish firm points that trigger new, staffed fire stations. The trigger points will be area specific and will be based on number of factors such as occupied buildings (tax base), road networks in place, availability of fire response from adjacent areas and distribution and concentration of buildings.
6. Sprinklers must be required in all buildings, not just homes, which fall outside of a 10-minute first response time.
7. The pace of growth within new areas should be considered prior to issuing approvals for development. A rapidly growing area will acquire the tax base necessary to support emergency services more quickly.
8. Distribution of growth should be considered when issuing permits. Concentrated growth is easier to service than growth allowed to progress in a "patchwork" fashion.
9. The City of Calgary may wish to propose an amendment to the Alberta Building Code to mandate residential sprinklers for all new construction for developments where fire department response time is less than 10 minutes.

10. The City should encourage builders and developers in growth areas, where response times fall between the SLRTT and the 10-minute threshold covered under the ABC, to install sprinklers in all buildings.
11. The City should undergo a new Fire Underwriters Survey. Any potential costs to the residents and businesses as a result of amending the SLRTT in growth areas, in the form of increased insurance premiums, will be identified in the resultant report.
12. The Calgary Fire Department and the City of Calgary 911 Centre must enter into a service level agreement to ensure all time benchmarks are accurately captured for the Calgary Fire Department.
13. The current SLRTT call handling time should be increased from 60 seconds to 64 seconds.

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8. Appendices:

Appendix 1

Flashover

The potential for flashover in a structure fire has increased significantly in the past fifty years. Scientific experiments conducted by Underwriters Laboratories in the United States have confirmed the timeline to flashover in modern homes has been reduced to less than five minutes. NFPA states flashover can occur within 8- 10 minutes. It must be noted that time to flashover varies, depending on the contents of the building and other factors. The fact that flashover may now occur prior to fire service response does not reduce the need for rapid intervention, as post flashover conditions will rapidly lead to fire spreading within the involved structure as well as to adjacent structures with associated risk to occupants of those structures.

The following information is reproduced as flashover and response time of the fire department are clearly linked for fire ground operations, search and rescue and limiting property loss.

Modern Residential Fires

UL determined that fires today are more dangerous and pose more risks than in the past. Fire propagation is faster, and time to flashover, escape times and collapse times are all shorter.

CONTEXT

UL's research scientists and engineers have conducted a number of innovative tests and evaluated their results, and have identified that the modern home fire is a "perfect storm" of conditions and outcomes: larger homes + open house geometries + increased fuel loads + new construction materials = faster fire propagation, shorter time to flashover, rapid changes in fire dynamics, shorter escape times and shorter structural collapse times.

WHAT DID UL DO?

UL has conducted hundreds of analytical studies to understand individual aspects of home fires over the years. In 2012 UL brought its cumulative insights together in a

series of unique tests to advance the science of residential fires. In order to understand the full implications of modern home fires, UL scientists conducted a series of experiments that took into account key changes to the modern home. These changes cover differences in the size and geometry of modern homes as well as the furnishings and construction materials used.

In the experiments, three modern home configurations were tested against three "legacy" configurations, defined as having furnishings from the mid-20th century and building materials from between 1950 and 1970. The tests showed a consistency of results among the three modern rooms and the three legacy rooms that we examined. All of the modern rooms transitioned to flashover — flashover occurs when the majority of exposed surfaces in a space are heated to their auto-ignition temperature and emit flammable gases — in less than five minutes, while the fastest legacy room to achieve flashover did so in just over 29 minutes. In the three sets of experiments, legacy-furnished rooms took at least 700 percent longer to reach flashover.[1]

The experiments revealed that the natural materials in the legacy rooms released energy more slowly than did the fast-burning, synthetic-furnished modern rooms, which leaves significantly less time for occupants to escape the fire. The experiments also demonstrate to firefighters that in most cases, the fire has either transitioned to flashover prior to their arrival or has become ventilation-limited and is waiting for a ventilation opening to increase its burning rate. This difference has a substantial impact on occupant and firefighter safety and leads to faster fire propagation, shorter time to flashover, rapid changes in fire dynamics and shorter escape times.[2]

Our advanced testing also examined four types of new construction materials: wall linings, structural components, windows and interior doors. The change in modern wall linings now allows for more content fires to become structural fires by penetrating the wall linings and involving the void spaces. This shift causes faster fire propagation and shorter times to collapse. Structural components have generally been made lighter by removing mass, which causes them to collapse significantly faster.[4]

In these experiments, an engineered I-joist floor system collapsed in less than one-third the time than did the dimensional-lumber floor system. Modern windows and interior doors fail faster than do their legacy counterparts. The windows failed in half the time, and the doors failed in approximately five minutes. If a fire in a closed room is able to access air to burn from a failed window, then it can burn through a door and extend to the rest of the house. As with the previous experiments, it was discovered that the use of new construction materials also leads to faster fire propagation, rapid changes in fire dynamics and shorter escape times for occupants and firefighters.[5]

The findings about modern home fires highlight that the conditions firefighters face today and will face in the future are very different than those faced by prior generations.

UL's first-of-its-kind testing also identified collapse implications. Specifically, in the modern fire environment, if firefighters arrive at eight minutes, collapse is possible as soon as 90 seconds later. Firefighters may not be in the house yet or may be just entering to search for occupants. In contrast, our research showed the legacy fire collapse begins 40 minutes after the arrival of firefighters. In a legacy home, the extra time before collapse would allow for a significant number of fire operations to take place while firefighters were reading the safety of the structure.[6] UL is working today

to make improvements in these systems, working closely with manufacturers and other important stakeholders.

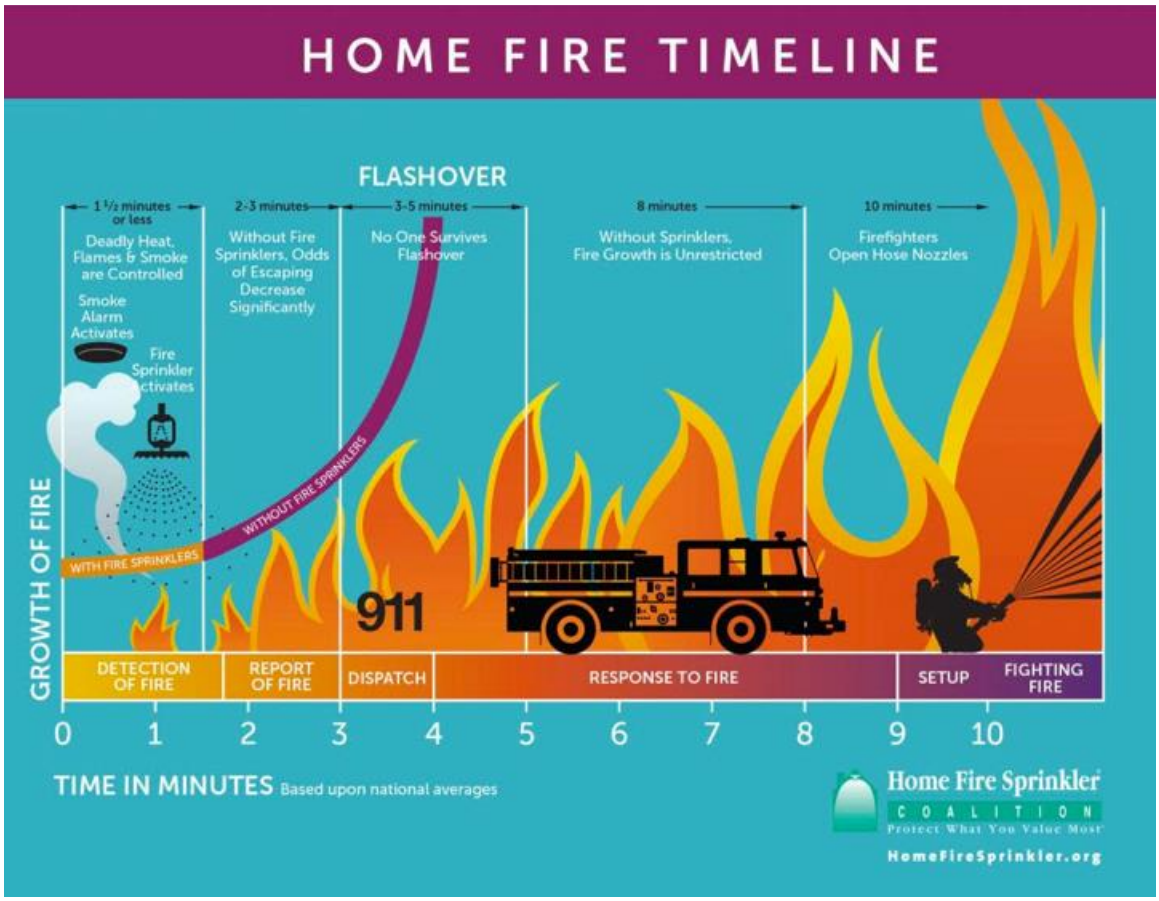
WHY IT MATTERS

The overall finding of UL's fire testing is that the changes in the modern home create fires that reach flashover more than eight times faster than homes built 50 years ago. This much more rapid progression to flashover gives residents, firefighters and other first responders much less time to react, creating significant hazards to health and property.

IMPACT

The findings about modern home fires highlight that the conditions firefighters face today and will face in the future are very different than those faced by prior generations. Because of these changes, firefighting tactics need to change or be re-evaluated to help assure they are effective. UL is working closely with the fire community to further examine and consider new methods and operational practices to advance safety.

Flashover has a direct impact to response time and assembling an effective firefighting force on the fire scene to perform rescue and firefighting operations. The slide below identifies the time line from the receipt of the fire call to arrival on scene of the fire department at the eight-minute benchmark.



Source: Home Fire Sprinkler Coalition

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Appendix 2

SLRTT Performance Charts

Charts and Data

Call Volumes by Incident – Last 5 Years

	2008	2009	2010	2011	2012	2013	2014	2015	2016	% of total
Medical assists	22,904	21,153	21,753	23,392	26,134	27,966	29,086	29,680	29,879	52.4%
Fire and fire related	15,856	15,140	14,964	14,908	14,669	15,091	15,148	15,269	14,780	25.9%
Rescues	542	474	444	522	579	711	584	693	680	1.2%
Hazardous conditions	6,539	6,817	7,181	7,965	8,033	8,023	9,852	7,821	7,214	12.7%
Public service assistance	3,987	3,364	3,168	3,544	3,441	3,894	4,691	3,873	4,301	7.5%
Severe weather	48	44	44	189	62	119	793	185	173	0.3%
Total number of incidents	51,884	49,001	49,564	52,531	54,930	57,817	62,168	59,536	59,043	

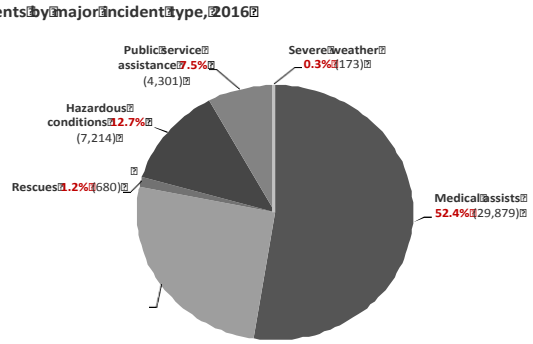
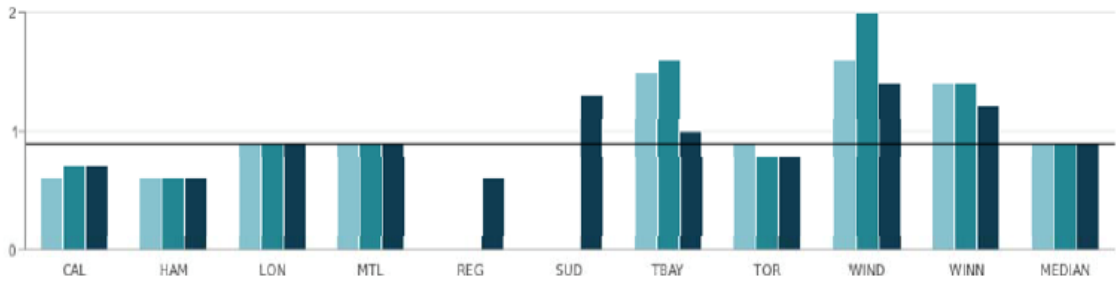


Fig. 10.4 Rate of Residential Structural Fires with Losses per 1,000 Households (Entire Municipality)

Number of residential structure fires with losses per 1,000 households as reported by the fire department.



2014	0.6	0.6	0.9	0.9	N/A	N/A	1.5	0.9	1.6	1.4	0.9
2015	0.7	0.6	0.9	0.9	N/A	N/A	1.6	0.8	2.0	1.4	0.9
2016	0.7	0.6	0.9	0.9	0.6	1.3	1.0	0.8	1.4	1.2	0.9

Source: FIRE115 (Community Impact)

Alberta Health Response Data

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Alberta Health Services

Monthly Emergency Medical Services Activity Summary

Source: Computer Assisted Dispatch (CAD) data

Publisher: System Performance and Innovation, AHS EMS

Note: This information is based on the events occurring within Calgary regardless of the EMS service provider attending

Calgary Event Volumes

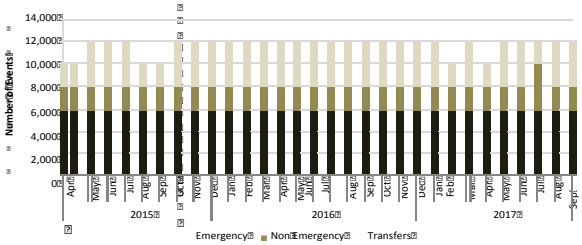
Event Volume is the number of individual events that EMS responded to. Multiple EMS ambulance vehicles may respond to a single event.

Event Volume is the basic measure of EMS activity.

Emergency events are those assigned a determinant of Bravo, Charlie, Delta, Echo.

Non-emergency events are assigned a determinant of Alpha or Omega.

Transfers are all inter-facility or inter-community transfers performed by emergency or dedicated transfer ambulance vehicles. Does not include transfers done by air ambulances.



Calgary Response Time for Life-Threatening Events

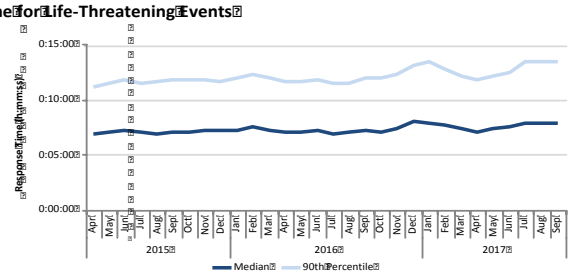
Response Time is the time elapsed from when a call is received at an EMS dispatch centre until the first EMS unit arrives on scene.

Response time is calculated for events thought to be life-threatening at the time of the 9-1-1 call. These events are assigned a Delta or Echo event determinant according to the rules of the Medical Priority Dispatch System (MPDS). These events are a subset of the total number of Emergency events.

Median (50th percentile) and 90th percentile response times are shown.

The median is the time at which half the response times are above and half are below.

The 90th percentile is the response time at which 90% of events are below.



Calgary EMS Hospital Time

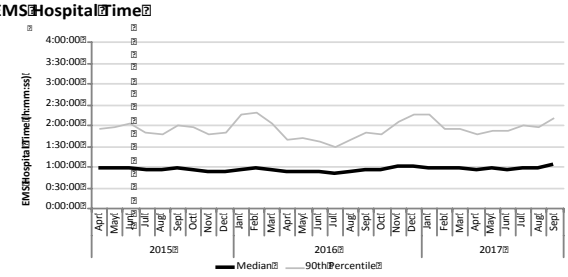
EMS Hospital Time is the time elapsed from when an EMS ambulance arrives at the Emergency Department until that ambulance is available to respond to another call.

EMS staff must care for their patient until care is formally transferred to the Emergency Department.

Median (50th percentile) and 90th percentile EMS hospital times are shown.

The median is the time at which half the EMS hospital times are above and half are below.

The 90th percentile is the time at which 90% of EMS hospital times are below.



Calgary 911 Centre Performance Data

Table 2: Performance Measures: Jan.-Mar. 2017

Calgary 911 Performance Measures		2018 Target	2017 Jan	2017 Feb	2017 Mar
2.1.1	●% of 9-1-1 calls answered within 15 seconds	95%	98%	98%	98%
2.1.2	●% of police 9-1-1 calls answered within 15 seconds	95%	95%	94%	93%
2.1.3	●% of police non-emergency calls answered within 30 seconds	90%	70%	68%	64%
2.1.4a	●% of fire non-emergency calls answered within 30 seconds	90%	97%	97%	98%
2.1.4b	●% of medical non-emergency calls answered within 30 seconds	90%	97%	98%	97%
2.1.5	●% of PSAP to Police 9-1-1 transfer time within 30 seconds	95%	87%	87%	88%

Calgary 911 Performance Measures		2018 Target	2017 Jan	2017 Feb	2017 Mar
2.1.6a	●% of fire communication time in 64 seconds	90%	82%	83%	81%
2.1.6b	●% of fire communication time in 106 seconds	99%	93%	94%	93%
2.1.6c	●% of medical communication time in 90 seconds	90%	91%	90%	91%
2.2.1a	●Police Quality Improvement Scores	90%	94%	94%	93%
2.2.1b	●Fire Quality Improvement Scores - Compliant	90%	53%	64%	67%
	●Fire Quality Improvement Scores Non-Compliant	7%	26%	20%	16%
2.2.1c	●Medical Quality Improvement Scores - Compliant	90%	91%	91%	91%
2.2.1d	●Medical Quality Improvement Scores Non-Compliant	7%	7%	5%	5%
2.2.1e	●Fire Dispatch Quality Improvement Scores	90%	99%	99%	99%

Source: Calgary 911 Centre Data

●**Completed:** All key deliverables have been achieved and indicator of success met or exceeded
●**On track**: Indicator of success is otherwise met, curve turned in the right direction or newly established baseline
●**Not on track but have a plan to get on track:** Indicator of success missed or curve turned in wrong direction
●**Not on track, no plan to get on track:** Objective will only be marked as red with Commander approval
●**Not started:** Work has not begun on the project and key deliverables are future dated

Table 3:Performance Measures: Apr. June 2017

Calgary 911 Performance Measures		2018 Target	2017 April	2017 May	2017 June
2.1.1	●% of 9-1-1 calls answered within 15 seconds	95%	98%	98%	98%
2.1.2	●% of police 9-1-1 calls answered within 15 seconds	95%	93%	90%	91%
2.1.3	●% of police non-emergency calls answered within 30 seconds	90%	58%	47%	54%
2.1.4a	●% of fire non-emergency calls answered within 30 seconds	90%	98%	98%	97%
2.1.4b	●% of medical non-emergency calls answered within 30 seconds	90%	97%	98%	97%
2.1.5	●% of PSAP to Police 9-1-1 transfer time within 30 seconds	95%	89%	89%	89%
2.1.6a	●% of fire communication time in 64 seconds	90%	78%	78%	76%
2.1.6b	●% of fire communication time in 106 seconds	99%	92%	92%	92%
2.1.6c	●% of medical communication time in 90 seconds	90%	91%	92%	90%
2.2.1a	●Police Quality Improvement Scores	90%	94%	94%	93%

2.2.1b	●Fire Quality Improvement Scores - Compliant	90%	68%	63%	66%
	●Fire Quality Improvement Scores Non-Compliant	7%	15%	17%	18%
2.2.1c	●Medical Quality Improvement Scores - Compliant	90%	88%	89%	90%
2.2.1d	●Medical Quality Improvement Scores Non-Compliant	7%	6%	7%	6%
2.2.1e	●Fire Dispatch Quality Improvement Scores	90%	99%	99%	97%

Source: Calgary 911 Centre Data

Table 4: Performance Measures: July. -Sept. 2017

Calgary 911 Performance Measures		2018 Target	2017 Jul	2017 Aug	2017 Sep
2.1.1	●% of 9-1-1 calls answered within 15 seconds	95%	97%	97%	98%
2.1.2	●% of police 9-1-1 calls answered within 15 seconds	95%	91%	94%	92%
2.1.3	●% of police non-emergency calls answered within 30 seconds	90%	54%	65%	51%
2.1.4a	●% of fire non-emergency calls answered within 30 seconds	90%	97%	97%	97%
2.1.4b	●% of medical non-emergency calls answered within 30 seconds	90%	97%	96%	92%
2.1.5	●% of PSAP to Police 9-1-1 transfer time within 30 seconds	95%	89%	89%	90%
2.1.6a	●% of fire communication time in 64 seconds	90%	76%	77%	81%
2.1.6b	●% of fire communication time in 106 seconds	99%	92%	92%	94%
2.1.6c	●% of medical communication time in 90 seconds	90%	n.a.	n.a.	n.a.
2.2.1a	●Police Quality Improvement Scores	90%	95%	95%	94%
2.2.1b	●Fire Quality Improvement Scores - Compliant	90%	65%	71%	71%
	●Fire Quality Improvement Scores Non-Compliant	7%	17%	15%	12%
2.2.1c	●Medical Quality Improvement Scores - Compliant	90%	88%	82%	87%
2.2.1d	●Medical Quality Improvement Scores Non-Compliant	7%	7%	10%	7%
2.2.1e	●Fire Dispatch Quality Improvement Scores	90%	98%	98%	99%

Performance to Target – Last 5 Years

The Calgary Fire Department prepares statistical reports based on the SLRTT. The SLRTT report reflects the time elapsed from when Calgary 911 receives the call to arrival on scene at the emergency incident. The seven-minute threshold is for all life threatening events that require the response of the CFD. The call types responded to by the CFD are varied as they range from all fire incidents, medical emergencies, high

and low angle rescue, water rescue, hazardous material incidents, auto extrication, trench rescues etc. The chart below identifies the major call types responded to by the CFD in 2016.

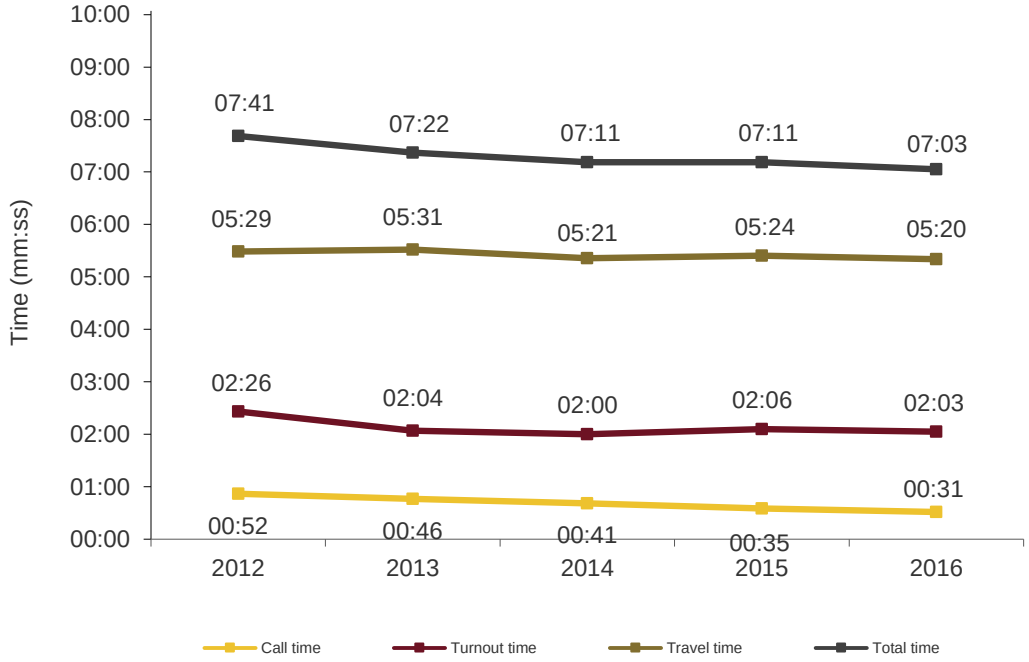
Table 5: 1st – Response Data – Medical Responses

First-In Unit 90th Percentile Response Times, Life-Threatening Emergency Medical Incidents, 2010-2016 (Minutes, Seconds)							
	2010	2011	2012	2013	2014	2015	2016
Call time	01:20	01:13	00:52	00:46	00:41	00:35	00:31
Turnout time	02:11	02:10	02:26	02:04	02:00	02:06	02:03
Travel time	05:30	05:27	05:29	05:31	05:21	05:24	05:20
Total time	07:49	07:41	07:41	07:22	07:11	07:11	07:03

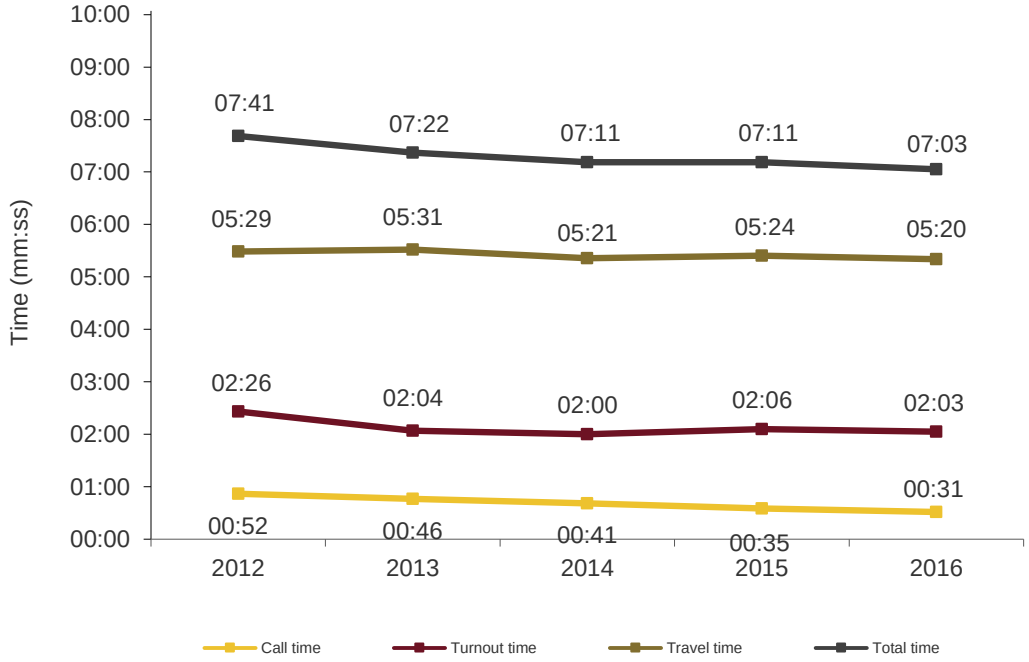
Source: Calgary Fire Department

Calgary Fire: "The chart indicates CFD performance at the 90th percentile for each component in the Total Time equation; it is not the calculation of the actual performance breakdown for the component to determine Total Time."

First-in unit response times (90th percentile)
Life-threatening emergency medical incidents, 2012-2016



First-in unit response times (90th percentile)
Life-threatening emergency medical incidents, 2012-2016



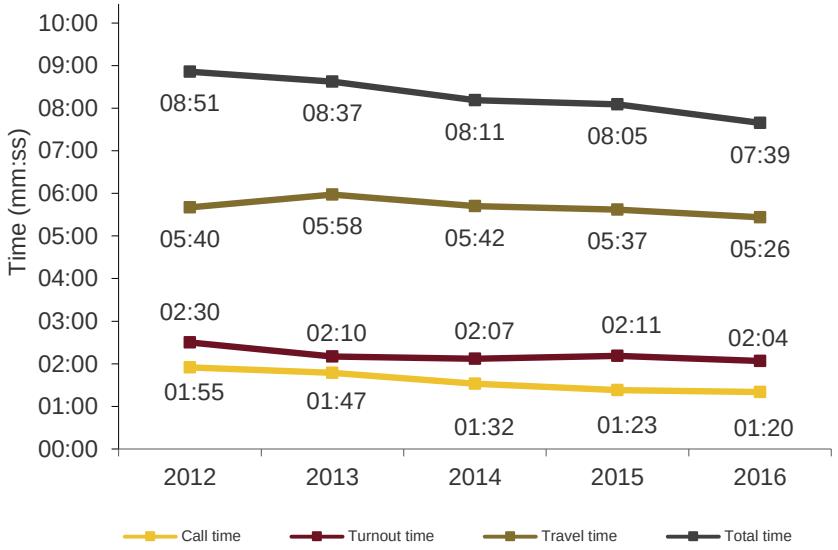
Source: Calgary Fire Department

Table 6 – Response Data – Fire Suppression

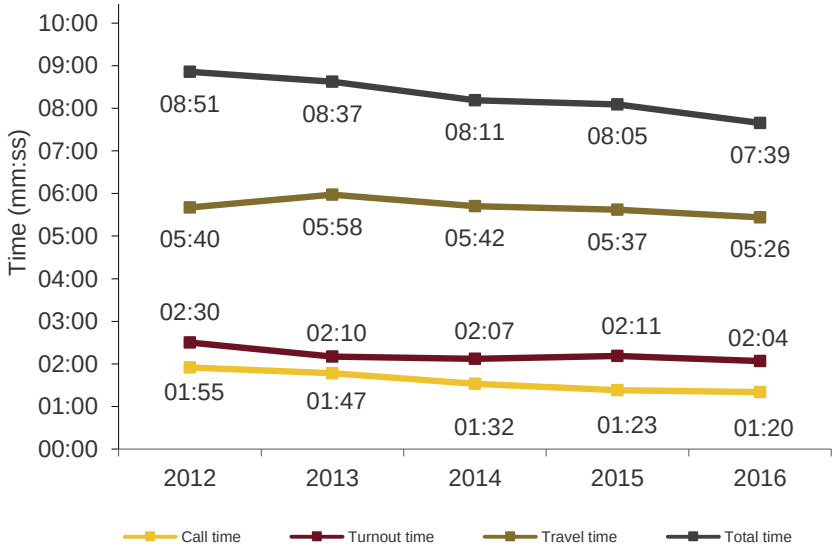
First-In Unit 90th Percentile Response Times, Fire Suppression Incidents, 2010-2016 (Minutes, Seconds)							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Call time	02:07	02:04	01:55	01:47	01:32	01:23	01:20
Turnout time	02:17	02:17	02:30	02:10	02:07	02:11	02:04
Travel time	06:00	05:39	05:40	05:58	05:42	05:37	05:26
Total time	09:08	08:39	08:51	08:37	08:11	08:05	07:39

Source: Calgary Fire Department

First-in unit response times (90th percentile)
Fire supression incidents, 2012-2016



First-in unit response times (90th percentile)
Fire supression incidents, 2012-2016



Source: Calgary Fire Department

Table 7: High-risk Fire Suppression Full First Alarm Assignment Response Time

High-risk Fire Suppression Full First Alarm Assignment Response Time Performance, Travel and Total Response Times, 2010-2016							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Travel Time at the 90th percentile (in seconds)	767.0	775.0	758.0	749.0	742.0	690.0	668.0

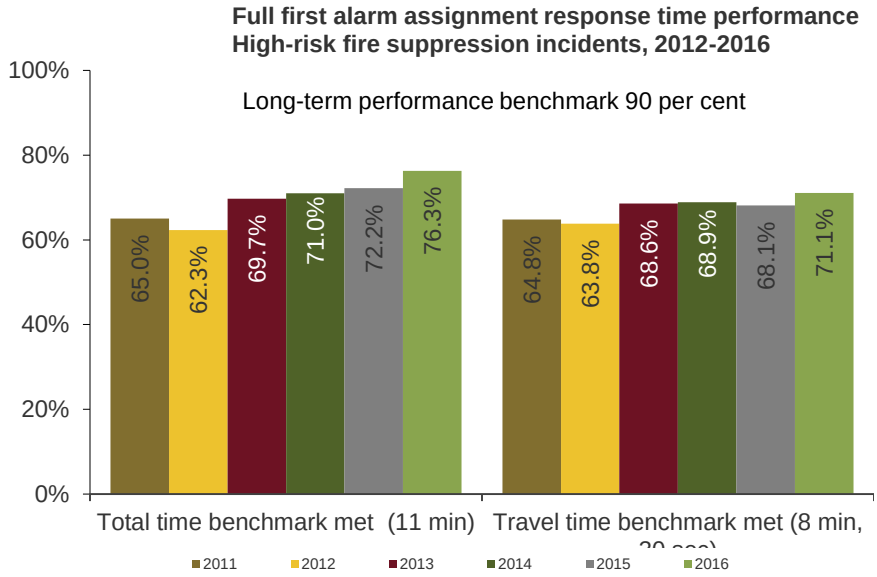
Travel Time at the 90th Percentile (mm:ss)	12:47	12:55	12:38	12:29	12:22	11:30	11:08
% of fire suppression incidents where the full first alarm assignment travel time to high-risk fire suppression incidents met the travel time benchmark (8 minutes 30 seconds)	63.6%	64.8%	63.8%	68.6%	68.9%	68.1%	71.1%
Total Response Time at the 90th percentile (in seconds)	910.0	934.0	939.0	899.0	876.0	819.0	791.0
Total Response Time at the 90th percentile (mm:ss)	15:10	15:34	15:39	14:59	14:36	13:39	13:11
% of fire suppression incidents where the full first alarm assignment total response time for high-risk fire suppression incidents met the total response time benchmark (11 minutes)	63.4%	65.0%	62.3%	69.7%	71.0%	72.2%	76.3%

Full First Alarm Assignment, High-Risk Fire Suppression Incidents

Response Time Performance 2010-2016

	2010	2011	2012	2013	2014	2015	2016
Total time benchmark met (11 min)	63.4%	65.0%	62.3%	69.7%	71.0%	72.2%	76.3%
Travel time benchmark met (8 min, 30 sec)	63.6%	64.8%	63.8%	68.6%	68.9%	68.1%	71.1%

Source: Calgary Fire



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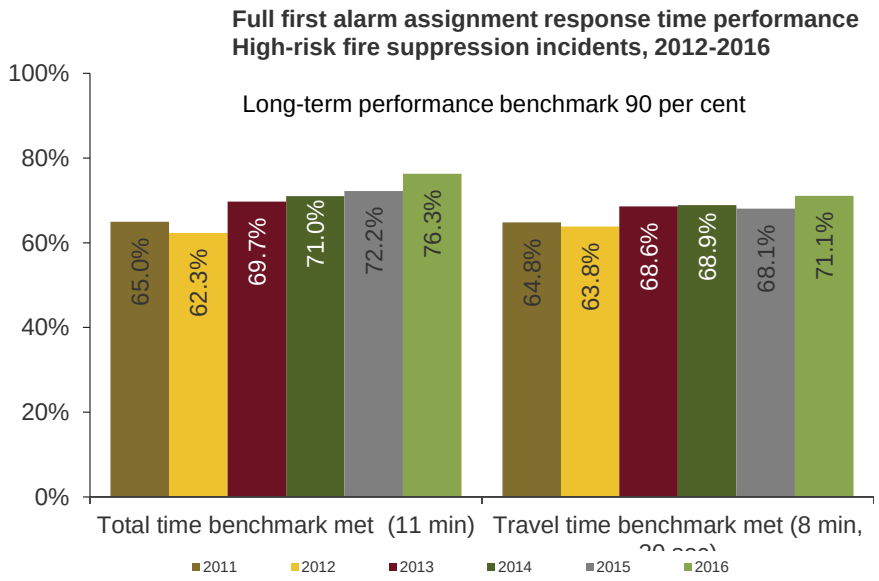
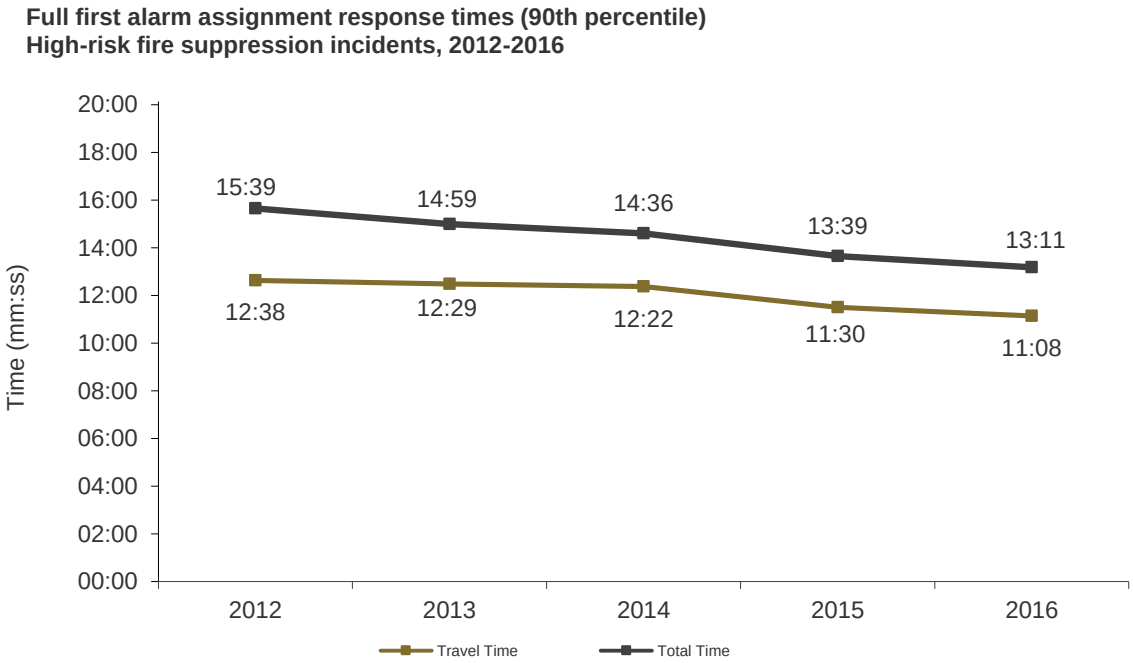
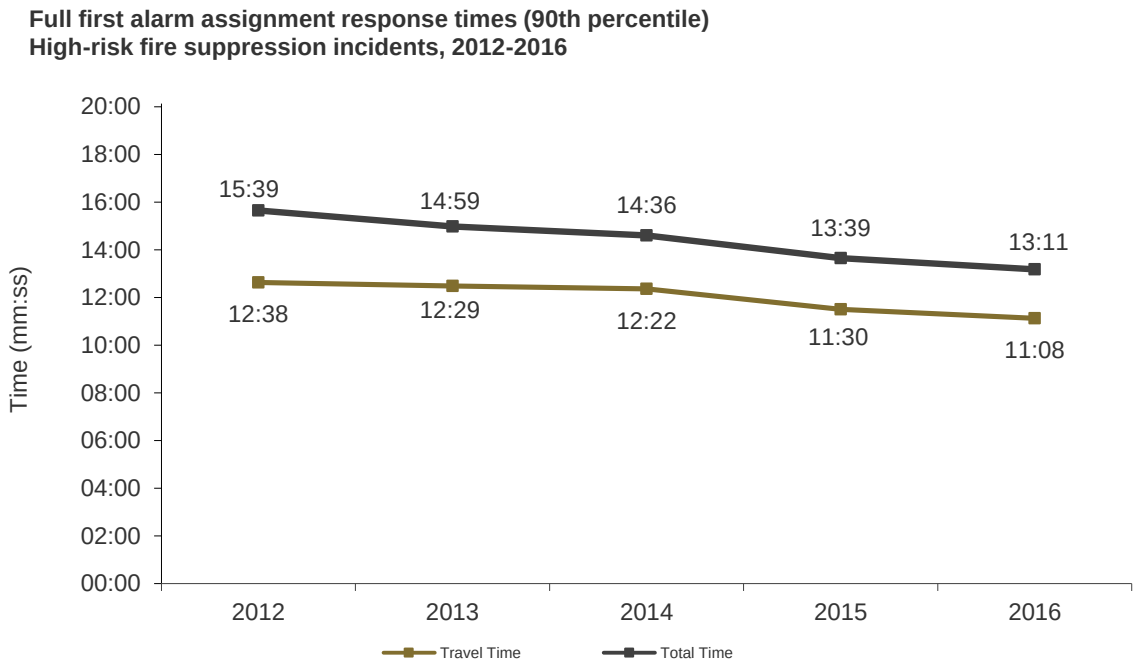


Source: Calgary Fire





Source: Calgary Fire

Table 8: Response Time – Suppression and Medical Calls – by Station

Response Time Performance for Fire Suppression and Emergency Medical Calls 90th Percentile and Percent Within NFPA standard for First-Arriving Unit 2016				
First Due District	**Fire Suppression Calgary-adopted standard (7:00)**	**Fire Suppression NFPA 1710 (6:24)**	**Emergency Medical Calgary-adopted standard (7:00)**	**Emergency Medical NFPA 1710 (6:30)**
Station 01	93.2% (6:28)	89.2%	92.3% (6:43)	87.8%
Station 02	96.7% (6:07)	93.1%	97.0% (5:47)	95.7%
Station 04	87.8% (7:07)	82.8%	94.1% (6:30)	89.9%
Station 05	93.5% (6:43)	86.3%	95.9% (6:06)	93.1%
Station 06	96.2% (6:02)	93.5%	95.4% (6:03)	92.4%
Station 07	86.9% (7:14)	79.4%	96.1% (6:19)	92.6%
Station 08	94.8% (6:35)	87.3%	95.3% (6:18)	91.6%
Station 09	75.4% (8:00)	60.5%	87.1% (7:21)	81.1%
Station 10	90.2% (6:58)	84.4%	93.6% (6:22)	91.2%

Station 11	85.4% (7:32)	72.9%	92.5% (6:45)	88.7%
Station 12	86.3% (7:18)	77.8%	87.3% (7:24)	81.7%
Station 14	89.1% (7:04)	78.8%	93.7% (6:30)	90.0%
Station 15	82.4% (7:32)	73.5%	90.1% (7:00)	85.6%
Station 16	83.8% (7:54)	70.8%	77.8% (7:45)	77.8%
Station 17	91.3% (6:50)	82.5%	90.2% (6:55)	82.3%
Station 18	78.0% (8:57)	71.7%	92.5% (6:33)	89.6%
Station 19	85.1% (7:29)	77.0%	91.4% (6:52)	83.6%
Station 20	81.3% (7:41)	72.5%	89.4% (7:03)	84.2%
Station 21	70.6% (8:31)	63.2%	78.7% (7:56)	70.3%
Station 22	82.3% (7:52)	72.8%	91.2% (6:52)	86.7%
Station 23	81.8% (7:46)	71.5%	89.8% (7:03)	85.7%
Station 24	91.4% (6:44)	82.8%	91.8% (6:51)	86.2%
Station 25	77.3% (8:58)	66.9%	92.3% (6:38)	90.0%
Station 26	71.7% (8:49)	60.5%	77.4% (8:05)	69.5%
Station 28	78.4% (7:39)	65.8%	86.9% (7:16)	78.6%
Station 29	77.3% (8:34)	62.2%	84.6% (7:20)	76.3%
Station 30	81.4% (7:53)	68.4%	86.0% (7:38)	78.4%
Station 31	85.0% (7:30)	79.7%	90.9% (6:50)	87.0%
Station 32	85.5% (7:25)	74.1%	91.4% (6:44)	87.4%
Station 33	79.2% (7:53)	68.5%	89.7% (7:01)	84.0%
Station 34	77.9% (7:57)	64.9%	86.2% (7:11)	75.4%
Station 35	71.0% (9:25)	54.8%	87.0% (7:10)	85.7%
Station 36	95.6% (6:31)	85.1%	96.5% (6:20)	92.6%
Station 37	79.2% (7:49)	67.4%	90.8% (6:55)	84.4%
Station 38	43.6% (10:39)	42.9%	57.0% (10:28)	53.8%
Station 39	61.3% (9:16)	46.2%	66.5% (8:29)	52.1%
Station 40	74.2% (8:55)	61.9%	81.0% (7:48)	73.5%
Station 41	81.0% (8:00)	75.2%	85.3% (7:14)	79.6%
City-Wide	84.5% (7:39)	76.5%	89.7% (7:03)	84.9%

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Data source: FireHub/DataWarehouse
The above analysis only includes priority responses for first-arriving units on emergency medical and fire suppression calls between January 1st, 2016 and December 31st, 2016.

Legend:
Green: > 90% Performance
Yellow: 85% - 94.9% Performance
Red: < 85% Performance

Appendix 3

Revised NFPA 1710

The NFPA 1710 information depicted below is for reference. The NFPA 1710 standard recommends a minimum of **14-15** firefighters to be assembled on scene to perform the required firefighting tasks at an emergency incident. The Calgary SLRTT ERF requires 12 to be assembled.

NFPA1710
Changes to Fireground Staffing Levels for Career Fire Departments

NFPA 1710 provides the minimum requirements relating to the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by career fire departments.
For the 2016 edition of the standard, subsection 5.2.4 on fire department service deployment was revised to include three new occupancies, along with the appropriate response staffing levels for each. The minimum staffing level for each occupancy is listed below. *(For the full breakdown of staffing requirements by position, refer to the subsections specific to each occupancy in 5.2.4.)*

Note: NFPA 1710 guidelines indicate that for each of the following call types, first in vehicle with a crew of 4 firefighters should respond within 6 minutes and 24 seconds. The ERF should respond within 10 minutes and 24 seconds

Single-Family Dwelling — minimum of 14 members (15 if aerial device is used)
The initial full alarm assignment to a structure fire in a typical 2000 ft2 (186 m2), two-story, single-family dwelling without a basement and with no exposures must provide for a minimum of 14 members (15 if an aerial device is used).

Open-Air Strip Mall — minimum of 27 members (28 if aerial device is used)
The initial full alarm assignment to a structure fire in a typical open-air strip shopping center ranging from 13,000 ft2 to 196,000 ft2 (1203 m2 to 18,209 m2) in size must provide for a minimum of 27 members (28 if an aerial device is used).

Garden-Style Apartment — minimum of 27 members (28 if aerial device is used)
The initial full alarm assignment to a structure fire in a typical 1200 ft2 (111 m²) apartment within a three-story, garden-style apartment building must provide for a minimum of 27 members
(28 if an aerial device is used).

High-Rise — minimum of 42 members (43 if building equipped with fire pump)
The initial full alarm assignment to a fire in a building with the highest floor greater than 75 ft. (23 m) above the lowest level of fire department vehicle access must provide for a minimum of 42 members (43 if the building is equipped with a fire pump).

Fire departments that respond to fires in occupancies that present hazards greater than those found in 5.2.4 shall deploy additional resources as described in 5.2.4.5 on the initial alarm.

NOTE: Even though fireground staffing levels have changed, NFPA 1710 continues to require that engine companies be staffed with a minimum of 4 on-duty members, as stated in subsection 5.2.3. In addition, paragraph 5.2.2.2.1 requires that the fire department identify minimum company staffing levels as necessary to meet the deployment criteria required in 5.2.4 to ensure that a sufficient number of members are assigned, on duty, and available to safely and effectively respond with each company.

Material used in this summary is taken from the 2016 edition of NFPA 1710, S*tandard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. This reprinted material is not the complete and official position of the NFPA or its Technical Committees on the referenced subject, which is represented solely by the standard in its entirety. That standard can be accessed online at www.nfpa.org.

 Revised 11/15/2016

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Appendix 4

Sunnybrook Report

The economic impact and potential years of life lost from fire deaths in residential homes

Joanne Banfield,[1] Sarah Rehou,[1,] Donald A. Redelmeier,[1,3] and Marc G. Jeschke[1,2,4]

[1]Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada; [2]Division of Plastic and Reconstructive Surgery, Department of Surgery; [3]Department of Medicine, Faculty of Medicine, University of Toronto; and [4]Department of Immunology, Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada.

Introduction

Fire is a leading cause of injury and death in Canada.[1] Loss of life due to fire-related injuries results in both societal and economic consequences. The magnitude of the economic burden of premature mortality due to burn injuries in Canada was estimated to be $290 million annually.[1]

Fires in residential homes are preventable and assessments of the impact of premature mortality may not be completely determined by mortality statistics alone. Measures such as potential years of life lost (PYLL) can provide a better estimate of the impact because it takes into account the effect on young and middle-aged adults.

Objective

The aim of this study was to quantify the impact of fatal injuries resulting from residential fires to develop priorities for prevention.

Methods

Study setting and population

Cohort analysis of adults that died due to a residential fire in Ontario, Canada between January 1, 1998 and March 31, 2012.

Inclusion criteria: adults (age ≥ 16) and death due to a fire in a residential home.

Exclusion criteria: mechanism of injury due to scald or chemical burns, or location of injury in motor vehicles, outdoors, or inside a location other than a residence.

Patient demographic and injury characteristics were recorded from coroner investigation statements and autopsy reports from the Office of the Chief Coroner. In Ontario, coroners investigate all unnatural deaths to determine the cause and manner of death.[2]

Economic impact analysis

The Canadian policy analysis recommended value of 6.5 million was used to estimate a value of statistical life.[3]

Potential years of life lost

To estimate PYLL, the age at death was subtracted from the reference age 75.[4] The upper age limit of 75 was used to represent premature mortality that could have been potentially avoided.[4]

Using data from Statistics Canada, the rate of fire-related mortality was standardized to the population size each year.[5]

Results

Participants

Assessed for eligibility (n = 1,633)

Excluded (n = 464)
Primary reason for exclusion
- Age (n = 154)
- Non-residential (n = 285)
- Non-flame related burn injury (n=25)

Analyzed (n = 1,169)

Figure 1. Flow diagram

Table 1. Demographic characteristics, residential fire deaths

Characteristic	
N	1,169
Male, No. (%)	684 (59%)
Age, mean (SD), years	56 (20)
Age ≥ 65, No. (%)	447 (38%)
Primary cause of death, smoke inhalation, No. (%)	839 (72%)

Economic impact and potential years of life lost

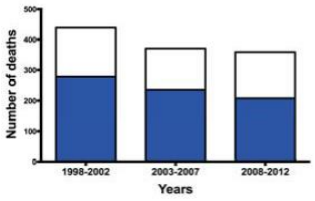

Figure 2. Mortality of adults (≥ age 16) due to residential house fires in Ontario from 1998 to 2012.

Table 2. Economic impact and potential years of life lost

N	1,169
Value of statistical life, dollars, CAN$	7,598,500,000
Number of potential years of life lost	23,782
Admitted to at least one healthcare institution, No. (%)	532 (45%)
Survived longer than 3 days, No. (%)	140 (12%)

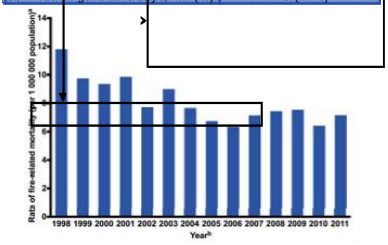

Figure 3. Annual rate of mortality (per 1,000,000 population) due to residential house fires in Ontario from 1998 to 2011.
[a]Rates per 1,000,000 population of adults aged ≥ 16.
[b]Limited to 2011 because study ended March 31, 2012.

Conclusions

Mortality due to residential fires has a substantial economic impact and resulted in 23,782 PYLL. Even with mandated smoke alarms, the primary medical cause of death from 1998 to 2012 was smoke inhalation in 839 (72%) cases. In that same time period, the percentage of fatal residential fire victims over 65 years of age dying due to inhalation injury increased from 30% to 39%. The overwhelming majority of deaths after a fire occurred either on scene or within one day. In addition to loss of life, these deaths create considerable costs incurred from medical transport, hospitalization,[6] and the coroner investigation process.

Continued increases in fire prevention combined with advances in burn injury treatment have led to fewer deaths over time. However, this study showed that there is still an urgent need to identify effective fire prevention strategies, such as implementation of automatic fire sprinklers, to prevent fatal residential fires.

References

1. SMARTRISK. The economic burden of injury in canada. Toronto: SMARTRISK; 2009.
2. Office of the Chief Coroner. Death investigations. http://www.mcscs.jus.gov .on.ca/english/DeathInv estigations/office_coroner/coroner.html. Updated 2011. Accessed April, 2015.
3. Chestnut LG, De Civita P. Economic valuation of mortality risk reduction: Review and recommendations for policy and regulatory analysis. Policy Research Initiative; 2009.
4. Canadian Institute for Health Information. Health indicators 2012. Ottawa: Canadian Institute for Health Information; 2012. https://secure.cihi.ca/free_products/health_indicators_2012_en.pdf.
5. Statistics Canada. Table 051-001 Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual Web site. http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=510001. Updated 2014. Accessed April, 2015.
6. Banfield J, Rehou S, Gom ez M, Redelmeier DA, Jeschke MG. Healthcare costs of burn patients from homes without fire sprinklers. J Burn Care Res. 2015;36(1):213-217.

External funding

Canadian Automatic Sprinkler Association; Canadian Institutes of Health Research # 123336; CFI Leader's Opportunity Fund: Project # 25407; NIH RO1 GM087285-01; and The Co-operators Insurance Group.

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Appendix 5

Project Team

Kelton, Chertow and Boyd Inc. (KCB), a management consultancy based in Mississauga, provided consulting services. The KCB project team included:

Bill Stewart:

Bill served as Fire Chief for Toronto Fire Services from May 1, 2003 to April 30, 2012 at which time he retired from the service after serving 39 and 1/2 years. During his long career, he served as an operations fire fighter, Captain, Administration Chief, Assistant Deputy Chief, Deputy Chief and ultimately was the Fire Chief of Canada's largest city for 9 years.

Sean Pearce:

Sean has 20 years of experience within the emergency services and business management field developing media relations, marketing and public relations plans, executing successful marketing strategies, and managing world-class service providers; specifically the Toronto Fire Services and Canadian Automatic Sprinkler Association.

Andy MacDonald:

Andy MacDonald served as Fire Chief for Brampton Fire and Emergency Services from January 2008 – June 30th, 2014 at which time he retired from active service after 35 ½ years. He recently completed a 2-year contract with the City of Guelph, ON. During that tenure, Andy designed and implemented a re-organization of the Fire and Paramedic management structure. He also performed the duties of Acting Deputy CAO for a period of 5-months in 2017.

Karl Kelton:

Karl is co-founder & Principal of KCB, a management consulting firm based in Mississauga, Ontario. Karl has 34 years of consulting experience including 10 years with Deloitte focused on the design & implementation of solutions that deliver significant financial and operational value to clients across multiple industry sectors.

Appendix 6

References:

1. Policy for the integration of emergency services in the City of Calgary, Land Use, Infrastructure and Mobility Planning – 2010
2. CPS2008-03 Calgary Fire Department Service Levels and Response Time Benchmarks
3. NIST Report on Residential Fireground Field Experiments https://www.nist.gov/publications/report-residential-fireground-field-experiments-0
4. NFPA 1710 Revised – 2016
5. Calgary Fire Department
6. Alberta Building Code
7. NFPA 1221
8. Standata
9. National Building Code of Canada
10. Safety Codes Act – Province of Alberta
11. Sudden Cardiac Arrest Association www.google.ca/search?q=sudden+cardiac+arrest+association&oq=Sudden+Cardiac+Arrest+A&aqs=chrome.2.69i57j0l5.11690j0j9&sourceid=chrome&ie=UTF-8
12. Leger Report – 2017
13. NFPA 13D
14. Fire Underwriters Survey
15. NFPA 13R
16. Letters of Support for Residential Sprinklers
    a. CAFC – Residential Sprinkler Systems
    b. IAFC Position Statement: Fire Sprinklers in New Construction
    c. IAFC Position Statement: Fire Sprinkler Retrofit of Existing High-Rise Buildings
    d. Metropolitan Fire Chiefs Association re: Residential Sprinklers
17. Rocky View Mutual Aid agreement

Additional Research:

1. Life Safety Systems, Fire Department Intervention and Residential Fire Outcomes: Analysis of 28 years of BC Fire Incident Reports 1998 – 2015
2. Communities with Home Fire Sprinklers: The Experience in Bucks County, Pennsylvania
3. Bylaw No. 7 – 2010. A bylaw of the City of Swift Current regulating the construction, erection, placement, alteration, repair, renovation, demolition, relocation, removal, use, occupancy, or change of occupancy of any building or structure.
4. Protection against Residential Fires and Fire Spread in the City of Calgary: Administration Response to Notice of Motion 2009-53
5. Fire Performance of Houses. Phase 1. Study of Unprotected Floor assemblies in Basement Fire Scenarios. Summary Report. NRC RR-252
6. Fire Outcomes By General Construction Type: A Retrospective Analysis of British Columbia Reported Fires.
7. Firefighter Injuries in British Columbia: An Examination of Frequency, severity, Locational and Temporal aspects

8. Firefighters and Cancer: Understanding Risk Factors in an Environment of Change.
9. Home Fire Sprinkler Cost Assessment: Final Report prepared by Newport Partners.
10. Research Technical Report: Environmental Impact of Automatic Fire Sprinklers. FM Global pdf.
11. The Latest NFPA Statistics on Sprinkler Performance by John R. Hall Jr.
12. Impact of Fire Department Response and Mandatory Sprinkler Protection on Life Risks in Residential Communities. Berichou N., Yung D.T., Hadjisophocleous G.V
13. NFPA 13D – Myths and Misconceptions: Matt Klaus – Principal Fire Protection Engineer
14. Leduc Alberta Building Code
15. Estimates of the Operational Reliability of Fire Protection Systems: Nist fire protection effectiveness pdf.
16. Nist Residential Sprinkler Report pdf.
17. NATIONAL RESEARCH CENTER CANADA – Performance of Protected Ceiling/Floor assemblies and Impact of Tenability with a Basement Fire Scenario – Research Report IRC-RR307 May, 2011
18. Benefits of Residential Fire Sprinklers. Prince George's County 15-Year History with its Single-Family Residential Dwelling Fire Sprinkler Ordinance
19. Residential Fire Injury and Death Rates in British Columbia: A statistical analyses Pre and Post 1975
20. Sprinkler Systems and Residential Structure Fires – Revisited: Exploring the Impact of Sprinklers for Life Safety and Fire Spread.
21. Sprinkler Systems and Fire Outcomes in Multi-level Residential Buildings
22. ULC Standards Report to Canadian Home Builders Association – Technical Research Committee. ULC Report – October 2013. Pdf.
23. U.S. Experience with Sprinklers and Other Automatic Fire extinguishing Equipment. John R. Hall Jr. September 2010
24. Residential Fire Sprinklers – "Protecting What You Value Most". A Report on Vancouver's 10 Year Statistics on Residential Fire Sprinklers
25. Wetaskiwin Alberta Building Code
26. Performance of Protected Ceiling/Floor Assemblies and Impact on Tenability with a Basement Fire Scenario. Research Report IRC-RR-### - December 15, 2010. Joseph Z. Su, Bruce C. Taber, Patrice Leroux, Nourredine Berichou, Gary D. Lougheed, Alex C. Bwalya