



R

RESEARCH REPORT

CANADIAN HOUSING FIRE STATISTICS

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CANADIAN HOUSING FIRE STATISTICS

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ABSTRACT

This report examines benchmarks and indicators related to Canadian housing fire losses, based primarily on statistics over the period 1980 to 1999. The high level statistical components used to establish fire risk in housing are fire incidence, fire deaths, fire injuries and fire damage. These four components are related to benchmarks, based on population, numbers of residential units and fire incidence. Statistics for both the Canadian population at large and First Nations are evaluated. Assessments are made based on residential unit type, ages of victims, urban-rural location, household size and crowding, household age and condition and ignition scenarios. Differences in fire risk between pre- and post-1980 residential units are identified. Recommendations for improvements in current fire data collection are suggested.

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GLOSSARY OF TERMS

The following terms are defined here for use in this report. They may have other meanings in the larger fire protection community, however, they are used in this report with only the meaning stated.

Apartment	A residential unit which shares one or more common walls and common floor and/or ceiling assemblies, and contains separate cooking and sanitation facilities.
Fire Damage	The economic value of the direct damage to the structure and contents caused by the fires reported in the national and provincial statistics. Fire damage is reported in constant dollars to eliminate any differences that may occur as a result of inflation.
Fire Deaths	The number of reported deaths which occur as a result of fires, including both civilians and firefighters.
Fire Incidence	The number of fires which are reported to the fire departments. Fire incidence is analyzed from several perspectives including incidents over a given time frame, for a particular type of residential unit, for a particular segment of the population or for the population at large.
Fire Injuries	The number of reported injuries which occur as a result of fires, including both civilians and firefighters.
Fire Losses	The total direct loss from fire including fire deaths, fire injuries and fire damage.
Mobile Home	A residential unit constructed on a frame for transport and usually conforming to the CAN/CSA-Z240 series of standards rather than the National Building Code of Canada.

Residential Unit	A single independent unit providing living facilities for one or more persons. In this paper, it includes a single detached dwelling, one-half of a semi-detached dwelling, a townhouse, an apartment, a mobile home, or an individually rented room in a lodging or rooming house. This does not include campers and recreational vehicles. The concept of "residential unit" is used primarily as a generic descriptor of housing units of each type for comparison purposes and includes both low rise and high-rise buildings.
Rooming or Lodging House	A building which contains individually-rented residential units which share common walls and common floor and/or ceiling assemblies, and with or without separate cooking and sanitation facilities.
Semi-Detached Dwelling	A residential unit which shares one common wall with another residential unit and has no residential unit located above it.
Single Detached Dwelling	A residential unit which shares no common walls or floor/ceiling assemblies with any other residential unit or other building.
Smoke Alarm	A device which detects smoke and sounds an alarm in the residential unit in which it is located. A smoke alarm is not connected to the fire alarm system in a building.
Townhouse	A residential unit which shares one or more common walls with other residential units.

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ABBREVIATIONS

The following abbreviations appear in the text and may be confusing to some readers. For easy reference, the commonly used abbreviations are included here.

CCFM/FC	-	Council of Canadian Fire Marshals and Fire Commissioners
CCSFLS	-	Canadian Code Structure on Fire Loss Statistics
CHBA	-	Canadian Home Builders' Association
CMHC	-	Canada Mortgage and Housing Corporation
HRDC	-	Human Resources Development Canada
INAC	-	Indian and Northern Affairs Canada
NBCC	-	National Building Code of Canada
NFCC	-	National Fire Code of Canada
NFPA	-	National Fire Protection Association - USA
NRCC	-	National Research Council of Canada
PWGSC	-	Public Works and Government Services Canada

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EXECUTIVE SUMMARY

The project develops benchmarks and indicators related to fire losses in housing in Canada that provide a better understanding of fire risk in Canadian housing. This statistical information on fire can assist in defining both the frequency (fire incidence) and consequences (fire deaths, injuries, damage) components which define fire risk. The project focused primarily on issues that could affect long-term and short-term Canadian housing policy related to fire safety.

The objectives for the project were first to provide Canadian statistical benchmarks for fire safety in housing, including First Nations' housing, that can be used by CMHC in examining future policy decisions on fire safety and housing, and, secondly, to provide recommendations for Canadian housing fire loss data that should be collected by the agencies that assemble this data. This project compared statistics on fire loss data collected by various agencies in Canada and the numbers and relevant characteristics (from a fire risk viewpoint) of housing collected as part of the Census of Canada.

Canadian fire statistics show that the greatest numbers of fires and life losses and injuries occur in residential buildings, especially 1 & 2 family dwellings. Annually fires in residential units account for 70-80% of Canadian fire deaths and 60-70% of fire injuries. Given the high portion of total fire losses attributed to residential fires, there have been numerous calls, over the past decades, for codes to require additional fire safety measures in residential units. This project studied the fire losses that have occurred since the introduction of requirements for smoke alarms in the National Building Code of Canada in the early 1980s to determine the impact of this change, and the concurrent public information campaign, on fire safety in Canadian housing.

When examining fire loss statistics for residential units, there are typically four high-level components for which data are collected: fire incidence, fire deaths, fire injuries and fire damage. This report examined the impact of fire in residential units using these four components and related these components to benchmarks based on

population, numbers of residential units and fire incidence. As well, these components were related to other indicators which included residential unit type, ages of victims, urban-rural locations, household size and crowding, household age and condition and ignition scenarios.

In overview, the research identified that housing fire incidence and losses have, for the most part, decreased since 1980. One important finding was that fire death and injury rates are still decreasing appreciably using 5-year averages while fire damage rates are increasing slightly.

- Population Benchmark – This most commonly used benchmark examined fire incidence and losses on the basis of a given population occupying residential units. This benchmark showed that Canadian fire incidence, deaths and injuries have significantly fallen over the 20-year study period whereas fire damage has remained approximately constant.
- Residential Units Benchmark – This benchmark examined fire incidence and losses on the basis of the number of residential units in Canada. The Residential Units Benchmark showed a greater reduction in fire incidence and fire deaths and a comparable reduction in fire injuries compared to the Population Benchmark. It also showed a slight reduction in fire damage over the 20-year period.
- Fire Incidence Benchmark – This benchmark examined fire losses on a per fire basis. While often considered a measure of fire risk (deaths, injuries, damage/fire), it has a basic shortcoming in that the fire incidence rate is the governing criterion. It is suspected that the number of reported fires used in this benchmark has decreased over time, as more fires are not reported since code requirements for smoke alarms have led to earlier fire discovery and extinguishment. As such, the Fire Incidence Benchmark may generate an unduly high rate of deaths, injuries and damage on a per fire basis because only the more severe fire incidents are reported. Using the Fire Incidence Benchmark shows that the fire death rate has decreased over the 20-year period while fire injury and damage rates (constant dollars) have increased.

It is suggested that this benchmark not be used extensively in determining fire risk unless improved reporting of all fires can be achieved.

First Nations – Using the three basic benchmarks, the First Nations' fire incidence and losses in residential units were compared to the Canada-wide figures. Using the Population Benchmark, the First Nations' fire death rate is approximately 4 times the Canada-wide rate whereas the fire incidence and injury rates were lower than the Canada-wide rate. Fire damage per capita was comparable. Comparing First Nations to the Northwest Territories rates, based on population, showed that the First Nations had comparable fire death rates and lower fire incidence, injuries and damage rates. Using the Residential Units Benchmark provided a different picture. Comparing First Nations to Canada-wide figures shows that the fire incidence is more than twice the Canada-wide rate, the fire death rate is almost 8.8 times and the fire injury and damage rates are approximately twice the Canada-wide rates. Using the Fire Incidence Benchmark, the First Nations' fire death rate is 4.4 times the Canada-wide rate and the injury and damage rates are comparable. Given the suspect fire incidence data, this latter benchmark result is also suspect.

Comparing fire losses in only 1 & 2 family dwellings for Canada-wide and First Nations (based on numbers of units) showed that the First Nations' fire incidence rate is 2.4 times the Canada-wide figure; the injury rate is 2.5 times; the damage rate is 1.7 times; and the fire death rate is 10.4 times. This last figure is considered to be reasonably reliable and points out the significantly higher fire death rate in First Nations' housing. Two other indicators point to possible reasons for the higher First Nations' losses. The first is remote location in which it was shown that rural locations have higher losses than urban areas. The second was crowding in which it was shown that crowding conditions lead to higher fire death rates.

Residential Unit Type – This examination compared fire incidence and losses for 1 & 2 family dwellings, rooming and lodging houses, mobile homes and apartments. The comparison showed that the fire incidence and loss rates for apartments and 1 & 2 family dwellings were essentially the same (apartments were slightly lower), whereas rooming and lodging houses had fire death and injury rates 11 to 12 times the rate for 1

& 2 family dwellings. The mobile home fire death rate was approximately six times the 1 & 2 family dwelling rate.

Ages of Victims – In examining ages of victims as a potential indicator, it was found that the rates of fire deaths for persons 65 years of age and over were approximately twice what would have been expected, based on their percentage of the population. Different groupings of ages for children by province made it impossible to determine any trends on a Canada-wide basis from that data.

Urban-Rural Location – This indicator shows that the rates of fire deaths, in particular, for rural locations, were 1.5 to 4.3 times the rates for urban locations, using community size as a basis.

Household Size and Crowding – While this examination provided some information on "crowding" as a measure of fire risk, the results related to household size alone were inconclusive due to only small provincial variations. The crowding trend line shows a slight increase in fire incidence with increased incidence of crowding and a significant increase in fire death rates.

Household Age/Condition – This examination looked at the age of a dwelling and its physical condition as a means of establishing fire risk. Using dwelling age showed a slight increase in fire incidence with age. A greater increase in fire incidence was noted, however, in plotting householders' perceptions of need for repairs against fire incidence. Plotting the fire death rates against Age of Units and perception of need for repairs showed that while the deaths per 1000 fires and per 1000 residential units decreased with increasing median age, the deaths per 1000 fires increased slightly with the increased homeowner perception of need for major repair.

Ignition Scenarios – This indicator showed that, over the 20-year study period, most fires caused by building-related sources of ignition have decreased at approximately the same rate as the decrease in all fires, however, fire exposure from external fires as a source has increased. This indicator shows, using 5-year averages, that cooking equipment as an ignition source has dropped 23% over the 20-year period, heating equipment 39% and electrical equipment and appliances 23%. External fire

exposure has increased 22% over the same period. From the cause of fire perspective, Construction, Design and Installation Deficiency has decreased 17% while mechanical, electrical failure or malfunction has decreased 48%.

Pre/Post 1980 Differences – In looking at the changes to residential units that could have resulted in increased fire safety, the requirements for smoke alarms in new buildings, in approximately 1980, in existing buildings in approximately 1985 and the accompanying public information campaign, constitute the single most determining factor. Examining fire incidence and deaths as compared to the percentage of pre-1981 residential units in Figure 16, shows that fire incidence and deaths both increase as the portion of pre-1981 housing increases. What is not known is the number of pre-1981 units that may have voluntarily installed smoke alarms or those which added smoke alarms as a result of retroactive National Fire Code requirements. The research showed the dramatic change in fire deaths per 100,000 residential units starting in 1980 and continuing through 1999. That rate dropped approximately 25% by 1984 and 75% by 1999. The fire injuries rate dropped by approximately one third over the period 1980-1999. In constant dollars, fire damage rates per residential unit increased through 1984 and dropped 41% by 1999.

In seeking and analyzing data from various sources, the authors occasionally found that there was no direct means to conduct a detailed investigation due to lack or absence of data. The authors, therefore, recommend some additions to or improvements in current data collection to allow a more complete review and analysis of fire losses in housing. Subjects in which improvements in reporting are recommended including Fire Nations, Fire Incidence, Housing Details, Ages of Victims, Age of Housing and Fatal Fires.

STATISTIQUES DES INCENDIES DANS LES HABITATIONS AU CANADA

RÉSUMÉ

La recherche vise à élaborer des repères et des indicateurs liés aux pertes à la suite d'incendies survenus dans des habitations au Canada dans le but de mieux comprendre les risques correspondants. Ces statistiques permettent de définir autant la fréquence (nombre d'incendies) que les conséquences (pertes de vie, blessures ou dommages) qui déterminent les risques d'incendie. La recherche a porté principalement sur les enjeux qui peuvent influencer à longue comme à courte échéance sur la politique canadienne d'habitation en matière de sécurité incendie.

Les objectifs de la recherche consistaient premièrement à fournir des repères statistiques canadiens pour la sécurité incendie dans les habitations, y compris les logements des Premières nations, dont pourra se servir la SCHL avant d'arrêter ses futures décisions de politique visant la sécurité incendie et l'habitation et deuxièmement à formuler des recommandations quant aux données sur les pertes liées aux incendies d'habitations au Canada que devraient recueillir les organismes compétents. On y a comparé les statistiques des pertes dues aux incendies recueillies par différents organismes au Canada et le nombre et les caractéristiques pertinentes (selon la perspective des risques d'incendie) des habitations dans le cadre du recensement canadien.

Les statistiques canadiennes indiquent que le plus grand nombre d'incendies, de pertes de vie et de blessures surviennent dans les bâtiments résidentiels, principalement les maisons unifamiliales et bifamiliales. Chaque année, de 70 à 80 % des décès surviennent lors d'incendies dans des logements et de 60 à 70 % des blessures sont occasionnées lors d'incendies. Vu la proportion élevée des pertes totales attribuables aux incendies survenus dans des bâtiments résidentiels, de nombreuses interventions visaient, au cours des décennies précédentes, à faire en sorte que les codes y prescrivent des mesures supplémentaires de sécurité incendie. La présente recherche a porté sur les pertes causées par les incendies qui ont eu lieu depuis l'adoption, au début des années 1980, des dispositions du Code national du bâtiment rendant obligatoires les avertisseurs de fumée de façon à déterminer l'incidence de cette mesure, et la campagne concomitante d'information publique sur la sécurité incendie dans les habitations canadiennes.

À l'examen des statistiques concernant les pertes causées par les incendies dans les logements, il y a généralement quatre éléments de haut niveau pour lesquels les données sont recueillies : le nombre d'incendies, les décès, les blessures et les dommages causés par les incendies. Le présent rapport touche à l'incidence de l'incendie dans les logements à l'aide de ces quatre éléments pour établir des repères fondés sur la population, le nombre de logements et la fréquence des incendies. De même, ces éléments ont été reliés à d'autres indicateurs qui comprennent, entre autres, le type de logement, l'âge des victimes, le milieu urbain ou rural, la taille des ménages et le nombre d'occupants, l'âge et l'état de santé des ménages, et des scénarios d'ignition.

En revue, la recherche a relevé que la fréquence des incendies dans des habitations et les pertes subies accusent, en grande partie, une baisse depuis 1980. Elle indique comme important résultat que les décès et blessures imputables aux incendies continuent de connaître une baisse importante selon des moyennes quinquennales, alors que les dommages dus aux incendies accusent une légère augmentation.

- Repère population – Ce repère le plus largement utilisé porte sur la fréquence des incendies et les pertes encourues, en fonction de la population donnée qui occupe les logements. Ce repère indique que la fréquence des incendies, les décès et les blessures ont chuté de façon appréciable au cours de la période d'étude échelonnée sur 20 ans, alors que les dommages causés par l'incendie sont demeurés sensiblement constants.
- Repère logements – Ce repère porte sur la fréquence des incendies et les pertes établies en fonction de nombre de logements au Canada. Le repère logements montre une grande réduction de la fréquence des incendies et des décès attribuables à cette cause, ainsi qu'une réduction semblable des blessures occasionnées par des incendies par rapport au repère population. Il indique également une légère réduction des dommages causés par les incendies au cours de la période de 20 ans.
- Repère fréquence des incendies – Ce repère porte sur les pertes subies par incendie. Bien qu'il soit souvent considéré comme une

mesure des risques d'incendie (décès, blessures, dommages/incendie), il y a une lacune fondamentale en ce sens que la fréquence des incendies est le critère déterminant. On présume que le nombre d'incendies signalés qu'utilise ce repère a connu une baisse au fil du temps, étant donné que davantage d'incendies ne sont pas rapportés depuis que les avertisseurs de fumée prescrits par les dispositions des codes permettent de découvrir l'incendie tôt et de l'éteindre. À proprement parler, le repère fréquence des incendies peut donner lieu à des décès, des blessures et de dommages indûment élevés par incendie, parce que seulement les incendies d'importance sont signalés. L'emploi du repère fréquence des incendies révèle que les décès attribuables aux incendies ont chuté au cours de la période de 20 ans, alors que les blessures et dommages causés par les incendies ont connu une hausse (en dollars constants). On propose de ne pas faire un usage étendu de ce repère pour déterminer les risques d'incendie à moins de pouvoir établir un meilleur mode de rapport des incendies.

Premières nations – À l'aide des trois repères de base, la fréquence des incendies chez les Premières nations et les pertes subies dans leurs logements ont été comparées aux statistiques pancanadiennes. Selon le repère population, le nombre de décès par incendie parmi les Premières nations est environ 4 fois plus élevé que la statistique pancanadienne, alors que le nombre d'incendies et les blessures étaient moins élevés que pour l'ensemble du Canada. Les dommages causés par l'incendie par habitant étaient semblables. Comparer les Premières nations avec les Territoires du Nord-Ouest, d'après la population, indique que les Premières nations enregistrent un nombre semblable de décès causés par les incendies, mais moins d'incendies, de blessures et de dommages. Le repère logement brosse un tableau différent. Comparer les statistiques des Premières nations avec celles de l'ensemble du Canada révèle que le nombre d'incendies est plus que le double de la statistique pancanadienne, le nombre de décès par incendie à peu près 8,8 fois plus élevé et les blessures et dommages sont environ le double des statistiques pancanadiennes. Selon le repère nombre d'incendies, les décès en raison d'incendies chez les Premières nations sont 4,4 fois plus élevés que

pour l'ensemble du Canada, sauf que les statistiques concernant les dommages sont semblables. Vu les données douteuses concernant le nombre d'incendies, il en va de même du résultat que donne ce dernier repère.

Comparer les pertes causées par les incendies dans seulement les logements unifamiliaux et bifamiliaux pour l'ensemble du Canada et les Premières nations (d'après le nombre de logements) indique que la fréquence des incendies chez les Premières nations est 2,4 plus élevée que pour l'ensemble du Canada, les blessures de 2,5, les dommages de 1,7 et les décès dans les incendies de 10,4. Cette dernière statistique est jugée suffisamment fiable et fait ressortir le nombre de décès beaucoup élevé pour cause d'incendie dans les habitations des Premières nations. Deux autres indicateurs pointent vers des raisons possibles pour expliquer les pertes plus élevées enregistrées chez les Premières nations. Le premier porte sur les endroits éloignés où il est démontré que les milieux ruraux enregistrent des pertes supérieures à ce que subissent les régions urbaines. Le deuxième concerne le surpeuplement qui démontre que les conditions de surpeuplement entraînent davantage de décès lors d'incendies.

Type de logements – Cet examen compare la fréquence des incendies et les pertes subies dans les logements unifamiliaux et bifamiliaux, les maisons de chambres et d'hébergement, les maisons mobiles et les immeubles d'appartements. La comparaison montre que la fréquence des incendies et les pertes pour les immeubles d'appartements de même que pour les logements unifamiliaux et bifamiliaux étaient essentiellement les mêmes (ceux des immeubles d'appartements étant légèrement inférieurs) alors que les décès lors d'incendies et les blessures étaient de 11 à 12 fois plus élevés dans les maisons de chambres et d'hébergement que dans les maisons unifamiliales et bifamiliales. Les décès survenus dans les maisons mobiles lors d'incendies étaient environ six fois plus élevés que dans le cas des maisons unifamiliales et bifamiliales.

Âge des victimes – En examinant l'âge des victimes comme indicateur possible, on a découvert que les décès de personnes âgées de 65 ans ou plus survenus lors d'incendies étaient environ deux fois plus élevés que ce à quoi on s'attendait, selon leur proportion de la population. Différents groupements d'âges pour les enfants, établis par province, ne permettent pas de déterminer à partir de ces données une tendance pancanadienne quelconque.

Milieu urbain ou rural – Cet indicateur montre que les décès lors d’incendies, en particulier en milieu rural, étaient de 1,5 à 4,3 fois plus élevés que ceux des régions urbaines, en se basant sur la taille des collectivités.

Taille des ménages et surpeuplement – Bien que cette étude ait permis d’en savoir un peu plus sur le « surpeuplement » à titre de mesure des risques d’incendie, les résultats liés à la taille des ménages n’ont pas été concluants, en raison de petites variations provinciales. La tendance en matière de surpeuplement montre une légère augmentation de la fréquence des incendies et une augmentation du nombre de cas de surpeuplement et une augmentation appréciable des décès lors d’incendies.

Âge et état du logement – Cette étude envisage l’âge du logement et son état comme moyen d’établir les risques d’incendie. L’âge du logement révèle une légère augmentation de la fréquence des incendies selon l’âge. Une hausse supérieure de la fréquence des incendies a toutefois été remarquée en traçant la courbe des perceptions des ménages quant aux besoins de réparations par rapport à celle de la fréquence des incendies. Tracer la courbe des décès lors d’incendies et celle de l’âge des logements et de la perception des besoins de réparations montre que, bien que les décès par tranches de 1000 incendies et de 1 000 logements ont diminué selon que l’âge médian augmente, les décès par tranche de 1 000 incendies ont accusé une légère hausse, compte tenu de la perception plus élevée des propriétaires-occupants quant au besoin de réparations majeures.

Scénarios d’ignition – Cet indicateur montre que, sur la période d’étude de 20 ans, la plupart des incendies causés par des sources d’ignition liées aux bâtiments ont régressé pour atteindre sensiblement le même taux que la diminution enregistrée dans toutes les catégories d’incendies; par contre, l’exposition aux incendies extérieurs a augmenté. Cet indicateur révèle qu’en se servant de la moyenne établie sur 5 ans, les appareils de cuisson comme source d’ignition ont connu une chute de 23 % au cours de la période de 20 ans, les appareils de chauffage de 39 % et le matériel électrique et les appareils électroménagers de 23 %. L’exposition aux incendies extérieurs a augmenté de 22 % au cours de la même période. Les défauts de conception, de construction et de mise en œuvre ont causé 17 % moins d’incendies et la défaillance ou le mauvais fonctionnement des installations mécaniques et électriques, 48 % moins d’incendies.

Différences avant et après 1980 – En jetant un coup d’œil sur les changements qui auraient pu entraîner une sécurité incendie accrue, les avertisseurs de fumée requis dans les bâtiments neufs vers 1980, dans les bâtiments existants vers 1985 et la campagne d’information publique correspondante, constituent l’élément le plus déterminant. L’étude de la fréquence des incendies et des décès comparativement au pourcentage des logements d’avant 1981 dont fait état la figure 16, indique que la fréquence des incendies et des décès ont à la fois augmenté à mesure que la portion d’habitations d’avant 1981 s’accroissait. Nous ne connaissons cependant pas le nombre de logements datant d’avant 1981 où les occupants auraient volontairement posé des avertisseurs de fumée ou décidé d’en ajouter par suite de l’effet rétroactif des dispositions du Code national de prévention des incendies. La recherche indique un changement spectaculaire du nombre de décès lors d’incendies par tranche de 1 000 logements, à partir de 1980, et par la suite jusqu’en 1999 inclusivement. Ce nombre a chuté d’environ 25 % vers 1984 et de 75 % vers 1999. Les blessures causées lors d’incendies ont diminué environ du tiers par rapport à la période de 1980 à 1999. En dollars constants, les dommages causés par les incendies par logement ont augmenté jusqu’en 1984 et baissé de 41 % avant 1999.

En tentant d’analyser les données de différentes provenances, les auteurs trouvent à l’occasion qu’il n’y a pas de moyen direct de mener une enquête approfondie en raison du manque ou de l’absence de données. Par conséquent, les auteurs proposent des ajouts ou des améliorations au mode de rassemblement des données courantes de façon à permettre de mieux revoir et d’analyser en détail les pertes survenues dans les habitations par suite d’incendies. Les améliorations à apporter au moment de signaler les incendies visent les Premières nations, la fréquence des incendies, les détails en matière d’habitation, l’âge des victimes, l’âge du logement et les incendies mortels.



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CANADIAN HOUSING FIRE STATISTICS

1.0 SCOPE, OBJECTIVES AND METHODOLOGY

1.1 Scope

The scope of the project encompasses fire loss data, collected by Canadian fire agencies, and the stock and relevant characteristics of Canadian housing from the Census of Canada. The scope does not include data on fire department practices or occupant behaviours related to fire incidents. The project will develop information (partially in the form of benchmarks and indicators) that will provide a better understanding of fire risk in housing in Canada. Statistical information on fires can assist in defining both the frequency (fire incidence) and consequences (fire deaths, injuries, damage) components which define fire risk.

The project focuses on issues that could affect long-term and short-term housing policy in Canada. As such, the benchmarks and other indicators being studied in this project are those which the authors consider as potentially useful to Canada Mortgage and Housing Corporation (CMHC) in examining the need for new or revised policies related to fire safety and Canadian housing. The term "policy" is used in this project in the broadest general sense and could involve such CMHC actions as recommendations for change to appropriate codes and standards writing bodies, regulatory authorities or the housing industry, in addition to potential policies that CMHC itself may wish to establish for its own activities, including eligible work categories under programs such as the Residential Rehabilitation Assistance Program (RRAP) and the Housing Adaptations for Seniors Independence (HASI).

1.2 Objectives

The objectives for the project are:

- To provide statistical benchmarks for fire safety in Canadian housing, including First Nations' housing, that can be used by CMHC in examining future policy decisions on fire safety and housing.

- To provide recommendations for Canadian housing fire loss data that should be collected by the agencies that assemble this data.

1.3 Methodology

The research methodology involved the following:

1. Identification of Canadian fire losses – through fire incidence, deaths, injuries and damage and housing information sources.
2. Analysis of data to determine the impact of various fire risk factors. Identification of missing data presently not collected.
3. Development of statistical benchmarks and indicators for fire safety in Canadian housing, focusing on those issues which potentially affect future policy on fire safety and housing by CMHC.
4. Consultation on recommended benchmarks with others such as Canadian code writers, fire loss data collection agencies, housing industry, code enforcement officials and CMHC program staff. Draft copies of the report were sent for review to the Canadian Council of Fire Marshals and Fire Commissioners, National Research Council of Canada, National Fire Protection Association, Canada Mortgage and Housing Corporation, Canadian Home Builders Association, Canadian Wood Council and Public Works and Government Services Canada. Comments were received from 12 separate agencies.
5. Reporting of findings, including recommendations on data that should be collected by fire loss data collection agencies.

This project compares statistics on fire loss data collected by various agencies in Canada and the numbers and relevant characteristics (from a fire risk viewpoint) of housing collected as part of the Census of Canada. The focus is on the use of data from these two major sources with the goal of better analysis and presentation to enable more informed fire safety decisions to be made.

2.0 BACKGROUND

2.1 Overview

Canadian fire statistics show that the greatest numbers of fires, fire deaths and fire injuries occur in residential buildings, especially 1 & 2 family dwellings. Annually fires in residential units account for 70-80% of Canadian fire deaths and 60-70% of fire injuries. Given the high proportion of total fire losses attributed to these fires, there have been numerous calls, over the past decades, for codes to require additional fire safety measures in residential units. It is important, as part of this debate, to understand firstly what the current fire safety measures are and when/how they came about, and, secondly, what data is currently being used to establish these calls for additional fire safety.

2.2 History of Code Fire Safety Requirements for Residential Units

Until the June 1978 Revisions to the National Building Code of Canada (NBCC), Canadian codes did not require smoke detection and alarm systems inside dwelling units (residential units). Until that time, building fire alarm systems were required for all residential buildings with sleeping accommodations for more than 10 persons, except for those serving 4 or fewer residential units, and except for buildings 3 storeys or less in height with direct access to an exit leading to ground level to the outside (e.g., townhouses). These fire alarm systems consisted of bells and pull stations with heat detectors in common areas such as storage rooms, service rooms and exit stairs. The only smoke detection required was for recirculating air handling systems serving more than 1 storey.

The June 1978 Revisions to the NBCC added requirements for wired-in smoke alarms in every residential unit and in every sleeping room not located in a dwelling unit (i.e., hotels, rooming houses). These requirements have remained essentially unchanged since that time, as have many other NBCC fire safety requirements, for such elements as fire separations and egress, related to residential units. Since the time delay for adoption of NBCC code changes by the provinces varies from months to years, it is reasonable to assume that the first enforcement of these requirements on new or

renovated housing would not have occurred until approximately 1980. These requirements were applicable only to new construction and major renovations, which is the mandate of building codes.

Retroactive application to existing residential units did not occur until the 1985 edition of the National Fire Code of Canada (NFCC), which applies to existing buildings in use. The voluntary installation of smoke alarms in homes began in Canada in the mid-1970s, however, the exact number of residential units that were equipped with smoke alarms in 1980 is not known. For existing buildings, the NFCC permitted the required smoke alarms to be battery operated. The adoption of smoke alarm regulations and by-laws related to existing buildings was not immediate nor is it complete across Canada even today. However, the vast majority of dwellings in Canada now have an installed smoke alarm.

Concurrent with these mandatory building and fire code provisions, a public information program was started in the early 1980s encouraging all homeowners to install smoke alarms. The introduction of these NBCC and NFCC requirements and the public information campaign which surrounded smoke alarms are considered to have had a significant impact on fire losses beginning in approximately 1980. At the same time, there have been advances in medical care which would also improve survivability following a fire. The impact of each and every potential mitigating factor cannot be determined specifically, however.

From the Code perspective, the advent of smoke alarms to protect residential units of all types can be considered to have occurred in approximately 1980, with increasing coverage appearing in later years. For that reason, in this report, the year 1981 will be considered to be the transition year as far as fire protection for occupants in individual residential units is concerned. The year 1981 has been chosen to coincide with the Census taken that year.

2.3 Basic Statistical Components

When examining fire loss statistics for residential units, there are typically four high-level components for which data are collected: fire incidence, fire deaths, fire

injuries and fire damage. This report examines the impact of fire in residential units using these four components.

A cursory review of current statistics on fire in Canadian housing may fail to provide a direct quantification of the total impact of the 1978 and later NBCC and NFCC changes (e.g., smoke alarms). To help in understanding the impact of these code changes, baseline figures, other than just on a population basis must be established against which the change in fire risk to Canadians and Canadian housing can, over time, be assessed. Such baseline information would also allow a rational assessment of the impact of those code changes and associated programs on fire losses.

As with the Canada-wide fire statistics, the reported statistics on fire losses in First Nations' housing may not provide an accurate assessment of the true extent of the risk. First Nations' fire losses and Canada-wide fire losses differ substantially. To enable decisions to be made on comparing risks and on improving fire safety in First Nations' housing, a multi-variable approach to fire statistics, as outlined in this report, is required.

Typically, fire statistics are reported in comparison to the population at large. What statistics based only on population fail to demonstrate is the change in fire loss rates caused by other factors which change at different rates from population changes; e.g., numbers of residential units and fire incidence. This project examines Canadian and First Nations' statistics for fire and for housing and develops and proposes statistical benchmarks that can be used to assess fire safety in Canadian housing at large, and in First Nations' housing specifically.

3.0 DATA SOURCES

3.1 Fire Data

3.1.1 Overview

In general, in Canada, data on fire losses is collected by the municipal fire departments using, in most cases, the Canadian Code Structure on Fire Loss Statistics⁽¹⁾ (see Subsection 3.1.2) as a basis. Canadian agencies attempt to collect and analyze all fire losses rather than to estimate Canada-wide losses based on sampling. Most municipal fire departments collect all of the information required by the Canadian Code Structure, however, the quality of data collection and reporting may vary depending on the size of the department, the remoteness of the community and whether or not it is a paid or volunteer department (or a large or small municipality). For the purposes of the data used in this report, no information was obtained directly from insurance companies. Some insurance company information has, however, been incorporated in some of the municipal and provincial reports.

The numbers of fire deaths and injuries used in this report are the totals of firefighters and civilians. Over the study period, fire department personnel represented less than 1% of reported fire deaths and almost a third of reported fire injuries. On the injuries side, the percentage of firefighter injuries decreased slightly over the period from 33% to about 30%, suggesting that firefighter injuries have decreased at a somewhat faster pace. They do, however, represent a sizeable proportion of total fire injuries. Thus, firefighter deaths and injuries are considered in this report to represent a real situation that fire safety in residential units should address. They have, therefore, been included in the statistics used.

In each province and territory, the municipal fire departments submit all of the collected data to the fire marshal or fire commissioner for compilation into provincial/territorial fire loss statistics. In some cases, insurance companies also provide information that is included in these statistics. Some provinces and territories also collect First Nations fire loss data. Some provinces undertake analysis of the data (e.g.,

Ontario and Alberta) while others compile it and develop annual provincial fire loss reports. All provinces and territories provide a reduced version of their reports to Human Resources and Development Canada (HRDC).

HRDC, on behalf of the Council of Canadian Fire Marshals and Fire Commissioners (CCFM/FC), develops an Annual Report of Fire Losses in Canada⁽²⁾, the most recent of which is for 1999. This Canada-wide report focuses on the broad overview compiled statistics rather than the detailed ones provided by the fire departments to the provincial authorities.

Indian and Northern Affairs Canada – compiles fire loss statistics⁽³⁾ collected from First Nations' communities. These statistics are compiled by Public Works and Government Services Canada (PWGSC/INAC) which provides an annual report to the government on these losses. (In some provinces, the same data may be included in the provincial report.) The most recent report is for losses in the year 2000. The data used in the PWGSC/INAC report is provided voluntarily by participating First Nations and may not necessarily be complete. The level of participation by First Nations has been inconsistent over the years, however, the level of under-reporting, in general, may not be any different from municipal fire department reporting described above. The fire deaths statistics from First Nations are considered to be the most reliable of the statistics received by PWGSC/INAC as these are often collected from other secondary sources as well (e.g., police reports).

U.S.A. Data – In the U.S.A., the National Fire Protection Association (NFPA), a private sector, non-profit codes and standards development, training and research organization, provides a number of reports on fire losses in residential units. These reports are estimates based on surveys which use data from municipal fire departments and state agencies. While this information is not used in this report, it serves as a useful reference to determine whether U.S.A. and Canadian trends are similar or divergent.

3.1.2 Canadian Code Structure on Fire Loss Statistics

In many cases, the fire loss statistics collected by municipal fire departments use the Canadian Code Structure on Fire Loss Statistics⁽¹⁾, or a similar method, as a basis.

This code structure, developed and maintained by the CCFM/FC, is a comprehensive document that describes in detail the categories of information required for each fire loss. Some provinces and territories have modified the Code Structure to suit their specific needs.

In the Code Structure, details are collected under the following broad headings. Significant detail is required under most of them.

- Incident Information (time, date, location, etc.)
- Property Description (by occupancy and for residential occupancies by type of housing)
- Property Details (size, number of occupants, etc.)
- Fire Protection Features
- Circumstances Contributing to the Outbreak of Fire (what first ignited, etc.)
- Factors Relating to Origin and Spread (means by which fire spread such as interior finishes, openings)
- Fire Loss Details (extent of damage and \$ loss). These are usually based on estimates made at the scene by fire departments
- Discovery of Fire and Action Taken (how initially detected, how extinguished, performance of smoke alarms)
- Fire Casualties (age, gender, etc.)

3.2 Housing Data

Housing for the Canadian population takes two main forms. Most people live in “private dwellings” (residential units) consisting of self-contained units that provide full bath and cooking facilities in addition to living and sleeping space. A small percentage of the population lives in so-called “collective dwellings”. These include penal, health and religious institutions as well as armed forces bases, construction camps and the like. These also include rooming houses. While the institutions are excluded from this report, since their main purpose is not accommodation, residential units in rooming houses are included.

The housing stock in Canada as a whole changes fairly slowly; the new additions each year are modest in number compared to the existing stock. Not many residential units are lost each year with fire being one source of loss of units, as is demolition. Table 1 provides an indication of the increases in Canadian residential units for the period 1971 to 1996. First Nations' increases are reported for the period 1981 to 1996.

**Table 1 – Numbers of Canada-Wide and First Nations' Residential Units
1971-1996**

Year	Canada	Index (1971 = 100)	First Nations	Index (1981 = 100)
1971	6,030,805	100.0	N/A	N/A
1976	7,166,055	118.8	N/A	N/A
1981	8,281,535	137.3	47,180	100.0
1986	8,991,670	149.1	56,084	118.9
1991	10,018,265	166.1	67,282	142.6
1996	10,820,050	179.4	80,443	170.5

Primarily, the Census of Canada collects Canadian housing data every 5 years. The Census of Canada ⁽⁵⁾ classifies residential units into the occupied private dwellings as shown below. 1 & 2 family dwellings constitute about two-thirds of the occupied residential units on a Canada-wide basis. Lodging and rooming houses are not shown as "private" dwellings since they are typically not self-contained units. They are considered collective dwellings.

- Single Attached (one single family unit adjacent to another – also called semi-detached)
- Single Detached
- Row Dwellings (townhouses – common walls between units on both sides)
- Duplex (one unit above another, with a total of two units in the building)
- Apartment in structures with five or more storeys
- Apartment in structures with less than five storeys
- Other Attached
- Mobile Home
- Other movable dwellings

While the Census classifies dwellings into these nine types, there is less detail available from the Canada-wide fire loss reports. Consequently, it is not yet possible to develop fire loss indicators by residential unit type with the same detail provided in the Census. Given these differences, the following residential unit types are addressed in this report, as a result of the availability of corresponding fire loss data:

- 1 & 2 Family Dwellings
- Townhouses (often part of 1 & 2 Family Dwellings)
- Apartments (Low Rise and High Rise)
- Lodging and Rooming Houses
- Mobile Homes

Other types of residential units that are not of policy interest to CMHC (such as hotels) are not addressed in this report. As was mentioned above, this study covers the rooming house portion of the collective housing segment. For the purpose of developing benchmarks, the basic housing unit will be a "residential unit" as defined in the Glossary. For rooming houses, the individual room will be treated as the residential unit.

First Nations' Housing – Data on the numbers of residential units on First Nations' Reserves was obtained from the INAC website. This is also included in Table 1.

4.0 STATISTICAL BENCHMARKS FOR RESIDENTIAL FIRE LOSSES

4.1 Baseline Profiles

4.1.1 Overview

Using the national/provincial/First Nations' fire loss statistics and the Census information on housing, basic benchmarks for fire losses in residential units are described. These take three forms: the first is based on population, the second is based on number of residential units, and the third is based on fire incidence. Other indicators which may serve as means of identifying and quantifying fire losses are also presented.

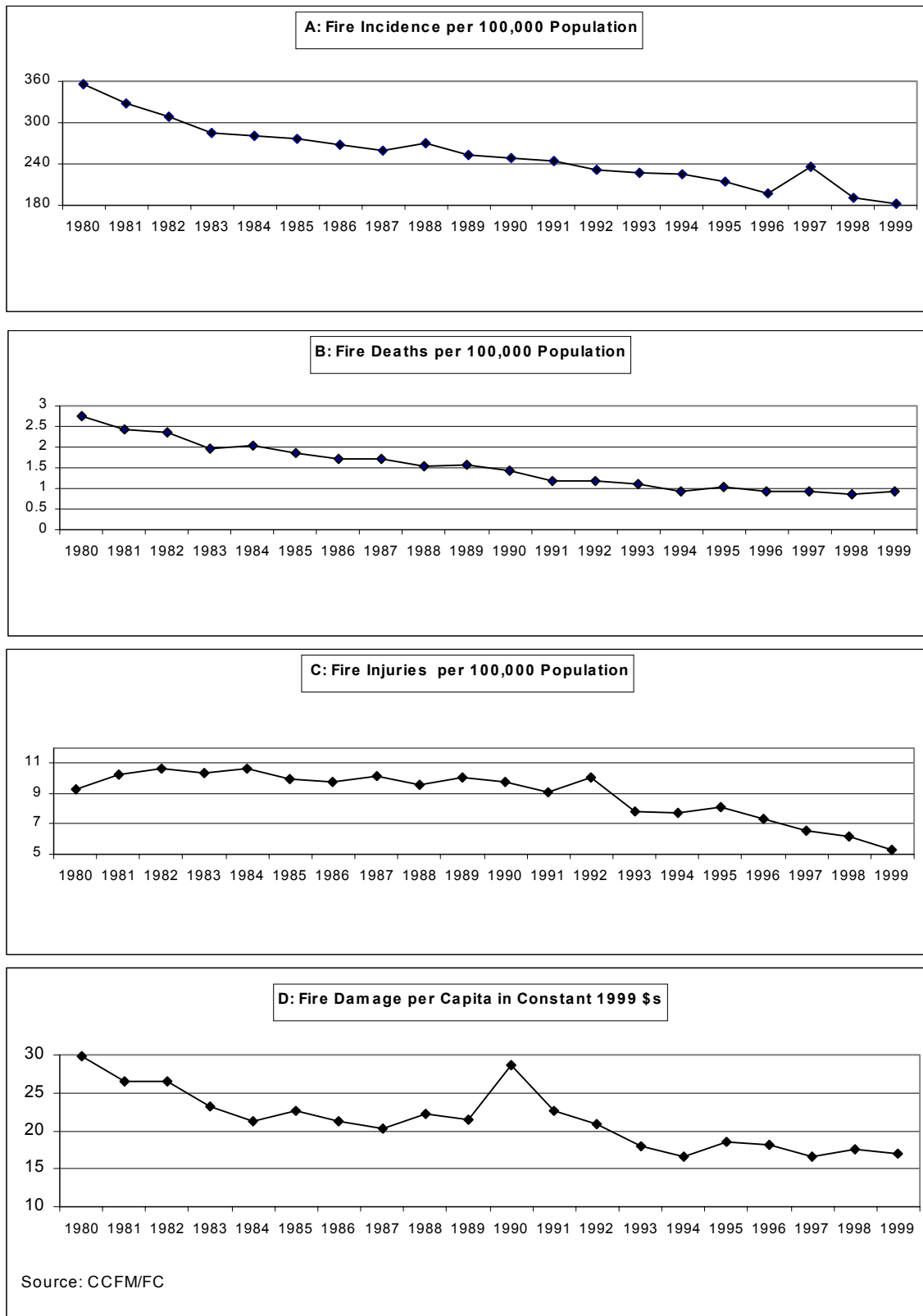
4.1.2 Population Benchmark

Perhaps the most commonly available benchmark for fire losses in Canada is to use the Canadian population at large (or some portion of it) to normalize the fire losses. In this case, the fire statistics from residential units obtained from fire authorities are divided by the Canadian and First Nations' housing, as determined from the Census.

Advantages – The primary advantage of the Population Benchmark is that it shows the probability that an individual in Canada will be touched by fire in any year. This benchmark is also useful as a first order proxy for the general risk of fire to the population at large and could be compared to other types of accidental deaths and injuries normalized by population, such as automobile accidents. It is also useful when examining losses related to ages of individuals.

Disadvantage – While often used to compare losses by province/territory, this benchmark tends to penalize those provinces/territories with low populations, where one or a few major fire losses can have significant impact.

Figure 1: Canadian Housing Fire Losses, Based on Population



The following components are used in the Population Benchmark as shown for the period 1980 to 1999 in Figure 1 for the Canadian population at large:

- Fire incidence/population
- Numbers of fire deaths/population
- Numbers of fire injuries/population
- Fire damage/population

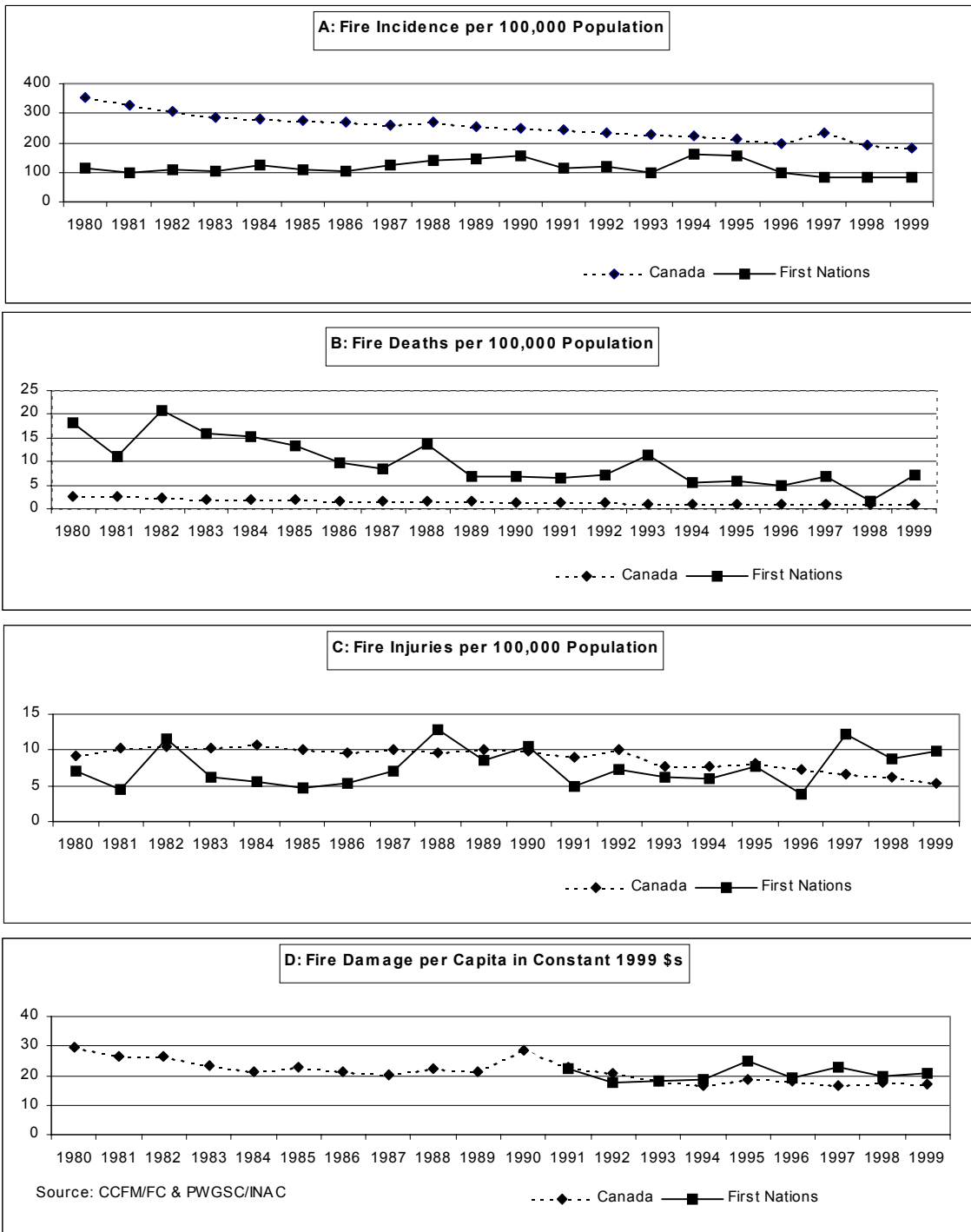
Figure 1 and Table 2 show that fire losses in Canadian residential units have dropped on the basis of population in the 20-year period from 1980 to 1999. The 5-year averages show that drop to be:

- Fire incidence from 311.6 fires per 100,000 population to 203.4, representing a decrease of 35%.
- Fire deaths from 2.3 per 100,000 population to 0.9, representing a decrease of 61%.
- Fire injuries from 10.2 per 100,000 population to 6.7, representing a decrease of 34%.
- Fire damage per capita of \$25.41 to \$17.59 (in constant dollars), representing a decrease of 31%.

**Table 2 – Housing Fire Losses Based on Population
1980-1999**

Table 2: Housing Fire Losses, Based on Population								
Five Year Averages	Rates per 100,000 Population						Fire Damage per Capita	
	Fire Incidence		Fire Deaths		Fire Injuries		Canada	First Nations
	Canada	First Nations	Canada	First Nations	Canada	First Nations		
1980-1984	311.6	109.1	2.3	16.3	10.2	7.0	\$25.41	N/A
1985-1989	265.1	124.8	1.7	10.4	9.9	7.7	\$21.57	N/A
1990-1994	235.0	130.7	1.2	7.5	8.9	7.0	\$21.36	\$19.05
1995-1999	203.4	100.6	0.9	5.2	6.7	8.5	\$17.59	\$21.43

Figure 2: First Nations' and Canadian Housing Fire Losses, Based on Population



For First Nations, for the years 1980 to 1999, the comparable Population Benchmark is shown in Figure 2 along with the corresponding Canada-wide figures. Table 2 provides 5-year averages for comparison purposes. The 5-year averages show that for First Nations for the 20-year period:

- Fire incidence declined from 109.1 fires per 100,000 population to 100.6, representing a decrease of 8%.
- Fire deaths declined from 16.3 per 100,000 population to 5.2, representing a decrease of 68%.
- Fire injuries rose from 7.0 per 100,000 population to 8.5, representing an increase of 21%.
- For the 10-year period for which data is available, fire damage per capita increased from \$19.05 to \$21.43, representing an increase of 12%.

While the comparison of First Nations' losses (based on population) from year to year is a valuable tool to determine the progress of fire safety measures in the First Nations' population, the comparison to Canada-wide losses may not necessarily provide the best assessment of proportional risk, given the differences in the populations such as the remote location of many First Nations' communities, the corresponding absence of water supplies and organized fire services, as well as the greater reliance on more hazardous heating systems (solid fuel appliances) in these remote locations. One possible solution to eliminate some of these variables is to compare the First Nations' statistics to a population with similar geographic features. Figure 3 shows an example of comparative fire losses by population for the Northwest Territories, Newfoundland and First Nations' residential units. The ratio of major centres to rural centres would appear to be similar for these 3 groupings.

Figure 3: Housing Fire Losses in First Nations' Communities, Northwest Territories and Newfoundland, Based on Population

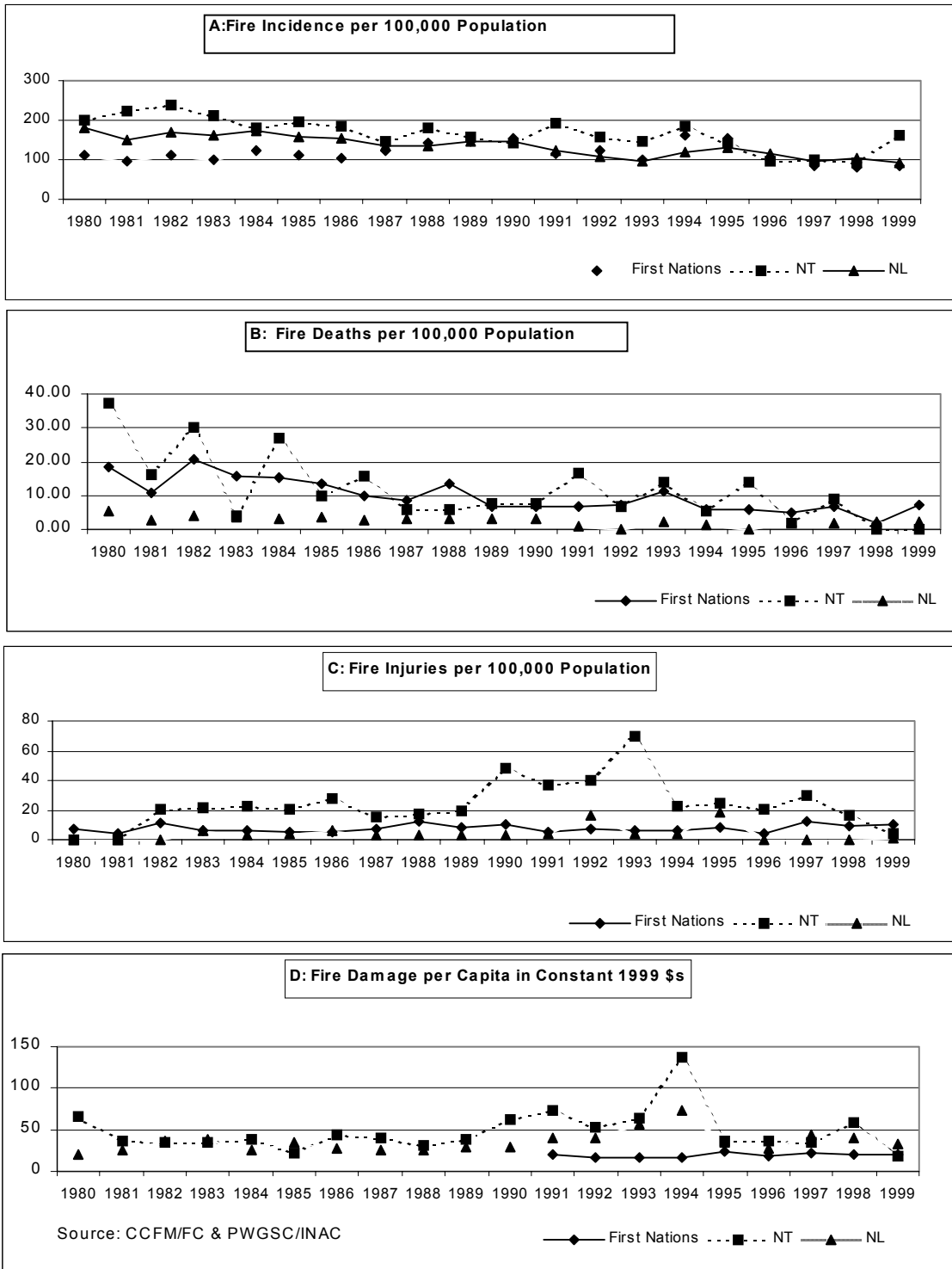


Table 3 also provides 5-year averages for the same data. It should be noted that First Nations' losses are often reported in the provincial/territorial reports in which the loss occurs. As such, there is some overlap in this comparative data.

**Table 3 – Housing Fire Losses Based on Population for First Nations, Northwest Territories and Newfoundland
1980-1999**

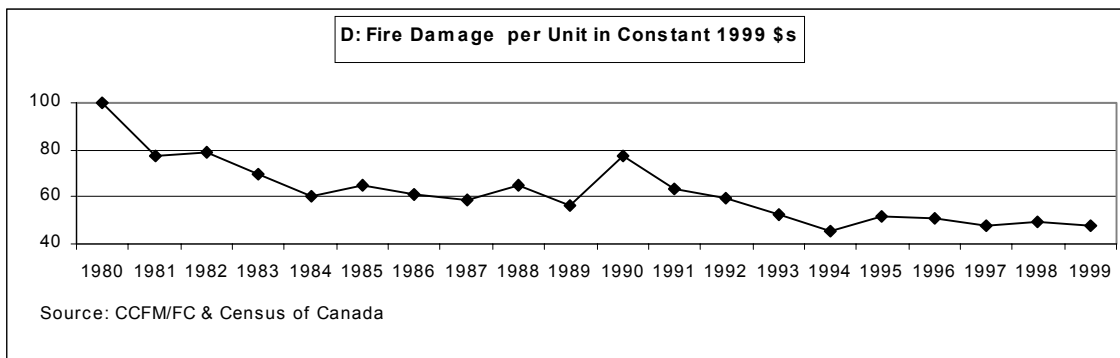
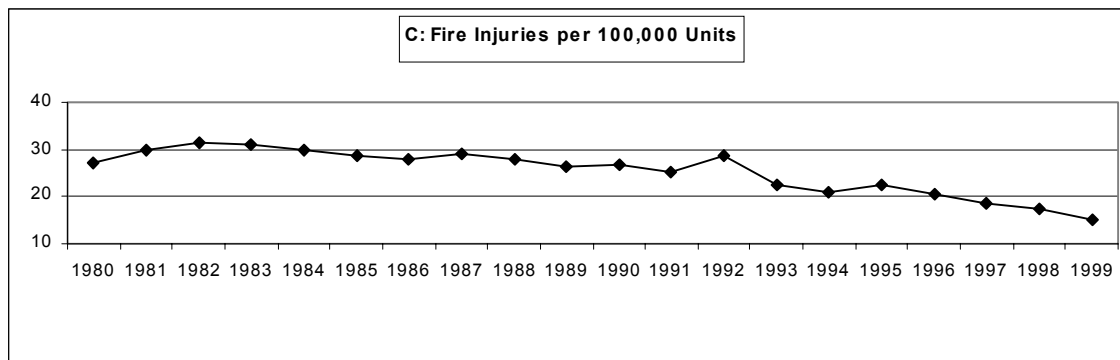
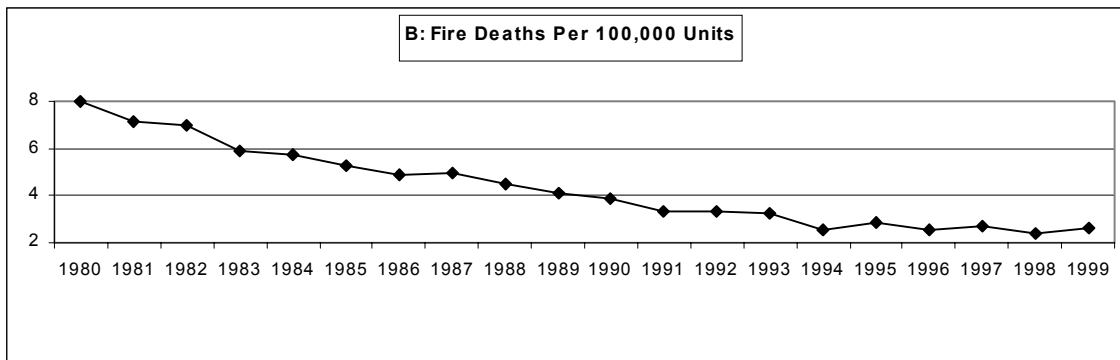
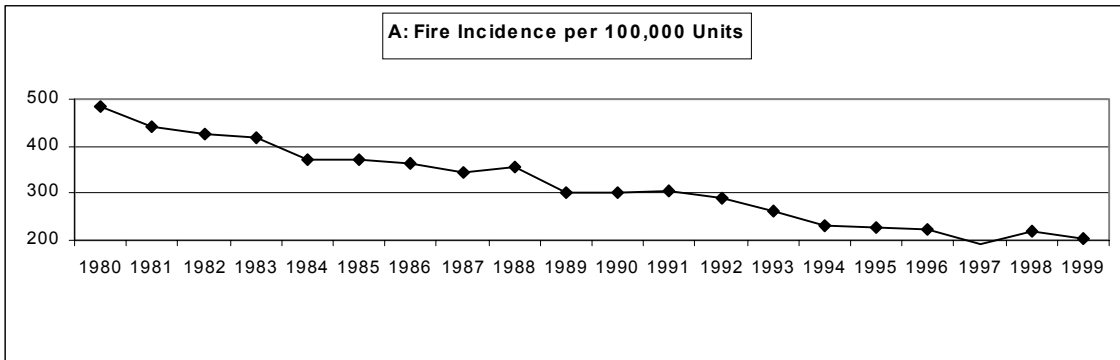
Table 3: Housing Fire Losses Based on Population in First Nations, Newfoundland and the Northwest Territories												
Five Year Averages	Rates per 100,000 Population									Fire Damage Per Capita		
	Fire Incidence			Fire Deaths			Fire Injuries			First Nations	NT	NL
	First Nations	NT	NL	First Nations	NT	NL	First Nations	NT	NL			
1980-1984	109.1	210.4	167.3	16.3	23.0	3.8	7.0	12.9	2.0	N/A	\$75.75	\$51.04
1985-1989	124.8	173.6	146.0	10.4	9.0	3.1	7.7	19.9	3.9	N/A	\$47.38	\$39.36
1990-1994	130.7	164.8	117.7	7.5	10.0	1.6	7.0	43.3	6.5	\$19.05	\$85.86	\$53.16
1995-1999	100.6	119.3	107.3	5.2	4.9	1.7	8.5	19.2	3.9	\$21.43	\$38.16	\$36.93

As an example of this type of comparison, for the most recent 5-year period, Table 3 shows that for First Nations:

- fire incidence rates are slightly lower than Newfoundland and the Northwest Territories;
- fire death rates are comparable to the Northwest Territories but three times the Newfoundland rate;
- fire injury rates are approximately one-half the Northwest Territories but approximately twice the Newfoundland rate; and
- fire damage per capita is over one-half the Northwest Territories and Newfoundland rates.

This example shows that it is difficult to quantitatively demonstrate that the remote locations and climate play a definite role in the higher First Nations' losses, however, the indicators seem to point in that direction if a comparison with the Northwest Territories is examined. This study realizes that several possible factors could play a role in fire risk at the residential unit level. Various factors could also appear in combination (which is confounding) and, as such, make it difficult to extricate the relative importance of each. Other possible factors for higher losses in the First Nations could be crowding, size of households, distance from a fire department, type of dwelling and lack of a code enforcement authority as would exist in larger centres.

Figure 4: Canadian Housing Fire Losses, Based on Residential Units



4.1.3 Residential Units Benchmark

A second benchmark to assess fire risk in residential units is to use the number of residential units to normalize the fire loss statistics to create a Residential Units Benchmark. (See Table 1 for numbers of residential units.) The Residential Units Benchmark is shown in Figure 4 for the years 1980 to 1999. This benchmark includes the following components:

- Fire incidence/number of residential units
- Number of fire deaths/number of residential units
- Number of fire injuries/number of residential units
- Fire damage/number of residential units

Advantages – The major advantage of using residential units as a benchmark is that it focuses on the "housing unit", which is the basic entity about which this research is concerned. Fire, while impacting populations, also impacts housing – which is, to a significant extent, an issue for CMHC programs. This benchmark also allows a measure of determining which types of residential units may be in need of additional fire safety measures.

Disadvantages – One disadvantage of the residential units benchmark is that it does not address the number of occupants who may be exposed to a single fire in a unit. Units containing only one or two occupants have the same weighting as those containing five or six – but all are exposed to the same fire.

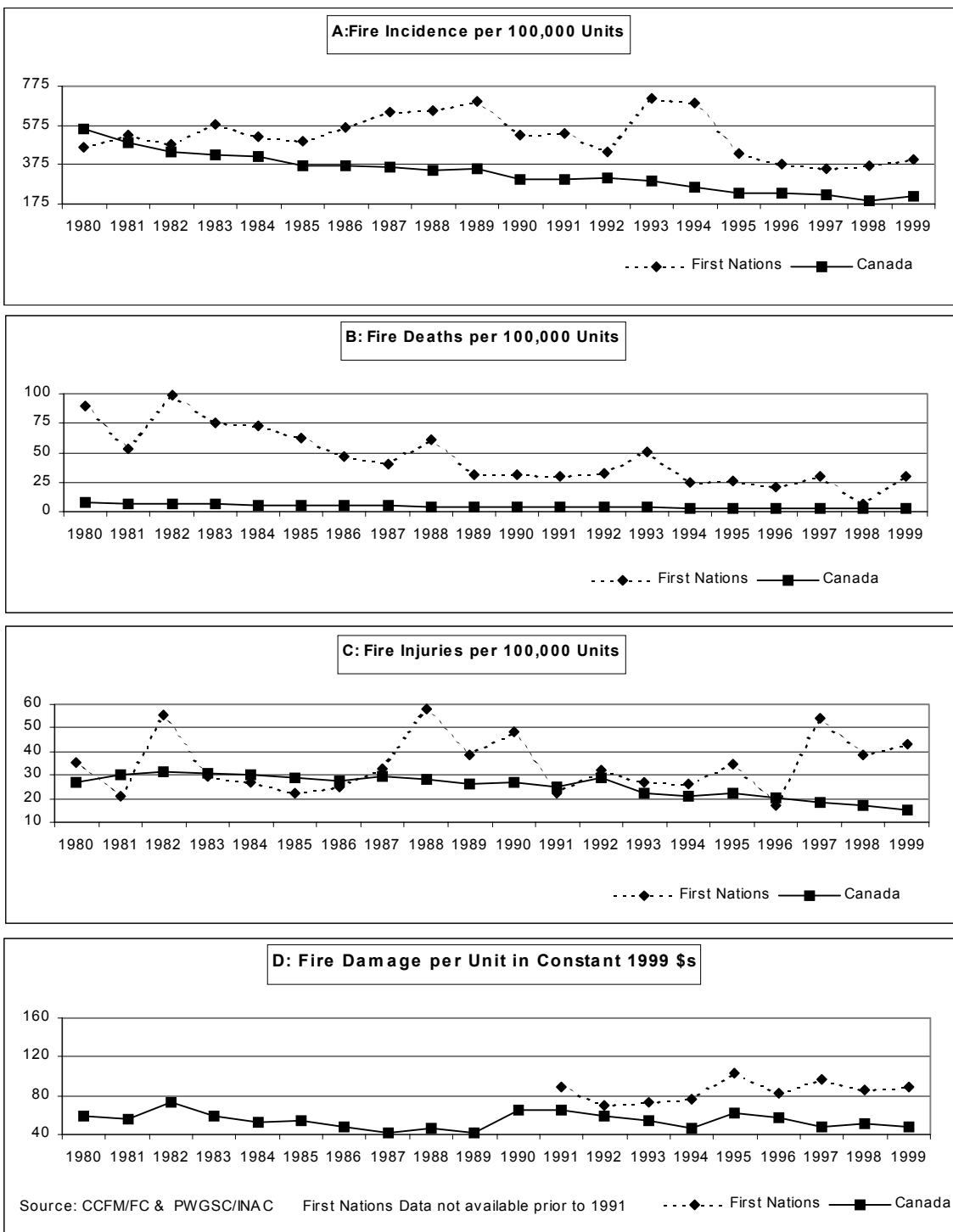
**Table 4 – Housing Fire Losses Based on Residential Units
1980-1999**

Table 4: Housing Fire Losses, Based on Residential Units								
Five Year Averages	Rates per 100,000 Units						Fire Damage per Unit	
	Fire Incidence		Fire Deaths		Fire Injuries		Canada	First Nations
	Canada	First Nations	Canada	First Nations	Canada	First Nations		
1980-1984	482.0	520.2	6.8	77.8	29.9	33.6	\$77.16	N/A
1985-1989	362.1	575.5	4.7	48.2	27.9	35.3	\$60.93	N/A
1990-1994	292.7	584.1	3.3	33.6	24.8	31.2	\$59.61	\$77.07
1995-1999	219.9	443.5	2.6	22.9	18.8	37.5	\$49.52	\$91.55

Based on numbers of residential units, Table 4 shows that, for the 5-year averages for the period 1980 to 1999 for Canada-wide:

- Fire incidence has dropped from 482.0 per 100,000 units to 219.9 (a 54% decrease).
- Fire deaths have dropped from 6.8 per 100,000 units to 2.6 (a 62% decrease).
- Fire injuries have dropped from 29.9 per 100,000 units to 18.8 (a 37% decrease).
- Fire damage has dropped from \$77.16 per unit to \$49.52 per unit (a 36% decrease).

Figure 5: First Nations' and Canadian Housing Fire Losses, Based on Residential Units

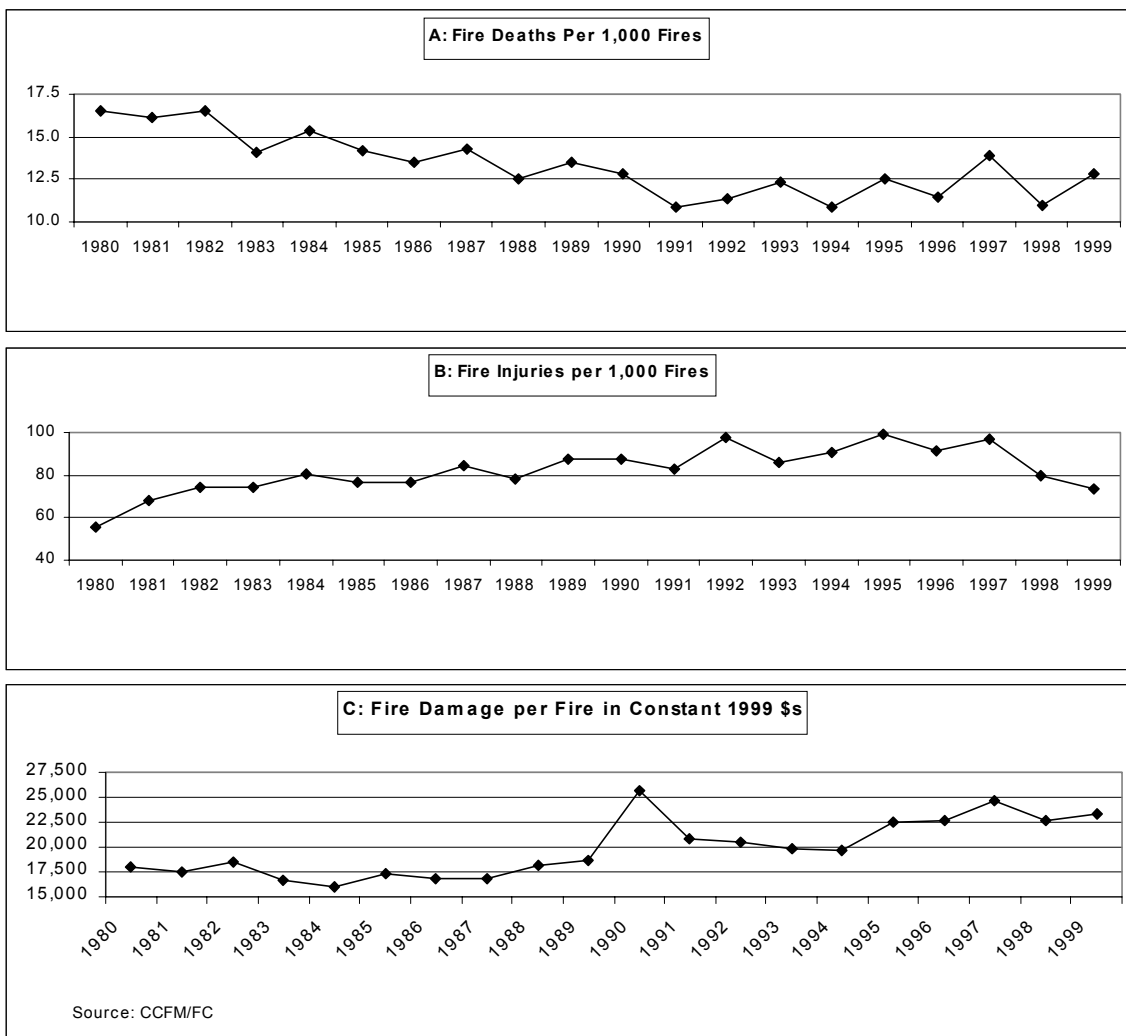


For First Nations, for the years 1980 to 1999, the corresponding Residential Units Benchmark is shown in Figure 5 along with the Canada-wide figures. First Nations' numbers of residential units are shown in Table 1. One factor to note in examining this benchmark is that First Nations' residential units are almost entirely 1 & 2 family dwellings while the Canada-wide figures contain a mix of unit types, with approximately two-thirds being 1 & 2 family dwellings. The comparison based on residential unit type (Section 5.2) may be more appropriate in this case. Table 4 shows this comparison based on 5-year averages for all residential units.

Using the number of residential units as the normalizing factor shows a significant difference in First Nations' losses compared to the Canada-wide losses. For the most recent 5-year reporting period (1995 to 1999), Table 4 shows that:

- Fire incidence rates in First Nations' residential units are currently at 443.5 fires per 100,000 units which is more than twice the Canada-wide rate.
- Fire death rates in First Nations' units are at 22.9 deaths per 100,000 units which is 8.8 times the Canada-wide rate. From the 1980-1984 average, however, that difference has dropped from 11.4 times the Canada-wide average.
- Fire injury rates in First Nations' units are at 37.5 injuries per 100,000 units which is twice the Canada-wide rate.
- Fire damage per unit is \$91.55 which is 1.8 times the Canada-wide rate.

Figure 6: Canadian Housing Fire Losses, Based on Fire Incidence



4.1.4 Fire Incidence Benchmark

A third basic benchmark in determining fire risk in residential units is to use the number of fire incidents to normalize the fire loss statistics. For the Fire Incidence Benchmark, the following components are shown in Figure 6 for the years 1980 to 1999:

- Number of fire deaths/1000 fire incidents
- Number of fire injuries/1000 fire incidents
- Fire damage/fire incident

Advantages – One of the major advantages of the Fire Incidence Benchmark is that it establishes a type of fire risk as a result of an individual fire and thus provides an indication of how "severe" an average fire has been.

Disadvantages – One significant disadvantage of the Fire Incidence Benchmark is its reliance on reported fires. As more fires are discovered from early warning smoke alarms and extinguished earlier, fewer are reported to the municipal fire departments thus giving an indication that, on a per fire basis, loss rates are increasing. Another disadvantage of this benchmark is its sensitivity to a single large fire loss.

**Table 5 – Housing Fire Losses Based on Fire Incidence
1980-1999**

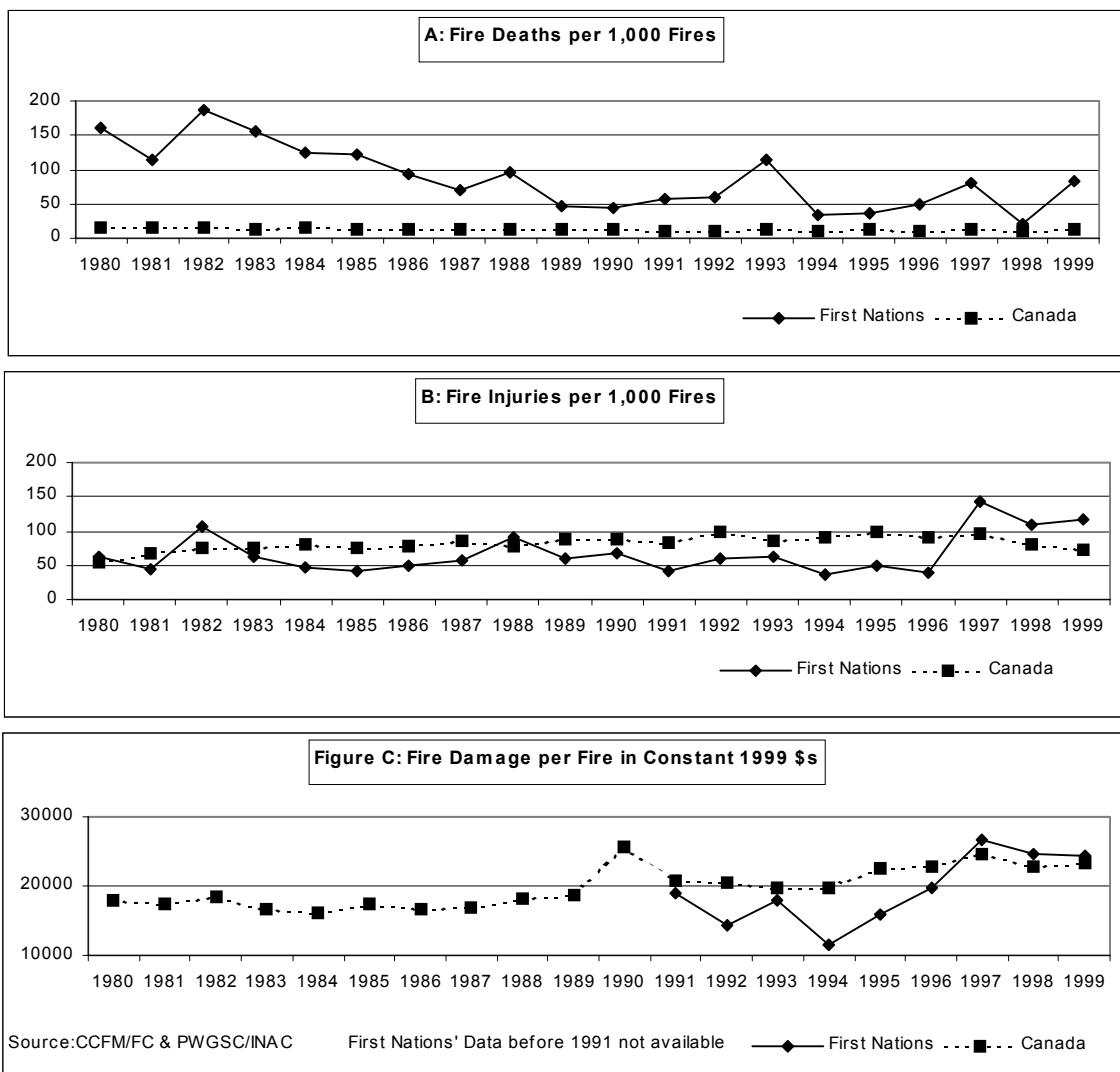
Table 5: Housing Fire Losses, Based on Fire Incidence						
Five Year Averages	Rates per 1,000 Fires				Fire Damage per Fire	
	Fire Deaths		Fire Injuries			
	Canada	First Nations	Canada	First Nations	Canada	First Nations
1980-1984	15.7	144.5	71.5	60.9	\$17,335	N/A
1985-1989	13.6	70.0	82.9	65.3	\$19,212	N/A
1990-1994	11.7	60.4	91.3	50.1	\$20,565	\$15,780
1995-1999	12.3	53.8	88.0	92.0	\$23,144	\$22,231

Examining Figure 6 and the information in Table 5, it can be seen that for the period 1980 to 1999, for the 5-year averages based on fire incidence on a Canada-wide basis:

- The fire death rate dropped 22% from 15.7 per 1000 reported fires to 12.3.
- The fire injury rate increased 23% from 71.5 per 1000 reported fires to 88.0.
- The fire damage rate per fire increased 34% from \$17,335 per fire to \$23,144.

In viewing this benchmark, care must be taken to recognize the total dependence on reported fires. It is considered that, with smoke alarms and increased public fire safety education, fewer fires are reported since they are discovered and extinguished while still quite small and not reported to the fire services. Thus, they do not usually appear in the fire loss statistics. Determining the exact number of fires in Canada is difficult. Informal information received from the insurance industry indicates that one insurance group (representing 64% of the value of insurance in Canada), for 1999, received 261,965 fire claims from residential units. The reported number of residential fires for 1999 was 22,150. It is not known what the total number of claims from all insurance companies was since scaling is impossible from the information received. It is also not known how many multiple claims for a single fire incident were received. Suffice to state that the actual number of fires in Canada in 1999 can conservatively be estimated to be 10 times the reported number of fires.

Figure 7: First Nations' & Canadian Housing Fire Losses, Based on Fire Incidence



For First Nations, for the years 1980 to 1999, the corresponding Fire Incidence Benchmark is shown in Figure 7. Table 5 provides 5-year average comparisons of First Nations' and Canada-wide losses based on fire incidence.

For the most recent 5-year period, the following comparative observations can be made:

- The rate of fire deaths, based on fire incidence, in First Nations' housing is 4.4 times the rate Canada-wide.
- The rate of fire injuries is approximately the same.
- The fire damage per fire is slightly less for First Nations' housing.

As indicated previously, possible under-reporting of fire incidents in both First Nations' communities and Canada-wide makes comparisons based on fire incidence somewhat suspect.

4.1.5 Rates of Decreases/Increases in Fire Losses

One of the issues identified early in this project was the need to determine whether or not the rates of decreases (or increases) in fire deaths, injuries and damage have changed over the study period of 20 years. Table 6 compares the annual average decreases (increases) over 20 years, 15 years, 10 years and 5 years for the three benchmarks. This is the total decrease/increase divided by the number of years in the reporting period. This assessment has been undertaken to determine if previously implemented fire safety measures in residential units are still having an impact on fire losses.

Table 6 – Average Annual Changes in Housing Fire Loss Statistics

Table 6: Average Annual In(De)crease in Benchmarks - Canada Wide			
	Per 100,000 Population	Per 100,000 Units	Per 1,000 Fires
Fire Deaths			
1999-1980	-5.2	-5.3	-0.6
1999-1985	-4.7	-4.7	-0.4
1999-1990	-4.5	-3.7	0.5
1999-1995	-4.2	-4.5	0.1
Fire Injuries			
1999-1980	-2.5	-2.7	2.0
1999-1985	-4.1	-4.2	-0.1
1999-1990	-5.7	-5.0	-1.2
1999-1995	-6.8	-6.3	-3.7
Fire Damage			
1999-1980	-2.3	-3.0	2.0
1999-1985	-0.7	-0.7	3.2
1999-1990	-1.4	-0.6	3.2
1999-1995	0.7	1.2	3.8

Fire Deaths – Table 6 shows that, for the study period, based on population, the average annual decrease in fire deaths is 4.2 to 5.2%. The average annual decrease based on residential units is in the range of 3.7 to 5.3%. Both of these mean that reductions in losses are still being accrued as a result of previous fire safety improvements and that improvement in loss rates is still occurring. On the basis of fire incidence (per 1000 fires), however, the annual average rate in fire deaths has increased both on a 5-year and 10-year basis. Recall the discussion on fewer reported fires thus making this number suspect.

Fire Injuries – Table 6 shows that the annual average rate of increase/decrease in fire injuries, based on all 3 benchmarks, continues to decrease. The most substantial average decreases have occurred over the past 5 years and are in the range of 3.7 to 6.8% per annum depending on the benchmark used.

Fire Damage – Based on population, residential units and fire incidence, Table 6 shows that the annual average rate of increase/decrease in fire damage has changed from a decrease over the 10-20 year period to an increase over the most recent 5-year period based on population and number of units. The rate based on fire incidence has

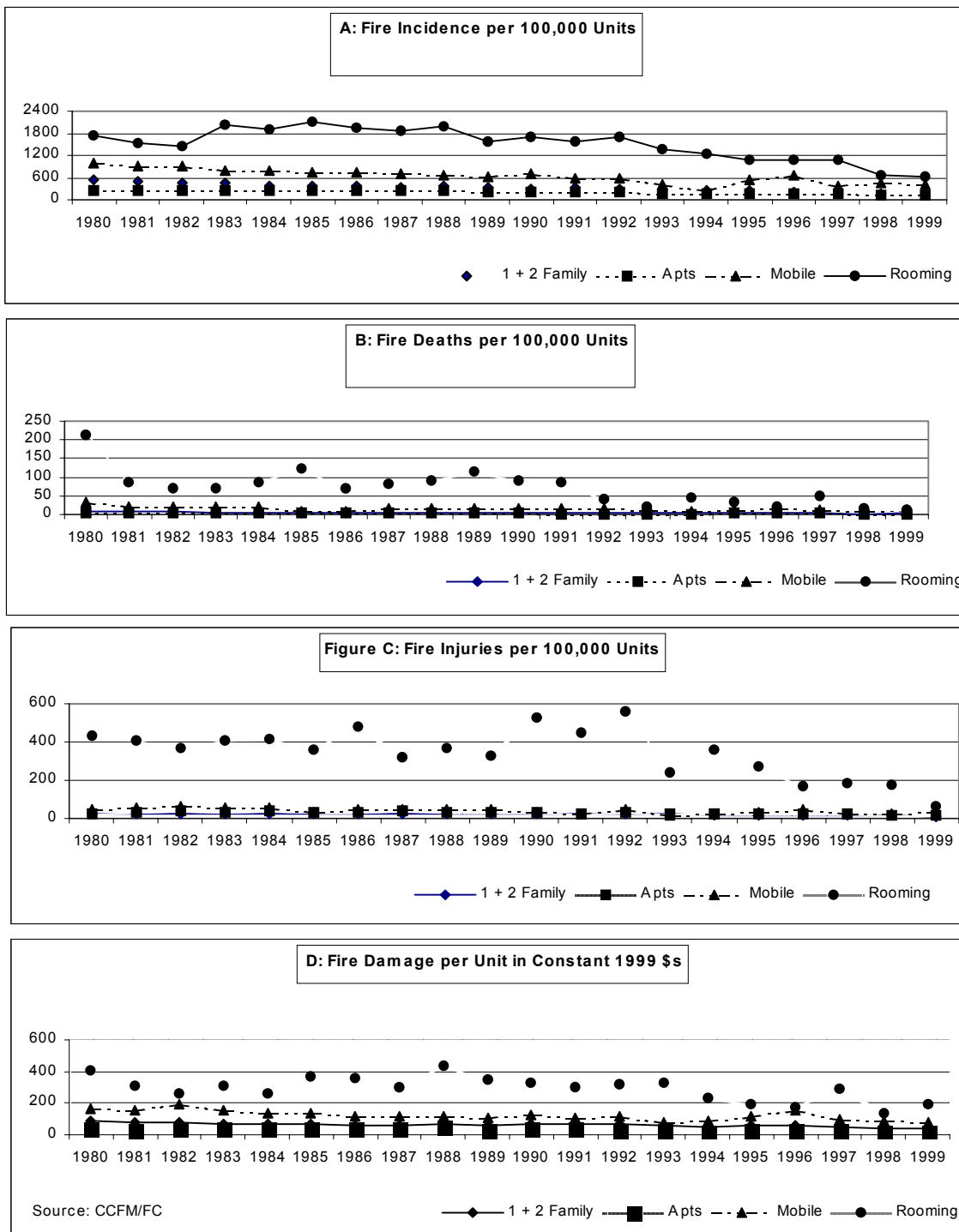
increased over all periods. Depending on the benchmark used, over the last 5-year period, that increase varied between 0.7 and 3.8% per annum. An increase in fire damage may be attributable to the greater accumulation of wealth in the average residential unit – this aspect could be investigated in the future. With an increase in wealth in residential units, even a smaller fire could result in greater fire damage.

4.2 Specific Fire Risk Indicators

4.2.1 Overview

While the Population, Residential Unit and Fire Incidence Benchmarks provide valuable baseline information on fire risk in housing, there are other specific indicators that may also be illustrative of fire risk for the purpose of examining housing fire safety policy. Candidate fire risk indicators to be examined are: types of residential units, ages of victims, urban/rural location, household size, condition of unit and ignition sources. Each of these will be analyzed using the available data to determine fire risk as represented by the fire incidence and loss rates. Other non-housing indicators, not included in this report but which have been shown to affect fire losses, include poverty, education level and the use of smoking materials.

Figure 8: Canadian Fire Losses, Based on Number of Residential Units, by Unit Type



4.2.2 Residential Unit Types

One suggested measure of risk to occupants is the type of residential unit in which they live. It is a commonly held belief that a person living in an apartment faces a greater risk from fire than in a single family dwelling since s/he does not have control over the total building environment, especially the means of egress. To study this possibility, Figure 8 shows the fire incidence, deaths, injuries and damage, on the basis of number of units for each dwelling type (Canada-wide). Table 7 shows the same data as 5-year averages. What stands out from an examination of this data are the substantially higher fire incidence and losses for Rooming and Lodging Houses and Mobile Homes compared to other residential unit types.

**Table 7 – Housing Fire Losses by Type of Residential Unit
1980-1999**

Table 7: Canadian Fire Losses, Based on Number of Residential Units by Type of Unit				
	1 & 2 Family Dwellings	Apts	Mobile	Rooming
Period	Fire Incidence per 100,000 Units			
1980-1984	461.6	252.5	883.7	1725.1
1985-1989	354.0	231.9	691.6	1895.8
1990-1994	283.3	183.7	504.9	1510.1
1995-1999	186.7	142.1	490.1	908.2
Period	Fire Deaths per 100,000 Units			
1980-1984	6.9	3.9	22.6	105.0
1985-1989	4.6	3.2	13.3	96.1
1990-1994	3.3	1.8	13.1	56.6
1995-1999	2.2	1.8	12.8	26.5
Period	Fire Injuries per 100,000 Units			
1980-1984	23.9	33.0	55.5	406.4
1985-1989	21.6	32.4	43.6	371.5
1990-1994	20.6	26.6	28.3	427.8
1995-1999	15.1	20.0	31.9	171.6
Period	Fire Damage per Unit			
1980-1984	\$76.72	\$36.18	\$162.08	\$308.65
1985-1989	\$61.32	\$38.61	\$118.95	\$363.55
1990-1994	\$59.08	\$31.28	\$102.33	\$303.35
1995-1999	\$46.71	\$23.23	\$108.57	\$196.43

1 & 2 Family Dwellings – From Table 7, it can be seen that, based on 5-year averages, the fire incidence rate per 100,000 units has dropped 60% from 461.6 to 186.7; the fire death rate from 6.9 to 2.2, a 68% decrease; the fire injury rate from 23.9 to 15.1, a 37% decrease; and the fire damage rate per unit has dropped 39% from \$76.72 to \$46.71. What is interesting to note is that while the 1 & 2 family dwelling fire death rate is 22% higher than the rate for apartments, the fire injury rate is 24% lower for the period 1995 to 1999. The reasons for these differences are not yet clear but could point to higher fire safety requirements in Codes for apartment buildings.

Rooming and Lodging Houses – Comparing Rooming and Lodging Houses to 1 & 2 family dwellings for the most recent five years indicates that, while fire incidence and losses are dropping with time:

- The fire incidence rate for Rooming and Lodging Houses is nearly five times the 1 & 2 family dwelling rate.
- The fire death rate is over 12 times the 1 & 2 family dwelling rate.
- The fire injury rate is over 11 times the 1 & 2 family dwelling rate.
- The fire damage per unit is over four times the 1 & 2 family dwelling rate.

Mobile Homes – Examining the mobile home fire incidence and loss rates, yields the following observations for the most recent five years:

- The fire incidence rate is 2.6 times the rate for 1 & 2 family dwellings.
- The fire death rate is 5.8 times the rate for 1 & 2 family dwellings.
- The fire injury rate is over twice that for 1 & 2 family dwellings.
- The fire damage per unit is 2.3 times the rate for 1 & 2 family dwellings.

Apartments – This information, especially Table 7, shows that for the most recent 5-year period, the fire losses in apartments are actually less than those for 1 & 2 family dwellings, except for injuries. The data also shows that most fire loss rates are decreasing over time. Specifically, for apartments:

- The fire incidence rate is 0.76 times the rate for 1 & 2 family dwellings.
- The fire death rate is 0.82 times the 1 & 2 family dwelling rate,

- The fire injury rate is 1.3 times the 1 & 2 family dwelling rate
- The fire damage rate per unit is 0.5 times the 1 & 2 family dwelling rate.

The higher fire injuries rate for apartments can possibly be attributed to the common egress path in apartment buildings where all occupants could be exposed to the smoke from a fire in a single unit. This, however, is not known for certain.

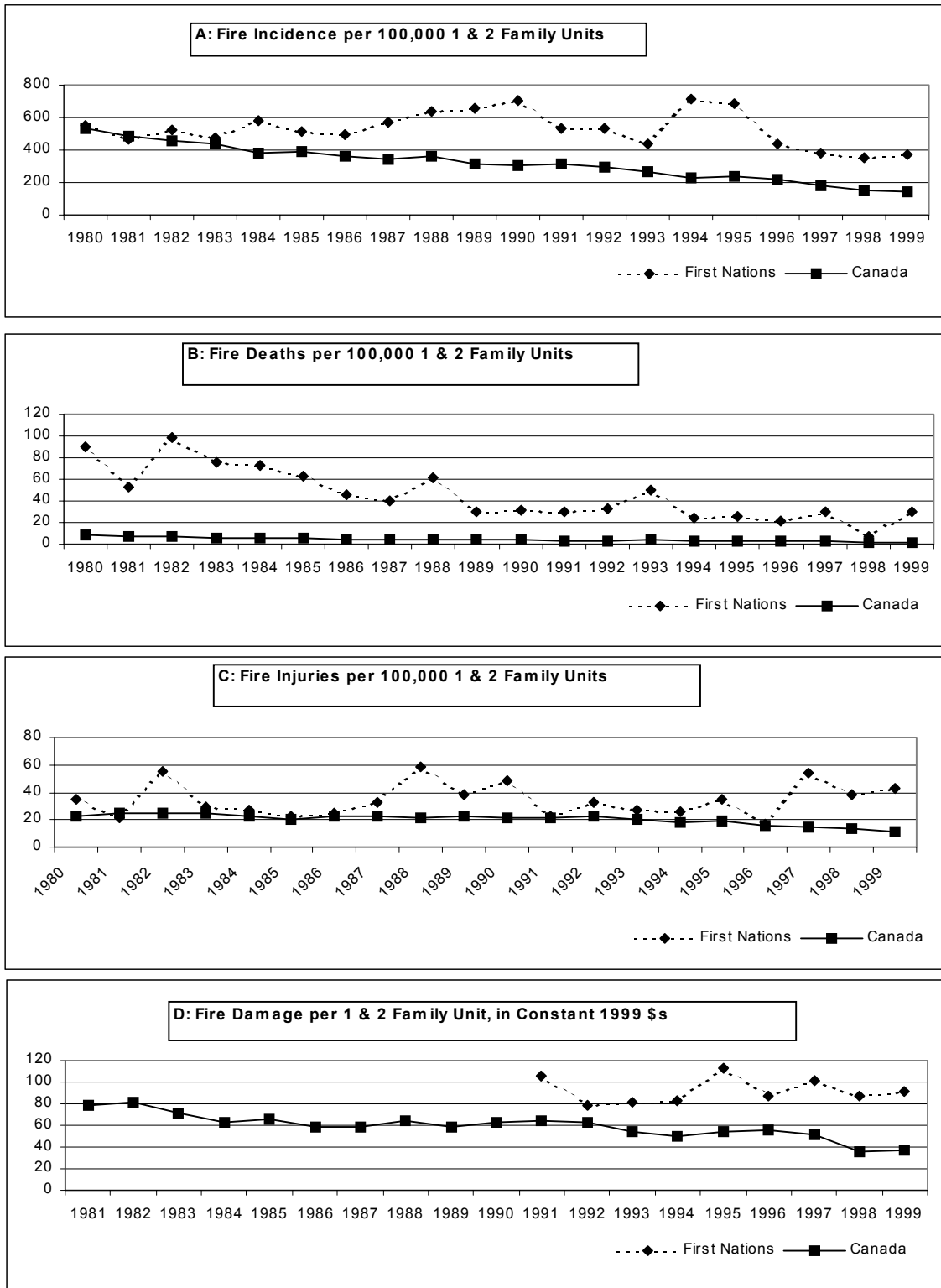
First Nations – For First Nations, given that most of their residential units are 1 & 2 family dwellings, a comparison with the Canada-wide figures for 1 & 2 family dwellings provides a more appropriate measure of relative losses. This comparison is shown in Figure 9. Table 8 provides the same data based on 5-year averages. In comparing the First Nations' and Canada-wide 1 & 2 family dwelling fire incidence and losses, Table 8 yields the following observations for the most recent 5-year period:

**Table 8 – Comparative Fire Losses in Canada-Wide and First Nations'
1 & 2 Family Dwellings**

Table 8: Canadian and First Nations' Fire Losses in 1 & 2 Family Units per 100,000 Dwellings								
Year	Fire Incidence		Deaths		Injuries		Damage per Unit	
	Canada	First Nations	Canada	First Nations	Canada	First Nations	Canada	First Nations
1980-1984	461.6	520.2	6.9	77.8	23.9	33.6	\$76.72	N/A
1985-1989	354.0	575.5	4.6	48.2	21.6	35.3	\$61.32	N/A
1990-1994	283.3	584.1	3.3	33.6	20.6	31.2	\$59.08	\$86.86
1995-1999	186.7	443.5	2.2	22.9	15.1	37.5	\$46.71	\$95.89

- The First Nations' fire incidence rate is 2.4 times the rate for Canada-wide.
- The First Nations' fire death rate is 10.4 times the rate for Canada-wide.
- The First Nations' fire injury rate is 2.5 times the rate for Canada-wide.
- The First Nations' fire damage per unit is 2.1 times the Canada-wide rate.

Figure 9: First Nations' & Canadian Fire Losses, 1 & 2 Family Units, per 100,000 Units



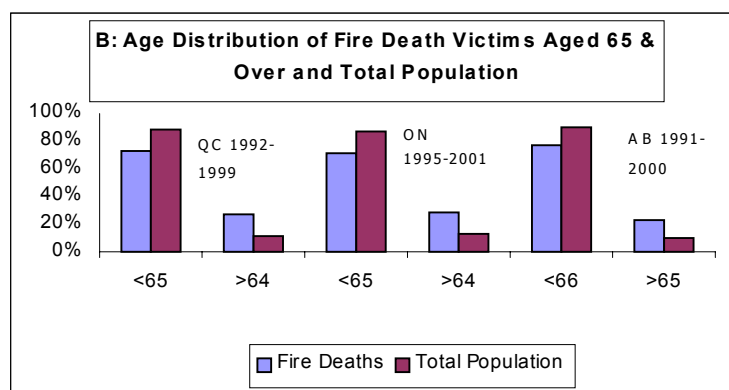
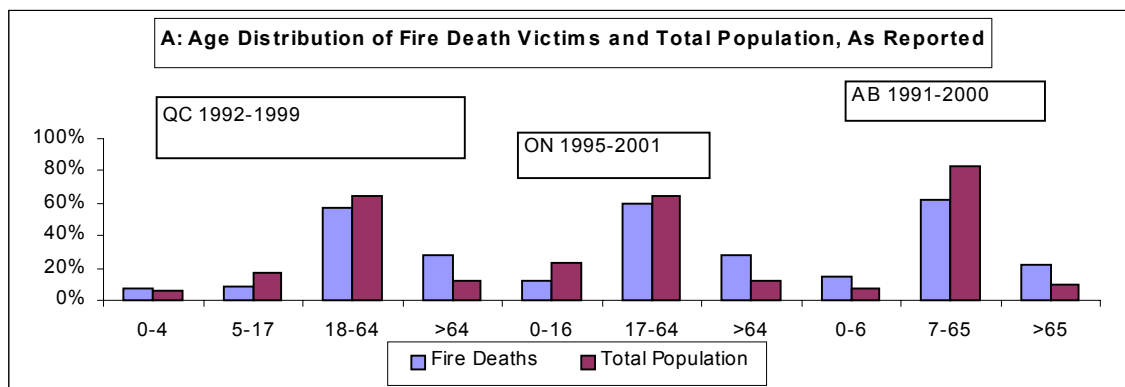
4.2.3 Ages of Victims

Another often-quoted fire anecdote is that the very young and the very old are those most likely to be injured or killed by fires. For older adults, in particular, this is an extremely important issue from the housing policy perspective. Due to provincial reporting differences, it is difficult on a Canada-wide basis to provide further analysis on the very young (Ages 0-5) age group since the data for this group is often combined with older children as shown in Figure 10A for Quebec, Ontario and Alberta. Figure 10A shows the information directly reported from those provinces.

For the purposes of this indicator, the Canadian population has been divided into two groups: ages 0-64 inclusive and those age 65 and over. Fire deaths are the only statistic reported by age of victim so an evaluation of impact on older adults based on injuries could not be undertaken. In residential unit fires (for the three provinces noted above), the breakdown by age is shown on a population basis in Figure 10B. Figure 10B compares the percentage of older adults in the population at large to the percentage of fire deaths of older adults compared to all fire deaths. This information ^(6,7,8) has been received from the provincial fire marshals and fire commissioners in Ontario, Alberta and Quebec. These provinces constitute approximately 75% of the population of Canada and approximately 70% of the population 65 years of age and older. For First Nations' fires, data on age of victim is not collected beyond "adult" and "child" with no ages given. Comparisons, such as Figure 10B, with other Canada-wide figures are not possible.

From a review of the data in Figure 10B, it can be seen that the fire death rate for those 65 years of age and older is approximately double the rate of the percentage of the population of older adults in the three provinces. Given that these three provinces account for a higher proportion of Canada's older adults, it is reasonable to assume that the death rates for Canada-wide would be approximately the same as these rates. This indicates that the risk of death from fire for older adults is approximately double the risk of those less than age 65, based on these statistics.

Figure 10: Fire Deaths by Age of Victim – Selected Provinces



4.2.4 Urban/Rural Location

There is also a commonly-held belief that fire losses in rural areas are higher than in urban areas. Since "rural" fire statistics are not collected per se, communities with populations less than 2,500 are sometimes used as proxies for "rural" communities. That approach will be used in this study.

British Columbia – The British Columbia Fire Commissioner's Office provided the project team with detailed fire information ⁽⁹⁾ for the province for the period 1987 to 2002 (although some of the later data was not yet complete). The project team constructed a database of this information which included the population for each municipality. From this database, Table 9 has been constructed. By comparing the population range to the fire loss statistics, it is possible to determine if a certain size of community contributes more or less to the fire statistics than its share of the population would suggest. The BC

data shows that, for communities with a population of 2,500 or less, the fire incidence, deaths and damage are disproportionately large compared to the population. In fact, the fire deaths are 4.3 times the rate that would be expected, based on population.

**Table 9 – B.C. Fire Losses by Community Size
1987-2002**

Table 9: British Columbia Fire Statistics by Community Size, 1987-2002					
Population Range	Fire Incidence	Fire Deaths	Fire Injuries	Fire Damage	Population
0 - 2,499	2.4%	7.3%	1.6%	2.8%	1.7%
2,500 - 4,999	4.5%	6.2%	2.8%	5.3%	3.2%
5,000 - 9,999	5.6%	4.8%	3.7%	7.1%	4.9%
10,000 - 24,999	12.5%	15.7%	12.6%	12.7%	11.0%
25,000 - 49,999	8.2%	9.0%	5.3%	10.2%	7.4%
50,000 - 99,999	26.2%	24.1%	23.0%	24.6%	25.6%
100,000 - 249,999	13.6%	10.4%	13.7%	12.7%	20.2%
250,000 - 499,999	9.2%	7.8%	8.7%	9.7%	9.7%
500,000 - 999,999	18.0%	14.8%	28.6%	14.9%	16.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Ontario – In examining fire incidence rate based on community size⁽¹⁰⁾, the Ontario Fire Marshal's Office reports that the fire incidence rate in communities less than 2,500 is 6.1 fires/1000 population/year (average 1995 to 1999) whereas for communities with 5,000 or more, the rate is 3.4 fires/1000 population/year or less. Information was not received in the same format as Alberta and BC to provide equivalent statistics. Communities between these two populations have fire losses between these two limits. The 5-year average fire death rate for "rural" communities is 3.5 deaths/100,000 population whereas the provincial average is 1.2 deaths/100,000 population. These statistics show, therefore, that the rural fire incidence rate is 1.8 times the urban and the fire death rate is almost 3 times the urban rate.

Alberta – The Fire Commissioner of Alberta provided data on the size of municipality and fire incidence and losses for the period 1991 to 2001⁽¹¹⁾. For that 10-year period, Table 10 shows that the "rural" population represented 5.5% of the total. The fire incidence rate was approximately the same at 5.6%. While the fire damage rate was approximately 0.5 times the expected rate, based on population, the fire injury rate

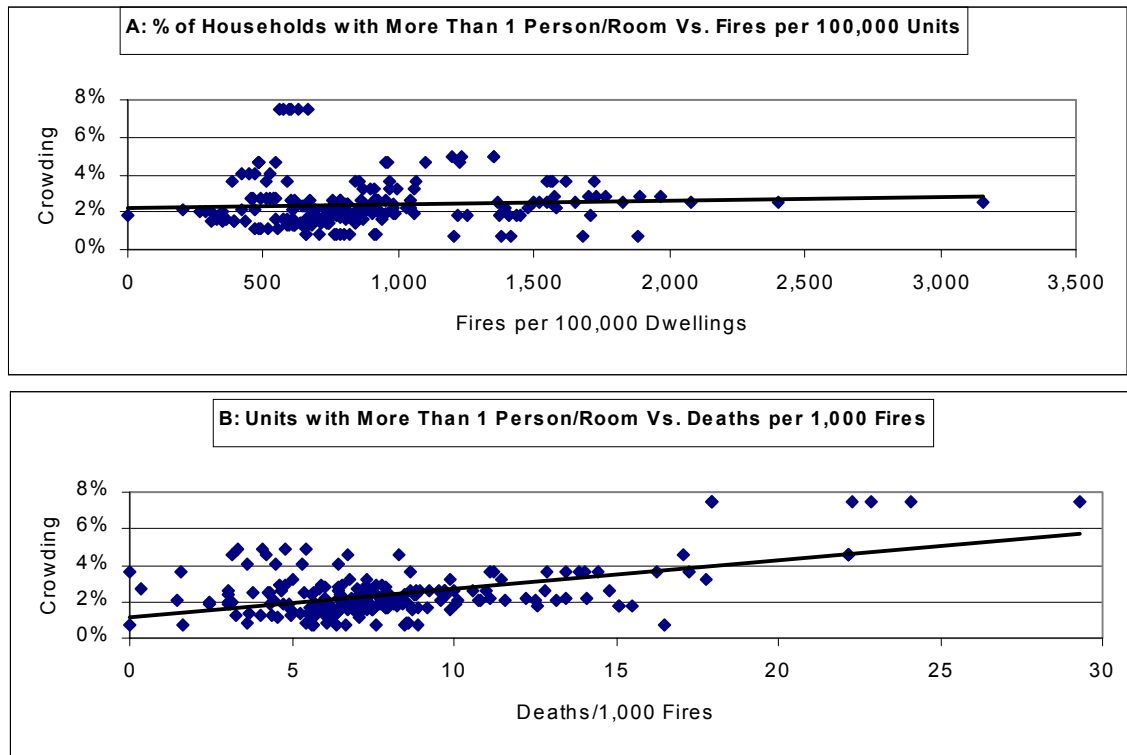
was almost 1.9 times. The fire death rate was 1.5 times the expected rate based on population.

**Table 10 – Alberta Fire Losses by Community Size
1991-2002**

Population Range	Fire Incidence	Fire Deaths	Fire Injuries	Fire Damage	Population
0 - 2,499	5.6%	8.5%	10.3%	2.8%	5.5%
2,500 - 4,999	6.1%	8.9%	4.6%	3.7%	6.3%
5,000 - 9,999	10.3%	16.4%	15.7%	5.1%	13.4%
10,000 - 24,999	9.5%	16.2%	11.8%	6.1%	8.6%
25,000 - 49,999	6.5%	7.6%	3.8%	4.3%	6.0%
50,000 - 99,999	10.8%	9.5%	23.3%	10.2%	7.1%
500,000 - 999,999	51.1%	32.9%	30.5%	67.8%	53.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

In examining community size as an indicator, these statistics for three provinces show that smaller community size correlated with higher fire losses, especially fire deaths. Communities of 2,500 or less (considered "rural") have fire incidence rates up to twice that for larger communities and fire death rates of approximately 2 to 4 times the rates for larger communities, based on the samples studied.

Figure 11: Canadian Fire Incidence & Deaths Related to the Number of Residential Units with More than One Person per Room



4.2.5 Household Size and Crowding

One of the other axioms related to fire losses is that there are a greater number of deaths and injuries in residential units that have larger numbers of occupants than in those with fewer occupants. This indicator may be of value in seeking correlations of losses based on socio-economic conditions, or between societies where families are traditionally large or where, traditionally, multiple generations occupy the same residential unit, and those where they do not. It was hoped that by examining provincial/territorial variations in sizes of households, a correlation between fire losses and size of household could be established. In examining the interprovincial household size data, it was found that the variation was from 2.5 to 2.9 persons per household – too narrow a variation for further analysis.

This indicator was also investigated by examining the impact of crowding on fire incidence and fire deaths. As defined in the Census, "crowding" occurs when the number of persons in a household exceeds the number of rooms – or there is greater than one person per room. In examining Canada-wide data, the incidence of crowding from the Census was compared to the incidence of fires and fire deaths over the 20-year study period. Figure 11A shows that there is a slight increase in the trend line in fire incidence with increased crowding, however, this is quite small. Figure 11B, however, shows that, as crowding increases, the trend line for the number of fire deaths per 1000 fires also increases. This, then, shows that crowding, while not a factor in fire incidence rate, has a definite impact on fire death rates. The data does not, however, allow a comparison of increased household size, without crowding, with fire incidence and fire deaths. While there is still no data to support the reasons for this increase, it can be surmised that greater numbers of occupants mean more persons at risk to a single fire and more potential for fire starts. On the other hand, there are also more persons to detect fire. While the correlation between crowding and fire deaths is far from perfect, it is positive and statistically significant.

In examining fire losses in First Nations' housing in Alberta ⁽¹³⁾, the Alberta Fire Commissioner reports that the percentage of First Nations' dwellings with more than one person per room (i.e., crowding exists) was 8 times the Canada-wide rate. This may be one indicator for the higher First Nations' fire death rates, given the correlation shown in Figure 11B.

4.2.6 Household Age/Condition

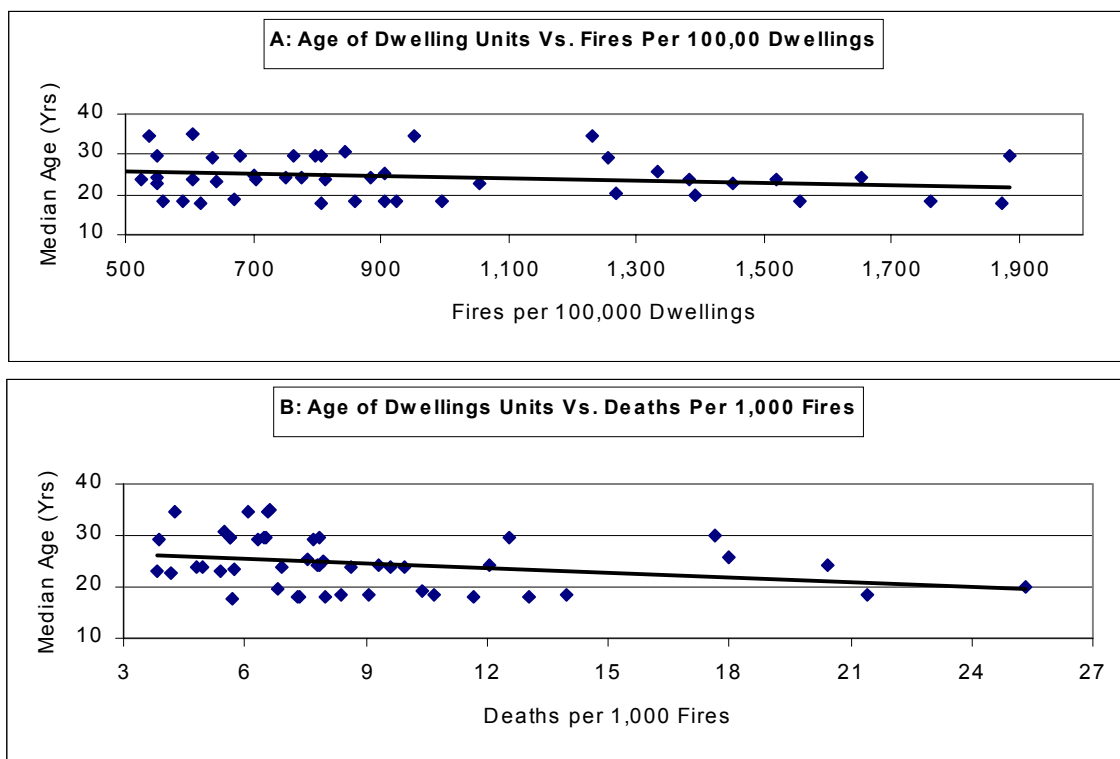
The research also looked for other possible correlations for the incidence of fires and fire deaths in residential units. Two such indicators that are available are age of dwelling and its physical condition. Another factor could be the building codes applicable at the time of construction of the unit - which also correlates with the age of the unit. Building codes have, over the years, incorporated changes such as smoke alarms, less flammable interior finishes and improved electrical wiring and devices. All of these would, over time, result in improved fire safety. By knowing when a dwelling was built, one can determine which edition of the code applied and what fire safety

measures would have been incorporated in the unit at that time – assuming that no major renovation had occurred in the interim.

As a dwelling ages, its condition will normally deteriorate unless it is renovated or renewed. Such activity is common in high cost areas where the location of the dwelling justifies this additional investment. That is an example of a confounding variable that could overshadow any correlation between dwelling age and condition.

It is commonly assumed that the more run-down a dwelling is, the greater the propensity for fire and for fire losses. Since there is no means to determine the condition of a dwelling from fire loss statistics, a proxy for condition is age of dwelling at the time of the fire. That information is not commonly reported so the average age of a unit from the Census has been used. The results of this analysis are shown in Figure 12 for age of residential units, fire incidence and fire deaths.

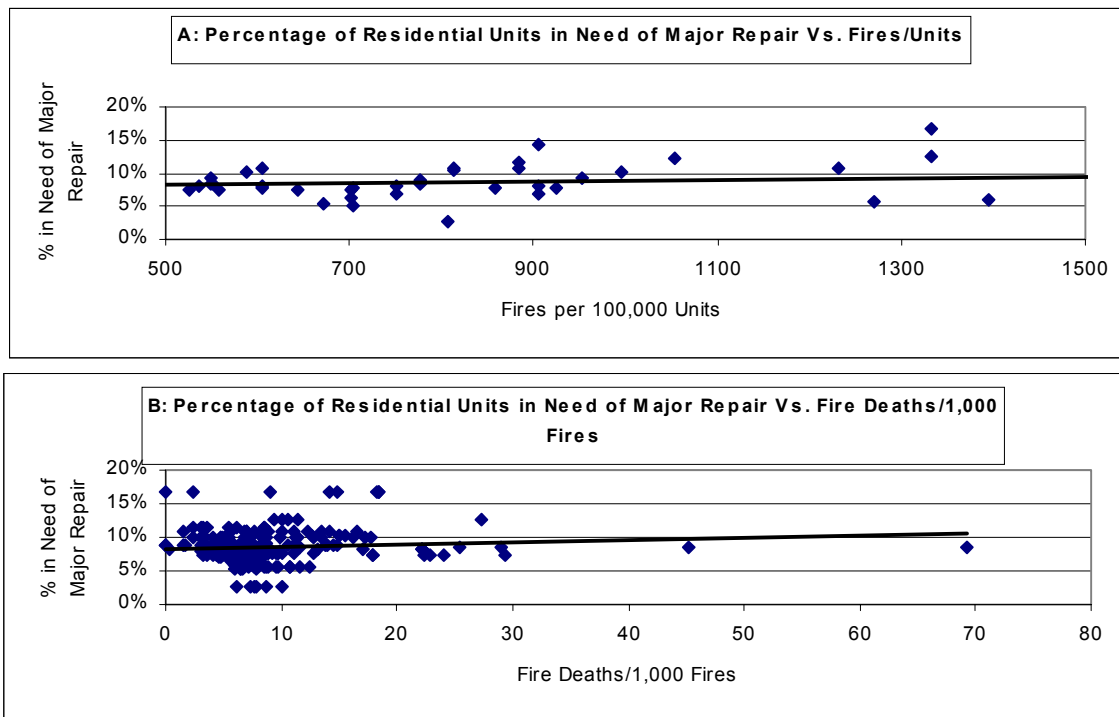
Figure 12: Canadian Fire Incidence & Deaths Related to the Age of Residential Units



The data used in Figure 12 involves “pooling” the information on fire incidence per province and the average age of dwellings in that province from the Census (4 editions) which collects the age of units in ranges. These were converted to a median age, at the provincial level, for each Census. If age is a true indicator, then those provinces with older dwelling stocks should have higher fire incidence and deaths. Data series were constructed for fire incidence and deaths and age of residential units for the period 1980 to 1999. The pooled data were then plotted in Figure 12. The pooled data series had four dimensions – province, year, average age of units and fire incidence (and deaths). Two of these variables, age and fire deaths and age and fire incidence, were isolated for analysis. The trend line in Figure 12A shows that there is a very slight increase in fire incidence as the age of residential units increases. The trend line in Figure 12B shows a gradual decrease in the fire deaths per 1000 fires as the median age of units increases. This latter trend line would appear to be counter-intuitive but can be explained by the lower reporting of small fires in residential units (after 1980) equipped with smoke alarms. Older units could have been retrofitted with smoke alarms as they probably, given their age, have been subjected to renovation activity of some sort. Obviously other factors, than just unit age, are playing a role in fire losses. This requires further study.

The Census also asks householders if they consider their unit to be in need of major repair, minor repair or simply regular maintenance. "Major repair" is generally defined as including such factors as structural changes, or major mechanical or electrical system upgrades. In the latter cases, the need for repairs could indicate a heightened fire risk. As in Figure 12, data series were constructed in Figure 13 for fire incidence and deaths by province on "need for repair" for the period 1980 to 1999. To isolate the effect of need for repair, it alone is plotted against fire incidence and fire deaths. Figure 13A shows the correlation between the need for major repair and the incidence of fires. The trend line shows an increase in fire incidence with increasing householder perception of the need for residential unit repairs. The trend line in Figure 13B shows a slight increase in fire deaths as householder perception of the need for repairs increases.

Figure 13: Canadian Fire Incidence & Fire Deaths Related to Need for Repair of Residential Units



4.2.7 Ignition Scenarios

Many of the issues surrounding fire ignitions in residential units could be impacted by the housing itself while others may only be impacted by occupant behaviours, regardless of the housing. (For example, smoking was considered to be an occupant behaviour issue rather than a housing issue.) Only housing issues were considered as part of this research; occupant behaviour issues were considered to be beyond the scope. In looking at ignition scenarios, therefore, only scenarios related to the residential unit and its equipment were considered. In this research, ignition source is the actual equipment, device or item which brings about ignition of the residential unit or its contents. The act or omission causing the fire (or cause of fire) is the set of circumstances which led to the fire occurring.

For most of the sources of ignition and causes of fires related to the residential unit, a gradual decrease in fire incidence and losses over the 20-year study period can generally be observed in Figures 14 and 15. Tables 11 and 12 provide 5-year averages for some of the data presented graphically in Figures 14 and 15.

**Table 11 – Fire Incidence by Ignition Source
1980-1999**

Year	Cooking Equipment	Heating Equipment	Exposure	Electrical Equipment & Appliances
1980-1984	14,705	14,272	3,537	24,446
1985-1989	14,291	11,883	3,184	18,932
1990-1994	12,192	9,213	2,356	14,586
1995-1999	8,998	6,887	3,036	14,133

**Table 12 – Fire Incidence by Cause
1980-1999**

Year	Construction, design or installation deficiency	Mechanical, Electrical failure, malfunction	Misuse of Equipment	Misuse of Material
1995-1999	4,212.93	26,383.83	1,650.30	6,164.76
1990-1999	4,040.42	23,813.58	1,565.54	5,810.53
1985-1999	3,575.96	21,219.94	1,321.53	4,010.70
1980-1999	3,974.24	18,977.93	661.90	3,862.64

Figure 14: Canadian Fire Incidence & Fire Deaths Related to Need for Repair of Residential Units

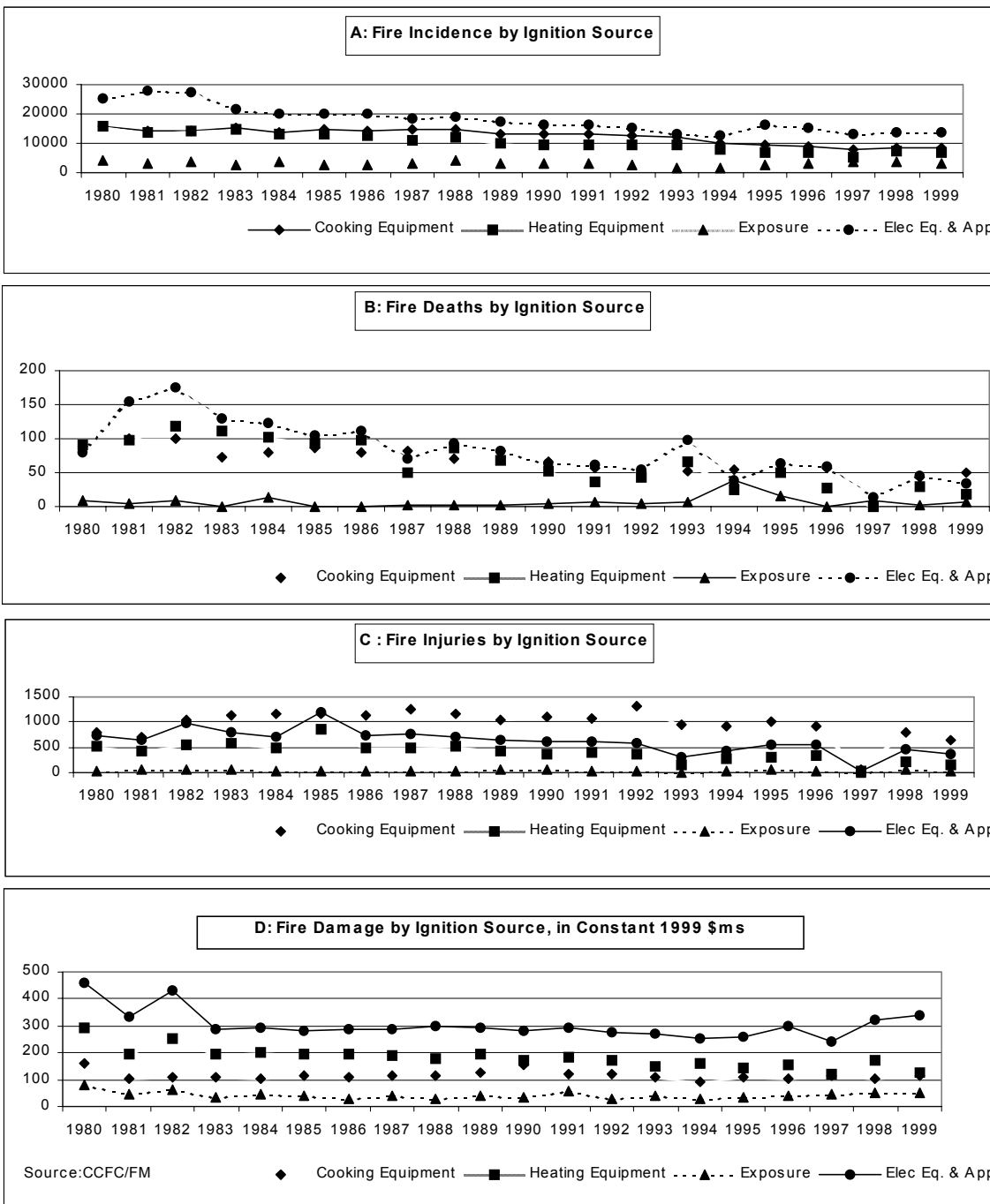
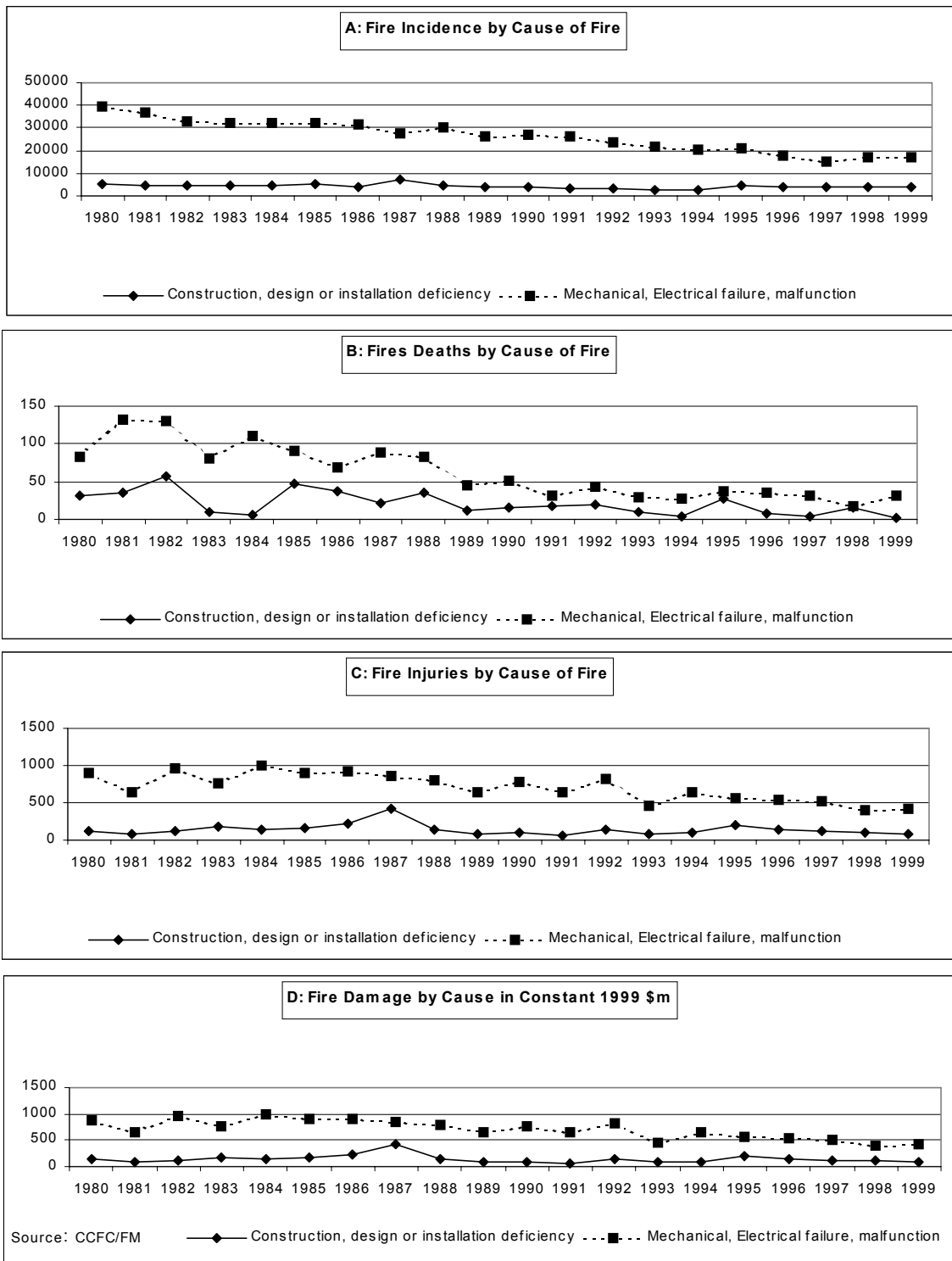


Figure 15: Canadian Housing Fire Losses, Based on Cause of Fire: Units Normalized for Changes in Total Dwelling Stock



In Figure 14, the recent slight increase in dollar loss attributed to electrical equipment and appliances (Figure 14D and Table 11) could easily be the result of greater values of contents (including electrical equipment) in residential units. As shown in Figures 1 and 4, the fire damage per capita and per residential unit has not dropped appreciably over 20 years and the number, use and value of electrical appliances has increased. As Table 12 and Figure 15 show, mechanical/electrical failure or malfunction is dropping as a cause of fire incidence.

Source of Ignition – In terms of Source of Ignition (as defined in the CCSFLS ⁽¹⁾), the following are addressed in this research:

- Cooking equipment
- Heating equipment
- External fire exposure
- Electrical distribution equipment and other electrical equipment (including “other appliances and equipment”)

Over the period 1980 to 1999, the Canadian fire incidence and losses by sources of ignition are shown in Figure 14 and the 5-year averages in Table 11. The number of residential units was normalized to the 1999 figures to provide a full housing stock basis of comparison. From Table 11, the most significant source of ignition, related to issues that can be impacted by housing policy, is electrical equipment and appliances. The number of fires attributed to these sources has been declining gradually over the last 20 years (Table 11). The second most frequent source has been cooking equipment, which has also showed a decline. Heating equipment as an ignition source is declining even more rapidly in numeric terms but remains the third most common source. Although fourth as a source, external fire exposure (from sources outside the unit) has been exhibiting a slight increase in numeric terms as the other sources have declined in importance.

Cause of Fire – In terms of Act or Omission Causing Fire (as defined in the CCSFLS ⁽¹⁾), the following are addressed in this research:

- Construction design or installation
- Mechanical, electrical failure or malfunction

Over the period 1980 to 1999, the Canadian fire incidence and losses by cause of fire are shown in Figure 15 and the 5-year averages in Table 12. The number of housing units was again normalized to the 1999 figures. In terms of causes of fires, malfunctions of mechanical/electrical equipment are declining whereas construction design or installation deficiency appears to be constant. Greater detail on this latter cause is needed to determine what deficiencies are causing these fires.

4.2.8 Residential Units Fires Compared to All Losses

One of the means to evaluate the magnitude of housing fire losses and whether or not they are changing in relation to other fire losses is to compare, over time, residential unit losses as a percent of total losses. Table 13 examines residential fire losses as a portion of all losses over the period 1970 to 1999 on a 5-year average basis.

**Table 13 – Residential Unit Fires Compared to all Canadian Fires
1970-1994**

Table 13: Residential Fires Compared to All Fires 1970-1999				
Period	Residential As Per Cent of All Fires			
	Fire Incidence	Fire Deaths	Fire Injuries	Fire Damage
1970-1974	60.1%	85.9%	N/A	31.3%
1975-1979	51.1%	84.6%	N/A	37.9%
1980-1984	47.0%	85.3%	62.7%	38.5%
1985-1989	46.1%	79.7%	62.3%	41.2%
1990-1994	42.3%	79.3%	65.8%	44.4%
1995-1999	39.5%	73.5%	64.4%	40.9%

The following observations apply to that data:

- Fire Incidence – As a percentage of total fires, residential fire incidence has dropped from 60.1% to 39.5% – comparing the early 1970s to the late 1990s.
- Fire Deaths – As a percentage of total fire deaths, residential fire deaths have dropped from 85.9% to 73.5% – comparing the early 1970s to the late 1990s.

- Fire Injuries – Injuries were not recorded until the 1980s. Over the 20-year period from 1980 to 1999, residential fire injuries have increased slightly from 62.7% to 64.4% of total fire injuries.
- Fire Damage – As a percentage of total fire damage, residential fire damage has increased from 31.3% to 40.9%.

These comparisons indicate that while housing fire incidence and fire deaths have been falling as a percentage of all fires, the fire injury rate has essentially remained constant and fire damage has increased as a percentage of total fire damage.

5.0 SUMMARY AND RECOMMENDATIONS

5.1 Overview

This research has identified, using available data on both housing and fire losses, that there are a number of ways to look at Canadian housing fire statistics. It has identified benchmarks and indicators that can be used to help establish the fire incidence and consequences components of fire risk in Canadian housing.

In overview, the research identified that housing fire incidence and losses are, for the most part, decreasing since 1980. One important finding was that fire death and injury rates are still decreasing appreciably using 5-year averages while fire damage rates are increasing slightly. This finding indicates that existing fire risk reduction programs are still having an impact on reducing fire deaths.

5.2 Basic Benchmarks

Three basic benchmarks provide different and valuable information:

- Population Benchmark – This most commonly-used benchmark examines fire incidence and losses on the basis of a given population occupying residential units. It is perhaps the most readily comparable benchmark with other risks to persons, such as falls or automobile accidents. This benchmark shows that Canadian fire incidence, deaths and injuries have fallen significantly over the 20-year study period whereas fire damage has remained approximately constant.
- Residential Units Benchmark – This benchmark examines fire incidence and losses on the basis of the number of residential units in Canada. The Residential Units Benchmark shows a greater reduction in fire incidence and fire deaths and a comparable reduction in fire injuries compared to the Population Benchmark. It also shows a slight reduction in fire damage over the 20-year period.

- Fire Incidence Benchmark – This benchmark examines fire losses on a per fire basis. While often considered a measure of fire risk (deaths, injuries, damage/fire), it has a basic shortcoming in that the fire incidence rate is the governing criterion. It is suspected that the number of reported fires used in this benchmark has decreased over time, as more fires are not reported since code requirements for smoke alarms have led to earlier fire discovery and extinguishment. As such, the Fire Incidence Benchmark may generate unduly high rates of deaths, injuries and damage on a per fire basis because only the more severe fire incidents are reported. Using the Fire Incidence Benchmark shows that the fire death rate has decreased over the 20-year period while fire injury and damage rates (constant dollars) have increased. It is suggested that this benchmark not be used extensively in determining fire risk unless improved reporting of all fires can be achieved.

5.3 First Nations Comparisons

Using the three basic benchmarks, the First Nations' fire incidence and losses in residential units were compared to the Canada-wide figures. Using the Population Benchmark, the First Nations' fire death rate is approximately 4 times the Canada-wide rate whereas the fire incidence and injury rates were lower than the Canada-wide rate. Fire damage per capita was comparable. It is also suspected that there is an under-reporting of fire incidence in the First Nations' figures comparable to the Canada-wide figures. Comparing First Nations' rates to the Northwest Territories' rates, based on population, showed that the First Nations had comparable fire death rates and lower fire incidence, injuries and damage rates. This may help explain that the higher First Nations' losses are, in part, due to colder climates, rural locations and possibly less effective fire service capabilities.

Using the Residential Units Benchmark provides a different picture. Comparing First Nations' to Canada-wide figures shows that the fire incidence is more than twice the Canada-wide rate, the fire death rate is almost 8.8 times and the fire injury and damage rates are approximately twice the Canada-wide rates. The two pieces of statistical evidence with high confidence values are the fire deaths and the number of units. This

benchmark clearly points out the higher First Nations' risk of fire death in residential units – and higher fire incidence, injuries and damage, despite possible under-reporting.

Using the Fire Incidence Benchmark, the First Nations' fire death rate is 4.4 times the Canada-wide rate and the injury and damage rates are comparable. Given the suspect fire incidence data, this benchmark result is also suspect.

Comparing fire losses in only 1 & 2 family dwellings for Canada-wide and First Nations (based on number of units) shows that the First Nations' fire incidence rate is 2.4 times the Canada-wide figure; the injury rate is 2.5 times; the damage rate is 1.7 times; and the fire death rate is 10.4 times. This last figure is considered to be reliable and points out the significantly higher fire death rate in First Nations' housing.

Two other indicators point to possible reasons for the higher First Nations' losses. The first is remote location in which it was shown that rural locations have higher losses than urban. The second was crowding in which it was shown that crowding conditions lead to higher fire death rates.

5.4 Other Indicators

Statistical data was assembled to develop other indicators in an attempt to characterize fire risk.

Residential Unit Type – This examination compared fire incidence and losses for 1 & 2 family dwellings, rooming and lodging houses, mobile homes and apartments. The comparison showed that the fire incidence and loss rates for apartments and 1 & 2 family dwellings were essentially the same (apartments slightly lower), whereas rooming and lodging houses had fire death and injury rates 11 to 12 times the rate for 1 & 2 family dwellings. The mobile home fire death rate was approximately six times the 1 & 2 family dwelling rate.

Ages of Victims – In examining ages of victims as a potential indicator, it was found that the rates of fire deaths for persons 65 years of age and over were approximately twice what would have been expected, based on their percentage of the

population. Different grouping of reporting ages for children by province made it impossible to determine any trends on a Canada-wide basis from that data.

Urban-Rural Location – This indicator shows that the rates of fire deaths, in particular, for rural locations, were 1.5 to 4.3 times the rates for urban locations, using community size as a basis. Using British Columbia data, the rural fire death rate was determined to be 4.3 times the rate expected for that portion of the population, Ontario is approximately 3 times and Alberta showed a rural death rate of 1.5 times the rate expected. This also is a valuable indicator to help assess the need for mitigating fire safety measures in rural areas where fire department response is often slower and where alternative heating methods may be employed.

Household Size and Crowding – While this examination provided some information on "crowding" as a measure of fire risk, the results related to household size alone were inconclusive due to only small provincial variations. The crowding trend line shows a slight increase in fire incidence with increased incidence of crowding and a definite increase in fire death rates.

Household Age/Condition – This examination looked at the age of a unit and its physical condition as a means of establishing fire risk. Using unit age as a basis showed a slight increase in fire incidence with age. A greater increase in fire incidence was noted, however, in plotting householders' perception of need for repairs against fire incidence. This indicator shows that the age and condition of a residential unit appear to have a slight impact on fire incidence rates. Plotting the fire death rates against Age of Units and perception of need for repairs showed that while the deaths per 1000 fires decreased with increasing median age (remember under-reporting of small fires where smoke alarms were present), the deaths per 1000 fires increased slightly with the increased homeowner perception of need for major repair.

Ignition Scenarios – This indicator relates to sources of ignition and causes of fire that could be attributed to building-related issues as a means of establishing fire risk. This indicator showed that, over the 20-year study period, most fires caused by building-related sources of ignition have decreased at approximately the same rate as the decrease in all fires, however, fire exposure as a source has increased. Using 5-year

averages, this shows that cooking equipment as an ignition source has dropped 23% over the 20-year period, heating equipment 52% and electrical equipment and appliances 42%. Exposure has decreased 14% over the same period. From the cause of fire perspective, Construction, Design and Installation Deficiency has decreased 16% while mechanical, electrical failure or malfunction has decreased 28%. Ignition scenarios can be a useful indicator in examining trends when specific fire safety strategies are employed (e.g., educational programs to reduce cooking related fires).

5.5 Pre/Post 1980 Differences

In looking at the changes to residential units that could have resulted in increased fire safety, the requirements for smoke alarms in new buildings, in approximately 1980, in existing buildings in approximately 1985 and the accompanying public information campaign, are collectively the single most determining factor. Examining fire incidence and deaths as compared to the percentage of pre-1981 residential units in the various provinces in Figure 16, shows that fire incidence and deaths both increase as the portion of pre-1981 housing increases. This finding is not new but it clearly shows a connection between higher fire losses and buildings constructed before 1981 – those that possibly would not have a wired-in smoke alarm. What is not known, however, is the number of pre-1981 units that may have voluntarily installed smoke alarms or those which added smoke alarms as a result of retroactive Code requirements. Another qualification of this finding is its reliance on fire incidence as a basis, which has been previously indicated to be under-reported.

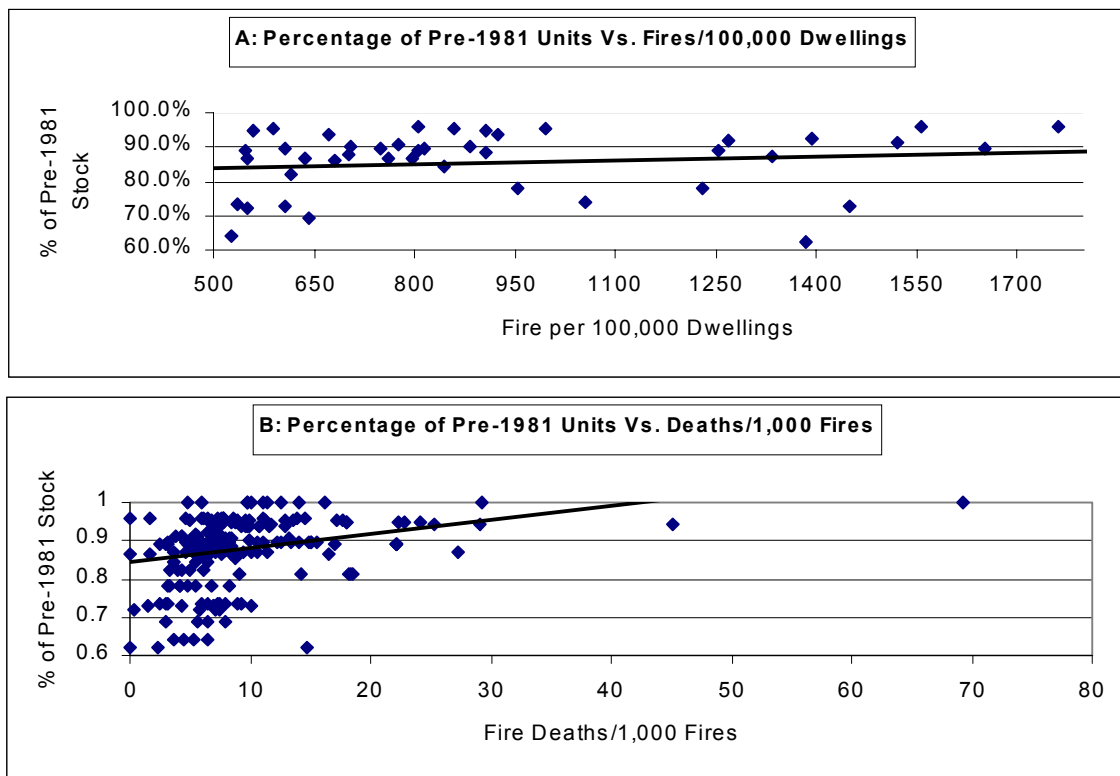
**Table 14 – Housing Fire Losses Based on Residential Units
1970-1999**

Table 14: Fires Incidence, Deaths, Injuries and Damage based on Residential Units				
Period	Per 100,000 Residential Units			Damage per Unit (1999\$s)
	Fires	Deaths	Injuries	
1970-1974	798.2	10.4	N/A	\$56.25
1975-1979	592.2	10.9	N/A	\$84.61
1980-1984	482.0	7.6	29.4	\$84.22
1985-1989	362.1	5.1	26.9	\$61.66
1990-1994	292.7	3.6	24.6	\$61.74
1995-1999	219.9	2.6	18.7	\$49.07

Table 14 shows the 5-year average housing fire losses, based on numbers of residential units, for the period 1970 to 1999. In the period 1970 to 1979, some provinces did not report losses by occupancy. Those "unknown" occupancy losses for those years were pro-rated according to the known occupancy losses to establish a probable national picture. Table 14 shows the dramatic change in fire deaths per 100,000 residential units starting in 1980 and continuing through 1999. That rate drops approximately 25% by 1984 and 75% by 1999. Starting in 1980, the fire injuries rate drops by approximately one third by 1999. In constant dollars, fire damage rates per residential unit increased through 1984 and dropped 41% by 1999. With the decreases in fire incidence, deaths, injuries and damage, it can be claimed that fire risk in residential units has indeed dropped over that period.

Figure 16 explores the correlation between pre-1981 built units and fire incidence and fire deaths. This is in an attempt to determine the possible impact of wired-in smoke alarms on fire risk. As Figure 16A shows, fire incidence gradually increases with increasing percentage of pre-1981 housing. Figure 16B shows a significant increasing trend in deaths per 1000 fires as that percentage of pre-1981 units increases. This data shows that there appears to be a link between pre-1981 housing and the risk from fire, based on this comparison. Recall, however, the reliance on possible under-reporting of fire incidence as a basis for this analysis.

Figure 16: Percentage of Pre 1981 Units Related to Fire Incidence and Deaths



5.6 Recommendations for Improvement in Data Collection

In seeking and analyzing data from various sources, the authors occasionally found that there was no direct means to conduct a detailed analysis due to lack or absence of data. The authors, therefore, are recommending some additions to or improvements in current data collection to allow a more complete review and analysis of fire losses in housing:

- **First Nations** – The authors compliment those collecting and submitting First Nations' fire data which allows current reports to be prepared. Given the incompleteness of First Nations' fire reports, the authors recommend that a basic easy-to-complete fire report be developed and implemented for First Nations. Since residential fires represent a high portion of fires involving deaths and injuries for First Nations, it may be appropriate to develop a less complicated form for residential fires and a separate form for all other fires.

This may help improve the participation in reporting First Nations' fire losses. As well, reporting actual ages of victims for First Nations' losses would help establish a basis for programs based on the young or older adults.

- Fire Incidence – The authors recommend that those collecting fire loss data in the provinces and territories strive to correlate data with the insurance companies in order to obtain a better idea of the real number of fire incidents in Canada on an annual basis.
- Housing Details – It would be helpful if the Canada-wide reports included a more detailed breakdown of the types of housing fire losses. In particular, a category of townhouses or rowhouses would be useful as would a breakdown of low rise and high rise apartments. These further breakdowns on a Canada-wide basis would allow a more extensive analysis of housing fires and would enable better targeting of mitigating measures. As well, greater details would be useful in those cases where fires result in deaths or injuries. Such detail on fatal fires may aid in determining appropriate mitigating measures.
- Age of Victims – Currently, ages of persons killed or injured in fires are not reported nationally. Given the present focus on housing for the elderly, in particular, it would seem that a nation-wide reporting of ages of victims (deaths and injuries) could again enable a better focussing of efforts to reduce losses.
- Age of Housing – In trying to correlate the impact of past fire safety measures, it is important that the age of a unit be determined and compiled in higher level reports. While age can be a proxy for condition of the dwelling, it is also an indicator of the building code under which the dwelling was built, thus allowing a better comparison of the impact of code changes. It would also be useful to have dwellings under construction at the time of a fire reported separately since these fires likely have different origins than those affecting occupied dwellings.

- Fatal Fires – As the number of reported fire incidents appears to be difficult to ascertain from existing data sources, there may be considerable value in reporting greater detail on fires involving deaths or injuries to enable a more rigorous analysis of the data from these fires. Reported provincially and compiled nationally, this greater detail may provide clues on a Canada-wide basis as to areas where fire safety in housing can be improved through housing policy changes.

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