Canadian Wood Council
Conseil canadien du bois

FIRE SAFETY AND INSURANCE IN COMMERCIAL BUILDINGS

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The Canadian Wood Council is the national association representing Canadian manufacturers of wood products used in construction.

Table of Contents

MOORELANDS CAMP DINING HALL
LAKE KAWAGAMA, DOSET, ONTARIO
PHOTOS: JAMES DOW
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1.0 INTRODUCTION

MOORELANDS CAMP DINING HALL
LAKE KAWAGAMA, DOSET, ONTARIO
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Throughout history, protecting commercial structures from fire has been important. Fire poses risk in terms of safety to occupants, building integrity, business interruption and the economic health of a community. Consequently, reduction in the risk of fire for commercial buildings has been a significant goal for society, achieved through a better understanding of all the factors that contribute to fire risk.

Designing and building structures in compliance with building and fire code requirements, and insurance industry guidelines, contributes to the reduction of fire losses.

Wood has had a long history of use in commercial construction. Some of the reasons for this are:

- high strength-to-weight ratio,
- ease of use and constructability,
- known performance characteristics,
- resource abundance and renewability,
- economy in construction, and
- architectural aesthetics.

Wood construction that makes use of good design and appropriate fire protection measures provides a level of fire safety that is comparable to other types of construction. This document discusses some of the basic factors that affect fire risk and property insurance rates, as well as some common misconceptions regarding what conditions make commercial buildings fire-safe.

2.0 FIRE RISK AND INSURANCE: A BRIEF HISTORY

Fire risk is defined as "... an estimation of expected fire loss that combines potential for harm in various fire scenarios that can occur with the probabilities of occurrence of those scenarios."[1]

In the past, those affected by fire had little choice but to manage their risk by assuming it themselves. One example where this occured was the Great Fire of London, England in 1666, which is considered a turning point in the management of fire risk. In its wake grew concepts and practices that focused on ways to manage risk other than assuming it oneself. Many factors played a role in this major fire, including:

- lack of adequate fire divisions,
- untrained fire brigades,
- poor water supplies,
- inadequate fire-fighting equipment, and
- improper storage of combustible materials and hazardous products.

As a result, a method of sharing the losses arising from fire among a large group of investors or 'insurers' was developed in order to protect owners and businesses against the financial consequences of such a disaster. This led to the creation in London of one of the first property insurance firms, known as "The Fire Office."

As Canada was colonized, a similar need for property protection through insurance was met in part by the Canadian Fire Underwriters Association (CFUA), who mandated to all insurance companies what minimum premiums would be collected for each building insured. Since 1974, the Insurer's Advisory Organization (IAO) has provided 'advisory' premium rates, which insurance companies can choose to use or not use in determining what level of insurance premium should be collected for any building.

Insurance is a means to share or transfer the risk of loss. As such, it improves an individual's level of protection from incurring financial loss. Historically, fire was the major peril for property owners. It is for this reason that early property insurance was known as ‘fire insurance’. Other perilous events have been added over time, such as windstorms, earthquakes, floods and vandalism, to form general property insurance.

Early insurance companies, like “The Fire Office”, established their own trained fire brigades in order to protect their investments. As the property insurance business evolved and increased, insurers played an important role in monitoring and promoting additional fire protection measures for buildings. Premium discounts would be offered to owners whose buildings were soundly built and adequately protected, while premium increases or reductions in insurance coverage would be implemented for properties considered unprotected or unsafe.

This approach provided a certain amount of risk control for the insurance companies, and encouraged the construction of better protected buildings with expanded control of fire hazards by increasing public understanding of the factors that contribute to the risk of fire.

As well, building regulations have evolved from the 17th century to the present time, which in Canada has led to the development of the National Building Code of Canada[2] (NBCC). The NBCC is a model code used as the basis for individual provincial and municipal regulations adopted and enforced across the country. One of its goals is to ensure buildings are built to provide a minimum level of fire safety.[3]

The following sections examine the methods used today by the insurance industry to assess fire risk and calculate insurance premiums, providing a means of understanding the relationship of those methods to building codes, and to the many factors that affect fire protection.

3.0 UNDERWRITING AND RATING OF FIRE RISK

Most private (non-government) property insurance is sold in Canada by companies that are represented by the Insurance Bureau of Canada (IBC). The IBC Insurance Information Division collects, validates and analyzes data relating to properties insured, hazards of exposure, and claims that member companies voluntarily submit.

IAO analyzes historical loss cost data available from IBC, Statistics Canada and other databases. The IAO rating of commercial properties looks at the physical risk characteristics of a building and the analyzed historical loss costs for similar building types. Physical risk criteria are meant to reflect the performance of building, contents and occupants under fire and other insured perils.

Ratemaking is the process of establishing a premium rate for a particular class of insurance. The rate is the price of a unit of insurance for one year. The premium for a particular property is arrived at by multiplying the amount of insurance coverage by the premium rate.

The IAO recommends its rates to member insurance companies, and those companies use the commercial property rating information as a guideline. Insurers then apply their own discounts and surcharges. IAO also inspects individual commercial risks to develop specific advisory rates for the inspected properties, for the exclusive use of its subscribers.

Recently, several of the major insurance companies in Canada have developed ‘in-house’ rating systems that rely on their own loss experience and statistics, rather than the information provided by IAO. The rating approaches used by some of these major insurers sometimes can be based more on the influence of economic conditions such as competition and market capacity than on actuarial information.

Underwriting: “ . . . assuming liability for a risk as an insurer.”[4]

‘Loss cost’ is defined as the ratio of losses to units of exposure (insured value).

“Rate setting will never be an exact science. In the highly competitive field of Property and Casualty insurance, prices are determined by the interplay of market forces, government regulations, and taxes at many levels.”[5]

4.0 BUILDING DESIGN FACTORS

The IAO physical risk evaluation criteria are based on four main factors: construction class; occupancy type; level of protection; and, degree and type of external exposures. These factors, based on features of a property that can affect its level of fire safety, are typically used to set the initial premium base rate for a given property. The NBCC also uses these four criteria – construction, occupancy, protection and exposures – to determine minimum fire safety requirements for design of buildings.

4.1 Construction Class

Construction classes are intended to divide structures into categories of differing resistance to fire. Historically, this has been achieved by categorizing buildings according to the 'combustibility' of their materials of construction. However, the fire safety of a building is more complicated – the characteristics of the entire system must be taken into account, particularly with today's construction methods and materials.[6]

In the insurance industry, construction class is the first and foremost consideration for most commercial properties because it is the most static and tangible of the key measurable factors, and is the least likely to change. The following six basic construction classifications are used by the insurance industry.[7]

1) Fire Resistive (Construction Class 1) – buildings in which the structural members including walls, floors and roof are constructed of masonry materials or of fire-resistive materials or assemblies (floors and exterior walls rated not less than two hours, roof rated not less than one hour);

2) Masonry Noncombustible (Construction Class 2) – buildings with walls of masonry or of fire-resistive materials or assemblies (rated not less than one hour), and floors and roof of noncombustible materials with noncombustible supports;

3) Noncombustible (Construction Class 3) – buildings with walls, floors and roof of noncombustible materials supported by noncombustible supports;

4) Masonry (Construction Class 4) – buildings with walls of masonry or fire-resistive materials or assemblies (rated not less than one hour), and with combustible floors and roof. Includes joist (or ordinary construction) and heavy timber construction;

5) Masonry Veneer (Construction Class 5) – buildings with walls of combustible construction veneered on the outside with masonry materials not less than 100 mm (4 in.) in thickness, and with combustible floor and roof; and,

6) Frame (Construction Class 6) – buildings with walls, floors and roof of combustible construction except as provided for under Class 5 above or buildings with exterior walls of a noncombustible construction with combustible floors and roof.

This historical classification system is based on the combustibility of the construction materials used. Concrete and masonry are generally considered fire resistive, and these two materials, as well as iron and steel, are examples of noncombustible materials. Combustible construction most often refers to construction in wood. The insurance industry uses this classification system in the following way: structures with lower construction class numbers (1, 2, and 3) are considered to be better protected from fire and, therefore, are generally

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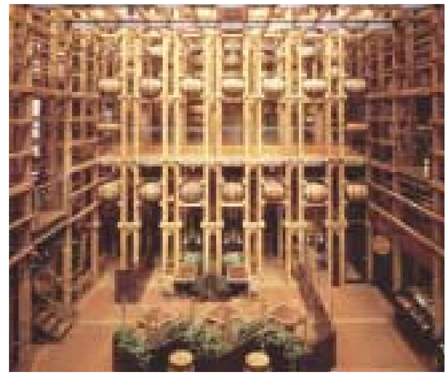
assigned lower premium base rates. Similarly, structures with higher construction class numbers (4, 5, and 6) are considered to be less protected from fire and are assigned higher premium base rates.

Anomalous results can occur in the use of this system. For example, a building constructed of light-gauge steel framing may be assigned a lower premium base rate than one of wood-frame construction, even when their resistance to fire under similar conditions, or 'fire resistance rating', is identical. Another example of such an anomalous result occurs when comparing the premium base rate for an 'unrated' structure consisting of exposed steel members to the rate given to a wood-frame building having two-hour rated floor assemblies. In this case, the exposed steel construction could still be given a lower premium base rate than the fire-resistance-rated wood construction, even though the latter has a high level of fire resistance and the former does not.

In the construction class system described, it may appear as though only masonry or 'fire-resistive' materials can be rated for fire resistance. However, a fire resistance rating (FRR) is a measure of the elapsed time during which any building material, element or assembly continues to exhibit resistance to fire under specified exposure conditions.[1] FRRs can be used to compare the fire resistance between elements or assemblies of different construction materials and methods.

For example, wall and floor assemblies with FRRs up to 60 minutes, using a similar standard fire exposure, can be composed of metal framing, wood framing, steel, or even concrete or masonry. There are some assemblies of wood construction, as well as those of protected steel or concrete, that have FRRs of 2 hours. Such variations in ratings show that the manner in which materials are put together significantly affects the overall fire performance of a structure.

The NBCC classifies different types of construction based on their 'combustibility' (i.e., combustible vs. noncombustible). Because the Code often limits wood-frame construction to 'smaller' buildings, an erroneous perception may be produced that most commercial projects cannot be designed in wood due to code limitations. However, the vast majority of commercial structures are less than five storeys in height.[8] Consequently, the use of wood as a main structural material very often is not precluded by the restrictions found in the building code. Table 1 provides a sample of maximum allowable building areas for both sprinklered and unsprinklered combustible construction.



SEAGRAMS MUSEUM
WATERLOO, ONTARIO
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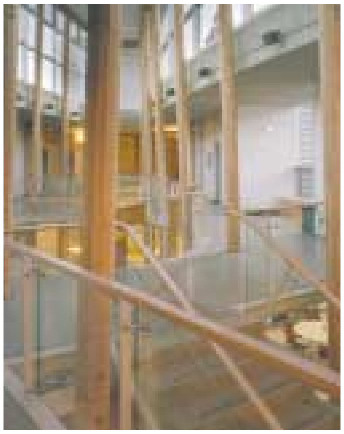
Table 1. Maximum allowable building areas for sprinklered and unsprinklered combustible construction for a sample of occupancy types.[2]
NP – not permitted.

Occupancy Type	No. of Storeys	Maximum Allowable Building Area (m²) (Sprinklered)	Maximum Allowable Building Area (m²) (Unsprinklered)
Group D (Business and personal services occupancies)	4 3 2 1	3 600 4 800 7 200 14 400	NP 2 400 3 600 7 200
Group E (Mercantile occupancies)	4 3 2 1	1 800 2 400 3 600 7 200	NP 1 500 1 500 1 500
Group F, Division 3 (Low hazard industrial occupancies)	4 3 2 1	3 600 4 800 7 200 14 400	1 800 2 400 3 600 7 200



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4.2 Occupancy Type

The main use or occupancy of a structure, represented by its ‘occupancy type’, also significantly influences the level of fire risk within a property. For various buildings, differences occur in the activities taking place, types of materials used and stored, quantity of storage needed, number of occupants present and the equipment and building services required to fulfil the function of a property. All these attributes of an occupancy type can introduce fire hazards and may increase the necessity for additional fire protection measures in a commercial building.

The NBCC divides all non-residential buildings into five major occupancy types: Assembly (Group A), Care or Detention (Group B), Business and Personal Services (Group D), Mercantile (Group E), and Industrial (Group F). Some of these types are then sub-divided based on levels of hazard. For example, Industrial is divided into low (Group F3), medium (Group F2) and high hazard (Group F1) occupancies.

In the insurance industry, ‘occupancy factors’ take into consideration the contents of a structure, the method and volume of storage, and the use of the premises to determine any manufacturing or process hazards, as well as the contribution of building services such as heating, plumbing, electrical and air conditioning. Sixteen individual major classes of occupancy are used, which are based on the main activities that take place in a structure. Some examples of the major classes are warehousing, retail stores, hotels and resorts, entertainment, and business and professional services. Many of these classes are then sub-divided by specific use and size. The categories of occupancy classification in this system are referred to as the IBC ‘Industry Codes’.

One factor that is based on occupancy classification, and is used by the insurance industry to adjust the premium base rate, is called the ‘building adjustment factor’ (BAF).[9] For each occupancy category, or ‘industry code’, the BAF is given for two construction categories: Construction Classes 1, 2 and 3 are grouped together, as are Construction Classes 4, 5, and 6. The BAF also takes into consideration regional differences apparent in the IAO and IBC loss information statistics, because it is based on the province where the building is located. One result of the regional variation in the BAF is that final premium rates for wood construction in some occupancy types can be lower in British Columbia and some east-coast provinces than in Alberta, Ontario and Quebec. This is believed to be based on the difference in the historical loss data for those provinces.

4.3 Level of Protection

In this context, ‘level of protection’ refers to the degree of fire protection provided by active fire-protection systems and services, both on a property and provided by the community in which the property is found. In assigning ‘protection factors’, insurers assess both ‘public’ protection, such as fire department capabilities, fire hydrant distribution and available water supply, and ‘private’ protection, such as fire extinguishers, automatic sprinklers, and fire alarm systems, provided inside a building. The levels of reliability of these and other fire-protection systems and services can significantly affect the overall level of fire protection provided to a structure, as well as the insurance rates charged. (Also see section 5.0, Fire Protection Factors.)

4.4 Degree and Type of External Exposure

Fire protection of commercial structures can also be affected by exposure to risk of fire from beyond the boundaries of a given property. ‘External exposure factors’ used by the insurance industry typically reflect any additional hazards introduced by communicating, adjoining or surrounding properties. Reducing the external exposures of a property can lower the applicable premium rate because of the reduced risk of fire loss. The percentage of openings, exterior wall construction and cladding type are regulated by the NBCC based on distance between buildings or distance to property lines (i.e. 'limiting distance'). This is primarily intended to avoid major conflagrations and significant property loss from fire spread between adjoining buildings or structures.

4.5 Other Considerations

In addition to the factors outlined above, insurance rating systems often consider what are referred to as 'secondary construction charges', to address other construction details or typical building features that may affect the level of risk exposure. Some of the features considered can be: building height, vertical openings (e.g. stairs and shafts), building area (i.e. 'effective undivided floor area'), roof surfaces, concealed spaces, interior construction or finishes, exterior finishes, and building condition (e.g. damage or deficiencies). Good design and maintenance of a building, using basic fire prevention principles and fire protection measures, can result in the reduction or elimination of such charges.[9]

The NBCC regulates building heights and areas as well. But, like the insurance industry, the Code permits buildings of wood-frame construction of unlimited area to be constructed, provided firewalls divide the building into separate areas no greater than the maximum building area permitted for its specific occupancy classification. The use of combustible interior and exterior finishes is allowed by the code for most building types and sizes.

5.0 FIRE PROTECTION FACTORS

There are other factors besides those of building design that affect the underwriting and rating of fire risks in a building.

5.1 Municipal Protection Class Rating System

The adequacy and reliability of public fire-protection systems and services have a significant impact on minimizing the fire risk for commercial properties. Consequently, these systems and services are important underwriting considerations when evaluating a potential insurance premium rate. 'Public' fire protection primarily refers to the fire-fighting services, as well as fire hydrant and water supply coverage, provided by a municipality.

The insurance industry uses a factor known as the 'municipal protection factor' to reflect the level of fire-protection service provided by a community. The Fire Underwriters' Survey (FUS), which is a division of the IAO, conducts fire-protection surveys of municipalities throughout Canada. The FUS survey assesses the adequacy and reliability of public fire-protection programs, including the main aspects of fire department operations, training and administration; water supplies for fire-fighting; emergency communication systems; and fire-prevention programs.

These municipal surveys are used to determine a final 'municipal protection class' for each community: a Class 1 rating represents the highest level of protection, while a Class 10 rating represents no protection. Each municipal protection class is assigned a 'municipal protection factor' that is then used to adjust the recommended premium base rate.[9]

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If private fire-protection services and systems are provided to a property that is publicly unprotected, or they supplement existing municipal protection, a separate evaluation of the municipal protection factor can be made by FUS or the insurer.[9] Such private fire-protection systems could take the form of an on-site water supply and hydrant system, or an automatic sprinkler system. The impact of such private-protection systems on fire insurance rates is largely dependent on the level of maintenance and supervision (i.e. electrical supervision and off-site monitoring) provided to the systems.

5.2 Water Supply for Fire-Fighting

Various guidelines and references exist for calculating adequate water supply for fire-fighting, often called the ‘needed fire flow’. These include insurance industry guidelines, such as those produced by FUS[10], and specific building code requirements for calculating water supplies as can be found in the Alberta Building Code[11], the Ontario Building Code[12] and the British Columbia Building Code[13]. In Part 3 of the NBCC, it states only that "an adequate water supply for fire fighting shall be provided for every building". (See also "Fire Fighting Assumptions" in Appendix A-3 of the NBCC.) The use of different calculation methods in these guidelines and Code provisions sometimes causes confusion, and often, misapplication of the appropriate requirements due to significant differences in the individual criteria used in the methods.[9]

The principal water supply guidelines referenced by the insurance industry are intended to be used in grading the efficacy and reliability of fire protection for municipalities, for determination of the ‘municipal protection factors’.[9] The FUS guideline is often inappropriately used for establishing a minimum water supply for building code design criteria of individual buildings. This results in onerous or uneconomical requirements for the water supply, especially in those areas where a built-up infrastructure does not exist (see Table 2).

Table 2.
Comparison of typical fire flow requirements.
High School, Unsprinklered
Building Area: 2000 m^2
Building Height: 3m
No. of Storeys: 1
NBCC Occupancy Classification: Group A, Division 2

Fire Flow Calculation Method	Combustible Construction (Wood-frame)		
	Min. Flow Rate (L/min [U.S. gpm])	Total Volume (L [U.S. gal])	Flow Duration (min)
FUS 1999[10]	15,000 [3,950]	2,925,000 [772,700]	195
ABC 1997[11]	3,800 [1,000]	162,000 [42,800]	43*
OBC 1997[12]	4,750 [1,250]	138,000 [36,450]	29*
NFPA13[14] (sprinkler + hose stream requirement, for comparison only)	1,050 [275] max.	31,500 [8,300]	30

* Indicates those flow durations that are extrapolated from the total volume divided by the minimum flow rate; the ABC and OBC do not specify a minimum flow duration.

5.3 Automatic Sprinklers

The insurance industry acknowledges the contribution that automatic sprinkler systems can make to the increased fire protection of properties. Significant reductions in insurance premium rates can be obtained with the installation of an automatic sprinkler system having an adequate and reliable water supply. In general, the IAO advisory insurance rates for wood construction are reduced by as much as 50 to 60% for sprinklered versus unsprinklered structures.[9] Further, by installing sprinklers in a building, the secondary construction charges added to the premium rate could be reduced or eliminated altogether.

In the NBCC, the effectiveness arising from the use of sprinklers in the reduction in fire risk is recognized in the building codes by the allowance of larger and taller buildings of wood-frame or noncombustible construction when an automatic sprinkler system is installed.

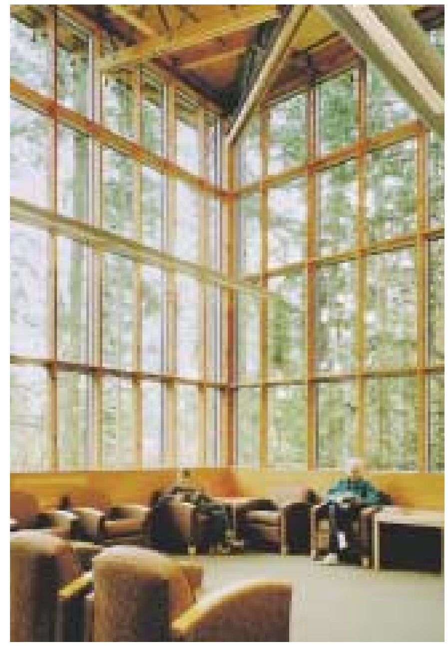
While some guidelines and references for calculating 'needed fire flow' allow reductions in the total water supply required for fire-fighting for sprinklered buildings, the FUS guidelines provides only a partial credit when sprinklers are used in a building.

5.4 Loss-control Engineering

Loss-control engineering and fire-protection engineering have their roots well-founded in the insurance industry. On many projects, especially large facilities and industrial buildings, insurance companies would often provide fire-protection specifications to the design team early in the process, be involved throughout the design and construction of a building, and provide additional inspection services after the building was occupied and in use.

These activities were called loss-control engineering, and were viewed by insurance companies as a sound investment. It was considered to be in the insurer's interest to protect the building, operations and the insured's business continuity from loss.[15]

However, over the last 10 to 15 years the insurance industry's involvement in fire-protection design has decreased. This shift is due, in part, to the modern business environment where both insurance companies and business corporations are continually reorganizing. Also, insurance companies can no longer expect to insure a facility for an extended time, and thus have less incentive to make an investment in providing on-going loss-control services.[15] Today, organizations such as the Society of Fire Protection Engineers (SFPE) and the National Fire Protection Association (NFPA) lead the effort to provide design methods and guidelines for fire-safe buildings.



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As insurers cut back on loss-control engineering services, it is more important than ever that design professionals recognize the value of the specialized field of fire-protection engineering. By working directly with owners, or as an integral part of a design team, fire-protection engineers and building code consultants have a greater opportunity to influence a project, to ensure appropriate fire-protection features are included at the crucial preliminary design stage, avoiding costly changes or additions later in the construction process. More cost-effective construction types, such as wood-frame, can often be included for consideration where they are normally excluded when specialists familiar with fire-resistant design methods for all materials are included in the design process.

Preventing fire losses has always been more important to the insured than to the insurer. Although a particular fire loss may not be statistically significant to an insurance company, to the owner involved such a loss is not only a direct financial issue but it also impacts many other important business aspects, such as employee moral, access to suppliers and the economic health of the community.[15]

6.0 COMMERCIAL PROPERTY INSURANCE RATING SUMMARY

Having discussed many of the building design and fire protection factors that can affect the level of fire safety in a commercial building, and that influence the insurance premium rate applied to a given property, a summary of the general process used to determine property insurance rates can be made.

> "To establish premiums, insurance actuaries estimate the number and cost of future and current claims and the amount of investment income that the insurance company may earn between the receipt of the premiums and payment of claims." [5]

Six of the top-ten property insurance companies in Canada use the same process to determine an insurance rate for commercial properties. The following steps present an example of that process.[7]

1. Determine occupancy and assign industry code.
2. Determine construction class.
3. Determine age and condition of building.
4. Determine 'technical rate', which is based on use of building, and factor in the construction class, and age and condition of building.
5. Determine 'base rate' by factoring into the technical rate the municipal protection class of the area where the risk is located; then, factor in the charges appropriate for the type of perils and level of coverage desired.
6. Factor in credit, if any, for building being sprinklered.
7. Determine extended coverage desired, and as a result,
    - factor in credits, if any, for premises protection and alarm systems;
    - factor in charges, as necessary, for flood, earthquake and sewer back-up coverage;
    - factor in charges, as necessary, for business interruption coverage (extra expense, profits, etc.); and,
    - factor in adjustments, as necessary, for special coverage (accounts receivable, valuable papers, etc.).

The process is the same for all buildings.

Beyond the consideration of all of the 'underwriting factors', premium rates are very much influenced by market factors. Some of these market factors include business history between the owner and insurer, competition between insurance companies, market capacity, volume of business (i.e. number of policies 'on the books'), and general economic effects, as well as the relationship between insurance brokers and insurance companies. For these reasons, the fire insurance rate for a particular construction class, like wood-frame, and occupancy type can vary greatly even within the same region, so it often pays to look around for the best rate.

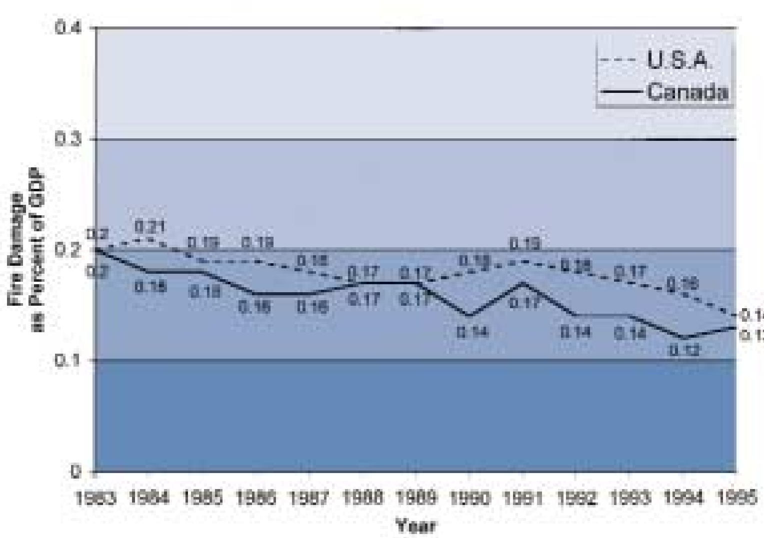

Figure 1. Fire loss rates, U.S.A. and Canada, as a percentage of Gross Domestic Product (GDP).[16]

7.0 FIRE LOSS STATISTICS

Fire statistics can be used to identify trends and assess the overall effectiveness of fire protection measures. However, complete, consistent and comprehensive data is difficult and expensive to gather. Consequently, where such data exists, the conditions under which the information was collected are very important.

Canada and the U.S. have similar construction methods, materials and environments. It is not surprising then, to see that Canada and the U.S. have similar fire loss records. Figure 1 shows that, in both countries, the annual fire losses as a percentage of 'Gross Domestic Product' (GDP)[16] is decreasing at comparable rates. Since U.S. fire statistics are much more extensive than current Canadian statistics,

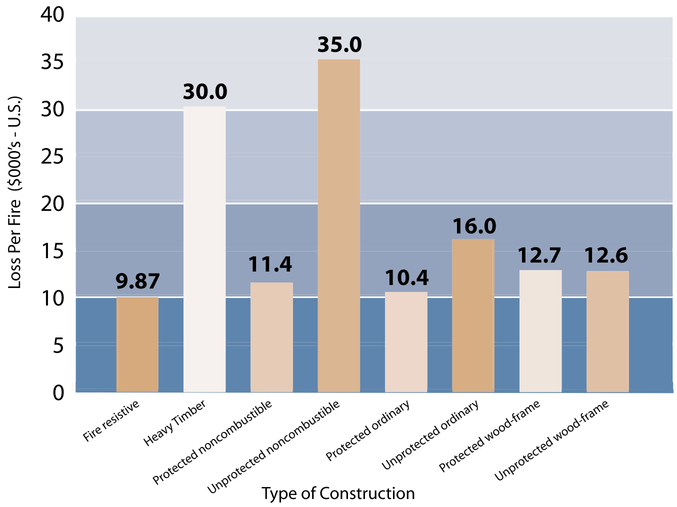

Figure 2.* Average loss per fire for 1989 to 1998 for fires in commercial structures – Unsprinklered.[17]

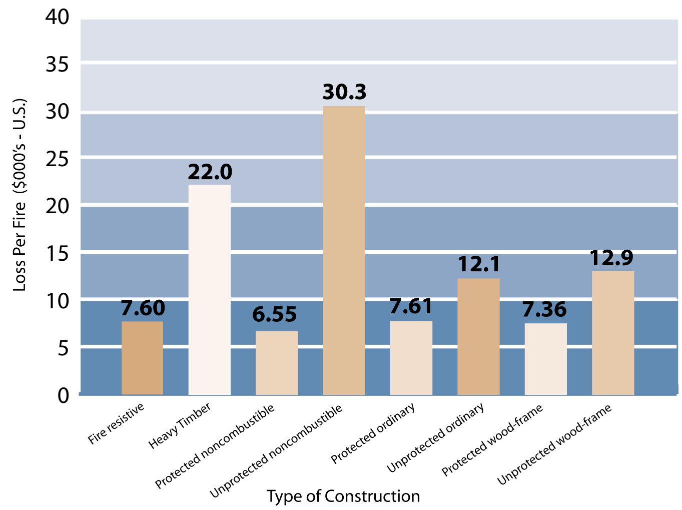

Figure 3.* Average loss per fire for 1989 to 1998 for fires in commercial structures – Sprinklered.[17]

U.S. fire statistics are examined here for information on fire protection in commercial buildings.

The average dollar loss per fire can be looked at as one means of assessing the effectiveness of the building construction and fire-protection systems. In general, the lower average loss is presumed to indicate less damage sustained to the contents and the structure of each construction type, and therefore, is presumed to indicate that construction type and fire-protection features have influenced the outcome.

The loss-per-fire values for the unsprinklered protected and unprotected wood-frame construction types in Figure 2* compare favourably with those for other construction types, in that they are close to the lowest values of the other construction types. For sprinklered structures, Figure 3*, protected wood-frame construction holds the second-lowest loss-per-fire value. This demonstrates the efficacy of the advances in fire protection of wood-frame buildings. What can also be seen in these two figures is that unprotected noncombustible construction with or without sprinklers experiences average losses per fire that are approximately three times greater than those of either protected noncombustible construction or protected and unprotected wood-frame construction.

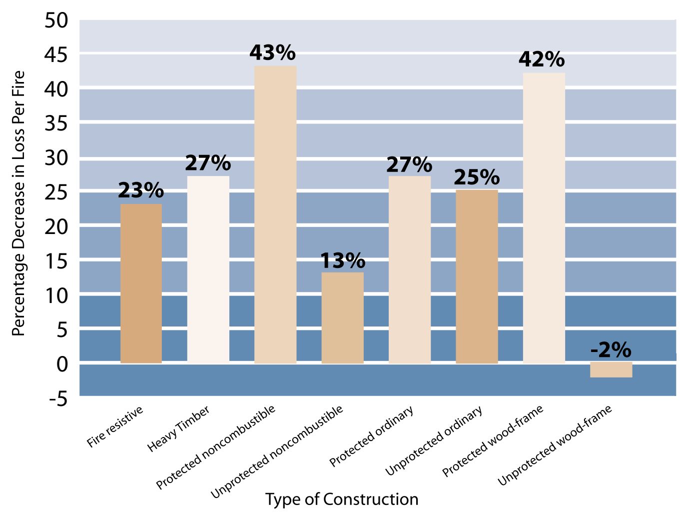

Figure 4.* Percentage decrease in average loss per fire, for 1989 to 1998, when sprinklers are present.[17]

It is generally believed that sprinklered buildings are better protected from fire than similar buildings that are unsprinklered, especially if constructed of wood. In Figure 4*, the effectiveness of sprinklers in reducing property losses per fire is clearly shown, with the reduction of the average loss per fire by an average of 21%. Of particular interest are the similar larger-than-average decreases for both protected noncombustible and protected wood-frame construction. This shows that protected noncombustible structures can benefit as much from the installation of sprinklers as do protected wood-frame buildings.

* The construction-type categories used are those found in fire incident databases in the U.S., corresponding to categories in the National Fire Protection Association (NFPA) Standard 220, *Standard on Types of Building Construction*.

IAO Construction Classes		NFPA Construction Types*
Class 1:	Fire Resistive	Fire Resistive
Classes 2 & 3:	Masonry Noncombustible and Noncombustible	Protected Noncombustible and Unprotected Noncombustible
Class 4:	Masonry	Heavy Timber, Protected Ordinary, Unprotected Ordinary
Classes 5 & 6:	Masonry Veneer and Frame	Protected Wood-Frame, Unprotected Wood-Frame

Table 3. Assignation of NFPA construction types to IAO construction classes, for analysis of data from Figure 2 and 3 using IAO construction classes. (See section 4.1 for description of IAO construction classes.)

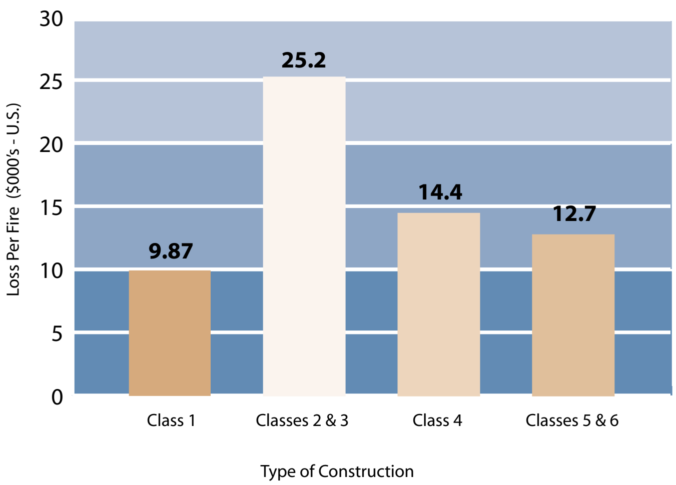

Figure 5. Average loss per fire for 1989 to 1998 for fires in commercial structures – Unsprinklered[17] – using IAO Construction Classes.

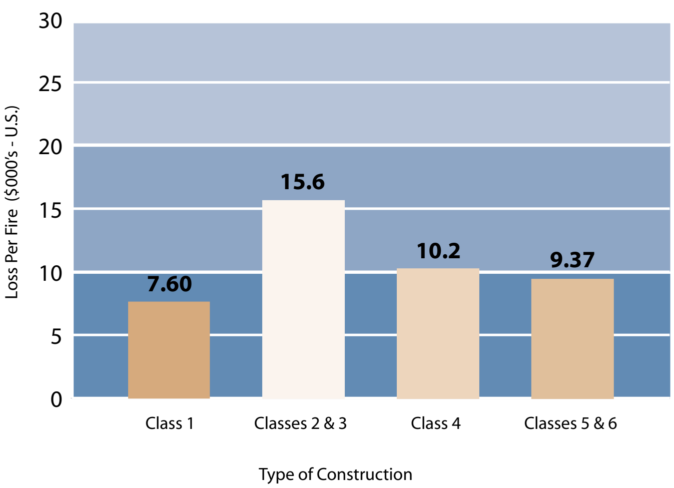

Figure 6. Average loss per fire for 1989 to 1998 for fires in commercial structures - Sprinklered[17] - using IAO Construction Classes.

The number of fires where sprinklers are present in unprotected wood-frame structures is relatively low, as these tend to be small wood-frame buildings that do not typically have sprinkler systems installed. The average loss per fire calculated for sprinklered structures in that category, therefore, could be easily overwhelmed by a few extreme values. This may explain the anomaly in the statistics that seems to show that sprinklers in unprotected wood-frame construction actually increase the average loss per fire.

Differences between organizations, as well as countries, in terminology, methods of data collection, and categorization of data make it difficult to analyze on a -one-to-one basis the data presented in Figures 2 and 3 using IAO Construction Classes. However, if the eight construction-type categories used by NFPA are assigned to a combination of the six Construction Classes from IAO in the manner shown in Table 3, some useful observations can be made.

Figures 5 and 6 show that, in both sprinklered and unsprinklered buildings, the grouped Classes 5 and 6 (Masonry Veneer and Frame Construction) compare favourably to the other classes. Only Class 1 (Fire Resistive) shows a lower loss per fire in either case, even though Classes 5 and 6 are considered by the insurance industry to be least protected from fire of all the Construction Classes. It is interesting to note that Classes 2 and 3 show the highest average loss per fire.

When examining loss-amount data provided by the Insurance Bureau of Canada, for 1996 to 2000, related to insurance claims for commercial buildings (Figure 7),[18] Classes 5 and 6 show the two lowest loss amounts per claim, and Classes 2 and 3 show the two highest loss amounts per claim. In this way, the insurance industry data differs from the U.S. data in that Class 1, fire-resistive construction, no longer shows the lowest loss per claim value — it is in fourth place. Class 4 (Masonry) is a close third place behind frame construction. It is interesting that the three construction classes generally assigned the highest rates by the insurance industry (i.e. Classes 4 to 6) show the lowest loss-per-claim values.

Figure 8 provides a measure of how well insurance premiums collected match losses incurred, by showing the loss amount paid out as a percentage of the premiums earned, by Construction Class, for 1996 to 2000. For Class 3, Noncombustible Construction, a value well over 100% shows that losses are much greater than premiums charged for that Construction Class, while the ratios of losses to premiums charged for Classes 4 to 6 are comparable to that of the Fire-resistive Construction Class (Class 1).

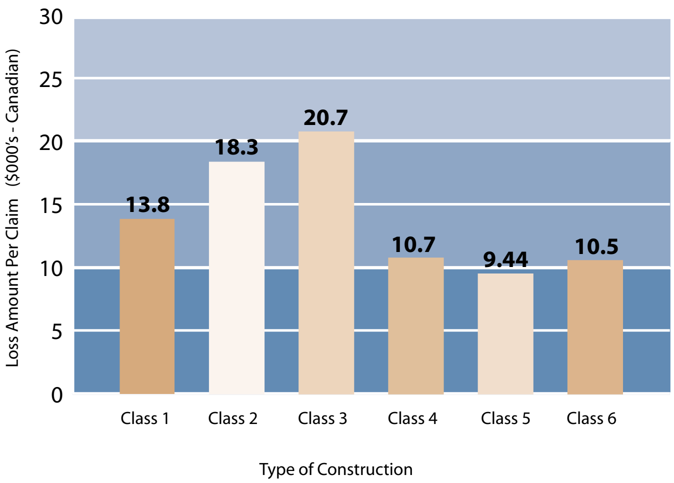

Figure 7. Average loss amount per claim, for all perils - such as fire, water, theft, and wind - for 1996 to 2000, for commercial structures in Canada.[18]

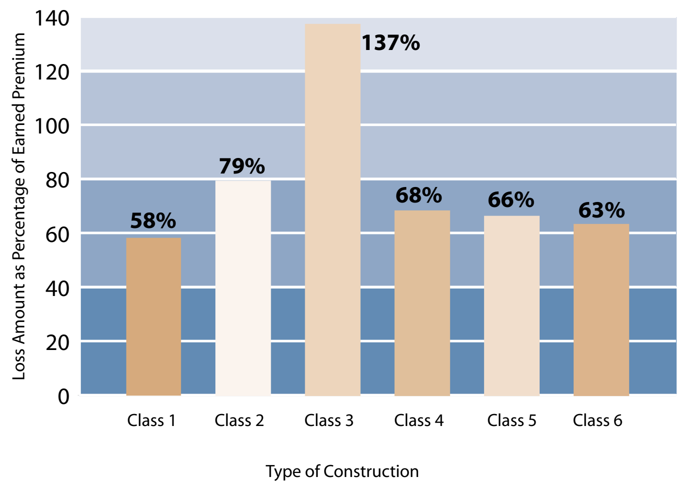

Figure 8. Loss amount as a percentage of earned premiums, for all perils – such as fire, water, theft, and wind - for 1996 to 2000, for commercial structures in Canada.[18]

8.0 INSURANCE RATES — EXAMPLES AND IMPACT

How insurance rates are applied has some of its roots in the early history of fire insurance, when a noticeably higher insurance rate existed for wood-frame construction versus masonry and other construction types due to the perceived higher level of risk associated with buildings constructed of wood.[9]

Although this historical bias still influences some aspects of ratemaking today, there are occupancy types in some regions in Canada where wood construction is accorded a better premium rate compared to other classes of construction. For example, a multi-unit condominium complex constructed of wood in Vancouver, British Columbia, may be quoted a premium rate that is less than one half of the rate charged for a similar building constructed of steel or concrete.[9] In addition, insurance rates for fully sprinklered wood-frame buildings can be on par with rates for unprotected noncombustible buildings of a similar occupancy type. Even so, there is sometimes the perception that if a building is designed in wood, the insurance premiums will be prohibitive for the building owner.

In order to determine if insurance premium rates could be the over-riding factor that causes an owner to decide against wood construction, an examination of some other cost effects related to construction must be made. Building owners tend to think first of initial capital costs to build a structure. A comparison among wood, concrete,

Example Calculation:	Wood Construction	Steel Construction
Construction Cost* Insured for 80% of Value Amount of Insurance Coverage	$ 100,000.00 x 0.80 $ 80,000.00	$ 117,000.00 x 0.80 $ 93,600.00
Annual Rate Per $100.00 of Coverage Annual Insurance Premium	x 0.40 $ 320.00	x 0.08 $ 74.88
The wood construction premium exceeds the steel construction premium per year by: $ 320.00 – $ 74.88 = $ 245.12		
Mortgage Amount (Assume 75% of Construction Cost) Steel Construction Wood Construction Mortgage Savings by Using Wood:	 $ 87,750.00 - 75,000.00 $ 12,750.00	
Interest Rate on Excess Mortgage Amount (7%) Annual Interest on Excess Mortgage Amount Excess Insurance Premiums for Wood Construction	x 0.07 $ 892.50 - 245.12	
Savings Per Year Using Wood Construction	**$ 647.38**	

*Concrete slab and footing not included – same cost for both construction options

masonry and steel designs will often favour wood in terms of construction costs, because wood construction traditionally costs less than other construction types.[19] However, when fire insurance rates are introduced as an operating cost factor, the lower rate offered to other construction types is often given undue weight.

The initial cost of constructing a building relates directly to the amount of money that must be borrowed for its construction. The interest paid influences the cost of a building over the life of a mortgage. Premium costs, even if they seem high, usually represent only a small fraction of the total cost over the years. A far more important factor can be the reduction in cost of borrowing money that is saved as a result of the initial savings realized through building with wood.

The example calculation above illustrates a procedure by which the relative costs of insurance for a particular structure can be compared.[19] Such an analysis often shows that wood construction is a better investment despite higher insurance rates, since there are costs to other construction types that can be much greater than annual property insurance premiums.

Assume that the initial cost of $117,000 for a given building constructed of steel is 17% more than the same building constructed of wood.[20] As well, assume that the insurance rate for the wood building is $0.40 per $100 of insurance coverage, while the rate for the steel building is $0.08 per $100 of insurance coverage. This represents a rate for wood that is five times greater than that for steel. This is a difference in rate between wood and non-wood construction much larger than is typical for commercial structures in Canada. Buildings of combustible construction can be charged up to double the rate of those of noncombustible construction.[21] The extremely high rate difference in this example was used in order to examine a 'worst-case', with respect to insurance premiums.

The calculations in the example show that a substantial gain per year in favour of wood construction results from just the interest on the difference in cost between wood and another construction type. The interest on the difference between mortgage amounts is shown to be a far more important cost factor, even though the wood insurance rate used is 5 times greater than that used for the steel construction. Of course, the $17,000 difference in initial construction cost also would be saved by the building owner. In this case, with a typical 25-year amortization period, it would take at least 125 years for the lower insurance rate for the steel construction to offset the savings provided by using wood.

When other life-cycle costs are considered as in the example, the difference in insurance rates often has to be extraordinarily large before wood construction is placed at a cost disadvantage due to insurance premiums, within a typical life-cycle of a building.

When surveyed, over 70% of responding architectural and engineering design firms in Canada reported that the issue of property insurance premiums never or only occasionally arose when deciding to use wood, even though half always or frequently considered wood for commercial designs.[22] When asked to rate the importance of various factors influencing their choice of materials, insurance and fire safety ranked next to last, overall (Table 4).

Factors	Very Important	Somewhat Important	Not Important	Not a Factor
Cost Competitiveness	269	146	12	0
Product Performance	285	129	6	3
Product Availability	203	194	26	7
Client Preference	225	169	19	7
Aesthetic Purposes	224	165	26	5
Energy Efficiency	150	223	23	18
Fire Safety/Insurance	157	203	34	21
Environmental Friendliness	118	227	49	24

Table 4. Importance to designers of various factors influencing choice of materials in design.[22]

9.0 CONCLUSION

Over time, an increased understanding of the many factors that contribute to the risk of fire has led to positive developments in the fire protection of commercial structures. Improvements in public fire-protection systems and services, as well as increased use of private active or passive systems through fire-protection and loss-control engineering, has meant an overall decrease in the cost of fire.

A discussion of the factors affecting insurance premium rates demonstrates that, although building construction type is one factor used, there are many other equally important considerations when determining a property's level of fire risk, and hence its insurance premium. A similar level of fire safety can be achieved by various means. The sum effect of all fire safety factors should be weighed, and a variety of active and passive fire-protection measures can be assessed and market factors considered, to optimize both fire safety and overall cost for a commercial building.

Wood construction has benefited from all that has been learned regarding good design and appropriate active and passive fire-protection measures. The evolution of methods of construction has resulted in an enhanced level of fire protection, as reflected in the presented fire-loss statistics. Those statistics show that wood-frame construction can result in low fire-loss costs and that the presence of sprinklers can further reduce that low cost by almost half. Consequently, well-designed wood construction is a cost-effective means of protecting commercial endeavours from the risk of fire loss.

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ARCHITECT: KUWABARA PAYNE MCKENNA BLUMBERG ARCHITECTS

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