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The Historical Development of the Building Size Limits in the National Building Code of Canada

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1.0 EXECUTIVE SUMMARY

The use of wood is limited in larger and taller buildings by the National Building Code of Canada (NBCC) based on concern of increased fire risk. The current requirements were developed long ago, under much different conditions than today. Since then the industry's knowledge of fire science has evolved considerably, fire service equipment and capabilities have improved, detection and suppression systems have advanced, construction materials and techniques have changed significantly, and public awareness and education regarding fire safety has increased.

Having an understanding of the knowledge, capability, materials and methods used to develop the height and area limits and the risks they were intended to mitigate, sets the basis for re-examination of those limits in a current context. This can be achieved through a historical examination of the development of the limits and their bearing on the use of combustible construction in buildings.

Historical records indicate that there was a need to regulate building construction in the City of Rome as a result of several conflagrations. Augustus in 18 B.C. limited building height to 70 feet. The Annals of Tacitus note that the Great Fire of Rome occurred on July 9 in 64 AD and burned for 5 days, destroying 10 of fourteen districts. In order to limit the occurrence of future conflagrations, regulations limiting combustible construction, building height and separation were enacted. Over a millennium later, as the city of London expanded, several "Great Fires" occurred. One of the earliest in 1087 destroyed most of London including St. Paul's Cathedral. Another occurred in 1135 and again resulted in the destruction of most of the city. As a result of these large conflagrations, an ordinance termed the "Assize of Buildings" was issued, regulating combustible construction and use of an early version of today's firewall concept.

The Great Fire of London in 1666 burned for 4 days and destroyed a large part of London. In response, an act was passed in 1667 for rebuilding the city, regulating the construction of exterior walls and roofs, basic occupancy differentiation, building height, types of construction and party walls.

As a result of the proliferation of warehouse fires, the City of London building regulations were revised in the late 1700's to include area limits as a function of building construction. These regulations were further altered in the early 1800's as a result of fires rapidly growing beyond the capability of the local fire brigade, putting the community at risk of conflagration. As a result, the building act of London revised the area limits into cubic capacity limits to control the volume of these structures. These volume limits were further altered in the mid 1800's to cover a broader group of structures and a slightly greater volume of 216,000 cubic feet, which is the cube of 60 feet, a hazard considered to be within the capabilities of a properly equipped fire brigade at that time.

A proposal in the early 1870's to increase the maximum undivided building capacity to 300,000 cubic feet was considered in London, and permitted on a case-by-case basis for industrial facilities requiring greater space. At the same time, the Great Fires of Chicago and Boston occurred within a year of each other, resulting in significant losses for many insurance companies and bankruptcy in some cases. Following these conflagrations, the fire insurance industry banded together to establish a schedule of (premium) rates associated with an acceptable level of risk inherent to certain building characteristics, including height and area. The schedule of rates was intended to address the London-based insurers' concerns of building construction practices in the US. This schedule resulted in the definition of a "standard building", to which basic rates were set. Any deviation from the standard was considered to increase the fire hazard of the building, resulting in higher rates. The height and area limits associated with a "standard Building" were 60 feet and 5,000 square feet respectively, which coincided with the capacity of 300,000 cubic feet being considered in London at that time.

Over the 20-30 year period following the establishment of the definition of a standard building, height and area limits and other standard building features were gradually incorporated into city building ordinances. However, these limits were inconsistent, causing hardship for the construction industry, who pressed for uniform building regulations. A meeting of the Combined Committee on Building Ordinances was convened in New York on April 2 and 3, 1891 to discuss the framing and adoption of a model building law. The Committee was composed of seven delegates representing the American Institute of Architects, National Association of Builders, National Board of Underwriters, National Association of Building Inspectors and National Association of Fire Engineers. The meeting resulted in a draft of suggested ordinances combined from ordinances in force in various large cities, such as New York and Chicago, at the time.

A more successful attempt at drafting a model code occurred several years later (1893) by the National Board of Fire Underwriters, who had several decades of experience in drafting building ordinances for insurance purposes. This eventually became the National Board of Fire Underwriters (NBFU) Model Code published between 1893 and 1965. The 1905 NBFU Model Code was the first to include substantial height and area limits and variations of those limits as a function of occupancy type, construction type, streets facing and whether sprinklers were provided.

A report prepared in 1913 by Ira H. Woolson, Consulting Engineer for the National Board of Fire Underwriters, summarized the results of a study of allowable heights and areas for factory buildings in the United States. The study was based on a survey of fire marshals and fire chiefs in the United States representing cities of over 20,000 population. The results were consistent with those of the 1905 NBFU Model Code and the New York and Chicago City Ordinances.

Height and area limits were further developed by the National Fire Protection Association (NFPA) Committee on Fire Resistive Construction between 1913 and 1927. The committee was initially chaired by Woolson, and incorporated many of the same limitations established by NBFU and the survey conducted by Woolson in 1913.

Two groups continued development of height and area limits beyond 1927 including the Uniform Building Code (UBC) prepared by the International Conference of Building Officials, and the Recommended Minimum Requirements for Fire Resistance in Buildings (1930 NBSFR) prepared under the technical direction of the National Bureau of Standards by the Department of Commerce Building Code Committee. The 1930 NBSFR was originally chaired by Woolson until his death in 1927. The UBC and 1930 NBSFR had height and area limits consistent with those of the NBFU Code, NFPA limits and Large City ordinance limits and were a function of occupancy type, construction type, streets facing and sprinklering. The 1930 NBSFR limits were used as the basis for the limits contained in the first Canadian Model Code published in 1941.

The first National Building Code of Canada was published in 1941 and contained height and area limits based on model building regulations developed by the Department of Commerce in the United States as part of their “Elimination of Waste” Series. These limits were considered arbitrary in origin and assumed that a process of “juggling” was used to broaden these limits within the context of different occupancies and construction types.

In the 1953 NBCC, the 1941 NBCC height and area limit tables were revised using a combination of risk balancing and arbitrary alterations. The risk balancing was based on a method outlined in a book by B.L. Wood, considering conflagration and life safety as the primary risks.

In the 1960 NBCC, the 1953 NBCC height and area table was revised into a “spelled-out” format, intended to move in the direction of performance-based design and allow for more design flexibility. Short- and long-term approaches were developed to address further changes to the height and area limits. The

short-term approach involved basic changes to the limits within their existing framework. The long-term approach proposed consideration of changes to both the height and area limit framework and the specific limits.

In the 1960 NBCC, a number of the short-term changes were implemented. The long-term approach was suspended at approximately the same time austerity measures were implemented by the NRC.

In the 1965 NBCC, the height and area limits remained primarily unchanged. The significant change that occurred during this cycle was the simplification of the definition of "noncombustible" and move to describe two primary types of construction, 'combustible' and 'noncombustible', upon which the height and area limits were based. Provisions for 'heavy timber construction' were also detailed at this time, but this type of construction was a subset of the type 'combustible'.

In the 1970 NBCC, small revisions of height and area limits and a new "covered mall" concept were introduced. The covered mall concept was based on the consideration that building portions on opposite sides of a covered pedestrian mall were essentially two separate buildings connected by a covered area considered as an open space, based on the provision of protective features.

In the 1975, 1977 and 1980 editions of the NBCC, the basic height and area limits changed little. However, significant changes included consideration of a parking garage as a separate building and waiving of any roof rating where a building is sprinklered or where a fire retardant treated wood is provided.

In the 1985 NBCC, the covered mall provisions that allowed designers to consider a mall structure to be made up of separate buildings were deleted, except that the Code changed to permit heavy timber roof construction for any 1- or 2-storey structure of unlimited area, provided the building was sprinklered. Changes in the 1985 NBCC also introduced a special approach for determining the height of low-rise residential buildings constructed on sloped sites. This change provided a basis for later changes that permitted fully sprinklered Group C, D and E buildings 4 storeys in building height to be constructed of combustible construction.

In both the 1990 and 1995 NBCC, the allowable height for residential, business (office), and mercantile (retail) buildings of combustible construction was increased from 3 storeys to 4 storeys in height, provided the buildings are sprinklered throughout and designed to provide 1-hour fire rated elements. Prior to this time, 4-storey combustible construction had only been permitted for unsprinklered medium (Group F, Div.2) and light hazard (Group F, Div. 3) industrial occupancies of ¾-hour rated construction. In addition, in the 1990 NBCC, increased areas were provided for 1-storey residential buildings and also for 1- to 3-storey unsprinklered residential buildings with increased (1-hour) fire resistance for the structure.

In the 1995 NBCC, significant changes introduced relative to height and area provisions related to considerations for mandatory sprinklering including:

- Mandatory sprinkler protection for all tall (noncombustible) buildings.
- Mandatory sprinklers for all combustible buildings greater than 3 storeys in building height.
- Increases in the permitted area limits of any sprinklered building by 50%, with such buildings only required to face a single street, removing any impact (credit) of multiple streets faced in sprinklered buildings.
- Reduction of minimum fire resistance, for Group E and Group F-Divisions 1 and 2, from 3-hours to 2-hours, resulting in major increases in permitted areas for sprinklered noncombustible buildings of 2-h rated construction.

In both the 2005 and 2010 NBCC, the basic height and area limits changed little, with the exception of the limits associated with Group B, Division 3 occupancies added to the 2010 NBCC.

The risk associated with building size has historically been the spread of fire to involve more than one building (conflagration). Risk perceptions evolved over the historic development of the codes to include limiting full building involvement and collapse of high buildings. For lower buildings of combustible construction, where the assumption has been that smaller buildings may become fully involved and spread fire to adjacent buildings, the association of risk has remained largely unchanged since the limits were conceptualized.

The base height and area limits have remained relatively constant for nearly 160 years, with some variation in concept recognizing containment of fire to a single storey under certain conditions and greater area in sprinklered buildings, and only required to face one street. Therefore, the height and area limitations evolved as reflected in the fire department's ability to limit conflagrations given the fire service capabilities in London and New York dating back the origin of the requirements in the late nineteenth and early twentieth centuries.

Over the period of time that the building size limits have been established:

- firefighting techniques, equipment, response and overall capability has advanced significantly;
- construction methods and materials have advanced; and,
- analysis techniques have evolved significantly.

Knowledge of the risk basis of the building size limits allows for reconsideration of those limits in light of industry understanding and advancements, and facilitates the development of alternative solutions and changes to the NBCC to limit risk consistent with that intended by the prescriptive building size limits.

2.0 INTRODUCTION

Recent initiatives by industry to facilitate greater use of wood in construction have considered a growing societal recognition of the importance of sustainable development, building affordability and aesthetics. These initiatives are supported by the advancement of wood-based products having unique properties and construction techniques that differ from conventional stick framing or heavy timber. However, the use of wood is limited in larger/taller buildings by the National Building Code of Canada (NBCC) based on concern of increased fire risk. This has led to a reconsideration of these limitations in light of current capabilities, materials and analytical methods; however, the re-assessment is complicated by a lack of information linking the actual risk attributed to building size to the existing requirements and limits.

The development of building code requirements to limit building size and type of construction have evolved following incidents of significant scale or impact, which due to the catastrophic circumstances, drew attention to specific building design issues. Investigation and analysis following the incidents identified specific conditions that led to the "unacceptable" occurrences, and new requirements were developed to limit future similar losses. This cycle of code change would continue following the next incident or other impetus for change, incrementally advancing the code without a reconsideration of the cumulative risk basis. Over time, the changes have become entrenched as accepted practice and recollection of the incidents and the specific risk context around the incidents have diminished. This cycle of change was described by the Head of the Building Standards Section of the National Research Council of Canada in the 1960's [1, 2]:

> *In the broadest sense, building regulations develop from contingency to contingency. Each one represents an emergency measure taken with very little or no study. As the emergency recedes, the regulation tends to form part of traditional practice. It is added to the pile, which grows and grows.*
>
> *…*
>
> *Progress towards better regulations in this country will be speeded when we have an understanding of the history of the regulations which are now enforced.*
>
> *R.S. Ferguson, Head of Building Standards Section (1960's), NRC*

The history of the NBCC has been one defined by a subtle balance between facilitation of innovation in building design, while keeping safety to life and property protection paramount. Building codes are intended to regulate the built environment and limit risks that may occur. They have existed for hundreds of years in various forms and have evolved to what they are today very much through the process characterized above by Ferguson.

Requirements and limits are formulated based on knowledge, capability, materials and methods available at the time of their development and represent a solution, which was deemed necessary and socially acceptable at the time, to achieving an objective. Quantification of the objective in terms of expected performance may have been known at the time a requirement or limit was developed, but can become lost over time where it is developed as a prescriptive solution and without a quantifiable link to the original objective. Establishing the knowledge, capability, materials and methods upon which a requirement or limit was formulated allows for quantification of the connection between the prescribed solution and the intended reduction in risk.

The primary properties of a building that define the allowable type(s) of construction within the NBCC are the building's occupancy, height and area, street access and provision of automatic sprinklers. The

building height and area limits are considered the most defining of these factors, and knowledge of their origin allows industry to establish whether their application is appropriate in addressing the risk(s) associated with combustible construction today.

The development of the current height and area limits spans centuries and they are implicitly connected with foundational fire and life safety provisions in the NBCC. Over the past several centuries, the industry's knowledge of fire science has evolved considerably, fire service equipment and capabilities have improved, detection and suppression systems have advanced, construction materials and techniques have changed significantly, and public awareness and education regarding fire safety has improved.

In order to facilitate an assessment of the merits of larger and/or higher buildings of combustible construction, it is necessary to verify the root foundation of the height and area limits, and provide the framework to reconsider those limits and their bearing on the use of combustible construction in buildings.

This report details research into the historical development of the building height and area limits in the NBCC, and covers the following:

- Ancient Rome between 390 B.C. and 491 A.D.
- Early London in 1087 to Victorian London in 1874.
- The United States between 1871 and 1940.
- Early Canadian considerations between 1905 and 1920.
- The development of the NBCC from 1937 to the present.

The development of the height and area limits in the NBCC are founded on measures established to limit significant risks of the above geographic locations in the specified eras. While these individual locations have their own history of development of height and area limits, the focus of this report is the development of those limits as they relate to the NBCC.

The height and area limits have also developed in conjunction with and integral to other foundational concepts of the NBCC, such as fire-resistance ratings and compartmentation. The evolution of each of these concepts is a topic in itself, and for purposes of brevity are examined in this report as they relate to the development of the height and area limits.

In summary, the history of development of the height and area limits is lengthy and complex. In order to address the complexity, this report is limited to a chronological presentation of factual information. The intent is to use the information in this report as a basis for defining the risk, in a current context, associated with building size and to develop recommendations for reconsideration of the parts of the NBCC that regulate building size.

3.0 EARLY TIMES

In early times, the risk of conflagration was mitigated by regulating construction type, building separation, and height. These regulations preceded the development of building area limitations; however, area was implicitly regulated through limitations on property size and separation requirements. Early separation regulations evolved into what is currently the firewall concept.

The following sections summarize the development of regulations related to building height and area limitations from 390 B.C. through to the mid 1800's.

3.1 ROME, 390 B.C. TO 18 B.C.

Records indicate that after the Gauls burned Rome around 390 B.C., Roman citizens returned and rebuilt the city around 387 B.C. Houses were built close together and using combustible materials. Conflagrations occurred in 213 B.C., 211 B.C., 192 B.C. and 50 B.C. Reconstruction following the fire in 50 B.C. had not yet been completed at the time of accession of Augustus in 27 B.C. A building regulation "Lex Iulia de modo aedificiorum", accredited to Augustus in about 18 B.C., limited building height to seventy feet and required minimum wall thicknesses [3].

> To guard against these dangers, in the reign of Augustus the height of new houses in streets was limited to seventy feet, by a "Metropolitan Building Act," as it would now be called (Strab. v. p. 235). Augustus recommended a work on this subject by Rutilius, entitled "De Modo Aedificiorum" (Suet. *Aug.* 89). Vitruvius (ii. 8, 17) gives some of the provisions of this Act, *e.g.* that houses, if several stories high, were to be built *pilis lapideis, structuris testaceis, parietibus caementitiis* ; that is, on stone piers, with walls of concrete and burnt brick,—not of sun-dried clay, as had been the usual custom.

The mention of "dangers" is in reference to collapse resulting from flooding due to the Tiber River, and fire.

3.2 GREAT FIRE OF ROME, 64 A.D.

The Annals of Tacitus [4] note that the Great Fire of Rome occurred on July 9 in 64 A.D. and burned for 5 days, destroying 10 of fourteen districts [**Figure 1**]. To limit the occurrence of future conflagrations, the following regulations, attributed to Nero, were enforced following the conflagration [4]:

> The buildings themselves, to a certain height, were to be solidly constructed, without wooden beams, of stone from Gabii or Alba, that material being impervious to fire. And to provide that the water which individual license had illegally appropriated, might flow in greater abundance in several places for the public use, officers were appointed. and everyone was to have in the open court the means of stopping a fire. Every building, too, was to be enclosed by its own proper wall, not by one common to others.

Figure 1: An illustration depicting the "Great Fire of Rome" [5].

3.3 ROME, 98 A.D. TO 491 A.D.

Nero did not specify a height limit for buildings, but referred to "a certain height". The height limit previously specified by Augustus was further limited to 60 feet by Trajan during his reign between 98 A.D. and 117 A.D. [6]:

> *(a)* Strabo says, that by an ordinance of Augustus, no new-built house was to be more than seventy feet high. Trajan afterwards, according to Aurelius Victor, fixed the elevation at sixty feet.

Emperor Zeno, who reigned from 476 A.D. to 491 A.D., enacted legislation relative to the height and separation of houses. The height limit was governed by obstruction of sea views rather than for purposes of limiting fire spread or facilitating firefighting activity. These regulations are included below [7]:

— Sect. II. *On the Height to which it is permitted to raise a House.*—Moreover, since our constitution directs that an interval of twelve feet must be left by him who is about to build, between his own and his neighbour's house, and that he may add to it *more or less*,—(as this gives great security to those who build), and as no doubtful or ambiguous words ought to be admitted,—we ordain, in the most clear and explicit terms, that an interval of twelve feet must be left between each house, beginning from the part immediately above the foundations, the same admeasurement being preserved to the very summit of the building. He who shall accordingly in future observe this ordinance, will be allowed to raise his house as high as he pleases, and may construct windows, as well those which we call prospective,* as those which are only luminiferous,† according to the said divine constitution, whether he is desirous of erecting a new house, or of reinstating an old one, or of re-constructing one which has been destroyed by fire. He shall, however, be in nowise permitted to encroach upon the prescribed interval, so as to deprive his neighbour of a direct and uninterrupted prospect towards the sea, from any or every side of his house—a prospect which he may enjoy at home either standing or sitting; nor can he be allowed in any such manner to affect this prospect, so that his neighbour should have only an oblique view of the sea. In respect to gardens and trees, the former constitutions contain no regulations regarding them, nor will any be given on this occasion—they are not required.

3.4 1189 Assize of Buildings, London

One of the earliest "Great Fires" of London occurred in 1087 and destroyed most of London including St. Paul's Cathedral. Another occurred in 1135 and resulted in the destruction of most of the city. At that time, the structures in the greater part of London were constructed of wood, roofed with straw or similar material [8].

As a result of these large conflagrations, an ordinance was issued by the then Mayor of London, Henry Fitz-Aylewin, in 1189. An excerpt of a translated version of the "Assize of Buildings" is included below [8]:

It should be remarked, that in ancient times the greater part of the City was built of wood, and the houses were covered with straw, stubble, and the like.

Hence it happened, that when a single house had caught fire, the greater part of the City was destroyed through such conflagration

After this, many of the citizens, to the best of their ability to avoid such a peril, built stone houses upon their foundations, covered with thick tiles, and [so] protected against the fury of the flames; whence it has often been the case that, when a fire has broken out in the City, and has destroyed many buildings, upon reaching such houses, it has been unable to do further mischief, and has been there extinguished; so that, through such a house as this the houses of the neighbours have been saved from being burnt.

> Hence it is, that in the aforesaid Ordinance, called the 'Assize,' it was provided and ordained, in order that the citizens might be encouraged to build with stone, that every one who should have a stone-wall upon his own land sixteen feet in height, might possess the same as freely and meritoriously as in manner already stated
>
> And this, to the end that [1]such house may remain secure and protected against the violence of fire when it comes, and so, through it, many a house may be saved and preserved unharmed by the violence of the flames.

In addition to requiring houses be built of stone with tile roofs, the Assize of Buildings contained one of the earliest regulations forming the basis for what would eventually become party-wall (firewall) requirements [8]:

> *Of Buildings erected between Neighbours.*
>
> When it happens that two neighbours wish to build between themselves a stone-wall, each of them ought to give one foot and a half of his land; and so at their joint cost they shall build a stone-wall between them, three feet in thickness and sixteen feet in height.

These requirements were intended to limit fire spread from house-to-house and subsequently limit the risk of conflagration. However, the changes intended by the regulations did not have an immediate effect and another significant fire occurred in 1212, destroying London Bridge and a large number of houses [9]. As a result, the "Assize of Buildings" was amended and included the following related to type of construction [10]:

> "Whosoever wishes to build, let him take care, as he loveth himself and his goods, that he roof not with reed, nor rush, nor with any manner of litter, but with tile only, or shingle, or boards, or, if it may be, with lead, within the city and Portsoken. Also all houses which till now are covered with reed or rush, which can be plastered, let them be plastered within eight days, and let those which shall not be so plastered within the term be demolished by the alderman and lawful men of the venue.
>
> "All wooden-houses which are nearest to the stone-houses in Cheap, whereby the stone-houses or Cheap may be in peril, shall be securely amended by view of the mayor and sheriffs, and good men of the city, or, without any exception, to whomsoever they may belong, pulled down.

3.5 HEIGHT LIMITS IN THE LAWS OF EDINBURGH IN THE 1600'S TO 1800'S

Several large fires occurred in Edinburgh in the 1600's as a result of house construction (wood with thatched roofs [11] and unrestricted height [12]). Building height was attributed to "the high price of

building ground and the habit which the inhabitants of Edinburgh had acquired of living above each other in separate floors of the same house, it had been necessary to raise the buildings to a very dangerous height" [12], and was up to 12 storeys in some cases. To address these fires, the Scottish Parliament in 1698 enacted a law limiting the height of buildings to no more than 5 storeys [13]:

VIII.

ACT Regulating the Manner of Buildings within the Town of Edinburgh.

August 30. 1698.

OUR SOVERAIGN LORD Conſidering, That the New Buildings within the City of *Edinburgh*, having been Built without any ſettled Rule, or particular Over-ſight, ſeverals of the Houſes are Built to exceſſive, incommodious and dangerous Height, and all of them very Slight and Unſufficient, whereby not only the Policy and good Neighbourhood of the Town is prejudged, but alſo, in caſe of Fire happening, all Acceſs for ſtaying or extinguiſhing the ſame is ſo difficult, that it may prove dangerous to the whole Town: For Remeed whereof, and for the better Ordering and Regulating of all New Buildings within the City of *Edinburgh*, in all time coming, His Majeſty, with Advice and Conſent of the Eſtates of Parliament, *Statutes and Ordains*, That, in the Building of any New Houſes, or Land within the City and Suburbs, theſe Rules be Obſerved, *viz.*

...

And *Statutes and Ordains*, That all New Houſes be built no higher than five Stories above the Calſay;

Additional noteworthy conflagrations occurred in 1700 and 1824. The more significant of these was the great fire of November 1824, which started in the High Street and spread through the whole city [11]. Edinburgh's first chief of the fire brigade distinguished himself in leading the suppression of this fire. He eventually became the first fire chief of the London Fire Brigade, which is detailed in the clip below, and is discussed in more detail in **Section 4.1** of this report:

> The municipal fire service was inaugurated in Edinburgh in 1824 by Mr James Braidwood, who was the first municipal fire chief in the world as far as can be traced, and he remained here until 1833, when he went to London as London's first chief. His work in Edinburgh was the model upon which the different cities in the kingdom founded their fire establishments, and the principles laid down by Braidwood in Edinburgh in 1824 are being followed to this day in almost every city in the country.

James Braidwood was the son of a respectable upholsterer whose premises was destroyed by fire in 1807 when James was age 7 [11]:

> **1807.—On the morning of Nov. 10, between three and four o'clock, the work-shop of Mr. Francis Braidwood, upholsterer in the Pleasance, was discovered to be on fire; and before assistance could be procured, the premises were entirely consumed.**

3.6 LIMITS IN THE BUILDING ACTS OF LONDON, 1666 TO EARLY 1800'S

Following the great fire of London in 1666, the city of London enacted building legislation including requirements to separate buildings and regulate construction as a function of height and area. The following sections of this report detail these regulations from 1667 to the early 1800's.

3.6.1 THE GREAT FIRE OF LONDON

The Great Fire of London occurred on September 2, 1666 and burned for 4 days destroying 13,200 houses, 87 parish churches, St. Paul's Cathedral and most of the buildings of the City authorities [14] [**Figure 2**]. This fire resulted in the development of detailed building regulations and the origin of the fire insurance industry [15].

Figure 2: A painting of the "Great Fire of London" as seen from a boat in vicinity of Tower Wharf [14].

3.6.2 ACTS OF 1667 TO 1774

In 1667 an Act was passed titled, "An Act for rebuilding the City of London", to regulate the re-building following the great fire. This act included provisions for the construction of exterior walls and roofs, basic

occupancy differentiation, building height, types of construction and party walls [16]. The Act required the following for construction of exterior walls and roofs [16] (Note that the wall thicknesses in this act are identified by brick lengths[a]):

Building with brick, ſtone, oak.

VII. *And in regard the building with brick is not only more comely and durable, but alſo more ſafe againſt future perils of fire:* (2) be it further enacted by and with the authority aforeſaid, That all the outſides of all buildings in and about the ſaid city be henceforth made of brick or ſtone, or of brick and ſtone together, except door-caſes and window-frames, the breaſt ſummers, and other parts of the firſt ſtory to the front, between the piers, which are to be left to the diſcretion of the builder, to uſe ſubſtantial oaken timber inſtead of brick or ſtone, for conveniency of ſhops; and that the ſaid doors breaſt ſummers and window-frames be ſufficiently diſcharged of the burthen of the fabrick by arch-work of brick or ſtone, either ſtraight or circular.

An early consideration of occupancy differentiation as a function of hazard classification, the Act regulated trades considered perilous to be kept from principle streets [16]:

Noiſome trades prohibited in the high ſtreets.

XXI. And be it further enacted, That it ſhall and may be lawful to and for the lord mayor, aldermen and common council of the ſaid city from time to time, to prohibit ſuch trades and occupations as they ſhall judge noiſom or perilous in reſpect of fire, to be uſed or exerciſed in the high or principal ſtreets of the ſaid city.

House height and the requirement for party wall construction was regulated based on four types ("sorts") of construction [16]:

There ſhall be four ſorts of buildings only.

V. And to the end that all builders may the better know how to provide and fit their materials for their ſeveral buildings; (2) be it enacted, That there ſhall be only four ſorts of buildings, and no more; and that all manner of houſes ſo to be erected, ſhall be of one of theſe four ſorts of buildings, and no other; (that is to ſay) the firſt and leaſt ſort of houſes fronting by-lanes; the ſecond ſort of houſes fronting ſtreets and lanes of note; the third ſort of houſes fronting high and principal ſtreets; the fourth and largeſt ſort, of manſion-houſes, for citizens, or other perſons of extraordinary quality, not fronting either of the three former ways: and the roofs of each of the ſaid firſt three ſorts of houſes reſpectively, ſhall be uniform.

The height, construction, wall thicknesses and separation of the four sorts of house are summarized in the following [16]:

[a] An Act was passed in 1725 to "prevent abuses in making of bricks and tiles, and to ascertain the dimensions thereof", which defined the dimensions of a standard brick.

Houſes of the firſt and leaſt ſort of building.

IX. And be it further enacted, That the ſaid houſes of the firſt and leaſt ſort of building, fronting by-ſtreets or lanes as aforeſaid, ſhall be of two ſtories high, beſides cellars and garrets; that the cellars thereof be ſix foot and a half high, if the ſprings of water hinder not; that the firſt ſtory be nine foot high from the floor to the cieling, and the ſecond ſtory nine foot high from the floor to the cieling; that all walls in front and rear, as high as the firſt ſtory, be of the full thickneſs of the length of two bricks, and thence upwards to the garrets, of the thickneſs of one brick and an half; and that the thickneſs of the garret-walls on the back part be left to the diſcretion of the builder, ſo that the ſame be not leſs than the length of one brick; and alſo that the thickneſs of the party-walls between theſe houſes of this firſt and leſſer ſort of building, be one brick and an half, as high as the ſaid garrets; and that the thickneſs of the party-walls in the garrets be of the thickneſs of one brick in length at the leaſt; and that the ſcantlings of timber and ſtone to be uſed about the building thereof, be as in the ſaid table are ſet down and preſcribed.

Houſes of the ſecond ſort of building.

X. And be it further enacted, That the ſaid houſes of the ſecond ſort of building, fronting ſtreets and lanes of note, and the river of *Thames*, ſhall conſiſt of three ſtories high, beſides cellars and garrets, as aforeſaid; that the cellars thereof be ſix foot and an half high (if the ſprings of water hinder not;) that the firſt ſtory contain full ten foot in height from the floor to the cieling, the ſecond, full ten foot: the third, nine foot: (2) That all the ſaid walls in front and rear, as high as the firſt ſtory, be of the full thickneſs of the length of two bricks and an half, and from thence upwards to the garret-floor of the thickneſs of one brick and an half; and that the thickneſs of the garret-walls on the back part be left to the diſcretion of the builder, ſo that the ſame be not leſs than the length of one brick; (3) and alſo that the thickneſs of the party-walls between every houſe of this ſecond and larger ſort of building, be two bricks in length as high as the firſt ſtory, and thence upwards to the garrets of the thickneſs of one brick and an half: the ſcantlings of timber and ſtone to be as in the ſaid table are preſcribed.

Houſes of the third ſort of building.

XI. Alſo that the houſes of the third ſort of building, fronting the high and principal ſtreets, ſhall conſiſt of four ſtories high, beſides cellars and garrets, as aforeſaid; that the firſt ſtory contain full ten foot in height from the floor to the cieling; the ſecond, ten foot and an half; the third, nine foot; the fourth, eight foot and an half: (2) that all the ſaid walls in front and rear, as high as the firſt ſtory, be of the full thickneſs of the length of two bricks and an half, and from thence upwards to the garret-floor of the thickneſs of one brick and half; that the thickneſs of the garret-walls on the back part be left to the diſcretion of the builder, ſo as the ſame be not leſs than the length of one brick; (3) and alſo that the thickneſs of the party-walls between every houſe of this third and larger ſort of building, be two bricks lengths as high as the firſt ſtory, and thence upwards to the garrets, of the thickneſs of one brick and an half: the ſcantlings of timber and ſtone to be as in the ſaid table are preſcribed.

XII. And be it further enacted, That all houſes of the fourth ſort of building, being manſion-houſes, and of the greateſt bigneſs, not fronting upon any of the ſtreets or lanes as aforeſaid, ſhall bear the ſame ſcantlings as in the table are ſet down for the ſame; and that the number of ſtories, and the height thereof, be left to the diſcretion of the builder, ſo as he exceed not four ſtories. Houſes of the fourth ſort of building.

The heights of the four sorts of houses, ignoring cellars and garrets, was limited to 18 feet for the first sort, 29 feet for the second sort, 38 feet for the third sort, and no more than four stories[b] for the fourth sort. The actual physical height of the four sorts of houses could be greater depending on the protrusion of a cellar above ground level and the height of a garret. This Act recognized increased height with thicker front and back walls and party walls.

The heights on a storey-by-storey basis and wall thicknesses of the four sorts of houses are summarized in the table below [16].

XLIII. *A ſcheme of proportions and ſcantlings for ſtories, walls and timbers for the building of leſſer and larger houſes within the city of* London.

Brick.	Diviſion of ſtory		Height of ſtory. Foot.		Thickneſs of walls	Bricks.		Bricks.
First ſort, being the leaſt houſes fronting, by-ſtreets, lanes, &c.	Cellars		6 ½		To the first floor.	2		1 ½
	1 ſtory		9		2d	1 ½		1 ½
	2 ſtory		9		3d	1 ½		1 ½
	garrets					1		1
	Cellars	Where the ſprings prevent not.	6 ½	Thickneſs of walls in front and rere from the foundation.	To the first floor	2 ½	Thickneſs of walls between houſe and houſe.	2
2 Second ſort, houſes, fronting all ſtreets, lanes of note, and river of Thames.	1 ſtory	Not leſs in height clear than	10		2d	2		1 ½
	2 ſtory		10		3d	2		1 ½
	3 ſtory		9		4th	1 ½		1 ½
	garrets					1		1
3 Third ſort, houſes fronting all high ſtreets and lanes of note.	1 ſtory		10		1ſt	2 ½		2
	2 ſtory		10 ½		2d	1 ½		1 ½
	3 ſtory		9		3d	1 ½		1 ½
	4 ſtory		8 ½		4th	1 ½		1 ½
	garrets					1		1

[b] In many early documents and regulations, the word was spelled ‘story’ and ‘stories’; in later documents, including today in the National Building Code in Canada, it is spelled ‘storey’ and ‘storeys’

This Act recognized the importance of providing a barrier to fire spread (and conflagration) in requiring buildings within the City to have exterior walls and roof coverings of noncombustible material, and reducing the risk of fire initiation by prohibiting high hazard occupancies from the built-up streets of the City. At this point, building areas were not limited.

Act's passed in 1670, 1707 and 1708 expanded the provisions for party-walls. The Act of 1707, "An Act for Better Preventing Mischiefs that happen by Fire" noted the following relative to party-walls [17]:

> have party walls between houſe and houſe, wholly of brick or ſtone, and of two bricks thick at the leaſt in the cellar and ground ſtories, and thirteen inches thick upwards from the foundation quite through all the ſtories of each houſe, and eighteen inches above the roof; and that no mundillion or corniſh of timber or wood under the eaves ſhall hereafter be made or ſuffered in any ſuch new houſe or houſes, but that all front and rear-walls of every houſe and houſes ſhall be built of brick or ſtone, to be carried two foot and an half high above the garret floor, and coped with ſtone or brick;

As a result of questions of enforcement and legal issues regarding compensation, the party-wall requirements were further developed in Acts in 1724, 1759, 1763, 1722 and 1774. These changes largely related to joint ownership and responsibility of party-walls by neighbours. Due to complexities evolving out of law, the resulting statutes were so complex, they became difficult to apply and enforce. The following illustrates the complexity of its use [18]:

> The Judges seem never to have missed an opportunity of censuring its provisions, they even advised parties to avoid so intricate an act; and had parties rightly understood their own interests, it is probable that many harassing lawsuits would have been saved.

3.6.3 ACT OF 1774

In addition to the revisions to the party-wall requirements, building classification as a function of construction characteristics further developed from the four "sorts" of house in the 1667 Act to seven "rates" of building in the 1774 Act, entitled "An act for the further and better Regulation of Buildings, and Party-walls; and for the more effectually preventing Mischiefs by Fire". The purpose was to expand the application of the Act to a broader group of buildings and provide more options relative to construction. Each rate of building was not occupancy specific, but covered a group of occupancies depending on the rate.

The first four rates of building each covered groups of occupancy, as noted above, including dwelling-houses. Each rate of building was limited in height for all of the occupancy groups, but only limited area for dwelling-houses. An excerpt for the fourth rate of building is included below [19]:

> XI. And be it further enacted, That every Warehouſe, Stable, and other Building, not being a Dwelling-houſe, except ſuch Buildings as are herein particularly declared to be of the Firſt, Fifth, Sixth, or Seventh Rate or Claſs of Building, now built, or hereafter to be built, which does not or ſhall not exceed one clear Story above Ground, excluſive of the Rooms (if any) in the Roof thereof, or which is not or ſhall not be of the Height of more than thirteen Feet from the Surface of the Pavement, Ground, or Way, above the Area before either of the Fronts thereof, to the Top of the Blocking-courſe or Coping on the Parapet thereof; and every Dwelling-houſe now built, or hereafter to be built, which, with the Offices thereto belonging and adjoining, or connected otherwiſe than by a Fence or Fence-wall, or covered Paſſage open on one or both Sides, when finiſhed, does not or ſhall not exceed the Value of one hundred and fifty Pounds; and alſo every Dwelling-houſe which does not or ſhall not exceed three Squares and an Half of Building on the Ground Plan thereof, ſhall be deemed to be of the Fourth Rate or Claſs of Building,

Construction type for exterior walls and party-walls was limited to brick and wall thicknesses were specified as a function of building rate and height. The height and area limits for the first four rates of building are included in **Table 1**. Building area was measured in "squares" at the level of the floor at the principal entrance to the dwelling. One "square" is equal to 100 square feet [19].

Table 1: Height and area limits for first four rates of building [19].

Building Rate	Height	Area
First	> 3 storeys (31 feet)	> 9 squares
Second	≤ 3 storeys (31 feet) > 2 storeys (22 feet)	≤ 9 squares > 5 squares
Third	≤ 2 storeys (22 feet) > 1 storey (13 feet)	≤ 5 squares > 3.5 squares
Fourth	≤ 1 storey (13 feet)	≤ 3.5 squares

Similar to the first four rates of building, the fifth and sixth rate of building covered groups of occupancy including dwellings. These rates of building were not limited in height and area, but by a separation distance from public streets or other buildings. The separation distances, construction materials and dimensions for the fifth and sixth rates of building are included in **Table 2**, which shows building height and area (dimensions) are not limited, and with increased distance, construction material is not limited.

Table 2: Height and area limits for first four rates of building [19].

Building Rate	Distance from a Public Road, Street or Causeway	Distance from any Other Building	Construction Materials	Dimensions
Fifth	≥ 4 feet < 8 feet	≥ 16 feet < 30 feet	Limited	Unlimited
Sixth	8 feet	≥ 30 feet	Any	Unlimited

The seventh rate of building covered specific occupancy types and locations (outside the cities of London and Westminster) and were not limited in dimension. An excerpt of the requirements relative to the seventh rate of building are included below [19]:

XX. And be it further enacted, That every Cranehouſe, now built, or hereafter to be built, on any Wharf or Quay, and every Shamble, Windmill or Watermill, and alſo every Building which is or ſhall be ſituated without the Cities of *London* and *Weſtminſter*, and the Liberties thereof, uſed for Workſhops or Drying-places for Tanners, Fell-mongers, Glue-makers, Size-makers, Callico-printers, Whitſters, Whiting-makers, Curriers, Leather-dreſſers, Buckram-ſtiffners, Oil-cloth Painters, Wool-ſtaplers, Throwſters, Parchment-makers, and Paper-makers, ſo long and at ſuch Times as they are or ſhall be uſed for ſome or one of thoſe Purpoſes, and no longer, ſhall be deemed the Seventh Rate or Claſs of Building, and may be built of any Dimenſions whatever.

In addition to dwelling houses, the 1774 Act was the first to limit the area of warehouses and stables to 35 and 25 squares respectively [19]:

LIII. And be it further enacted by the Authority aforeſaid, That no Stack of Warehouſes to be erected after the ſaid twenty-fourth Day of *June*, ſhall contain more than thirty-five Squares of Building on the Ground Plan thereof, including all the external and internal Walls, and ſo much of the Party-walls, if any, as belong to ſuch Stack of Warehouſes; and no Enlargement ſhall be at any Time thereafter made to any Stack of Warehouſes already built or begun, ſo as to increaſe the ſame beyond the ſaid thirty-five Squares on the Ground Plan, including ſuch Walls as aforeſaid, except ſuch Stack of Warehouſes be ſeparated and divided by one or more Party-wall or Party-walls, built, in every Reſpect, according to the Directions herein-before contained concerning Party-walls, into Diviſions of not more than thirty-five Squares each, including ſuch Walls as aforeſaid, on the Ground Plan of ſuch Warehouſes; and that no Stack of Warehouſes ſhall communicate with any other Warehouſe or Building through a Party-wall, unleſs the Door-caſe and Sill of every ſuch Communication be of Stone, and unleſs there be to every ſuch Communication a Door of wrought Iron, of the Thickneſs of a Quarter of an Inch at leaſt in the Pannels thereof; and no Timber, Bond, or Lintel, ſhall be laid into the Brick-work of any Wall in any ſuch Stack of Warehouſes nearer than eighteen Inches to the Opening of ſuch Communication.

LIV. And be it further enacted by the Authority aforeſaid, That no Building for Stables, to be erected after the ſaid twenty-fourth Day of *June*, ſhall contain more than twenty-five Squares of Building on the Ground Plan thereof, including all the external and internal Walls, and ſo much of the Party-walls (if any) as belong to ſuch Building for Stables; and no Enlargement ſhall be at any Time thereafter made thereto, or to any Building for Stables already built, or begun to be built, ſo as to increaſe the ſame beyond the ſaid twenty-five Squares on the Ground Plan, including ſuch Walls as aforeſaid, except ſuch Building for Stables be ſeparated and divided by one or more Party-wall or Party-walls, built in every Reſpect according to the Directions herein-before contained concerning Party-walls into Diviſions of not more than twenty-five Squares each, including ſuch Walls as aforeſaid, on the Ground Plan of ſuch Stables: And that no ſuch Building for Stables ſhall communicate through a Party-wall with any other Stables or Building, unleſs the Door-caſe and Sill of every ſuch Communication be of Stone, and unleſs there be to every ſuch Communication a Door of wrought Iron, of the Thickneſs of a Quarter of an Inch in the Pannels thereof; and no Timber, Bond, or Lintel, ſhall be laid into the Brick-work of any Wall in any ſuch Building for Stables nearer than eighteen Inches to the Opening of ſuch Communication.

3.6.4 BILL OF 1830

A Bill enacted in 1830 titled [20] "A Bill For the regulation of Buildings and Party Walls, and for the more effectually preventing Mischiefs by Fire," further progressed the requirements relative to building construction including general application of the rates to all occupancies rather than specific ones. An eighth rate was added and changes were made to the height and area limits for all rates. The Bill also clarified application of the first four rates of building as follows [20]:

> **And be it further Enacted, That all Buildings, if attached or intended to be attached to one another, also if the same, whether attached or not, shall be within four feet of any public or private way, or any intended public or private way, exclusive of the sunk area (if any) lying between the same, shall be held to be either of the first, second, third or fourth rate of building.**

As shown in **Table 3**, the area limits changed slightly, but the heights increased significantly and limits were added for roofs.

Table 3: Height and area limits for first four rates of building [20].

Building Rate	Height	Area
First	≤ 60 feet > 50 feet Roof ≤ 75 feet	≤ 35 squares > 9 squares
Second	≤ 50 feet > 45 feet Roof ≤ 60 feet	≤ 9 squares > 6 squares

Building Rate	Height	Area
Third	≤ 45 feet > 30 feet Roof ≤ 50 feet	≤ 6 squares > 4 squares
Fourth	≤ 30 feet Roof ≤ 35 feet	≤ 4 squares

The limits associated with the fifth, sixth and seventh rates only moderately changed from the 1774 Act. The eighth rate of building permitted a greater area than first rate buildings, but were not permitted to be private dwellings. The specific limits associated with eighth rate are as follows [20]:

> **And be it further Enacted, That every Building hereafter to be built, which having no internal walls or divisions of brick or stone above the level of the ground floor, shall in its dimensions, measuring horizontally either on the basement floor or on the ground floor, exceed thirty-five squares of Building, or which having such divisions shall exceed forty-five such squares, or which having no floors or horizontal divisions extending from one opposite wall to another, shall exceed in height to the top of any of the external walls of such building sixty feet, or to the top of the roof of such building seventy-five feet, or which shall, having such floors or horizontal divisions, exceed in height from the basement thereof to the top of any of the external walls of such building seventy-five feet or to the top of the roof thereof ninety feet, whether the same shall be attached to or detached from any other building, or whether the same shall abut upon or be distant from any public way, shall be of the Eighth Rate of building, and be built as is hereinafter particularly directed.**

The primary difference between the eighth rate and the first four rates, was greater height and area, reference to internal walls or divisions of brick or stone and the requirement of a more rigorous approval process.

3.6.5 Act of 1844

The next significant change to the height and area limits occurred in the 1844 Act, which defined three building classes (occupancy types) and rates of building (construction specifications). The rates of building were similar to previous Acts. The classes included groups of occupancy and were defined as follows [21]:

> ***First Class.***
>
> **If a Building be built originally as a Dwelling House, or be occupied or intended to be occupied as such, then it is to be deemed to belong to the First or Dwelling House Class.**

Second Class.

If a Building be built originally as a Warehouse, Storehouse, Granary, Brewery, Distillery, Manufactory, Workshop, or Stable, or be occupied or intended to be occupied as such, or for a similar Purpose, then it is to be deemed to belong to the Second or Warehouse Class.

Third Class.

If a Building be built originally as a Church, Chapel, or other Place of Public Worship, College, Hall, Hospital, Theatre, public Concert Room, public Ball Room, public Lecture Room, public Exhibition Room, or occupied or intended to be occupied as such, or for a similar Purpose, or otherwise used or intended to be used, either temporarily or permanently, for the Assemblage of Persons in large Numbers, whether for Public Worship, Business, Instruction, Debate, Diversion, or Resort, then it is to be deemed to belong to the Third or public Building Class.

The height and area limits for the first four rates of building of the First Class (Dwelling House) are included in **Table 4**.

Table 4: Height and area limits for First Class of building [21].

Building Rate	Height	Area
Extra First	> 7 storeys (85 feet)	> 14 squares
First	≤ 7 storeys (85 feet) > 7 storeys (70 feet)	≤ 14 squares > 10 squares
Second	≤ 6 storeys (70 feet) > 5 storeys (52 feet)	≤ 10 squares > 6 squares
Third	≤ 5 storeys (52 feet) > 4 storeys (38 feet)	≤ 6 squares > 4 squares
Fourth	≤ 4 storeys (38 feet)	≤ 4 squares

The Second Class of buildings were limited in height as a function of Building Rate. However, they were not limited on a specific area basis. The height limits for the first four rates of building of the Second Class (Warehouses) are included in **Table 5**.

Table 5: Height limits for Second Class of building [21].

Building Rate	Height
First	> 66 feet
Second	≤ 66 feet > 44 feet
Third	≤ 44 feet > 22 feet
Fourth	≤ 22 feet

The area of the Second (Warehouse) Class of Building was limited indirectly by specifying overall cubical contents (volume) of this class of building. Cubical limits are discussed in more detail in the following section of this report.

The 1844 Act did not specifically limit the height and area of Third Class of Buildings (i.e., assembly type occupancies).

4.0 THE CUBIC CAPACITY CONCEPT

Until the late 1700's, with the exception of certain assembly-type structures, the majority of buildings were limited in size and height due to increased costs associated with the construction and maintenance of larger buildings and utility of such buildings. This changed with the proliferation of bulk goods warehouses in England, which by their nature were required to be of large unbroken area in order to house machinery, assembly lines and large quantities of mass produced goods. Fires occurring in these buildings would rapidly grow beyond the capabilities of the local fire brigade, putting the community at risk of conflagration. This was addressed through the development of requirements to limit the size of these fires.

4.1 ACT OF 1844

The increase in large fires in warehouses particularly in the 1830's and early 1840's was addressed by the passage of "The Metropolitan Act" in 1844 [21]. This act was intended to regulate the construction and use of buildings in the Metropolis (London) and its neighbourhood and specifically addressed the potential for large warehouse facilities (Second Class buildings) by limiting the volume between party-walls [21]:

> ***Warehouses, &c.***
>
> **With regard to any Building of the Second Class hereafter built or rebuilt, in reference to the Capacity or Contents thereof within the same inclosing Walls,—**
>
> **If such Building contain more than 200,000 Cubic Feet,—then such Building must be divided by Party-Walls, so as that there be not in any one Part of such Building more than 200,000 Cubic Feet without Party-Walls.**

The specific origin of the 200,000 cubic foot limit could not be established from the documentation reviewed. However, the 1774 Act permitted buildings of the first rate to be up to 60 feet in height and 35 squares, which equates to 210,000 cubical feet. This limit likely relates, through experience of the fire brigade, to the total quantity of combustibles and subsequent fire expected within an unbroken space. This theory of 'cubic content' was mentioned in an 1844 paper by James Braidwood, first Chief of the London Fire Brigade, relative to water supply for fires [22]:

> If water can be obtained at an elevation, pipes with plugs or fire-cocks on them, are preferable to any other mode at present in use. The size of the pipes will depend on the distance and elevation of the head, and also on the size of the buildings to be protected. It may be assumed as a general rule, that the intensity of a fire depends, in a great measure, on the cubic content of the buildings; distinction being made as to the nature and contents of such buildings. If no natural elevation of water can be made available, and the premises are of much value, it may be found advisable to erect elevated tanks; where this is done, the quantity of water to be kept ready and the rate at which it is delivered, must depend on the means possessed of making use of the water.

4.2 ACT OF 1855

Based on his knowledge and experience, Braidwood was consulted in the reframing of the Metropolitan Building Act and in doing so, endeavored to prevent the proliferation of "monster" warehouses, not governed by the 1844 Act due to a discrepancy in interpretation of what constituted a warehouse.

4.2.1 216,000 CUBIC FEET

The Metropolitan Building Act was revised in 1855, based on passage of a Bill from 1851 [23], to broaden the scope of the size limitation to warehouses and buildings used wholly for purpose of trade or manufacture [24]:

> 4. Every warehouse, or other building used either wholly or in part for the purposes of trade or manufacture, containing more than two hundred and sixteen thousand cubic feet, shall be divided by party walls in such manner that the contents of each division thereof shall not exceed the above-mentioned number of cubic feet (*b*).

The resulting limit was expressed, similar to the Act of 1844, in terms of cubical content, but increased from 200,000 to 216,000 cubic feet. In addition, clarification relative to the uniting of two buildings and openings between them was added to limit ultimate building size. Specifically [24]:

> Walls of a Building of the Dimensions of such Two Buildings taken together as One Building, or if any Two Buildings when united would exceed Thirty-six Squares in Area, or 216,000 Cubic Feet in Capacity, being Buildings which in such Case are by this Act required to be divided, then no Opening in any Wall or other Structure separating the same may be made wider than Seven Feet or higher than Eight Feet; and each Opening must have the Floor, Jambs, and Head thereof formed of Brick, Stone, or Iron Work, and must have Two strong Wrought-iron Doors One Fourth of an Inch thick in the Panels thereof, distant from each other the full Thickness of the Wall, fitted and hung in rebated Frames without Woodwork of any Kind, unless by special Certificate in that Behalf an Official Referee shall certify that any Openings may be otherwise made with a due Regard to the Purposes of this Act.
>
> And no Opening may be made in any Wall or other Structure dividing any Building which by this Act is required to be divided into Parts not exceeding Thirty-six Squares in Area, or 216,000 Cubic Feet in Capacity, except in accordance with such and the same Conditions as are set forth in the foregoing Rule.
>
> And every Wall which has been built for or used as a Party Wall is to be and to continue to be subject to the Rules and Directions of this Act in respect of Party Walls, whether the Buildings parted thereby continue in different Occupations or not.
>
> And whenever any Buildings shall cease to be in the same Occupation, every Opening in any Wall or other Structure separating the same must be stopped up with Brickwork of the full Thickness of such Wall or Structure, and properly bonded therewith.

Even though the maximum permitted cubic capacity was increased, the increase was minimal and the change broadened the scope of the cubic limitation in the Metropolitan Act to a larger group of buildings. In support of this change, it was Braidwood's assertion that a properly equipped fire brigade should be reasonably capable of suppressing a fire in a building having a volume that is the cube of 60 feet, or

216,000 cubic feet. This assertion was noted in a book written in the 1870's by the then Chief of the London Fire Brigade, E.R. Shaw [25]:

Greatest height of building quickly protected.

Greatest cubical capacity quickly protected.

> With a well organized and properly equipped fire brigade it is found that sixty feet is the greatest height at which a building can be quickly protected, and that the cube of 60, or 216,000 cubic feet, is the largest cubical capacity which can be protected with reasonable hope of success after a fire has once come to a head.

A committee discussion several decades following the passage of the 1855 Metropolitan Building Act, affirmed the origin of the 216,000 cubic limitation [26]:

> It is only a fire questiou. It all arose out of Mr. Braidwood giving evidence upon the Committee of 1855. The Committee said, What sized building can you manage? and he gave the size of the building, and that has been put into the Act of Parliament;
>
> Are you aware that there was a limit so long ago as 1774?—That was a different limit. The Committee extended limit, in 1855.
>
> So it was Mr. Braidwood's evidence which led to a relaxation of the limit?—It was his evidence that gave the size, and he gave it thinking that he could manage a building within that size.

As noted above, the increase in cubic capacity between the 1844 and 1855 Acts was perceived, in isolation, as a "relaxation". However, considering the small increase in cubic capacity and the scope of the requirement applying to a broader group of buildings, the change was more characteristic of a limitation than a relaxation. Regardless, these regulations were often evaded for purposes of private profit. Braidwood continued his campaign to prevent endangering of whole neighbourhoods through the construction of these large structures by writing letters to politicians as noted below [27]:

> In a letter to Sir W. Molesworth, First Commissioner of Public Works, dated 10th February, 1854, on the subject of a proposed warehouse in Tooley-street, he wrote 'The whole building, if once fairly on fire in one floor, will become such a mass of fire that there is now no power in London capable of extinguishing it, or even of restraining its ravages on every side, and on three sides it will be surrounded by property of immense value.'

Mr. Braidwood would eventually lose his life to such a fire that occurred at Tooley-Street on June 22, 1861. The fire spread through several warehouses by way of iron doors in the division walls (party walls) that had been propped open. The fire also spread to nearby wharves considered to be the best built in London. The fire department had limited water supply and the fire burned for a fortnight (14 days). Mr.

Braidwood was crushed early in the fire by the collapse of a wall as he was standing by to encourage his firefighters in their efforts to suppress the fire.

4.2.2 300,000 CUBIC FEET

As a result of the damage caused by the Tooley Street fire, insurance premiums for mercantile risks increased and a "panic rates" schedule was developed. The rate schedule included limits associated with building volume [15]:

Requirements of the Fire Offices for the improvement of risks and reduction of prems.

1. That no warehouse or shed hereafter built shall contain more than 216,000 cubic feet, and shall be built according to the regulations of the Metropolitan Buildings Act.
2. As respects existing buildings, the cubical contents of which exceed 300,000 feet, the dimensions allowed in connexion with the reduction of prem. shall be subject to special arrangement with the Committee of Offices, who under the advice of their surveyor will take into consideration any special circumstances.

The rate schedule suggested an increase in insurance rate for buildings exceeding 300,000 cubic feet. However, did not identify increased rates for existing buildings 300,000 cubic feet or less. As noted above, new warehouses and sheds were required to comply with the Metropolitan Buildings Act with a maximum cubic capacity of 216,000 feet.

The 216,000 cubic foot capacity limit remained in the Metropolitan Building Act until second reading of a Bill submitted to parliament in the 1870's. This Bill suggested that the limit of 216,000 cubic feet be increased to 300,000 cubic feet as a compromise to a misinterpretation of the Act by magistrates in several instances, permitting buildings of greater cubical extent to accommodate operations of a greater industrial scale. The increased cubical extent resulted from interpretation that a party-wall could be horizontal, allowing storeys each having 216,000 cubic feet. Specifically [28]:

> By the Act of 1855 the limitation of the cubic contents of a building was fixed at 216,000 feet; but the magistrates had decided that that amount of cubical space might be contained on each separate floor. The Bill proposed that the 216,000 feet should be extended to 300,000 feet, but that the 300,000 feet should comprise the whole building.

As noted above, the misinterpretation by magistrates on specific cases related to the application of the party-wall concept in a horizontal configuration, thus permitting buildings to have unlimited cubical content. This was considered contrary to the intent of the party-wall requirements as noted by Mr. Walter Newall, the Principal Clerk in the Department of the Superintending Architect of the Metropolitan Board of Works, who was involved with the development of the 1844 and 1855 Acts [26]:

70. Sir *J. Lawrence.*] With reference to your remark as to the want of a definite interpretation of the Act, is not it really the fact that the magistrates, before whom the causes were heard, felt that the requirements of the trade of London were quite beyond the cubical contents defined in the Act, and therefore they did not interpret that clause of the Act with that rigidity which you think desirable?—I do not know that I can go so far as that, but we do not accept the decisions, we want to apply the law.

71. Mr. *Bazalgette.*] I think I may take it from what you have said, that it is your opinion that it was the intention of the Act, that the divisions limiting this cubic capacity of 216,000 feet should be vertical divisions?—Yes, that the separation should be vertical. A party-wall is a vertical structure, and a party structure means a fire-proof floor.

72. The magistrates have interpreted the clause so as to enable those divisions to be made horizontally, have they not?—In some instances they have.

...

94. I believe it is provided by the present Bill, that the cubical contents shall be increased to 300,000 feet, but at the same time, to make it clear, that the divisions shall be vertical, by means of party-walls?—Yes; that is the scope of the clause.

732. You have told us that the law has been construed by magistrates to enable a man, by putting a horizontal division instead of a vertical one, to increase the size of his dwelling-house, and to count each floor only as being represented by the limit of 216,000 feet?—Yes, a warehouse.

The concern of interpreting the horizontal application of party-walls for purposes of increasing cubical content was also expressed by Mr. George Frederick Deacon, a member of the Institute of Civil Engineers for the borough of Liverpool. Mr. Deacon identified the risk of such an interpretation on the basis of floor-to-floor fire spread and collapse [26]:

932. There is much greater danger of fire from floor to floor than there is from building to building, when there is a party wall intervening?—Much more; the flame impinges against the floor with much more effect.

933. In case of a fire burning out in one floor, is it a common occurrence for the upper floor to fall on to it?—Very common.

Captain Eyre Massey Shaw, Chief Officer of the London Metropolitan Fire Brigade, identified cubical extent, height of building and floor construction as key risk factors associated with interpretation of the party-wall requirement. These were considered within the context of the capabilities of the London Fire Brigade.

Cubic Extent

The risk associated with cubical extent was primarily related to combustible content, which for purposes of the Act had been associated with volume of a structure (cubical content). A fire involving a building with cubical extent greater than 216,000 cubic feet was considered by the London Fire Brigade to be beyond their capability to control, and could result in spread of fire to adjacent structures [26]:

1054. With regard to division of houses, and fires spreading from building to building, does the size of the buildings at all affect the danger?—Very much.

1055. In what respect?—Fires in very large buildings attain such a magnitude that they spread to the adjoining buildings.

1056. From the amount of combustion?—Yes; from the amount of combustible matter contained in them.

1057. Of course when a fire is limited within certain divisions or walls, the incandescent mass is so much more restricted and under management?—Much more restricted.

1071. What, according to your experience, is the maximum size which a building should have so as to be fairly dealt with within the scope of your appliances in case of fire?—I should say about 60 feet cubic is a very safe size for us to deal with; we could always make sure of a building of about 60 feet cubic, if properly constructed, which would easily be separated from others in case of fire; the Fire Brigade, in fact, would be able to prevent the fire spreading.

Specific to the interpretation of party-wall in a horizontal configuration, Captain Shaw indicated it would result in a dangerous condition [26]:

1058. Supposing that the maximum size of houses were indefinitely extended horizontally, so that the largest buildings that the law would allow were to exist on one floor without vertical divisions, would, in your judgment, that be so safe as if vertical divisions severed the building?—Certainly not.

1059. Supposing that the whole area now of 216,000 cubic feet were upon one floor, and likewise 216,000 cubic feet over it on the next floor, and also the same area on the third floor, would that, in your judgment, be a dangerous building?—Exceedingly dangerous.

1060. Would you be able to cope with it?—I think, certainly not.

1061. Are there many such in London, do you know?—No, I do not know of many in London; I am afraid there are some approaching to it, but not many.

Height

The risk associated with height related to the ability of the London Fire Brigade to access the upper part of a high building from the outside for purposes of suppression and facilitating escape of occupants [26]:

1048. First of all, with regard to the question of the height of buildings, is that a matter which you find practically connected with the safety of life and property?—Yes.

1049. In what respect?—The difficulty of protecting a high building is very greatly increased by the height of the building. A building which is less than, say, 50 feet high, can be very quickly reached in every part, but a building which is over 50 feet high is very difficult to reach; and if it comes to 70 or 80 feet high, as it occasionally does in the metropolis, it is absolutely impossible, with the present arrangements, to get at it, except under very favourable circumstances.

1050. What is practically the highest maximum to which water can be thrown with effect by a steam engine?—That is a question which very seldom arises with us, but it can be thrown to 80 or 90 feet, although not with good effect.

1051. What is the extreme height to which fire escapes and ladders can be reasonably carried for the protection of life and the saving of life?—About 50 feet.

1120. What limit, according to you, would be a fair and safe limit to impose? —I should say that the limit applied in Liverpool is about the best for this country; 60 to 65 feet.

The excerpt above was clarified by Captain Shaw relative to the initial strategy of the London Fire Brigade, prior to an exterior attack, in accessing a building for purposes of controlling the fire [26]:

1479. And I also gather from the general answers that you have given, that you have great difficulty in dealing with fires when the houses are more than 65 feet high, by reason of the incapacity of the engines to cope with them?—Not of the engines, but of the want of the means of access to these high buildings. As a rule we do not throw water from the ground level into buildings at all; as a rule we do not throw water from the outside; we do not extinguish fires, as a rule, in London, by pouring water from the outside of buildings into the inside, but by going into the inside.

1480. But still, you have led me to suppose that you have a great difficulty in getting your engines to force the water up above a certain height; whereas you can deal with 30 or 40 feet easily, you cannot with 70 feet?—No, that was not my meaning: I said that our ladders do not enable us in those cases to get access from the outside, when there is no means of access from the inside, because there is no such thing as a high ladder that will enable us to get into a high building quickly.

Floor Assembly

The risk associated with a horizontal party-wall was primarily related to the instability of certain construction materials exposed to heat from a fire. At this point in time, the concept of fire-resistance rating had not yet been introduced, but certain assemblies of materials were considered to have inherent resistance to fire varying as a function of type and configuration of material. Captain Shaw noted the following relative to a floor providing resistance to fire spread [26]:

1062. In your judgment, is it possible or reasonably practicable to make a floor fire-resisting so as to prevent the spread of fire from one to the others?—I have never seen a floor of that kind which I would trust.

Captain Shaw noted the following form floor assemblies supported and constructed primarily of wood, steel, and brick [26]:

1063. You know the construction of so-called fire-proof floors; what is the safest floor according to your view?—I should say a floor made on the French principle, with good strong joists, and boards and plaster.

1064. The effect of the plaster with the wood prevents the combustion of the wood very materially, does it not?—As far as the combustion of the wood goes, very much indeed.

1065. Is that, in your judgment, and according to your experience, a safer floor than a stone floor supported upon iron columns?—Certainly it is.

1066. Less liable to fall?—Much less liable to fall down.

1067. Mr. *Goldsmid.*] The floor that you describe has no iron in it?—No iron at all, except some small pieces of hoop iron, which are imbedded so as to hold up the plaster when it is soft.

1075. With regard to the way in which the floors are supported, in your judgment, where a floor takes the bearing on iron supports, is that the safest or the best mode of construction in case of fire?—Certainly not.

1076. Will you be kind enough to explain to the Committee what happens when the floor or weight is borne on iron pillars in case of fire?—I have seen iron columns soften with the heat, and fall down; I have also seen them crack upon the application of water, and fall down, and I have seen them trickle and fall.

1077. They are practically safer with the wooden posts that you get in some cases?—Yes, if they are sufficiently massive.

1372. Mr. *Cawley*.] I presume you have many warehouses in London with wooden floors, supported in the interior with cast-iron columns?—Yes.

1373. You have others with wrought or cast-iron girders and brick arches?—Yes.

1374. Do you consider that there is any difference in the safety of a building in the two cases?—Yes.

1375. Which do you consider the best?—I consider that the floors laid on wood are very much safer than a brick-arched floor, unless the arches are supported by very much stronger buttresses and tie-rods than I have ever seen.

1376. I am putting the case where they are both supported by cast-iron columns?—In that case the wooden floor is decidedly safer, from my point of view, than the brick-arched floor.

Following the Select Committee report and associated deliberations, the Bill proposing the 300,000 cubic capacity limit was defeated by the opposition and not adopted into the Metropolitan Building Act. However, following the Tooley Street Fire, this capacity was considered appropriate from an insurance perspective for existing warehouses and sheds. This is important to changes occurring in the insurance industry in the United States at the same time (1870's) as a result of the large number of conflagrations occurring there, which is discussed in more detail in the following section of this report.

5.0 INSURANCE RATING SYSTEM AND THE "STANDARD BUILDING"

The concept of a "standard building" was developed in the United States following the devastation resulting from several significant city conflagrations and UK-based insurers' concerns of the substandard construction of buildings in the US. Two of the most significant conflagrations occurred in Chicago on October 10, 1871 and in Boston on November 9, 1872 [**Figure 3**]. There had been many large conflagrations in the United States prior to these two; however, their occurrence just over a year apart and resulting impact on the insurance industry attracted much attention from insurers relative to the substandard conditions of construction in cities across the United States.

Figure 3: A mosaic photograph showing the destruction in Boston following the fire.

5.1 INSURANCE INTERESTS

Following the Boston Conflagration, a report by a Commission appointed to investigate the cause and management of the fire noted the following [29]:

> This danger had been foreseen, and our calamity had been foretold both here and abroad. There is sad interest in the statements of our State Insurance Commissioner, who tells us that just before the fire, English underwriters spoke to him, at Liverpool and London, of the probable fate of Franklin Street, Winthrop Square, and their surroundings, and proposed to cancel their policies, and to cease insuring in our city. While some of us were justly priding ourselves on the elegant architecture of this district, and boasting that it was practically fire-proof, English insurers were dreading a conflagration on this very spot, and preparing to withdraw their agencies from our city.

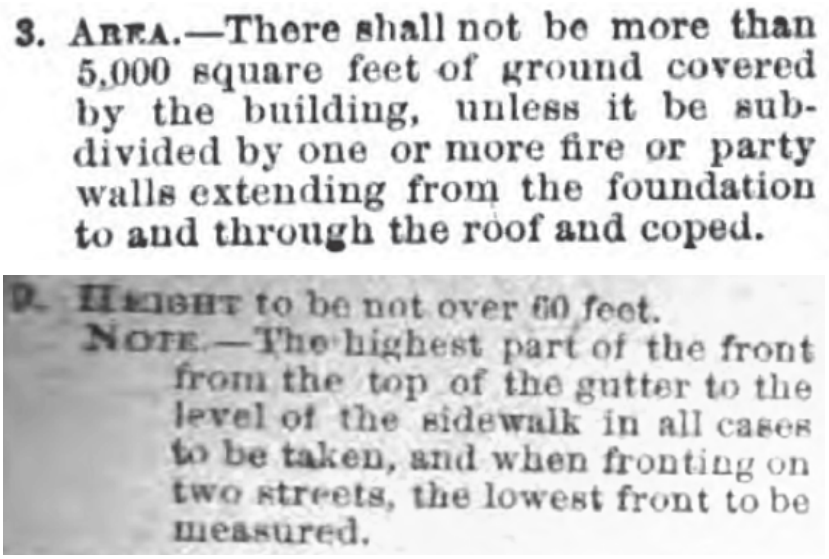
The proximity in time of these conflagrations and extent of loss resulted in the demise of all but the most prudent insurance companies, who remained solvent solely as a result of their cautious assessment of fire risk. Following these conflagrations, the US fire insurance industry banded together to establish a universal schedule of rates associated with an acceptable level of risk inherent to certain building characteristics. This resulted in the definition of a "standard building", to which basic rates were set. Any

deviation from the standard was considered to increase the fire hazard of the building, resulting in higher rates.

5.2 STANDARD BUILDING

Some of the key characteristics of a "standard building" included occupancy, type of construction, building area, building height and sprinklers. These building characteristics were identified following the Chicago and Boston conflagrations as significantly contributing to, or limiting in the case of sprinklers, the spread of fire. Regulating these characteristics through increased insurance rates was intended to limit the potential for a building to become involved during a conflagration, or contribute to the growth and spread of a conflagration.

One of the earliest definitions of a "standard building" was by the New York Board of Fire Underwriters in their "Standard Rates Schedule" issued in January of 1873 [30], just two months after the Boston Conflagration. This schedule was specific to Standard Private Warehouses and Storage Stores and included rate variations for certain building height and area limits; wall, roof, cornice/gutter, parapet wall and floor construction; provision of iron shutters; openings in floors; and width of street. The specific area and height limits were as follows [30]:



3. AREA.—There shall not be more than 5,000 square feet of ground covered by the building, unless it be sub-divided by one or more fire or party walls extending from the foundation to and through the roof and coped.

2. HEIGHT to be not over 60 feet.
NOTE.—The highest part of the front from the top of the gutter to the level of the sidewalk in all cases to be taken, and when fronting on two streets, the lowest front to be measured.

The basis of the height and area limits for a standard building were not explicitly stated in any of the reviewed documentation. The development of these limits was likely influenced by those existing in London at the time, given the interest from London-based insurance companies. Several factors associated with the development of these limits in a US context, including building volume and lot size, are outlined in the following sections of this report.

5.2.1 BUILDING VOLUME

As outlined in **Section 4.0** of this report, the greatest height and area to which a building could be quickly protected by the London Fire Brigade was the cube of 60 feet, or 216,000 cubic feet. This cubic capacity was reconsidered in deliberations of a Bill proposing changes to the London Metropolitan Building Act in 1874 with a suggested increase to 300,000 cubic feet. This cubic capacity was suggested for existing buildings in an insurance rating system developed following the Tooley Street Fire.

It is reasonable to assume that the capability of fire service in the large cities of the US in the 1870's was comparable to that of London. A "standard building" height of 60 feet into 300,000 cubic feet results in

an area of 5,000 square feet, which is the "standard building" area noted previously. In addition, the 60 foot limit for a "standard building" is consistent with the height considered manageable by the London Fire Brigade as outlined previously.

A report on Insurance published in the American Exchange and Review Journal discussed the destruction and financial aftermath of the Chicago and Boston conflagrations and relative to building design noted that [31] "[a]s the cubical capacity of our buildings augments, their fire destructive capacity increases". The reference to "cubical capacity" suggests a possible link to building size concepts in London at that same time.

The similarities of the limits of a "standard building" with those of the London Metropolitan Buildings Act is supported by a report in the Insurance Times in 1880 relative to the height of buildings. The report makes reference to the 5,000 square foot building area and equates it to the London Fire Brigade's capability [32]:

> An architect in this city said to me not long ago, speaking of large buildings—I think it was *apropos* of one of these large buildings that burned here: "A building that is more than 50 by 100 feet, or 5,000 square feet on the surface, is a dangerous building to insure." That is to say, it is dangerous, for it cannot be reached, and will be a total loss. He quoted the authority of the Chief of Brigade in London, for this very statement that 50 by 100 feet was as large a building as he wanted to cope with.

Similar to the cubic capacity within the capability of the London Fire Brigade, the New York Fire Department suggested 5,000 square feet as the maximum area that could be efficiently handled by a city fire department [33]:

> 3. It has been pointed out that the volume and intensity of fire, and the rapidity with which it will gain headway, are all vastly greater in large areas than in small ones. It is also a much more difficult matter for a fire department effectively to surround and fight a fire of large area. Much valuable time is lost in running long lines of hose, in addition to which, smoke conditions are often so bad that the actual location of the fire cannot either be found, or reached if found. There is a limit to the ability of firemen to inhale smoke or withstand heat, and once this limit is reached, the offensive operations of extinction cease, the firemen are put on the defensive, and the fire is master of the situation. These considerations would point to the desirability of fixing what might be termed the maximum area which can be efficiently handled by a city fire department. "As a working unit, 5000 square feet has been suggested, with a limit of 100 feet in any direction (or a rectangle 50 by 100), which is as large an undivided area as the experience of the New York Fire Department indicates to be within the capacities of effective fire department operations."*

5.2.2 LOT SIZE

A city plan drawn up in 1811 in the City of New York imposed a uniform lot size of 25 feet by 100 feet north of 14th Street [34]. See **Figure 4** below for a representative map. In some districts of the City, such as the Warehouse District, buildings were permitted to occupy 100 percent of a lot [35]. Where not restricted by light and ventilation requirements, buildings such as department stores located outside the Warehouse District were also permitted to occupy 100 percent of a lot.

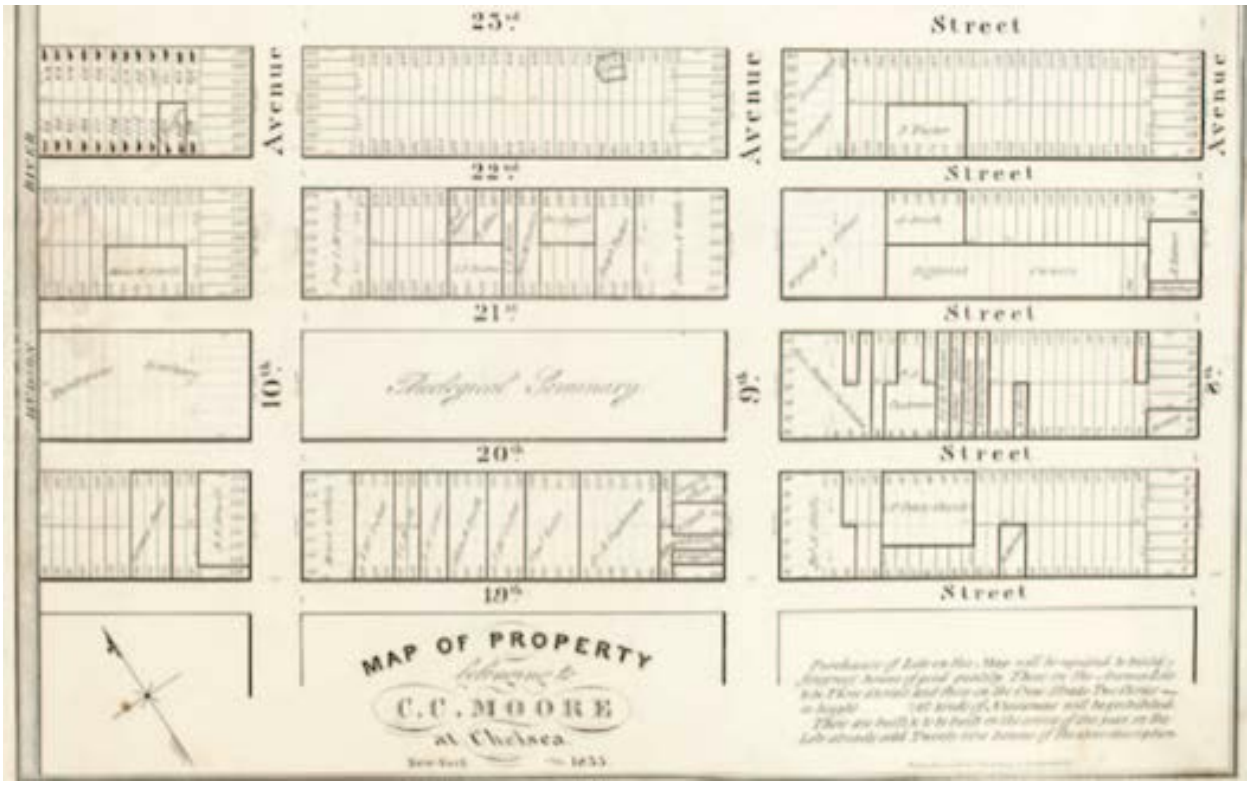


Figure 4: Representative map of the lot layout in the City of New York.

Buildings could occupy single or multiple lots, resulting in areas that were multiples of 2,500 square feet, and warehouses/factories occupied an area greater than a single lot, consistent with that of a "standard building", as noted by H.F.J. Porter below [36]:

> Some of these factories occupy one or more floors in so-called loft buildings of the standard type, 100 feet square, from ten to twelve stories high, of which there are hundreds in the city.

In addition, as noted in the last excerpt of the previous section of this report, "5000 square feet has been suggested, with a limit of 100 feet in any direction (or a rectangle 50 by 100)", which is equivalent to two lots as outlined above.

5.2.3 AREA BASIS

The relationship between the London cubic limit and units of lot size in the City of New York, in addition to the other links previously noted, is supportive of the origins of the "standard building" area limit being the London cubic limit applied to standard lot sizes.

5.3 INSURANCE RATING SYSTEM

As noted previously, the universal rating system was developed following the Chicago and Boston conflagrations with the definition of a "standard building" by which base rates were set. Additions to or subtractions from the base rate were considered as a function of factors that were considered to either increase or decrease the risk of fire respectively [37]:

> A *schedule* may be defined as a method of assessing the insurance tax by computing this tax by means of a series of charges, which charges shall have the effect of penalizing those factors in a property which are known to cause or increase the fire loss, and crediting those factors in a risk which are known to be helpful in preventing or retarding fire loss.

The origins of systems of insurance rating correspond with the origin of the fire insurance industry in the late 1600's where it was recognized that buildings have different inherent fire risk depending on construction. The identification of differences was likely a result of observation from actual fires such as the Great Fire of London, which was one of the primary motivators in the establishment of the fire insurance industry [37]:

> **THE MAKING OF A SCHEDULE**
>
> While considered of comparatively modern origin, schedule rating as a matter of fact really began with the business of fire insurance. The mere fact that the first underwriters made two sets of rates, one for wood and another for other kinds of buildings showed a discrimination between the only things then considered in the rate of insurance, namely, the construction of the property. The whole process from that time forward down to the present day, and it is still going on, has been simply a refining of what the early underwriters started.

Once faced with the occurrence of real fires, insurance offices recognized that in addition to building construction, activities occurring within buildings also varied in risk, and were classified accordingly [37]:

> when the insurance offices began to experience real fires, attention would be drawn to the fact that property occupied by certain businesses had more fires than that occupied by others. Insurance could not long have continued without acting upon this information. If the existing offices had not taken note of it, new ones would certainly be established that would. It seems to be fairly well es-

> tablished, however, that the Union Fire Office, founded in 1714, was the first to introduce the distinction of hazardous and doubly hazardous risks. They really had three classes, the first being called *common*, the second *hazardous*, and the third *doubly hazardous*

Between the 1870's and early 1900's the rating system evolved to cover a broader range of building types and associated design features. A rating system developed by several large underwriters' associations in the United States in 1892 [38] covered building construction types from frame to fully "fireproof". In addition to heights and areas, the rating system considered features such as occupancy, type of construction, access and sprinklers. These are discussed in the following sections of this report.

5.3.1 OCCUPANCY

A large list and ranking of occupancies was provided in most schedules of rates based on the risk of fire initiation and combustibility associated with that type of occupancy [37]:

> The schedule furnishes a list of occupancies beginning with the number 400 and ending with 1,687, thus listing 1,287 different businesses. There are actually more than this since there are some, as department stores, coffee dealers, and groceries, that are divided into several sub-classes. The division of the charge for occupancy into two parts, a first column and a second column, is made for *ignibility* and *susceptibility*, respectively.

An example of the occupancy list is included below with rate for base building in the first column on the right, and rate for building contents on the second column on the right [39]:

1191	Matting (floor) Manuf'y.....	75	100
1192	Mattress Making, Hair only, no Picker.....	50	100
1193	" " other than hair, no Picker.....	100	100
1194	" " " " " with "	200	100
	Medicines, Patent, Stocks of (see Patent M. No. 1283)	50	100
	" " Manuf'y (see 1284, 1285)	75	100
1195	Merchandise (see Dry Goods & Remarks, U. M. S. p. 35)		
	" in Warehouses (see Warehouses).....		
	Merchant Tailors (see Tailor, No. 1528).....	.....	50
	Merry-go-rounds (see Carousels, No., 630).....	100	100

5.3.2 TYPE OF CONSTRUCTION

As noted previously, type of construction was recognized early in the development of a rating system based on observation of real fires. Rating associated with type of fire evolved primarily into two types of construction: fireproof and non-fireproof [37]:

> **Early Rates for Fireproofing.** The fireproof building while old in a certain sense, since early examples were erected one hundred years ago along somewhat modern lines, is nevertheless quite new from the standpoint of insurance rating. In the very beginning the tendency was to over-estimate this form of construction and it took many years before there was evolved a treatment of that type of construction which was at all satisfactory. The earliest attempts used the rate of a non-fireproof building and from that made a certain percentage deduction if the structure was fireproof. In certain cases that treatment is still followed and there are rules in force today which simply make this distinction between the fireproof and non-fireproof, namely: The property is rated as though it was of non-fireproof construction and then a deduction of a fixed percentage is made. It may be forty per cent for the contents and sixty per cent for the building.

Rates associated with other factors such as height and area were determined as a function of type of construction, which is discussed in more detail in the next sections of this report.

5.3.3 ACCESSIBILITY (STREETS FACING)

Accessibility was identified as a key factor in reducing the consequences of fire and having an associated rate reduction on the basis that access to more than one side of a building enhanced the fire departments' ability to reach and control the fire [37]:

> **Accessibility.** A building may be situated on the corner and thus present two sides from which fire may be fought. It may even stand on the corner and have a street in the rear and thus present three sides. Some buildings, as department stores, occupy whole blocks; hence, a fire may be fought from all four sides. This accessibility, as it is termed, to the fire department is deemed of large value and of increasing value accordingly as more than two sides are accessible; hence, the allowance is made for each side accessible in addition to the front, which, of course, is not given an allowance. It will be noticed that accessibility is something which the building enjoys solely from its location.

The reduction in rate was three percent for each accessible side of the building [39]:

> 165. **Accessibility to Fire Department.**—If building is on a corner or extends through to rear street or wide alley, affording access to fire department for fire extinction or removal of goods, deduct for each side or rear so accessible (none for front)..... 3 %

5.3.4 AREA

The fire risk associated with the area of a non-fireproof building was considered to be twice that of a fireproof building. Accordingly, a non-fireproof building of 5,000 square feet in area was considered equivalent from a "risk" and rate perspective to a fireproof building of 10,000 square feet in area [37]:

> **Area. Twice as many square feet are permitted in this type of structure as in the non-fireproof before charges are imposed,**

The phrase "this type of structure" in the excerpt above is in reference to fireproof construction. The following shows the rate schedule and associated area limits in a non-fireproof building [39]:

> 58. **Area.**—If ground-floor area in excess of 2,500 square feet and not exceeding 5,000 square feet, add for each 1,000 square feet in excess of 2,500 square feet..... 1 cts.
>
> 59. " If ground floor exceeds 5,000 square feet, add for each 1,000 in excess of 2,500 up to 10,000.....
> In buildings not over 3 stories high.... 2 "
> " " over 3 stories and not over 6, 3 "
>
> 60. " If ground-floor exceeds 10,000 square feet, add for each 1,000 or fraction thereof in excess of 2,500.....
> In buildings not over 3 stories high.... 2½ "
>
> 61. " " " over 3 stories and not over 6, 5 "
> (Not exceeding a total of 200 cents.)
>
> 62. " If building exceeds 6 stories in height and 10,000 square feet of ground floor area, double the area charge.....

The following shows the rate schedule and associated area limits of a fireproof building [39]:

> 293. **Area.**—If ground-floor area exceeds 5,000 square feet, up to 10,000, charge for each 1000 or fraction thereof in excess of 5,000.....¼ of 1 "
> (If building occupied above grade floor for offices or dwellings, no charge for area.)
>
> 294. " If ground floor area exceeds 10,000 square feet, charge for each 1,000 or fraction thereof in excess of 10,000 (not exceeding a total of 40 cents)..... 4 "

Risk was considered to increase gradually as a function of building area. The rate schedule provided a base area and associated rate. Additional charges were added to the rate for each incremental fraction of area added onto the base area. However, there was a value beyond which the rate was not permitted to increase, limiting the total corresponding area. Meaning that, in the judgment of some underwriters, there were areas (and heights) at which the risk was too great to insure [37]:

> In connection with the item of area and the item of height, unless the risk be a sprinkled one, it should be pointed out that the judgment of the underwriters, and experience bears this out, is that the charges can hardly be made too high for those points in the schedule.

5.3.5 HEIGHT

As outlined above for area, height was rated as a function of type of construction, but not in the same gradual manner as area. The risk of height was considered to increase significantly where it exceeded the capability of the responding fire service. The rating schedule considered heights above the seventh floor as beyond the reach of responding fire service and assumed that any contents above the seventh floor would perish in a fire [37]:

> **Height.** Under item 297*a* there will be noted that a certain charge is made if merchandise is stored above the seventh floor. This is quite a heavy charge and is founded on a desire to keep stocks below the eighth floor and also the belief that presence of stocks on the upper floors would tend to wreck the building during a fire. The first reason, when the property is unsprinklered, is certainly excellent, since the difficulty of fighting a fire in such a building beyond the height noted is enormous. In fact, there is no way for the firemen to get hold, but it must burn itself out, which was what happened when the Parker Building fire occurred in New York City. This was a twelve-story building unsprinklered, with poor floor openings, stocks on every floor. The fire took possession, so to speak, of the property and burned until it exhausted itself. The firemen were not able to do more than protect, to a certain extent, surrounding property.

Item 297a noted in the excerpt above is shown below for fireproof buildings. Note that for both non-fireproof and fireproof buildings, the rate for contents increased significantly on the seventh floor and higher [39]:

Non-fireproof Height Increments

63.	**Height.**—	For fifth story, add.....	5 cts.
64.	"	For sixth story, add.....	10 "
65.	"	For seventh story, add.....	25 "
66.	"	For each story in excess of seven, add.....	40 "

Fireproof Height Increments

295. **Height.**—For each story in excess of eight, up to twelve, charge..... 1 "

Office buildings may be ten stories without charge of 293 or 294.

296. " For 12th and each story over 12 up to 15, charge 3 "

297. " For 15th and each story over 15, charge..... 10 "

If merchandise be stored above 7th floor charge 15 cts. and add 2 cts. more for each floor over 7th up to 10th, and 5 cts. more for 10th and each floor above 10th. For example: an eleven-story building would have 29 cents added.

5.3.6 SPRINKLERS

The use/installation of automatic fire sprinkler systems was (and still is) considered to be one of the key factors in reducing the risk and consequence of fire [37]:

SPRINKLERS

The sprinkler device is recognized as the most efficient factor in the fighting of fire. Like most other things which enter into the fire prevention and fire insurance problem it has required years to educate the insured and insurer to the proper appreciation of this valuable device.

The efficiency of sprinklers took several decades to become fully appreciated by underwriters. Reductions in rates were initially small, but increased within a short period of time following the development of the first sprinkler standard (NFPA 13) in 1896. Design of systems in conformance with this standard increased reliability and permitted a 30 percent reduction in rates [37]:

In the beginning the allowance was rather small, seven and one-half per cent and under a slightly different condition ten per cent. The growth of the sprinkler equipments was very slow. In the first two or three years after 1884 probably not fifteen buildings were equipped in the larger cities. From that time on the growth has been quite rapid. After a while the allowance was advanced to twenty per cent and continued at that point until 1896 when experience led to the drafting of new rules, the adoption of new standards and an inducement made to secure two sources of water supply for the equipment. When the equipments were installed under the new rules in 1896, with two sources of supply, an allowance of thirty per cent was made in the rate of insurance. It was thus possible for the property to receive an allowance of twenty or thirty per cent depending wholly upon the standard of equipment put into the building.

Note that in some versions of the universal rating schedule the percentage sprinkler reduction was listed as 33⅓ percent. Until 1905 the rate reduction had been increased up to fifty percent for standard sprinkler equipment and up to sixty percent for a supervised system [37]:

> **Restricted Sprinkler Schedule.** Until 1905, the only effect in the rate of insurance by sprinkler installation (and it will be appreciated that effect may be a very large one, since it means a reduction if the equipment is standard of fifty per cent, and with the supervisory system a possible sixty per cent), had proceeded along the lines followed when the allowance was first made for the device, that is, it had only affected the rate by making a percentage reduction.

The gradual increase in the sprinkler rate reduction was a function of the increase in reliability of sprinkler systems, recognized through provision of design standards, improvements in operation and means of supervision, and experience.

5.3.7 RATING SYSTEM SIGNIFICANCE

The rate schedule was not intended as a universal regulation (i.e., having force in law) to limit the ultimate height or area of a building, but to deter heights and areas beyond those considered of a "standard building" by increasing rates. This was the primary purpose of a rating schedule: not to define fundamental hazards, but relative hazard as noted below by Dean [40]:

> You doubtless realize that as a system schedule rating consists of the establishing of relations in hazard; that it deals with a complex problem of relativity.

The impact of increasing rates to deter substandard construction was highlighted in a report of the Committee on Building Laws of the Fire Underwriters Association of the Northwest from their Sixth Annual Meeting [41] in 1875. This report noted that at that time there were very few buildings that met the requirements of a "standard building" as defined by the insurance industry. As a result of the losses in the United States over the preceding four years, including the Chicago and Boston conflagrations, reform was essential and the motivation to encourage reform was best initiated through reduced rates and reduced risk. A prominent underwriter noted that [41]:

> *It is entirely useless to appeal to an individual's love of his city, and of the public weal, to cause him to substantially improve his buildings, for protection against fire, from causes not entirely plain to him; this is true of the majority:—it is equally true of the entirety that if you can show them where to save money while benefiting themselves, they will do it; we all go for the great American dollar; and the key to many a man's attention is found in his pocket.*

The insurance industry concept of a "standard building", associated rating system and desire to influence change resulted in revisions to local building laws to eventually include height and area limits. These limits were largely based on the rating system of the insurance industry, which already provided a balance of risks based on expert judgment and experience. The development of height and area limits in local building laws is discussed in more detail in the following section of this report.

6.0 HEIGHT AND AREA LIMITS IN EARLY US CITY BUILDING ORDINANCES

Height and area limits were gradually incorporated into city level building ordinances as a result of building densification and the increased potential for conflagrations. The following sections of this report summarize the height and area limits from a few select US city ordinances. The cities examined include Washington D.C., Chicago, New York and St. Paul.

6.1 WASHINGTON D.C.

One of the earliest regulations to limit building height and area in the United States was in the Laws of the Corporation of the City of Washington in 1791. The limits are summarized below [42]:

REGULATION NO. 5.

By the President of the United States:

Whereas, by the first article of the terms and conditions declared by the president of the United States, on the seventeenth day of October, seventeen hundred and ninety-one, for regulating the materials and manner of buildings and improvements on the lots in the city of Washinton, it is provided, "that the outer and party walls of all the houses in the said city, shall be built of brick or stone;" and, by the third article of the same terms and conditions, it is declared, "that the wall of no house shall be higher than forty feet to the roof, in any part of the city, nor shall any be lower than thirty-five feet on any of the avenues." And whereas the above recited articles have been found, by experience, to impede the settlement, in the city, of mechanics, and others, whose circumstances do not admit of erecting houses of the description authorized by the said regulations—it is, therefore, declared, that the operation of the said first and third articles above recited, shall be, and the same is hereby, suspended until the first Monday of December, in the year one thousand eight hundred, and that all the houses which shall be erected in the said city of Washington, prior to the first Monday in December, one thousand eight hundred, conformable, in other respects, to the regulations aforesaid, shall be considered as lawfully erected; except that no wooden house, covering more than three hundred and twenty square feet, or higher than twelve feet from the sill to the eave, shall be erected, nor shall any such house be placed within twenty-four feet of a brick or stone house. Given under my hand, the 25th day of June, in the year one thousand seven hundred and ninety-six.

(Signed) GEORGE WASHINGTON.

N. B. The forgeing suspension and modification, was renewed and continued by the president of the United States, from time to time, from the first Monday of December, 1800, to the first day of January, 1818.

The requirements in Washington were similar to those of the 1774 Metropolitan Building Act of London. Washington limited wooden houses to 12 feet in height and 320 ft^2 in area. London limited fourth rate (dwelling) buildings to 13 feet in height and 350 ft^2 in area.

6.2 CHICAGO, ILLINOIS

Within a few years following the Chicago Conflagration in 1871, the Fire Ordinance of Chicago was revised and adopted in November 26, 1875 [43] to include height and area limits and noncombustible exterior wall construction within the city limits. These requirements are summarized as follows [43]:

> Section 9. All buildings henceforth to be erected within the corporate limits of the city of Chicago shall have their walls constructed wholly of incombustible materials, and with foundations of masonry. If timber is employed underneath these foundations, the same shall be kept below the bottom line of sewer pipes.
>
> Sills and lintels for doors and window openings, and posts for store fronts, may be of oak timber or plank, for buildings which are less than twenty-seven feet high. For higher buildings such posts, sills, and lintels shall be of incombustible material.
>
> Sec. 14. All business buildings being more than 56 feet high, covering an area exceeding 5,000 superficial feet, also all buildings exceeding 80 feet in height, shall have a 2½ inch (or larger) metallic standpipe within or near the front wall, extending above the roof, and arranged so that engine hose can be attached from the street. All hose couplings shall conform to the size and pattern adopted by the fire department of the city of Chicago for its engines and hose couplings.
>
> Sec. 15. All buildings having an area exceeding 1,000 superficial feet, and more than forty feet high, also all buildings having an area exceeding 6,000 superficial feet, and being more than 56 feet high, shall have all their floors deadened with mortar, or its equivalent, spread at least two inches thick.
>
> Sec. 16. All business signs extending above and beyond a height of 40 feet shall be made of incombustible material.
>
> Sec. 28. Stairways shall not be inclosed with partitions made of plank, boards, flooring, or bare scantling, unless plastered on both sides. In all factories, mills, or warehouses more than three stories high, and covering an area of more than 3,000 superficial feet, all stairway partitions shall be constructed of incombustible materials.

The City of Chicago is possibly one of the first Cities to incorporate these limitations into its building ordinance, likely as a result of the extended destruction resulting from the 1871 conflagration and the associated concerns. The height and area limitations remained unchanged in the revised Municipal Code of Chicago adopted in 1881 [44].

The Chicago Fire Ordinance did not specifically limit height and area, but required certain protective features based on height and area limits. These limits were consistent with those of a “standard building” with the exception of the 6,000 superficial feet limit for provision of mortar covered floors. The standard lot size in Chicago is understood to be 24 feet by 125 feet [45], having an area of 3,000 square feet. Similar to New York, assuming a warehouse building is likely to cover 2 or more lots, this corresponded with 6,000 square feet.

An ultimate height limit was not included in the Chicago Building Code until 1893 [46]. A maximum height of 130 feet was established. This is one of the first instances in the United States of an ultimate height limit.

In 1905, the 1881 Municipal Code of Chicago was revised to include building classifications based on use, construction types and height and area limits as a function of construction type. The building classifications were as follows [47]:

Class I: Sale, storage or manufacture of merchandise other than department stores, stables greater than five hundred square feet.

Class II: Office building, hospital, hotel, boarding house, lodging house.

Class III: Family residence, stables less than five hundred square feet.

Class IV: Assembly hall.

Class V: Public theatre.

Class VI: Tenements, apartment houses.

Class VII: Department stores.

Class VIII: School.

The three construction types defined in the 1905 Code were as follows [47]:

Ordinary Construction: *the ordinary system of construction in which timber and iron structural parts are not protected with fire resisting coverings.*

Mill Construction: *the girders and joists supporting floors and roof have a sectional area of not less than seventy-two square inches and above the joists of which there is laid timber floor not less than three and three-fourths inches thick. Wooden posts used in buildings of this type shall not be of smaller sectional area than one hundred square Inches.*

Fireproof Construction: *all parts that carry weights or resist strains, and also all exterior walls and all interior walls and all interior partitions and all stairways and all elevator enclosures are made entirely of incombustible material, and in which all metallic structural members are protected against the effects of fire by coverings of a material which shall be entirely incombustible, and a slow heat conductor, and hereinafter termed "fire-proof material." Reinforced concrete as defined in this ordinance shall be considered fireproof construction.*

The height and area limits in the 1905 Code were as follows [47]:

Ordinary Construction: up to 60 feet (approx. 5 storeys) in height and 9,000 square feet in area.

Mill Construction: up to 100 feet (approx. 8 storeys) in height and 12,000 square feet in area.

Fireproof Construction: up to approximately 12 storeys in height and 25,000 square feet in area.

By classifying buildings, the Code recognized varying hazard levels as a function of building use. By classifying building construction, the Code recognized advantages associated with certain assemblies of materials in limiting the hazard related to building use. Height and area limits were then allotted on a balance of risks and safeguards.

6.3 NEW YORK, NEW YORK

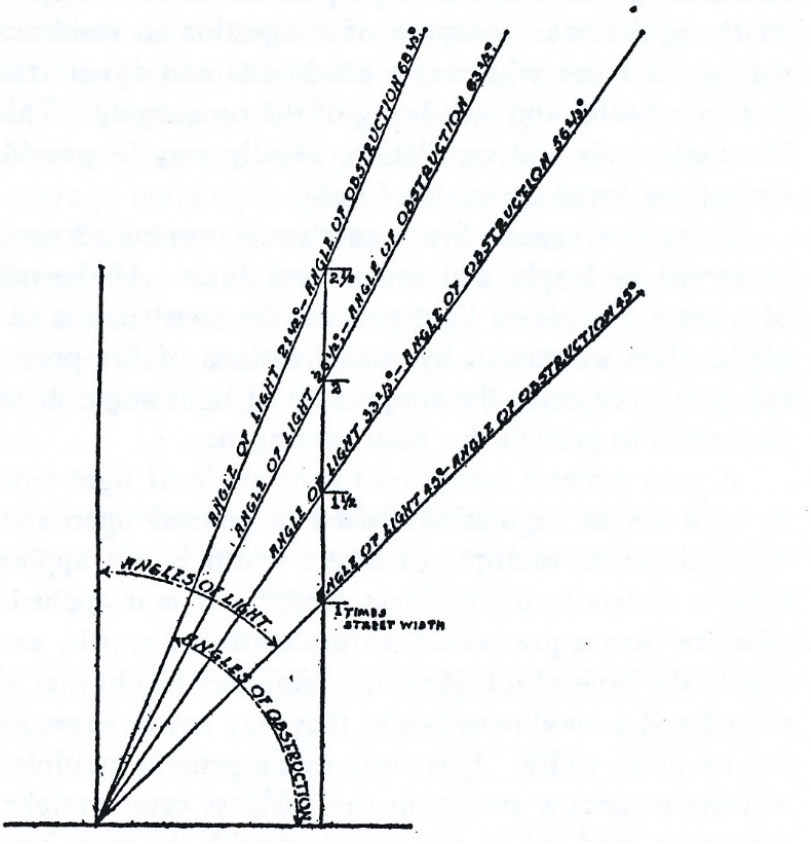
The City of New York experienced two significant conflagrations in 1776 and 1835, primarily as a result of building densification. This history led to reforms to building ordinances that set the pace for other cities within the Unites States (and Canada to some extent).

Height limits in the City of New York were originally limited as a result of sanitary conditions in tenement houses in the first half of the 19th century. The height limits were imposed to address light and ventilation conditions, as noted during senate hearings of the "Select Committee appointed to investigate the Health Department of the City of New York". Specific testimony indicated the following [48]:

> **Two years ago I attended with the committee of the Assembly, which was appointed to examine into the condition of the tenement houses. The evils complained of as existing in them were, *a want of ventilation, a want of proper space, and the too great height of the buildings.* I speak of carrying the buildings too high, more particularly as a nuisance, dangerous to the public life (by accident,) than to the public health.**
>
> **Now, in my estimation, it would be very important to provide, as one remedy for this evil, that the streets of the city of New York should be wider, or, in other words, that the height of buildings should be regulated according to the width of the streets.**

The following diagram illustrates the relationship between street width and building height as a ratio of the street width [49]:

Angles of Light and of Light Obstruction at Ground Floor on Street Front



Building height was not limited by law in the City of New York until 1885 with the passage of the Building Law of New York, which limited the height of dwelling houses to 80 feet. This law specifically noted that there [50]:

> **cannot be a hotel or residence building hereafter built within the limits of the city of New York more than seventy and eighty feet in height, however fire-proof it may be, or however thoroughly built in compliance with the Building Laws, until the law limiting the heights of such buildings is wiped from the statute books.**

The height of other classes of buildings was not limited, provided they were of fireproof construction, until zoning laws were enacted in 1916 [51]. At that time, building heights were limited as a ratio of street width, as shown in the previous "angles of light" diagram.

The Building Code of the City of New York, adopted on October 24, 1899 did not limit the area of fireproof buildings, but limited the area of stores, warehouses and factories of non-fireproof construction [52]:

NON-FIREPROOF BUILDINGS.

When girders are used instead of brick walls.

In all stores, warehouses, or factories, in case iron, steel, or wood girders, supported by iron, steel or wood columns, or piers of masonry, are used in place of brick partition walls—

Running through from street to street.

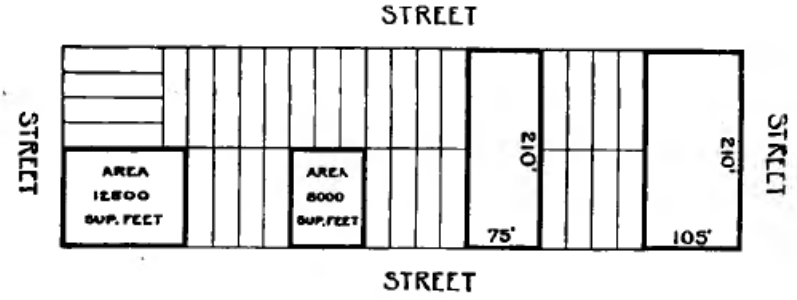
The building may be seventy-five feet wide and two hundred and ten feet deep, when extending from street to street,

Fronting on one street only, inside lots.

Or when otherwise located may cover an area of not more than eight thousand superficial feet.

Fronting on three streets, double corner.

When a building fronts on three streets it may be a hundred and five feet wide and two hundred and ten feet deep,



On two streets, single corner.

Or if a corner building fronting on two streets it may cover an area of not more than twelve thousand five hundred superficial feet;

As shown in the diagram above, the area was limited as a function of lot size and location relative to a street or streets. This is consistent with the area of a "standard building" as outlined in **Section 5.0** of this report, based on lot size. Note that the configuration of area shown in the diagram above results in almost all portions of the floor areas being within approximately 100 feet of a street, which is referenced in **Section 7.2.7** of this report relative to fire department hose stream reach within a building. The area limitations remained unchanged in the Building Code of the City of New York, adopted on November 8, 1906 [53].

The height and area limits were updated in the Building Code of the City of New York in a Building Code adopted on June 20, 1916. The following buildings were required to be of fireproof construction [51]:

a) Every public care and detention occupancy over 20 feet in height.

b) Every other public building over 40 feet in height or exceeding 5,000 square feet in area.

c) Every residence building (except tenements) over 40 feet in height and having more than 15 sleeping rooms.

d) Every tenement house exceeding six stories.

e) Every residence building having more than 15 sleeping rooms, and exceeding 2,500 square feet in area, unless divided by interior partition walls of approved masonry or reinforced concrete into sections less than 2,500 square feet in area.

f) Every other residence building over 75 feet in height.

g) Every garage within the suburban limits exceeding 600 square feet in area or 15 feet in height.

h) Every building over four stories in height used as a factory.

i) Every building or structure within the fire limits[c] or the suburban limits used as a grain elevator or a coal pocket.

j) Every business building over 75 feet in height.

k) Every business building within the fire limits or the suburban limits which exceeds an area of 7,500 square feet when located on an interior lot or when facing on only one street, or 12,000 square feet when facing on two streets, or 15,000 square feet when facing on three or more streets, provided that when any such building is equipped throughout with an approved system of automatic sprinklers, fireproof construction shall be required only when the areas exceed double those herein specified for the respective conditions, and provided also that when any such building is divided by approved interior fire walls, fireproof construction shall be required only when any undivided area exceeds 7,500 square feet.

Frame buildings were not permitted to exceed 40 feet in height and be greater than 5,000 square feet in area.

6.4 ST. PAUL, MINNESOTA

Early building ordinances of the State of Minnesota did not specifically limit the height and area of buildings, but required “deadened mortar” under the same height and area conditions as required for Chicago. In addition, the building ordinances required standpipes of a certain size as a function of building area. Specifically, in 1883 [54]:

[c] Fire limits were boundaries defined within a city to address the risk of fire spread by regulating type of construction and building separation.

Buildings under classification eight (8) of section two (2) of this act, for each two thousand five hundred (2,500) superficial feet of area covered by said building, shall be provided with an inside stand pipe of not less than one and one half (1½) inches diameter, and sufficient hose connected therewith of not less than one and one-quarter (1¼) inches inside diameter, on each floor, and furnished with a constant water pressure by water works or by steam or other pump which can be put in motion at a moment's notice; or for each five thousand (5,000) superficial feet of area covered by said building, there shall be one (1) two and one-half (2½) inch or larger metallic stand pipe, with metallic ladder attached

7.0 US MODEL BUILDING CODE DEVELOPMENT

US model building regulations were initially contemplated in the late 1880's to early 1890's. The purpose of developing a model code was to realize efficiencies resulting from consistency in construction, materials and regulation throughout the country. The following sections of this report summarize the model building code development in the United States, which the Canadian Model Code would eventually follow.

7.1 GENERAL

A meeting of the Combined Committee on Building Ordinances was convened in New York on April 2 and 3, 1891 to discuss the framing and adoption of a model building law. The Committee was composed of seven delegates representing the American Institute of Architects, National Association of Builders, National Board of Underwriters, National Association of Building Inspectors and National Association of Fire Engineers.

The meeting resulted in a draft of suggested ordinances acknowledging that it would not be practical to apply them to all cities without local modification. It was advised by the Committee that the Legislatures of the various States establish building laws applicable throughout the State. The draft of suggested ordinances included height and area limitations as follows [55]:

GENERAL REGULATIONS.

1. That all buildings over 70 feet in hight be constructed throughout of incombustible materials, protected in the most approved manner for resisting fire.

3. That all buildings over 50 feet in hight be furnished with permanent stand pipes and ladders for the assistance of the fire department.

4. That the hight of buildings to be erected should not be more than two and a half times the width of the principal street on which they are located, and that no building or portion of a building, except church spires, should be more than 125 feet high in any case, except under a special permit.

5. That the open floor space, not divided by walls of brick or other incombustible material, in all buildings hereafter erected for mercantile or manufacturing purposes, should not exceed 6000 square feet without special permission, based upon unusual and satisfactory precautions.

> 6. That every building to be erected, which shall be three stories high or more, except dwelling houses for one family, and which shall cover an area of more than 2500 square feet, should be provided with incombustible staircases, inclosed in brick walls, at the rate of one such staircase for every 2500 square feet high in area of ground covered.
>
> 7. That wooden buildings erected within 18 inches of the boundary line between the lot on which they stand and the adjoining property, should have the wall next the adjoining property of brick, or when built within 3 feet of each other shall have walls next to each built of brick.

These early ordinances attempted to combine the limitations from various large city ordinances in force at the time. The height and area limits are consistent with those of Chicago and New York from the same time period. A more successful attempt at drafting a model code occurred several years later by the National Board of Fire Underwriters, who had several decades of experience in drafting building ordinances for insurance purposes. The development of that model code is summarized in the following section of this report.

7.2 National Board of Fire Underwriters Model Building Code

The National Board of Fire Underwriters published a model building Code from 1893 to 1965 until becoming the American Insurance Association, phasing out its technical activities and contribution to fire protection engineering [56].

7.2.1 1892 Fire and Building Regulations in Foreign Countries

In 1891 the National Board of Fire Underwriters requested the Department of State, through its Consular Officers, secure fire statistics and information relative to building construction in foreign countries. The purpose of the request, as stated by the National Board of Fire Underwriters, was as follows [57]:

> The statistics are called for as of 1890, although if other years could be added it would be appreciated. We may further observe that the queries are similar to those which our committee on statistics has prepared and addressed to places in the United States, and you will apprehend their value for purposes of comparison with similar information from abroad. The ultimate purpose is a reduction of the fire waste of the country, which now averages over one hundred millions annually, by recommending to our own cities such measures as may have been found effective in curtailing the loss by fire in other and older countries which have bestowed attention upon the subject.

The primary purpose of this request was to collect information in support of the development of model building code requirements. The specific information requested was as follows [57]:

STATISTICS OF FIRES FOR YEAR ENDED DECEMBER 31, 1890 (AND FOR OTHER YEARS, IF PRACTICABLE).

1. **Name of place (city or town in which the consular office is located).**
2. **Population.**
3. **Area of city limits.**
4. **Number of brick or stone buildings.**
5. **Number of wooden buildings.**
6. **Number of alarms.**
7. **Number of fires in brick or stone buildings.**
8. **Number of fires in frame buildings.**
9. **Total value of property involved in the fires.**
10. **Total loss thereon.**
11. **Total insurance thereon.**
12. **Total insurance loss thereon.**
13. **Number of fires confined to floor in which they originated.**
14. **Number of fires confined to building in which they originated.**
15. **Number of fires extending to adjoining property.**
16. **Number of conflagrations, *i. e.*, fires extending beyond adjoining property.**
17. **Of what does the fire department consist?**
18. **What system of water supply for fire purposes is used and what is the capacity of the supply?**
19. **What provision is made by law to investigate causes of fire and to provide for prosecutions in cases of suspected incendiarism or crime?**
20. **Number of incendiary fires.**
21. **What regulations exist for the storage and sale of oils, explosives, and fireworks?**
22. **Copy of law regulating building construction, heating, lighting, etc.**

Responses were received from numerous consuls of large cities in Europe, Asia, South America, North America and a few cities in Africa and Australia. Responses included height limits; however, only included area limits for the British Regulations. An overall analysis of the results was not included in the 1892 report.

7.2.2 1893 Model Code

The first US Model Building Code was published by the National Board of Fire Underwriters in 1893 [58]. The Code was intended to be adopted by cities in the United States that didn't have adequate Building Regulations. The Code did not limit building height or area.

7.2.3 1905 Model Code

The First Edition of the National Board of Fire Underwriters Recommended Building Code (1905 NBFU) contained a table of heights and areas as a function of occupancy classification, construction type (i.e., fireproof and non-fireproof), streets facing and whether sprinklers are provided. This table is included below [59]:

Non-Fireproof Construction.		Non-Fireproof Construction.	
Any occupancy, height limited to 55 feet.		Any occupancy, height limited to 55 feet.	
Area, without Automatic Sprinkler Protection.		*Area, with* Automatic Sprinkler Protection (being an increase of 50 per cent. over the unsprinklered area).	
Fronting on one street only	5,000 sq. ft.	One street front	7,500 sq. ft.
Fronting on two streets, that is, extending through from street to street	6,000 sq ft.	Two street fronts	9,000 sq. ft.
Corner building, fronting on two streets	6,000 sq. ft.	Corner building, two street fronts	9,000 sq. ft.
Fronting on three streets.	7,500 sq. ft.	Three street fronts	11,250 sq. ft.

Fireproof Construction.		Fireproof Construction.	
Occupancy, stores, warehouses and factories. Height when not exceeding 55 feet.		Occupancy, stores, warehouses and factories. Height when not exceeding 55 feet.	
Area, without Automatic Sprinkler Protection.		*Area, with* Automatic Sprinkler Protection (being an increase of 33 1-3 per cent. over the unsprinklered area).	
Fronting on one street only	10,000 sq. ft.	One street front	13,333 sq. ft.
Fronting on two streets, that is, extending through from street to street	12,000 sq. ft.	Two street fronts	16,000 sq. ft.
Corner building, fronting on two streets	12,000 sq. ft.	Corner building, two street fronts	16,000 sq. ft.
Fronting on three streets.	15,000 sq. ft.	Three street fronts	20,000 sq. ft.

Fireproof Construction.		Fireproof Construction.	
Occupancy, stores, warehouses and factories. Height limited to 100 feet.		Occupancy, stores, warehouses and factories. Height limited to 100 feet.	
Area, without Automatic Sprinkler Protection, same as for non-fireproof construction.		*Area, with* Automatic Sprinkler Protection (being an increase of 33 1-3 per cent, over the unsprinklered area).	
Fronting on one street only	5,000 sq. ft.	One street front	6,666 sq. ft.
Fronting on two streets, that is, extending through from street to street	6,000 sq. ft.	Two street fronts	8,000 sq. ft.
Corner building, fronting on two streets	6,000 sq. ft.	Corner building, two street fronts	8,000 sq. ft.
Fronting on three streets.	7,500 sq. ft.	Three street fronts	10,000 sq. ft.

Fireproof Construction.		Fireproof Construction.	
Occupancy, other than stores, warehouses and factories. Height limited to 125 feet.		Occupancy, other than stores, warehouses and factories. Height limited to 125 feet.	
Area, without Automatic Sprinkler Protection, same as for fireproof construction limited to 55 feet and with Automatic Sprinkler protection.		*Area, with* Automatic Sprinkler Protection (being an increase of 50 per cent. over the unsprinklered area).	
Fronting on one street only	13,333 sq. ft.	One street front	20,000 sq. ft.
Fronting on two streets, that is, extending through from street to street	16,000 sq. ft.	Two street fronts	24,000 sq. ft.
Corner building, fronting on two streets	16,000 sq. ft.	Corner building, two street fronts	24,000 sq. ft.
Fronting on three streets.	20,000 sq. ft.	Three street fronts	30,000 sq. ft.

The basic height and area limits for non-fireproof and fireproof buildings up to 55 feet in height are consistent with those suggested for the “standard building”. However, the 1905 NBFU introduced

modification factors for building areas related to design features that were considered to reduce the fire hazard of the building. These modification factors included number of facing streets and sprinklering.

The NBFU Codes were prepared by the National Board of Fire Underwriters, who had a significant role in the development of the Universal Insurance Rating Schedule, which was summarized in **Section 5.3** of this report. This schedule addressed fire risk to the extent possible based on knowledge, methods and capabilities of the time. Modifying this framework in a regulatory context, where heights and areas rather than insurance rates are the dependent variables was a rational approach to an otherwise complex problem. The modification factors are discussed in more detail below comparing with the rate factors outlined in **Section 5.3** of this report.

Construction

The 1905 NBFU permitted fireproof buildings to have twice the area of non-fireproof buildings. This relationship can be seen by comparing the areas for non-fireproof and fireproof buildings up to 55 feet without sprinkler protection.

The building area relationship as a function of type of construction is consistent with that specified in Universal Rating Schedule as outlined in **Section 5.3.4** of this report.

Height

The 1905 NBFU required fireproof buildings of approximately twice the height to have half the area, and did not permit non-fireproof buildings to be greater than 55 feet (4 storeys) in height. This relationship can be seen by comparing the areas of buildings limited to 55 feet and 100 or 125 feet respectively of fireproof construction and the same occupancy.

The decrease in area with increase in height as specified in the 1905 NBFU is not directly consistent with the increase in rates for building height in the Universal Rating Schedule as outlined in **Section 5.3.5** of this report.

Sprinklering

The 1905 NBFU permitted an increase in floor area for buildings with sprinkler protection as a function of occupancy. Buildings occupied by stores, warehouses and factories were permitted an increase of thirty-three percent when equipped with automatic sprinklers. Buildings occupied by other occupancies were permitted an increase of fifty percent. The difference is likely attributed to the quantity of combustible material and fire risk associated with the different occupancies. Stores, warehouses and factories are considered to have a greater quantity of combustibles and have an inherently greater risk of fire than other occupancies.

The increase in area with sprinkler protection is consistent with the increases permitted by the Universal Rating Schedule as outlined in **Section 5.3.6** of this report.

Occupancy

The 1905 NBFU recognized the difference in occupancy types by permitting different area limits. Buildings containing occupancies other than stores, warehouses and factories are permitted to have an area more than twice that of buildings containing store, warehouse and factory occupancies. This is likely a function of the difference in quantity of combustibles and occupancy fire risk. This difference can be seen by comparing the areas of buildings not containing stores, warehouses and factories limited to 125 feet in height, with the areas of buildings containing store, warehouse and factory occupancies limited to 100 feet. The exact factor associated with occupancy type can be determined once the factor associated with the height difference is addressed.

The increase in area as a function of occupancy type is difficult to compare with that of the Universal Rating Schedule. The 1905 NBFU considered differences in area as a function of 2 occupancy groups whereas the Universal Rating Schedule considered rate differences as a function of more than 1000 occupancy types.

Streets Facing

The 1905 NBFU recognized the benefit of providing a responding fire department access to the greatest number of faces of a building. A multiplication factor was developed allowing an increase in area as a function of the number of streets the building fronted onto. A building fronting two and three streets was permitted an increase in area of twenty percent and fifty percent respectively. The proportionality of these increases will be discussed in more detail in **Section 7.6.3** of this report.

The increase in area with increase in "streets facing" as specified in the 1905 NBFU is not consistent with the decrease in rates for accessibility in the Universal Rating Schedule as outlined in **Section 5.3.3** of this report.

7.2.4 1907 Model Code

The Second Edition of the National Board of Fire Underwriters Building Code was published in 1907 [60]. The height and area limitations remained unchanged in this edition.

7.2.5 1909 Model Code

The Third Edition of the National Board of Fire Underwriters Building Code was published in 1909 [61]. The height and area limitations remained unchanged in this edition.

7.2.6 1913 Allowable Heights and Areas for Factory Buildings - Ira H. Woolson

A report prepared in 1913 by Ira H. Woolson, Consulting Engineer for the National Board of Fire Underwriters, summarized the results of a study of allowable heights and areas for factory buildings in the United States. The study was based on a survey of fire marshals and fire chiefs in the United States representing cities of over 20,000 population. The survey included the following 4 questions [62]:

1 What should be the greatest height allowed for manufacturing or warehouse buildings *without sprinkler equipment?*

Brick and joist construction.....Height in ft.—— or No. of Stories——
Fireproof construction.....Height in ft.—— or No. of Stories——

2 Take the same question as No. 1, but assume the buildings to be fully equipped *with automatic sprinklers.* What height would you approve?

Brick and joist construction.....Height in ft.—— or No. of Stories——
Fireproof construction.....Height in ft.—— or No. of Stories——

3 What should be the greatest floor area allowed in the same class of buildings *without sprinkler equipment?*

Brick and joist construction Area in sq. ft.—— or Width—— ft Length—— ft.
Fireproof construction.....Area in sq. ft.—— or Width—— ft. Length—— ft.

4 If the same buildings were fully equipped *with automatic sprinklers* what area would you approve?

Brick and joist construction Area in sq. ft.—— or Width—— ft. Length—— ft.
Fireproof construction .....Area in sq. ft.—— or Width—— ft. Length—— ft.

The questions were intended to apply to buildings of a “good class” with enclosed stairways and elevator shafts. Further, it was requested by Woolson that answers be based on the chief’s experience in fighting fires in the class of building described.

Responses were received from 117 representative cities, some of which were discarded due to misunderstanding of the questions. A summary of the results are included below [62]:

TABLE 1 GENERAL AVERAGE OF 99 TO 111 REPLIES RECEIVED FROM ALL CLASSES OF CITIES[1]

Type of Building	Stories in Height	Area between Fire Walls in Sq. Ft.
Non-fireproof, not sprinklered.....	3.1	6,300
Fireproof, not sprinklered.....	4.9	12,300
Non-fireproof, sprinklered.....	4.6	12,800
Fireproof, sprinklered.....	7.0	27,100

Average story height was 12 to 13 ft.

Additional comments from Woolson relative to the responses are included as follows [62]:

- The responses for allowable heights were much more consistent than for allowable areas. 83 percent of the respondents indicated 10 storeys as the maximum height for a sprinklered fireproof factory building.
- The responses for allowable areas for sprinklered buildings were not as consistent as for unsprinklered buildings.
- There was no consensus or policy regarding permitted credit for provision of sprinklers.

Woolson further refined the responses to those of 50 fire chiefs based on the character and number of factory buildings within their city and the chief’s experience with fireproof construction and sprinkler equipment. The results of these 50 responses are summarized below [62]:

AVERAGE OF THE REPLIES OF 50 FIRE CHIEFS SELECTED FROM 117, THE TOTAL NUMBER RECEIVED AS BEST QUALIFIED BY TRAINING AND EXPERIENCE TO PASS JUDGMENT ON THE QUESTIONS INVOLVED

TYPE OF BUILDING	STORIES IN HEIGHT	AREA BETWEEN FIRE WALLS IN SQ. FT.
Brick and joist construction, not sprinklered	3.2	5,200
Fireproof construction, not sprinklered	5.3	9,300
Brick and joist construction, sprinklered	4.8	10,500
Fireproof construction, sprinklered	7.5	21,600

Based on the results, Woolson prepared a table of limits that he considered to represent the “consensus of opinion among the fire chiefs of the country best qualified to judge as to what should be the proper limits of height and area for factory buildings”. This table is included as follows [62]:

TABLE 5 ALLOWABLE HEIGHTS AND AREAS IN FACTORY BUILDINGS

Type of Building	Stories in Height	Area between Fire Walls in Sq. Ft.
Brick and joist construction, not sprinklered.	3	6,000
Fireproof construction, not sprinklered.....	5	10,000
Brick and joist construction, sprinklered....	5	13,000
Fireproof construction, sprinklered.....	8	20,000

In the case of unsprinklered buildings, the area limits identified by Woolson were similar to those for a "standard building" and Chicago and New York building ordinances as outlined previously, whereas the heights are lower. In addition, the area limits for sprinklered buildings were approximately double those of buildings identified as not sprinklered.

The results of Woolson's study were considered later in the development of height and area limits for model codes, which will be discussed in more detail in later sections of this report. Woolson's pivotal role in developing height and area limitations and the significance of his paper will also be discussed in more detail in sections to follow.

7.2.7 1915 Model Code

The Fourth Edition of the National Board of Fire Underwriters Building Code (1915 NBFU) was completely revised and included commentary notes for certain requirements in the Code. The height and area limits were similar to those in the 1909 NBFU Code with some minor changes and additions. Building heights were expanded as a function of construction type and simplified in tabular format as outlined below [63]:

Section 37. Height of Buildings.

1. No building, or structure hereafter erected, except church spires, water towers, smoke stacks or chimneys, shall exceed in height two and one-half times the width of the widest street upon which it fronts, nor shall it exceed the following limits:

	Height in Stories.	Height in feet.
Frame buildings used for purposes other than dwellings and tenements.	2	30
Frame dwellings and tenements occupied by not more than two families.	2½	30
Frame dwellings occupied by not more than one family.	3	35
Buildings having bearing walls of hollow terra cotta or concrete blocks.	3	40
Non-fireproof buildings, ordinary construction	4	55
Non-fireproof buildings, mill construction..	5	65
Fireproof buildings used for factories, stores, warehouses or workshops.	7	85
Fireproof buildings used for purposes other than factories, stores, warehouses or workshops	10	125

The height limits outlined above recognized variation in hazard as a function of construction and occupancy. The maximum building height where combustible construction was permitted was 5 stories (65 feet). As noted below, 50 feet was considered the maximum distance inside a building that can be

reached by a hose stream through a window of a 5-storey building, which is described as a significant factor in limiting height in the Code [63]:

> NOTE 1.—It is generally conceded that five stories is the maximum height to which water can be thrown effectively by a fire department from the street level, and that 50 feet is the maximum distance inside a building which can be reached by a stream through a window. These facts have been a governing consideration in the establishment of the limits of heights and areas in this Code. In addition, the width of the street upon which a building fronts and the height of the building should be considered; a building endangers adjacent property in proportion to its size and proximity to other property.

The area limits were organized by Non-Fireproof and Fireproof Construction. The limits for Non-Fireproof Construction ranged from 3,000 square feet for tenement houses of ordinary construction to 6,500 square feet for mill construction. The limits are consistent with those of the 1909 NBFU Code, with the exception of the increase factor for sprinklering and increased areas for mill construction. The sprinkler factor was increased from 50% to 66⅔% (100% for mill construction), which was likely a recognition of the benefit of sprinkler protection beyond what was previously considered in **Section 5.3.6** of this report. The areas for mill construction were 33% greater than for ordinary construction. The limits are shown below [63]:

2. *Non-Fireproof Construction*—

(a). Tenement houses, 3000 sq. ft.

(b). All other ordinary non-fireproof buildings, height not exceeding 55 feet.

Fronting on	Without sprinklers.	With sprinklers, increase of 66⅔ per cent.
One street	5,000 sq. ft.	8,333 sq. ft.
Two streets	6,000 sq. ft.	10,000 sq. ft.
Three or more streets	7,500 sq. ft.	12,500 sq. ft.

(c). Mill construction buildings, height limit 65 feet.

Fronting on	Without sprinklers.	With sprinklers, increase of 100 per cent.
One street	6,500 sq. ft.	13,000 sq. ft.
Two streets	8,000 sq. ft.	16,000 sq. ft.
Three or more streets	10,000 sq. ft.	20,000 sq. ft.

The area limits for Fireproof Construction ranged from 7,500 square feet to unlimited as a function of occupancy and height. For buildings up to 65 feet in height (which was an increase of 10 feet from the previous edition of the Code) the area limits were consistent with the previous edition of the Code. The area limits for stores, warehouses, factories and workshops up to 85 feet in height and other occupancies up to 125 feet in height were reduced from the previous edition of the Code. The sprinkler factor was increased from 33⅓% from the previous edition of the Code to 66⅔% for buildings up to 65 feet. The increase in sprinkler factor was likely a result of an increase in reliability of sprinkler systems as outlined in **Section 5.3.6** of this report. The limits are shown below [63]:

3. *Fireproof Construction*—

(a). All buildings of Classes A, B, C, and D. . . . . } No restrictions as to area.
Light and power stations. . . . }
Office buildings . . . . . }

(b). All other buildings not exceeding 65 feet in height.

Fronting on	Without sprinklers.	With sprinklers, increase of 66⅔ per cent.
One street	10,000 sq. ft.	16,666 sq. ft.
Two streets	12,000 sq. ft.	20,000 sq. ft.
Three or more streets. . . .	15,000 sq. ft.	25,000 sq. ft.

(c). Stores, warehouses, factories, and workshops, not exceeding 85 feet; and other buildings not exceeding 125 feet in height.

Fronting on	Without sprinklers.	With sprinklers, increase of 50 per cent.
One street	7,500 sq. ft.	11,250 sq. ft.
Two streets	10,000 sq. ft.	15,000 sq. ft.
Three or more streets. . . .	12,500 sq. ft.	18,750 sq. ft.

(d). The first floor only of any fireproof building occupied as a store may have an area of 20,000 sq. ft., and if fully protected by approved automatic sprinklers may be increased 50 per cent or have a maximum area of 30,000 sq. ft.

The base area limits for ordinary construction (5,000 square feet) and for fireproof construction (10,000 square feet) are consistent with those recommended for a "standard building", as outlined previously in this report. Height limits are also consistent, with minor differences, to those of a "standard building".

The increase factor attributed to number of streets fronting did not changed from the previous edition of the Code. The area limits were based on average street width of 60 feet. This related to the space required for a fire department to stage and fight the fire, as well as reasonable separation of the buildings to limit fire spread. Reference relative to height and area limits was made to the paper prepared by Woolson, outlined in the previous section of this report. These additional notes are included below [63]:

> The term street as here used, is a public thoroughfare at least 20 feet wide.
>
> The areas given in this section are based upon an average street width of 60 feet. For less than this width, it does not appear unreasonable to require sprinklers for even smaller areas than herein given, particularly for buildings over two stories high. This could well be placed in the hands of the Chief of the Fire Department.
>
> NOTE 2.—Attention is called to a paper entitled "Allowable Heights and Areas for Factory Buildings," distributed by the National Board of Fire Underwriters, which contains a digest of opinion of over a hundred prominent Fire Chiefs upon this subject.

The area limits for frame buildings ranged from 3,000 to 5,000 square feet, as outlined below [63]:

> 1. No frame building shall exceed two stories or 30 feet in height, except that dwellings may have two and one-half stories, provided they do not exceed 30 feet in height or 3000 square feet in area.

> 3. No frame building erected for any occupancy other than buildings of Class F, shall cover a ground area exceeding 5000 square feet, except as restricted in paragraph 4; except also that a frame building equipped with an approved system of automatic sprinklers, may have an increase in area of 66⅔ per cent, or 8333 square feet.

An area increase was permitted, as noted above, for buildings of frame construction where equipped with an automatic sprinkler system.

7.2.8 1922 Model Code

The height and area limits in the 1922 edition of the National Board of Fire Underwriters National Building Code (1922 NBFU [64]) did not change from the 1915 edition.

7.2.9 1934 Model Code

The height and area limits in the 1934 edition of the National Board of Fire Underwriters National Building Code (1934 NBFU [65]) remained consistent with those of the 1922 edition.

7.3 National Fire Protection Association

The National Fire Protection Association (NFPA) was established in 1896 with a membership primarily composed of insurance representatives with the mission to "reduce the burden of fire and related hazards on the quality of life" [66]. The mission of the NFPA would eventually become "advocating scientifically-based consensus codes and standards, research, and education for fire and related safety issues" [66].

The NFPA published proceedings of meetings of various committees relating to fire and life safety from 1887 to 1967. These proceedings included minutes of meetings and proposed code changes. Several committees considered height and area limits, either as fundamental concepts or secondary to the primary application of the code/standard being developed by the respective committee.

The following sections summarize key discussions and developments of height and area limits based on NFPA committee proceedings.

7.3.1 1899 Proceedings

The 1899 Proceedings of the NFPA discussed the large areas and quantity of goods in department stores and the difficulty in fighting fires in these occupancies as a result of these factors. Sprinklers were suggested as the only means of controlling fires as noted below [67]:

> **Sprinklers and Hose Streams.** It is now generally conceded that after the first stages of a fire (when hand appliances may be used) sprinklers only can control a fire in these large area stores into which hose streams cannot penetrate. Hose service is essential, however, in following up the sprinklers and accomplishing the complete extinguishment. If sprinklers are of such importance they should not be handicapped, possibly rendered inefficient by faulty construction.

The discussion noted that sprinklers likely only controlled fires, and hoses were required to completely extinguish following sprinkler operation.

7.3.2 1904 BALTIMORE CONFLAGRATION

A conflagration occurred in the City of Baltimore, Maryland on February 7 and 8, 1904. The area of damage covered 140 acres, including 80 city blocks. The Committee on Fire-Resistive Construction of the National Fire Protection Association conducted an examination of the damaged buildings of the City with [68]:

> special view of determining the relative merits of the materials and methods of construction used in the fire-resistive buildings (commonly called "fire-proof") which passed through the conflagration.

They made observations of various aspects of building construction, water supply and the fire service capability. The following was noted relative to building areas and their impact on the spread of the conflagration [68]:

> LARGE UNBROKEN FLOOR AREAS ASSIST THE SPREAD OF FIRE AND SERVE TO AUGMENT ITS SEVERITY. BUILDINGS OF CONSIDERABLE AREA AND HAVING LARGE QUANTITIES OF COMBUSTIBLE CONTENTS SHOULD BE SUB-DIVIDED BY SUBSTANTIAL BRICK FIRE WALLS SUFFICIENT TO FORM A POSITIVE BARRIER TO THE SPREAD OF FIRE.
>
> The large areas now so common and particularly in those buildings having unenclosed vertical openings, undoubtedly furnish conditions which render even the most approved methods of fire-resistive construction now in use of doubtful value.
>
> The effect of a severe fire in buildings of fire-resistive construction having large stocks of combustible material was not demonstrated in this conflagration. It is believed, however, that a severe fire even in a single building under these conditions might readily equal if not surpass the severity of the tests noted at Baltimore.
>
> It was noticeable even in office buildings that the damage was generally greatest where there were large offices without any sub-dividing partitions.

7.3.3 1906 PROCEEDINGS

Following the Baltimore conflagration, the NFPA formed a Committee to examine building area. As noted below, the Committee determined that the limitation of areas was best left to underwriters and as a result it was decided that the Committee be discharged [69]:

> MR. BLAUVELT. Chairman and Gentlemen: Your Committee has taken up the subject of Area, and after investigating the subject, it has seemed that all fire protection matters relative to area are already covered by our existing standard. The matter of sub-division of area is also covered by existing standards of construction. It has seemed to me impossible to treat the subject of area in any other way than on an underwriting basis, and this causes the subject to run into the consideration of rating schedules. The National Fire Protection Association is not expected to consider matters that touch upon rating schedules, and the question has been raised in Committee, very correctly, I think, as to whether such treatment is not unconstitutional. That is my view, and on that ground I ask that the Committee be discharged.

7.3.4 1908 PROCEEDINGS

Following the disbanding of the Building Area Committee in 1906, discussion of height and area limits resurfaced in discussions of the Committee on Fireproof Construction relative to the organization of a conference on preparation of a standard for the construction of buildings, suitable to all insurance and other interests. Height and area limits were noted as follows [70]:

> Among the features to be considered by such a conference would be, first, the regulation of height and area of buildings to dimensions such as allow control of fire in combustible contents by whatever extinguishing agencies, public or private, may be provided.

In addition, the Committee on Uniform Requirements prepared a set of recommended ordinances intended for fire underwriters only. These ordinances included height and area limits as follows [70]:

> 12. AREA.
>
> Area not to exceed 5,000 square feet per fire section where building is not equipped with sprinklers.
>
> *Note*—By fire sections is meant a section either cut off by standard walls, as provided in Sections 2 and 3, or separated from all exposing buildings by a distance equal to at least the sum of the heights of the two buildings in question, but this distance should never be less than 50 feet and need ordinarily never be over 150 feet."
>
> 13. HEIGHT.
>
> Height not to exceed 5 stories or 65 feet above average ground level. Basement, if over 3 feet, measured from bottom of floor girders to ground above average ground level, to be counted as a story.

These limits are consistent with those suggested for a "standard building" with the exception of a 5 foot increase in the height limit.

The height and area limits were also discussed in a Report of Delegates to the Washington Convention of the International Association of Fire Engineers in the summary of a paper prepared addressing fire prevention versus fire extinguishment. The paper discussed the importance of requiring height and area limits for mercantile occupancies as follows [70]:

> The mercantile or manufacturing building is quite another proposition, and buildings of this class should be restricted in height and area; otherwise they become conflagration breeders and a serious menace to the vicinity in which they are located, due to the quantity of combustible material they contain. This is especially true of mercantile buildings, where space is valuable, and at times they contain stock piled from floor to ceiling, providing no means for interior protection by the local fire department, and rendering impossible the introduction of streams of water to the center of the floor. Where area is reduced by party walls the reduction will not

Similar to previous discussions, this paper highlighted the importance of fire department capability and penetration of hose streams.

7.3.5 1913 PROCEEDINGS

With the exception of the Building Area Committee, disbanded in 1906, no NFPA committee was responsible for the consideration of height and area limits as part of a suggested ordinance until 1913.

The Committee on Fireproof Construction, Including Concrete and Reinforced Concrete (later changed to "Committee on Fire Resistive Construction") was responsible for establishing requirements of

construction “suited to buildings of the greatest fire-resistance” including height and area limits. This was done by defining a “Standard Building”, intended to be applicable to any occupancy [71]:

> Your Committee defines a *Standard Building* as one in which the lives of the occupants are properly safeguarded against fire and panic; so designed and equipped, that damage resulting from exposure to fire from within or without, shall be reduced to a minimum; and capable of sustaining a complete burn-out of its contents without serious injury to its structural members.

The Committee was chaired by Mr. Ira H. Woolson, Consulting Engineer for the New York Board of Fire Underwriters and author of “Allowable Heights and Areas for Factory Buildings”, outlined previously in this report and prepared the same year as these proceedings. Woolson was also involved in the preparation of the National Board of Fire Underwriters Model Codes. He would later chair a Committee on “Recommended Minimum Requirements for Fire Resistance in Buildings” that would include height and area limits that would eventually be utilized in the development of the Canadian Model Code.

The specifications for construction of a Standard Building recommended by the Committee included the following relative to height and area limits [71]:

> SPECIFICATIONS FOR CONSTRUCTION OF A STANDARD BUILDING.
>
> *Height.*—The height from grade to roof-line, irrespective of its occupancy, shall not exceed 70 feet, unless the building be fully equipped with automatic sprinklers, in which case the height shall not exceed 125 feet; nor shall any Standard Building exceed a height of two and one-half times the width of the widest street upon which it is located.
>
> *Area.*—The area within inclosing or fire walls shall not exceed 7,500 square feet, with no dimension greater than 125 feet for a building without automatic sprinklers; or 20,000 square feet, unrestricted as to linear dimensions, for a building fully equipped with automatic sprinklers.

The height limit was approximately mid-way between the 55 foot and 100 foot limits for store, warehouse and factory occupancy buildings of fireproof construction in the 1905 NBFU Model Code. The area limit of 7,500 square feet was half way between the area limit corresponding with 55 feet and 100 feet height limits for store, warehouse and factory occupancy buildings of fireproof construction in the 1905 NBFU Model Code. The 20,000 square foot area limit with provision of automatic sprinklers corresponded with the greater area limit for store, warehouse and factory occupancy buildings of fireproof construction. These height and area limits were approximately equal to those recommended by Woolson in his paper on “Allowable Heights and Areas for Factory Buildings”.

The rationale for selecting the area and lineal dimension limit of 7,500 square feet and 125 feet respectively was given as follows [71]:

> Mr. A. G. Patton: It seems to me that any area that we might fix for this building would fail to satisfy some builders or some owners. There would always be a demand for an extension of the standard. There was a reason in the minds of the committee for fixing the standard as it is fixed here at 7,500 square feet, with a lineal dimension of 125 feet. It was based on the idea that a stream of water might be turned into such an area from the street and reach every portion of the floor. Now that is worked out on that theory;—that 125 feet probably represents the best limit of a good stream

of water from the street. And as Mr. Palm very well said, this typical building is provided with subdividing fire walls and the area can be extended, or if desired, the minimum area between fire walls can be made 20,000 square feet if sprinkler equipment is installed. I do not see personally why we should extend this 7,500 square feet or make any further explanation than we have in connection with our definition of what this specification is covering.

PROFESSOR WOOLSON: I might say in this connection that I have in my possession over one hundred letters received from fire chiefs throughout the United States within the last month, expressing their opinion upon this subject of allowable area in buildings, fireproof and non-fireproof, sprinklered and not sprinklered, in which they from their experience would consider that they had a reasonable chance of controlling the fire,—in a factory type of building I am speaking of particularly. I think the gentleman would be astonished at the conservatism of those men. I am preparing the matter, summarizing it, for publication. But I may say, though, that I think a summary of those figures will come very close to the specifications named in this paper, and the consensus of opinion from that number of that class of men is worthy of serious consideration.

7.3.6 1914 PROCEEDINGS

The Committee on Fire-Resistive Construction established construction types and occupancy classifications in 1914. The occupancy types included Public Buildings, Residence Buildings and Business Buildings. The following construction types were established [72]:

(*a*) **Full Protection—implies a resistance to a severe fire for 4 hours.**
(*b*) **Partial Protection—implies a resistance to a severe fire for 2 hours.**
(*c*) **Temporary Protection—implies a resistance to a severe fire for at least 1 hour.**

No additional changes or additions were made to the height and area limits.

7.3.7 1916 PROCEEDINGS

In 1916, the Committee on Fire-Resistive Construction changed the construction type descriptors from Full Protection, Partial Protection and Temporary Protection to Grade A, Grade B and Grade C respectively. They also established that these types of construction apply to structural materials rather than complete structures.

The specification for a Grade A Office occupancy was provided and is summarized including height and area limits in the excerpt below [73]:

SPECIFICATIONS FOR CONSTRUCTION OF AN OFFICE BUILDING, GRADE "A"

Definition:—An Office Building is one which is used for executive or clerical purposes, except for living rooms for the janitor, and is not used, above the grade floor, for the storage or exhibition for sale of merchandise, nor in any part for manufacturing purposes.

Height:—The height from grade to roof line shall not exceed 125 feet, nor exceed a height of two and one-half times the width of the widest street upon which it is located.

Area:—The area within inclosing or fire walls of building, not exceeding 70 feet in height, shall not exceed the following:—

Fronting on	Without Sprinklers	With sprinklers increase of 66⅔%
One street	10,000 sq. ft.	16,666 sq. ft.
Two streets	12,000 " "	20,000 " "
Three or more streets	15,000 " "	*20,000 " "

or from 70 to 125 feet, shall not exceed the following:—

Fronting on	Without Sprinklers	With sprinklers increase of 50%
One street	7,500 sq. ft.	11,250 sq. ft.
Two streets	10,000 " "	15,000 " "
Three or more streets	12,500 " "	18,750 " "

*Maximum area accepted under any conditions.

These were the first set of specifications by NFPA for a specific occupancy type. Note that these limitations were the same as those included in the 1915 NBFU Model Code for fireproof construction, with the exception of small differences in the height limits.

7.3.8 1917 PROCEEDINGS

The 1917 meeting of the Committee on Fire-Resistive Construction established specifications for Grade A Hotels, Apartment Hotels and Club Houses; as well as Grade A Department Stores. The height and area limits were as follows [74]:

Specifications for Construction of Hotels, Apartment Hotels and Club Houses, Grade A.

Definition:

A hotel, apartment hotel, or club house, is a building with fifteen or more sleeping rooms above the grade floor, used for dwelling purposes by transient or permanent residents or guests, and containing equipment for personal service for such occupants. A building of this classification shall not be used above the grade floor for the storage or exhibition for sale of merchandise nor in any part for manufacturing, but this shall not prohibit exhibition of salesmen's samples. A building of this classification shall not contain a theatrical stage, including movable scenery, but may contain assembly halls, provided the arrangement thereof and exits therefrom shall conform in all respects to the standards of this Association.

Height:

The height from grade to roof line shall not exceed 125 feet, nor exceed a height of two and one-half times the width of the widest street upon which it is located.

Area:

The area within enclosing or fire walls shall not exceed 7,500 square feet, with no dimension greater than 125 feet for a building without automatic sprinklers, or 20,000 square feet, unrestricted as to linear dimensions, for a building fully equipped with automatic sprinklers.

Specification for Construction of a Department Store. Grade A.

Definition:

A department store is a building in which general merchandise is exposed for sale, and in connection therewith restaurants, packing and repair rooms may be maintained. The type of construction for a department store of Grade A shall comply with the following requirements and shall be sprinklered throughout in an approved manner:

HEIGHT.

The height from grade to roof line shall not be more than 125 feet nor exceed a height of 2½ times the width of the widest street upon which it is located.

AREA.

The area within enclosing firewalls shall not exceed 30,000 square feet on the grade floor, the basement and other stories not exceeding in area the following: if fronting on one street 10,000 square feet; if fronting on two streets 15,000 square feet; if fronting on three or more streets 20,000 square feet. The term "street" as herein used is a public thoroughfare at least 20 feet wide.

7.3.9 1918 PROCEEDINGS

Limited work was done by the Committee on Fire-Resistive Construction relative to height and area limits as outlined in the 1918 proceedings. A formalization of the "Standard Building", defined in the 1913 proceedings and outlined in **Section 7.3.5** of this report was provided as follows [75]:

Specifications for Construction of a Standard Building.

Height. — The height from grade to roof-line, irrespective of its occupancy, shall not exceed 70 feet, unless the building be fully equipped with automatic sprinklers, in which case the height shall not exceed 125 feet, nor shall any Standard Building exceed a height of two and one-half times the width of the widest street upon which it is located.

Area. — The area within inclosing or fire walls shall not exceed 7,500 square feet, with no dimension greater than 125 feet for a building without automatic sprinklers, or 20,000 square feet, unrestricted as to linear dimensions, for a building fully equipped with automatic sprinklers.

7.3.10 1919 PROCEEDINGS

The Committee on Fire-Resistive Construction provided a specification for construction of a Grade B Office occupancy in 1919 as shown below [76]:

SPECIFICATIONS FOR CONSTRUCTION OF AN OFFICE BUILDING, GRADE "B."

Definitions: An Office Building is one which is used for executive or clerical purposes, except for living rooms for the janitor, and is not used, above the grade floor, for the storage or exhibition for sale of merchandise, nor in any part for manufacturing purposes.

A Grade "B" Office Building is one wherein the Use, Height, Areas, and Exits and Construction of the supporting members fulfill the Grade "A" requirements, but in which certain other structural modifications are permitted.

Height: The height from grade to roof line shall not exceed 125 feet, nor exceed a height of two and one-half times the width of the widest street upon which it is located.

Area: The area within enclosure or fire walls of a building not exceeding 70 feet in height shall not exceed the following:

Fronting on	Without Sprinklers	With Sprinklers Increase of 66⅔%
One street	10,000 sq. ft.	16,666 sq ft.
Two streets	12,000 sq. ft.	20,000 sq. ft.
Three or more streets	15,000 sq. ft.	*20,000 sq. ft.

or, for a building from 70 to 125 feet in height, shall not exceed the following:

Fronting on	Without Sprinklers	With Sprinklers Increase of 50%
One street	7,500 sq. ft.	11,250 sq. ft.
Two streets	10,000 sq. ft.	15,000 sq. ft.
Three or more streets	12,500 sq. ft.	18,750 sq. ft.

*Maximum area accepted under any conditions.

Note that the height and area limits for Grade A and B Office occupancies were the same, except for the structural modifications permitted for Grade B Office occupancies. These modifications related to walls, piers, floors, roofs, stairs, elevators and other shafts and openings.

7.3.11 1920 PROCEEDINGS

In 1920 the Committee on Fire-Resistive Construction changed its name to the Committee on Building Construction, and provided a specification for Grade A, B and C Apartment House occupancies as shown below [77]:

The three Grades of Apartment House Buildings, A, B, and C, as specified in this Report, embrace all buildings of this class from those moderately fire-resistive to those having the very best practical protection. The structural supporting members in all Grades are incombustible.

The essential differences in the Grades are as follows:

Occupancy:

Grade A—No commercial occupancy allowed.

Grades B and C—Commercial occupancy permitted in the first story and basement with restrictions as to method of construction surrounding same.

Limits of Height and Area:

	Grade A	*Grade B*	*Grade C*
Height	125 ft.	100 ft.	75 ft.
Area	7500 sq. ft.	6000 sq. ft.	5000 sq. ft.

Use of Wood:

Grade A—None allowed except for floor surfacing.
Grade B—Allowed for trim, finish, and floor surfacing.
Grade C—Allowed for any purpose, except wooden lath and supporting structural members.

A comment from one of the committee members clarified the rationale for limiting the height for buildings of Grade C construction with respect of fire department capabilities, and suggested the provision of standpipes for buildings exceeding this height limit as noted below [77]:

> MR. FERGUSON: May I ask a question right here that has appeared important in our work? The limit of fire fighting is important as regards the height of a building. In Pittsburgh we have an "80-foot" fire department, as we call it, for short; it cannot rescue persons above 80 feet, nor can it fight fire efficiently in buildings over 80 feet in height without considerable assistance from the interior of the building. We made our limit on height of construction 80 feet, which is not far from the 75 feet given here. It is significant that the two are so close together as probably to make an average for the country because of the fact that Pittsburgh has not far from an average fire department as regards the height to which it can reach readily.
>
> There is one thing I think ought to be considered very carefully, and that is what requirements we shall make for the use by the fire department of standpipes in buildings over 80 feet in height. The use of them is better than dragging hose up the stairways. I, for one, admire this requirement in all these sections; that every stairway must have a standpipe. In some respects that provision has been criticized in Pittsburgh, because it appears to some to demand more standpipes than would appear necessary; but in fire-fighting nobody is going to stop in the haste and excitement to pick out a stairway that has a standpipe in it. It is a mighty wise proposition to have such standpipes in each stairway, as I see it.

Comments were provided by S.H. Ingberg relative to consideration of consistent levels of fire-resistance but varied types of construction [77]:

> MR. INGBERG: Could not the objection be overcome by requiring uniform fire resistance for the three types, but permitting different construction. I understand that the objection raised is chiefly based on the fact that for a less severe fire exposure we make a higher requirement. We are working towards improved materials for fire protection and interpreting our results in such a way as to assign fire resistance periods to constructions tested so that the poorest one likely to be constructed will come within a given such period; but the supposition is that in applying that, it will be rated against the same probable exposure. I notice the same

question presents itself in regard to the thickness of the wall. As near as I can tell, we propose to permit eight-inch walls of brick laid in lime-stone mortar.

This was an early attempt at balancing of risk and suggestion of a performance-type approach, but was not accepted by the Committee.

7.3.12 1921 PROCEEDINGS

The Committee on Building Construction provided a specification for construction of a Grade E Office occupancy in 1921 as shown below [78]:

SPECIFICATIONS FOR CONSTRUCTION OF AN OFFICE BUILDING — GRADE E.

Definitions:

An office building is one which is used for executive or clerical purposes, except for living rooms for the janitor, and is not used, above the grade floor, for the storage or exhibition of merchandise, nor in any part for manufacturing purposes.

A Grade E office building is one wherein the use, areas and exits fulfill the Grade A office building requirements, subject to certain restrictions in respect to height, and in which protected combustible materials are accepted as supporting members and certain modifications are accepted in the construction of floors and protected partitions.

Height:

The height from grade to roof line shall not exceed 55 feet, nor more than 4 stories.

Area:

The area within enclosure or fire walls shall not exceed the following:

Fronting on	Without Sprinklers	With Sprinklers (increase of 66⅔%)
One street	5,000 sq. ft.	8,333 sq. ft.
Two streets	6,000 sq. ft.	10,000 sq. ft.
Three or more streets	7,500 sq. ft.	12,500 sq. ft.

Grade E was protected combustible materials and supporting elements, considered to be “fire-resistive ordinary construction”.

A supplementary discussion during this meeting regarding an increase in the factor for provision of automatic sprinklers resulted in an increase of 100% for areas, which was previously 66⅔% as noted below [78]:

MR. E. P. BOONE: May I ask if the Committee did, in their deliberations, give consideration to increasing the allowable height of the building in the event of automatic sprinklers being installed, following the same plan as that for area?

MR. WOOLSON: Yes, it was considered, but the Committee felt that for a joisted type of construction we should not go beyond four stories, which has been the standard of the National Board of Fire Underwriters for years (55 ft., that is, for this type.) The idea of the Committee is that there is another type of joisted building which it will have to recognize, and which is, I am sure, more common throughout the country, but still, we thought that this was a practicable proposition and not too severe in requirements for the best.

MR. BOONE: On the subject of area, 66 2/3% increase, I note, is allowed where sprinklers are installed. I feel that in a sprinklered office building cut up in small sections, with numerous partitions on each floor, the area could be very materially increased. As a matter of fact, I have always held the opinion that considerations of area are almost blotted out by standard automatic sprinkler protection, and in view of this light occupancy in offices with small sections and numerous partitions, I thought that, perhaps, the area might be increased to more than 66 2/3%, possibly 100%.

MR. WOOLSON: The Chairman appreciates the significance of that criticism. May I ask if you make the suggestion of 100%?

MR. BOONE: I would make that suggestion as a motion.

The motion was adopted.

This increase associated with provision of automatic sprinklers has remained in codes up to the 1990 Canadian Model Code (1990 NBCC), which allowed an increase of 200% as a result of an amalgamation of the sprinkler and streets facing factors. This will be discussed more in **Section 8.12** of this report.

7.3.13 1922 PROCEEDINGS

A comment in the 1922 meeting of the Committee on Building Construction re-affirmed the discussion and motion carried at the previous meeting relative to the area increase factor where automatic sprinklers are provided [79]:

PROF. WOOLSON: The changes in this report since its presentation at the annual meeting in June, 1921, follow the discussion and suggestions made at that meeting (PROCEEDINGS, 1921, page 271). 100% increase in area has been allowed where sprinklers are installed. Openings in exterior walls may ex-

7.3.14 1923 – 1925 PROCEEDINGS

The 1923 to 1925 meetings [80-82] of the Committee on Building Construction focused on the development of construction requirements for private dwelling houses. This was the result of prioritization of efforts in other building-code-related committees occurring at that same time, where it was established that due to the large number of fires in private residences, development of requirements relative to these structures was warranted.

7.3.15 1926 PROCEEDINGS

Work of the Committee on Building Construction was re-focused back to non-private dwelling structures in 1926. This same year, Woolson stepped down as chairman of this Committee to focus on other

committee commitments. Mr. Charles E. Paul, Armour Institute of Chicago (now the Illinois Institute of Technology) took over as Chairman of the Committee.

The Committee on Building Construction included tentative specifications for standard industrial buildings of three construction types in the 1926 report. The construction types included Reinforced Concrete, Slow-Burning Heavy Timber (Mill) and Steel. The height limits as a function of construction type were suggested to be [83]:

- 5 stories or 60 feet in height for Reinforced Concrete Construction.
- 6 stories or 75 feet when equipped with automatic sprinklers and 4 stories or 52 feet when not equipped with automatic sprinklers for Slow-Burning Heavy Timber Construction.
- 5 stories or 60 feet in height for Steel Construction.

The following was noted during the meeting relative to establishing area limits for standard industrial buildings as a function of construction type [83]:

> **Article 4. Allowable Floor Areas.** (To be supplied.)
>
> NOTE: Although the prevailing practice of limiting floor areas as required by building codes throughout the country has been in vogue for many years, the committee recognizes that the application of arbitrary limits without assurance of equitable results for all cases and conditions may involve hardships to constructors and owners, which, it is assumed, were not anticipated. Accordingly, the committee has discussed a method of limitation based upon recognized performance record of fire in buildings substantiated by fire-fighting experience. It is intended to permit uniform area increases for the different types of construction with respect to accessibility for fire defense, automatic sprinkler protection and the degree of fire hazard of the occupancy.
>
> In view of the height limitations of these specifications, and assuming that buildings constructed in accordance with their provisions will have the protection of modern fire-fighting, it is conceded that such study is deserved, and that the results to be expected therefrom will be beneficial.

Pending the study noted above, general height and area limitations, independent of construction type, were provided as follows [83]:

> 2. FLOOR AREAS. The committee has tentatively considered the suggested area limits of the sub-committee on the reinforced concrete type, without formally recommending them, pending a further study of area limitation. (See General Requirements, Article 4.)
>
> The area within enclosure or fire division walls shall not exceed the following:
>
> | *Fronting on* | *Without Sprinklers* | *With Sprinklers* |
> |---|---|---|
> | One street | 10,000 sq. ft. | 20,000 sq. ft. |
> | Two streets | 12,000 sq. ft. | 24,000 sq. ft. |
> | Three or more streets | 15,000 sq. ft. | 30,000 sq. ft. |

7.3.16 1927 PROCEEDINGS

The Committee on Building Construction continued developing specifications for standard industrial buildings in 1927, and reported that no conclusions on height limits had yet been established due to the following [84]:

Appreciating the extreme irregularity of municipal zoning restrictions upon height, the Committee is nevertheless reluctant to specify an arbitrary limit which might be regarded as providing uniform safety to life and property in all cases or even under average conditions. In industrial buildings the size of undivided floor areas is so related to height of building that each might seem to be inversely proportional to the other. Discussion upon this point is solicited from the membership of the Association for the guidance or instruction of its Committee.

Attention is called to the fact that the limitations of floor area provided in Art. 4, General Requirements, are applicable only to such buildings as are less in height than three times the width of the abutting street. (See Appendix III.)

Allowable floor areas were established by the Committee based on the consideration of a reasonable area subject to a single fire, protective construction, streets fronting and provision of sprinklers. These area limits and associated discussion were as follows [84]:

Article 4. Allowable Floor Areas.

In standard industrial buildings conforming in all respects to these specifications, the maximum floor area in any story within exterior, party and fire walls shall not exceed the following:

4.1. Buildings not more than 6 stories or 75 feet in height:

4.11. Fronting on one street, 10,000 sq. ft. except that a deduction of 100 sq. ft. shall be made from this maximum for each 2 ft. of depth exceeding the frontage and that an addition of 100 sq. ft. may be made to this maximum for each 2½ ft. of frontage exceeding the depth.

4.12. Fronting on two streets, 12,000 sq. ft., except that an addition of 120 sq. ft. may be made to this maximum for each 3½ ft. of difference between the frontages on intersecting streets.

4.2. Buildings more than 6 stories or 75 feet in height:

4.21. Skeleton frame protected structures less in height than three times the width of abutting street (or average width of abutting streets), shall be restricted to an undivided floor area of 10,000 sq. ft. in any story within exterior, party and fire walls.

4.22. Such areas may be increased 50 per cent when further subdivided by fire division partitions into sections not exceeding 75 per cent of the area permitted by Art. 4.21.

4.3. When protected by approved automatic sprinklers any of the foregoing area limitations may be further increased 100 per cent for buildings not more than, and 75 per cent for buildings exceeding, 6 stories or 75 feet in height.

Note. The foregoing limitations are based upon average conditions of use, occupancy and municipal fire department protection. However, because of the wide variations in these conditions, it is recommended that the fire hazard in each particular case be accurately analyzed and the degree of combustibility of contents and the method of storage of stock be surveyed, with their reflection upon the size of areas contemplated. Although the owner's desires are controlled by municipal or state requirements, the latter are likely to be less restrictive than the recommendations above. It is therefore recommended that the owner avail himself of the advice of underwriting authorities having jurisdiction in his territory. (See Appendix IV.)

7.3.17 1930 PROCEEDINGS

The 1930 meeting of the Committee on Construction Operations presented their first formal report titled "Recommended Good Practice Requirements for Construction Operations", which was intended to address methods of fire prevention and control. The scope of the requirements were as follows [85]:

> **1. Scope.**
>
> These Recommended Good Practice Requirements are intended to apply to all buildings in course of erection, except that incombustible or flame-proofed scaffolding may not be necessary in buildings four stories and/or fifty-five feet in height and which do not have a ground area of more than 10,000 sq. ft. provided they are located so as to be readily available and accessible to the operations of the fire department. They are intended to apply to all buildings of the auditorium type of construction irrespective of height and area.

Regarding the height limitation, the Chairman of the Committee, R. White, New York Board of Fire Underwriters noted the following [85]:

> **With regard to the limitations which these rules apply, the matter was given very thorough consideration by the committee. The National Board Building Code specifies that buildings over four stories or fifty-five feet in height shall be of "fireproof" construction, and the committee thought that, as a nationwide proposition, somewhere about that height was about as far as the average fire department cared to go. All fire departments are not equally well equipped to fight fires in high buildings. While we did not go to the figure suggested by Mr. Alcott, we did seriously consider six stories or seventy-five feet, but in the judgment of the committee the four-story limit in the report is most applicable to the country as a whole. If there is any good reason why the report should be changed, I will be glad to go back to the committee with the recommendations or suggestions of the convention**

7.3.18 1931 PROCEEDINGS

Two key issues related to height and area limits were discussed during the 1931 meeting of the Committee on Building Construction [86]:

- Given the development of various types of fire-resistive construction, new assemblies and combinations of materials, the Committee notes that the "Standard" building is a thing of the past.
- Based on the work of other non-NFPA committees on the development of requirements related to building construction, action of the NFPA Committee on Building Construction would be deferred until reports by the other committees were made available.

The "Building Code Committee" was one of the committees noted above, which during 1931 issued a report [87] on "Recommended Minimum Requirements for Fire Resistance in Buildings". This report is discussed in more detail in **Section 7.4** of this report.

7.3.19 1933 PROCEEDINGS

The "Recommended Good Practice Requirements for Building Construction Operations" was revised based on comments and presented at the 1933 meeting. The scope of the original recommendations was changed as follows [88]:

> **1. Scope.**
>
> These Recommended Good Practice Requirements are intended to apply to all buildings in course of erection, except that incombustible or flame-proofed scaffolding may not be necessary in buildings six stories and/or seventy-five feet in height and which do not have a ground area of more than 10,000 sq. ft. provided they are located so as to be readily available and accessible to the operations of the fire department. They are intended to apply to all buildings of the auditorium type of construction irrespective of height and area.
>
> NOTE: The height and area herein specified, contemplates the maintenance and operation of a well equipped, paid, fire department, with an adequate water supply. Where such protection is not available, the height and area should be reduced accordingly.

The height limit for the use of combustible scaffolding was increased from 55 to 75 feet and a note was added to define what was intended by "operations of the fire department". The Chairman of the Committee, Mr. White, noted the following relative to the change in height limit [88]:

> MR. WHITE: Division 2 of the report, Building Construction Operations, is presented for final adoption. When the original report of this committee was presented in 1930 there was not full agreement. Since that time we have largely reconciled our differences.
>
> The principal change is in Section 1, Scope. The original report recommended not more than four stories or 55 feet as the limit of height of buildings where ordinary combustible scaffolding might be used. The representatives of the concrete interests thought those figures were rather too restrictive, especially in cities that had first-class fire departments, and the recommendation now is made by the committee that that height be increased to six stories or 75 feet.

The committee deliberations summarized above are specific to buildings under construction, and not completed buildings; however, the information highlights how expected levels of fire service capabilities affected code requirements in general.

7.4 1930 RECOMMENDED MINIMUM REQUIREMENTS FOR FIRE RESISTANCE IN BUILDINGS

A Building Code Committee was appointed in 1921 by Herbert Hoover, then Secretary of Commerce, "with the object of determining basic requirements that could be recommended to ensure public safety and at the same time promote economy in construction" [87]. By 1930, the Committee had prepared 6 reports as part of an "Elimination of Waste Series" covering various aspects of building regulation [89]. These reports were prepared under the technical direction of the National Bureau of Standards (the predecessor to the National Institute of Standards and Technology), and based largely on existing "large city" regulations with refinements made where supported by technical information available at the time of their adoption.

The sixth document in the series [87] , "Recommended Minimum Requirements for Fire Resistance in Buildings" (the "1930 NBSFR"), was initiated under the chairmanship of Ira H. Woolson who brought many years of experience in the subject matter at hand, as noted previously in this report. The primary purpose of this report was to provide a minimum set of requirements to preserve life and guard against conflagrations. Among other subjects, the 1930 NBSFR included regulations pertaining to occupancy types, construction types and associated height and area limits.

Buildings were classified by the following 5 occupancy and 6 construction types [87]:

Class 1.—Public.
Class 2.—Institutional.
Class 3.—Residential.
Class 4.—Business.
Class 5.—Garages, hangars, barns.

Type 1. Fully protected.
Type 2. Protected.
Type 3. Heavy timber.
Type 4. Masonry wall and joist.
Type 5. Wood frame.
Type 6. Unprotected metal.

Based on the occupancy and construction types outlined above, the following table of permitted heights was developed [87]:

TABLE 1.—*Allowable heights*[1][2] *of buildings*

Class of occupancy	Type 1, fully protected	Type 2, protected	Type 3, heavy timber	Type 4, masonry wall and joist	Type 5, wood frame	Type 6, unprotected metal
Class 1, public	No restrictions.	80 feet	1 story; or 3 stories in 55 feet.	1 story; or 3 stories in 45 feet.[3]	1 story	1 story.
Class 2, institutional[4]	do	do	2 stories in 45 feet.	2 stories in 45 feet.	do	Do.
Class 3, residential	do	do	4 stories in 60 feet.	3 stories in 45 feet.[5]	2 stories in 35 feet.[6]	Do.
Class 4, business	do	do	80 feet	4 stories in 55 feet.	1 story; or 2 stories in 30 feet.	Do.
Class 5, garages, hangars, barns.	do	50 feet	2 stories	1 story[7]	1 story[7]	Do.[7]

[1] All limits on heights of buildings in this section are from the standpoint of fire only.
[2] Where a height of 1 story is indicated there is no restriction as to the height in feet.
[3] The allowable height of type 4 construction for educational occupancies shall not be more than 1 story, nor 2 stories in 35 feet.
[4] See sec. 4–5.
[5] When the first floor construction and the construction below it is of at least type 2 construction as defined in sec. 3–2, 4 stories may be allowed.
[6] Dwellings may be 40 feet and have 2 ½ stories.
[7] A private garage may have a story above it if the garage is protected as required in sec. 4–4–5.

NOTE.—Mezzanine floors or galleries not exceeding 10 per cent of the aggregate ground floor area may be permitted in 1-story buildings.

The 1930 NBSFR noted that building heights were limited as a function of the capability of the responding fire department [87]:

> (4) The height at which construction requirements should become more drastic from a fire-resistance standpoint is determined very largely by the height above which a city fire department can not cope successfully with fire from the exterior of a building because of limitations of water pressure and apparatus. This limit will vary to some extent in different cities, and building codes should vary accordingly.

Based on the occupancy and construction outlined previously, the following table of maximum area limits was developed [87]:

TABLE 2.—*Allowable area of buildings in square feet*

Class of occupancy	Type 1, fully protected	Type 2, protected	Type 3, heavy timber	Type 4, masonry wall and joist	Type 5, wood frame	Type 6, unprotected metal
Class 1, public.	No restrictions.	No restrictions.	1 story,[1] 15,000; 2 stories, 10,000; 3 stories, 7,500.	1 story,[2] 7,500; 2 or 3 stories, 5,000.	3,000	No restrictions.
Class 2, institutional.	do	do	1 story, 15,000; 2 stories, 10,000.	1 story, 7,500; 2 stories, 5,000.	3,000	Do.
Class 3, residential.	do	do	10,000	7,500	3,000 [3]	Do.
Class 4, business.	do	25,000	1 story, 20,000; 2 or 3 stories, 15,000; over 3 stories, 10,000.	1 story, 10,000; 2 or 3 stories, 7,500; 4 stories, 6,000.	1 story, 5,000; 2 stories, 3,000.	Do.
Class 5, garages, hangars, barns.	do	25,000	1 story, 20,000; 2 stories, 10,000.	10,000	3,000	Do.

[1] Public assembly occupancies in buildings not more than 1 story in height may be of unlimited area if not subdivided or with only minor subdivisions along the walls.
[2] Public assembly occupancies in buildings not more than 1 story in height may have an area not to exceed 20,000 square feet, if not subdivided or with only minor subdivisions along the walls.
[3] Dwellings may have an area of 4,000 square feet.

The 1930 NBSFR noted that the area limits were based on a study of existing requirements and Woolson's paper [87]:

> (5) The undivided areas given in part 2 are based upon a study of existing requirements and recommendations. The committee has also had the benefit of an analysis of opinion offered by fire chiefs throughout the country during a survey by its late chairman, Ira H. Woolson. Some difference of opinion exists as to whether limiting areas should be required for all types of construction, but the committee has not felt this necessary where such limiting areas are omitted in section 4–3 of part 2.

The resulting values are consistent both with the limits in other codes of the same time period as well as those recommended by Woolson.

7.5 BUILDING MATERIALS AND STRUCTURES (BMS92)

A report on the "Fire-Resistance Classifications of Building Materials", prepared by the Subcommittee on Fire-Resistance Classifications of the Central Housing Committee on Research, Design, and Construction and published by the National Bureau of Standards in the United States noted that [90]:

> it is intended to indicate some of the changes from current practice that should be considered in writing or revising building codes and to supply some of the factual data necessary to a proper consideration of the changes indicated.

The report contains four chapters addressing classification of building types, restrictions and limitations relative to types of construction, surveys of combustible contents of buildings, and fire-resistance ratings. This report covers several subjects related to height and area limits. These subjects are summarized in the following sections of this report.

7.5.1 CLASSIFICATION OF BUILDING TYPES

The report defines 4 types of construction [90]:

- Type I: Fireproof Construction
- Type II: Incombustible Construction
- Type III: Exterior-Protected Construction
- Type IV: Wood Construction.

Fireproof construction, as referenced in the report, was intended to withstand the fire severity resulting from complete combustion of the contents within. The intent of the other construction types was not explicitly stated.

7.5.2 FIRE SEVERITY

The report relates combustible content to degree of protection required for building construction using fire severity, which is defined as "a measure of the intensity and duration of a fire" [90]. A relationship is provided between quantity of combustibles and fire severity in terms of the standard time-temperature relationship as follows [90]:

TABLE 5.—*Relation of amount of combustibles to fire severity*

Average weight of combustibles, lb/ft² of floor area	Fire severity	Average weight of combustibles, lb/ft² of floor area	Fire severity
	hr		*hr*
5	½	30	3
7½	¾	40	4½
10	1	50	6
15	1½	60	7½
20	2		

The nature of combustible content represented by actual weight in the table above is cellulosic (i.e., wood, cotton, straw, grain, etc.). The report notes that "animal and vegetable oils, fats, and waxes, petroleum products, asphalt, bitumen, paraffin, pitch, alcohol, and naphthalene [should be considered] at twice their actual weights" [90].

7.5.3 HEIGHT RESTRICTIONS

The report notes that buildings having construction with higher ratings can be built to relatively greater heights. The height is typically not restricted for buildings of fireproof construction, where [90]:

> the building should withstand a fire completely consuming all combustible contents and trim without collapse of structural members, or that for the higher amounts of combustible contents, the fire resistance incorporated in the building, in combination with its fire-extinguishing equipments and the public fire protection, is deemed adequate to prevent such collapse.

For buildings of incombustible, exterior-protected or wood construction, resilience to collapse was not considered as certain as buildings of fireproof construction. Therefore, for buildings of these types of construction [90]:

> provision for prompt egress of occupants must be made. Also, the possibility of conducting fire-fighting operations from within the building is not assured unless the fire is of low or moderate severity or is controlled in its early stage. The general limit of height to which an effective fire department hose stream can be directed from the ground to fight fires in a building is near 50 ft. This can be increased some 30 ft by mounting the hose on the first section of the aerial ladder. Any added range would have to be obtained with hose towers, the limit of height of which is near 100 ft. At this height the water pressure available from the pumpers and safely carried by the hose lines, becomes a limiting factor. These considerations will limit the height to which buildings other than those of the Fireproof type can be safely built.

The report notes the following for residential buildings, considering the use of wood in building construction [90]:

The limitation in point of height for residential buildings of other than the Fireproof type has been variously placed at 3 to 6 or 7 stories. Considering that the application of firestopping to prevent communication of fire through the concealed spaces in wood framing cannot be assured, it appears that a reasonable degree of safety in the higher buildings having such framing is difficult to obtain. The increased

7.5.4 AREA RESTRICTIONS

The report states that the intent of limiting building area is to "restrict the spread of fire, obviate conditions unduly hazardous to occupants from the standpoint of egress, and to provide access for fire-fighting purposes" [90]. The report does not provide any specific area limits, or quantified risk considerations relative to building area.

7.5.5 SURVEYS OF COMBUSTIBLE CONTENTS OF BUILDINGS

The report summarizes a survey of combustible contents of buildings as a function of occupancy. The data obtained by the survey is summarized in 10 tables. An example for residential occupancies is provided from one of the tables included below [90]:

Survey No.	Floor area	Combustible contents			
		Movable property	Floor	Exposed woodwork other than floor	Total
	ft²	*lb/ft²*	*lb/ft²*	*lb/ft²*	*lb/ft²*
A–1	695	3.1	3	3.6	9.7
A–2	670.5	2.5	3	2.8	8.2
A–3	544	2.4	2.7	3.4	8.5
A–4	604.5	2.7	3	2.6	8.2
A–6	519	3.4	3	2.9	9.3
A–7	647	4.0	3	2.7	9.7
A–8	431	3.4	3	3.6	10
A–9	514	3.5	3.	2.9	9.4
A–10	734	3.7	1.9	2.9	8.5
A–11	734	2.9	1.9	2.8	7.6
A–12	748	4.9	0	2.7	7.6
A–13	529	4.6	3	1.5	9.1
A–17	796	3.1	3	2.2	8.3
Average	.....	3.4	2.6	2.8	8.8

7.5.6 FIRE-RESISTANCE RATINGS

The report provides detailed tables of specifications for fire-rated assemblies of fire-proof, incombustible and combustible construction.

7.6 METHOD OF B.L. WOOD

A book in 1941 by B.L. Wood of the American Iron and Steel Institute (AISI), "Fire Protection Through Modern Building Codes" [91] provided a rationalization and modernization of fire protection regulations and a suggested set of model building classifications and fire protection regulations. Wood's book presents a considerable amount of information on height and area limitations and, based on an examination of many codes, the rationale used in their development.

Wood's method of establishing height and area limits is important as it is used later in the development of these limits in the National Building Code of Canada, discussed later in this report.

7.6.1 HEIGHT LIMITS

Wood notes that it is not necessary to limit the height of a building intended to withstand a burnout using non-combustible construction. However, where constructed using combustible construction, Wood notes the following [91]:

> As the height of a building is increased, added difficulty will be involved in fighting a fire that may occur in the building. The limit of height above which a city fire department has difficulty in coping with a fire, operating from the exterior of the building, varies according to the limitations of available fire-fighting apparatus, water pressure, and similar factors unrelated to building construction. However, it is generally recognized that three or four stories is about the limit of effective fire-fighting from the ground. Above that height, the trajectory of a hose stream directed through a window is so nearly vertical that it hits the ceiling and is deflected downward without penetrating any appreciable distance into the building.

Wood goes on to discuss how this is not the case for fire resistive and heavy timber construction, where it is assumed that the fire resistant characteristics of those types of construction allow for firefighting from the building interior, and thus permit increased building height.

He also noted that height of buildings containing industrial and storage occupancies is limited to facilitate fire department activities and avoid the potential for conflagration. The hazard to life is also expected to increase with increasing building height, but varies as a function of occupancy type. The hazard is considered higher in hospitals, schools, places of assembly and apartments than business.

The following height limits are suggested for buildings having masonry exterior walls with unprotected wood interior (Ordinary Construction) [91]:

Occupancy	Maximum Height
Residential	3 stories
School	2 "
Institutional	2 "
Assembly	1 "
Business	4 "
Industrial	40 feet
Storage	2 stories
Hazardous	1 story

More liberal height limitations are permitted for buildings of heavy timber construction. For non-combustible and fire-resistive non-combustible construction, building height is limited as a function of the differences in the relative fire hazards and relative fire safety provided by the different construction types. Wood notes that the balance of relative hazard is primarily experiential based.

7.6.2 AREA LIMITS

Wood suggests that the ultimate spread of fire can be limited by restricting the total quantity of fuel available to a single fire. Limitation of the quantity of fuel is based on the expectation of fuel burn-out or fire service intervention. Protective measures are provided to either contain the fire to the point of burn-out or until such time as a fire department can respond and suppress or limit the spread of fire. Where designed for burn-out, area need not be limited. Where fire department intervention is expected, combustibles are directly limited by area such that a resulting fire can be controlled or suppressed by a responding fire department. Area is also limited for purposes of life safety, by indirectly limiting the number of occupants in any one building or fire compartment. In the consideration of limiting areas, Wood notes that [91]:

> The depth of penetration of hose streams being directed into a building from outside, is limited by an effective range of not over 100 feet*; as the height of the building increases above one story this effective range rapidly decreases. Consequently, where large floor spaces are involved in a fire, there is likely to be difficulty in reaching the heart of the fire with the hose streams, and the building is apt to be gutted by the fire. Water is one of the best extinguishing agents, but it must reach the burning material to be effective.
>
> ***Range of Fire Hose Streams**
>
> "As a general rule, 40 to 60 lb. nozzle pressure is required for an effective stream . . . This pressure will give a throw or reach of about 70 feet . . . it can be used effectively from a stairway or window, or across an average 60-foot street. For longer reaches pressures up to 100 lbs. are required, which give a reach of 90 to 100 feet. . . . Nozzle pressures in excess of 100 lbs. should never be used."—NBFU Bulletin #71.

It is proposed by Wood that hazards due to occupancy be considered in light of the relative protection afforded by each type of construction. The occupancies are either light (i.e., residential, school, institutional, assembly and business), or heavy (i.e., industrial, mercantile and storage). The construction types include Type I (Fireproof), Type II (Fire-Resistive), Type III (Heavy Timber), Type IV (Non-combustible), Type V (Ordinary) and Type VI (Wood Frame).

Based on studies of various codes, Wood notes the following with respect to area limits currently in these Codes [91]:

> it has been common practice heretofore to establish those limitations by a "juggling" process. That process usually has involved an examination of various codes with resulting confusion because of their wide variation. Finally, more or less arbitrary values have been selected for the area limits and adjustments in those values have subsequently been made in an attempt to eliminate such inconsistencies in their relationships as may have been conspicuously apparent to the adjustors. As a result of that procedure of visual analysis, the area limitations that appear in building codes often prove inconsistent when studied carefully in the light of existing data on the relative fire hazards involved in the various occupancies and the relative fire safety afforded by the different types of construction.

This discussion highlights the fact that the area limits in existing codes have primarily been established arbitrarily and juggled as a function of perceived risk.

Wood suggests that the purpose of area limits is to limit the fire risk that can be tolerated and avoid unbalanced risks. He notes that area limits should be proportional to the risk and protection such that one building and its occupancy will not constitute a greater risk than another building. Consideration of the following factors is suggested in developing area limits [91]:

1. Relative fire hazard involved in each occupancy (combustible content).
2. Relative fire hazard involved in the structure itself (combustible content).
3. Construction features that tend to retard the spread of fire (fire-resistive enclosure walls, fire-retardant interior construction, non-combustible interior construction).
4. The number of occupants, and their ability to evacuate a building during the early stage of a fire (occupants able-bodied or ill, of active age or very young or old, asleep or awake, free or restrained, many or few).

It is suggested that these factors can be represented mathematically, allowing for a calculation of the risk and associated balancing of that risk. The mathematic approach considers [91]:

1. Making the relationship between the area limits *in each occupancy* such that the *net conflagration hazard* to the community (net combustible content of occupancy and structure, with adjustment for fire protective features) will be the same for each type of structure.

2. Making the relationship between the area limits of *different* occupancies such that

(a) The *net conflagration hazard* to the community (see above) will be the same in *Business, Industrial, Storage* and *Hazardous* occupancies.

(b) The number of persons accommodated within the prescribed area limits liable to exposure from a single fire will bear the following relationships:

Residential	—½*	the number in a *Business* occupancy
School	—1½	the number in a *Business* occupancy
Institutional	—⅓	the number in a *Business* occupancy
Assembly	—Twice*	the number in a *Business* occupancy

The result of this approach is a set of factors in tabular format with occupancy types in rows and construction types in columns. A conflagration hazard factor is calculated for each “box” in the table as a function of fire load associated with each occupancy, potential contribution of combustible construction to that fire load, and degree of protection (translated to an equivalent burn-out fire load) provided by the construction. The factors are based on one type of construction as the base case and all factors for this case being 1.

An occupancy hazard factor is then calculated for each occupancy, based on a ratio of occupant load factors and associated multipliers. This approach also uses one single occupancy as the base case; the factor for the base case being 1.

The conflagration hazard factor in each “box” of the table is then multiplied by the occupancy hazard factor for each occupancy, resulting in a table of factors with one “box” having a value of 1, corresponding with the base case occupancy and construction type. A base area is associated with this “box” and multiplied by all of the “boxes” in the table, resulting in a table of area limits representing a balance of the hazards.

Wood uses heavy timber as the base construction type and business as the base occupancy. The base area is a function of the maximum area for a wood frame building (in Wood's example this is set at 5,000 square feet) and translating that into the base occupancy type and construction type to establish the base area. This base area is then multiplied by the table of factors resulting in a table of area limits.

In applying the maximum areas to multi-storey buildings, Wood recommends that the maximum area be divided amongst all floors such that the maximum area of the building represents the total area of all floor levels added together. This is based on the rationale that the maximum area is established as a function of the total building fire hazard, which is comprised of the total combustible content of the building and the total number of occupants.

7.6.3 AREA INCREASE - STREETS FRONTING

Wood recommends an increase in building area as a function of the number of streets a building fronts onto, recognizing the increased effectiveness of firefighting activities where greater access is provided to the building exterior. However, he suggests that the increase in area be proportional to the amount of street frontage. For example, building area is typically increased by 50 percent where the building fronts onto two streets, assuming 50 percent of the perimeter of the building will have street frontage under such conditions. Similar logic is used for three streets facing resulting in an increase of 75 percent.

7.6.4 AREA INCREASE – SPRINKLERING

Wood notes that in recognition of the effectiveness of sprinkler systems in controlling fires (96% based on statistics at the time) it is general building practice to permit an increase in area of 100% where approved automatic sprinkler protection is provided throughout a building.

8.0 CANADIAN HEIGHT AND AREA LIMITATIONS

The following sections of this report summarize the development of the height and area limitations in Canada from early in the Twentieth Century.

8.1 CANADIAN CITY BUILDING ORDINANCES

Similar to the height and area limits outlined for US Cities in **Section 6.0** of this report, several cities in Canada contained height and area limits in their Building Ordinances. The following is a sample of the height and area limits for Montreal, QC, Calgary, AB, and Hamilton, ON from Building Ordinances from the early 1900's.

8.1.1 MONTREAL, QUEBEC

The Code of Building Laws for the City of Montreal [92] in 1906 regulated building height and area as noted below. These limitations are similar to those of US Cities of the same time period [92]:

BUILDING FRONTAGE, LINES AND HEIGHT.

Section 23.—The Council may, in conformity with the provisions of the Charter, fix and from time to time determine streets on which a line shall be fixed at such distance from the line of said street, as may be determined on by said Council, and beyond which line no building shall hereafter be erected. The Council may also fix and determine streets in which it shall not be lawful, after such determination by said Council, to erect any building unless the said building is three (3) stories or more in height, and that it is constructed of stone or other material approved of by the Council, but no building, in any street in the City, shall exceed ten (10) storeys in height above the sidewalk or street level, or be more than one hundred and thirty (130) feet from level of sidewalk to the roof

DIVISION OF BUILDINGS BY BRICK PARTITION WALLS.

Section 56.—All second class buildings, hereafter built, shall be so divided by brick partition walls, of the thickness prescribed in the preceding tables, that no space inside of such building shall exceed in area ten thousand (10,000) square feet; all such partition walls shall be carried not less than twelve (12) inches above the roof at every point.

No existing wall in any second class building shall be removed so as to leave an area not enclosed with brick-walls of more than ten thousand (10,000) superficial feet.

8.1.2 CALGARY, ALBERTA

The Building Ordinances By-Law of the City of Calgary [93] in 1913 regulated building height and area as noted below. These limitations are similar to those of US Cities of the same time period [93]:

Height of Buildings

Maximum Height

Sec. 90. (a) No buildings or other structures hereafter erected, other than buildings heretofore approved by the Superintendent, except a church spire, smoke stack, water tower, hose tower, shall exceed one hundred and thirty feet in height, said height shall be measured from street level to the highest point of parapet, and no storey of such building shall measure less than ten feet from ceiling to floor.

Veneer Buildings

(b) No brick or stucco veneer as defined shall be allowed in the limits of the City of Calgary for more than two storeys, and the whole height from the ground to plate shall not be more than twenty-eight feet, and no gable shall exceed this height by more than ten feet, and every fourth course of brick must be nailed to the studding every two feet with five-inch nails.

Wood Frame Buildings

(c) Wood frame buildings shall be limited to a height of thirty-six feet. Spires of churches may be higher than fifty feet and shall then be covered with incombustible material.

Area

When Fireproof

(d) Every apartment house of over two stories in height shall be built of slow burning construction, and of over three stories in height shall be of fire-proof construction, and have all external windows and doors fire-proof, nor shall any building be altered for use as an apartment house unless same is made to conform to the above condition.

Fire Walls necessary every 1800 sq. ft. See Amendments

(f) No wooden apartment house shall hereafter be erected, nor shall any wooden building be hereafter altered or converted to such use, when such buildings exceed two stories in height, exclusive of basement; nor shall any wooden tenement house wider than 30 feet and deeper than 60 feet, or the equivalent in area be hereafter erected unless the interior be subdivided by fireproof walls to that size.

Non-fireproof must have Fire Walls

(j) No apartment house of non-fireproof construction shall have an area exceeding 2000 square feet. on any floor unless divided by interior division walls of fireproof construction extending from basement to roof.

Fire Walls may be omitted if Ceiling is Fireproofed

(k) In non-fireproof apartment houses covering an area of not more than 5,000 square feet where the first floor is used for business purposes the fire-proof division walls may be omitted, provided that the floor directly above the business premises and the stairway leading thereto be constructed of fire-proof materials.

8.1.3 HAMILTON, ONTARIO

The City of Hamilton Building Regulations, Comprising By-Law No. 4797 [94] was enacted on September 29, 1936. This By-Law contained detailed height and area limits as a function of type of construction, occupancy classification and number of storeys. Area increases were permitted as a function of exposure to streets or where the building is “entirely” sprinklered (where not required by the By-Law to otherwise be sprinklered). The area modifications and height and area limits table are included as follows [94]:

(b) The extent of any "area" shown in table 504 following, may be increased above that which is indicated in said table as the maximum permissible for one storey buildings in groups G1, G2 or J3 of said table by the following amounts under the following conditions, namely:-

(i) by 33 1/3 per centum if the building has full exposure to at least two streets, each of which has a width of not less than 50 feet; and

(ii) by 100 per centum if the building is entirely "sprinklered" when not required to be "sprinklered" by Section 1406.

TABLE 504

OCCUPANCY, HEIGHT AND AREA LIMITATIONS FOR THE VARIOUS TYPES OF CONSTRUCTION SAVE AS MODIFIED IN S. 504-4 AND 5.

CLASS	GROUP	OCCUPANCY [1]	HEIGHT	FIREPROOF CONSTRUCTION [**] AREA SQUARE FEET	MILL CONSTRUCTION [* II] HEIGHT NO. OF STORIES	MILL CONSTRUCTION [* II] HEIGHT FEET	MILL CONSTRUCTION [* II] AREA SQUARE FEET	ORDINARY CONSTRUCTION [* II] HEIGHT NO. OF STORIES	ORDINARY CONSTRUCTION [* II] HEIGHT FEET	ORDINARY CONSTRUCTION [* II] AREA SQUARE FEET	METAL FRAME CONSTRUCTION [§ *] HEIGHT NO. OF STORIES	METAL FRAME CONSTRUCTION [§ *] AREA SQUARE FEET	WOOD FRAME CONSTRUCTION [§ *] HEIGHT NO. OF STORIES	WOOD FRAME CONSTRUCTION [§ *] HEIGHT FEET	WOOD FRAME CONSTRUCTION [§ *] AREA SQUARE FEET
PUBLIC BUILDING	A	1. A THEATRE OR MOTION PICTURE THEATRE.	NO LIMIT	NO LIMIT	NOT ALLOWED.			NOT ALLOWED.			NOT ALLOWED		NOT ALLOWED.		
		2. AN ASSEMBLY HALL OR ANY PLACE OF ASSEMBLY.	NO LIMIT	NO LIMIT	1 2 3	 35 45	15,000 10,000 7,500	1 2 3	 25 35	7,500 5,000 4,000	NOT ALLOWED		NOT ALLOWED.		
	B	1. A CHURCH OR SUNDAY SCHOOL	NO LIMIT.	NO LIMIT.	SUBJECT TO SECTION 504-5(d)			SUBJECT TO SECTION 504-5(d)			NOT ALLOWED		NOT ALLOWED.		
		2. A NON-RESIDENT CLUB OR LODGE ROOM.	NO LIMIT.	NO LIMIT.	1 2 3	16 35 45	15,000 10,000 7,000	1 2 3	16 35 45	7,000 5,000 4,000	NOT ALLOWED		1	30	3,000
	C	A SCHOOL, COLLEGE OR UNIVERSITY	NO LIMIT	NO LIMIT	SUBJECT TO SECTION 504-5(e)			SUBJECT TO SECTION 504-5(e)			ONE STORY	NO LIMIT	1	30	3,000
	D	1. A LIBRARY, MUSEUM, ART GALLERY, ETC AS IN PARAGRAPH (d) OF DEFINITION	NO LIMIT	NO LIMIT	1 2 3	 35 45	15,000 10,000 7,500	1 2 3	 25 35	7,500 5,000 4000	NOT ALLOWED		1	30	3,000
		2. A STADIUM, REVIEWING OR BAND STAND OR OTHER SUCH STRUCTURE.	NO LIMIT	NO LIMIT	1 2		20,000 10,000	1		15,000	NOT ALLOWED		1		5,000
INSTITUTIONAL BUILDING.	E	1. A PLACE OF DETENTION INCLUDING ASYLUM, JAIL, ETC. AS IN PARAGRAPH (a) OF DEFINITION.	NO LIMIT	NO LIMIT	NOT ALLOWED			NOT ALLOWED.			NOT ALLOWED		NOT ALLOWED.		
		2. A HOSPITAL, INFIRMARY, SANATORIUM, ETC AS IN PARAGRAPH (b) OF DEFINITION.	NO LIMIT	NO LIMIT.	1 2	16 35	7,500 6,500	1 2	16 35	6,000 5,000	NOT ALLOWED		NOT ALLOWED.		
		3. A NURSERY, A CHILDREN'S, INFANT'S, MATERNITY HOME ETC. AS IN PARAGRAPH (c) OF DEFINITION	NO LIMIT	NO LIMIT	1 2	16 35	7,500 6,500	1 2	16 35	6,000 5,000	NOT ALLOWED		NOT ALLOWED.		
RESIDENCE BUILDING.	F	1. CLASS A MULTIPLE DWELLING (APARTMENT HOUSE ETC.) SUBJECT TO ARTICLE 13	NO LIMIT	NO LIMIT	NOT ALLOWED.			2 3	35 40	3,000 2,000	NOT ALLOWED		NOT ALLOWED.		
		2. CLASS B MULTIPLE DWELLING (HOTEL, LODGING HOUSE, ETC) SUBJECT TO ARTICLE 13	NO LIMIT	NO LIMIT	NOT ALLOWED			2 3	35 40	3,000 2,000	NOT ALLOWED		NOT ALLOWED.		
		3. PRIVATE DWELLING, TWO FAMILY DWELLING NOTE, SEE ALSO SECTION 502 ÷	NO LIMIT	NO LIMIT	2 3	35 40	3,000 2,750	2 3	35 40	3,000 2,750	NOT ALLOWED		1 2	 35	800 800
		4. ROW DWELLING	2½ 35'	No LIMIT	1 2½	35	3,000 3,000	1 2½	35	3000 3000	NOT ALLOWED		1 2½	35	OC
BUSINESS BUILDING.	G	1. AN OFFICE-BUILDING ETC AS IN PARAGRAPH (a) OF DEFINITION.	NO LIMIT.	NO LIMIT	1 2 3	 35 45	22,000 10,000 7,500	1 2 3	 35 40	11,000 5,000 5,000	ONE STOREY.	NO LIMIT	1 2	16 25	5,000 3,000
		2. A MARKET, STORE, WORKSHOP, FACTORY, ETC AS IN PARAGRAPH (b) OF DEFINITION		NO LIMIT	1 2 3 4 5 6	 35 40 55 65 85	32,000 17,500 15,000 10,000 10,000 10,000	1 2 3 4	 35 40 55	16,000 7,500 7,500 5,000		NO LIMIT	1 2	 25	5,000 3,000
	H	1. A GASOLINE FILLING STATION. SEE ALSO ARTICLE 13.		NO LIMIT	1		6,000	1		5,000		NO LIMIT	NOT ALLOWED		
		2. A GARAGE OR HANGAR.		NO LIMIT	1		6,000	1		5,000		NO LIMIT	1	16	800
		3. A DRY CLEANING ESTABLISHMENT.	ONE STORY	2500	NOT ALLOWED.			NOT ALLOWED.			NOT ALLOWED		NOT ALLOWED.		
		4. A BUILDING OR STRUCTURE WHEREVER ANY INFLAMMABLE LIQUID OR HIGHLY COMBUSTIBLE SUBSTANCE IS MANUFACTURED OR KEPT.	FOR SPECIAL REGULATIONS SEE ARTICLE NO. 13												
STORAGE BUILDING.	J	1. A BUILDING FOR HOUSING OR SHELTERING HORSES, CATTLE, ETC AS IN PARAGRAPH (a) OF DEFINITION (SEE ALSO HEALTH BY-LAW.)	NO LIMIT	NO LIMIT	1 2	35	7,500 5,000	1 2	35	5,000 3,000	ONE STOREY.	NO LIMIT	1		3,000
		2. A BARN		NO LIMIT.	1 2	50	20,000 10,000	1		10,000		NO LIMIT	1		5,000
		3. A GRAIN ELEVATOR, STORAGE WAREHOUSE, ETC. (AS IN PARAGRAPH (c) AND (d.) OF DEFINITION.		NO LIMIT.	1 2 3 4 5 6	 35 45 55 65 85	32,000 17,500† 15,000† 10,000† 10,000† 10,000†	1 2 3 4	 35 45 55	16,000 7,500 7,500 6,000		NO LIMIT	1 2	 25	5,000 3,000

8.2 EARLY MODEL CODE CONSIDERATIONS

A paper by John B. Laidlaw, Ontario Municipal Association, titled "The Conflagration Hazard" [95], published in 1905 outlined considerations relative to height and area limitations in a Canadian context. Specifically, Laidlaw suggested [95] :

- Reduction of the area of any unit that may become freely subject to one fire.
- Division of total area by number of floors (i.e., constant volume, given a set storey height):
  - 1 storey – 15,000 ft²
  - 2 storeys – 7,500 ft²
  - 3 storeys – 5,000 ft²
  - 4 storeys – 3,750 ft²
  - 5 storeys – 3,000 ft²
  - 6 storeys – 2,500 ft²

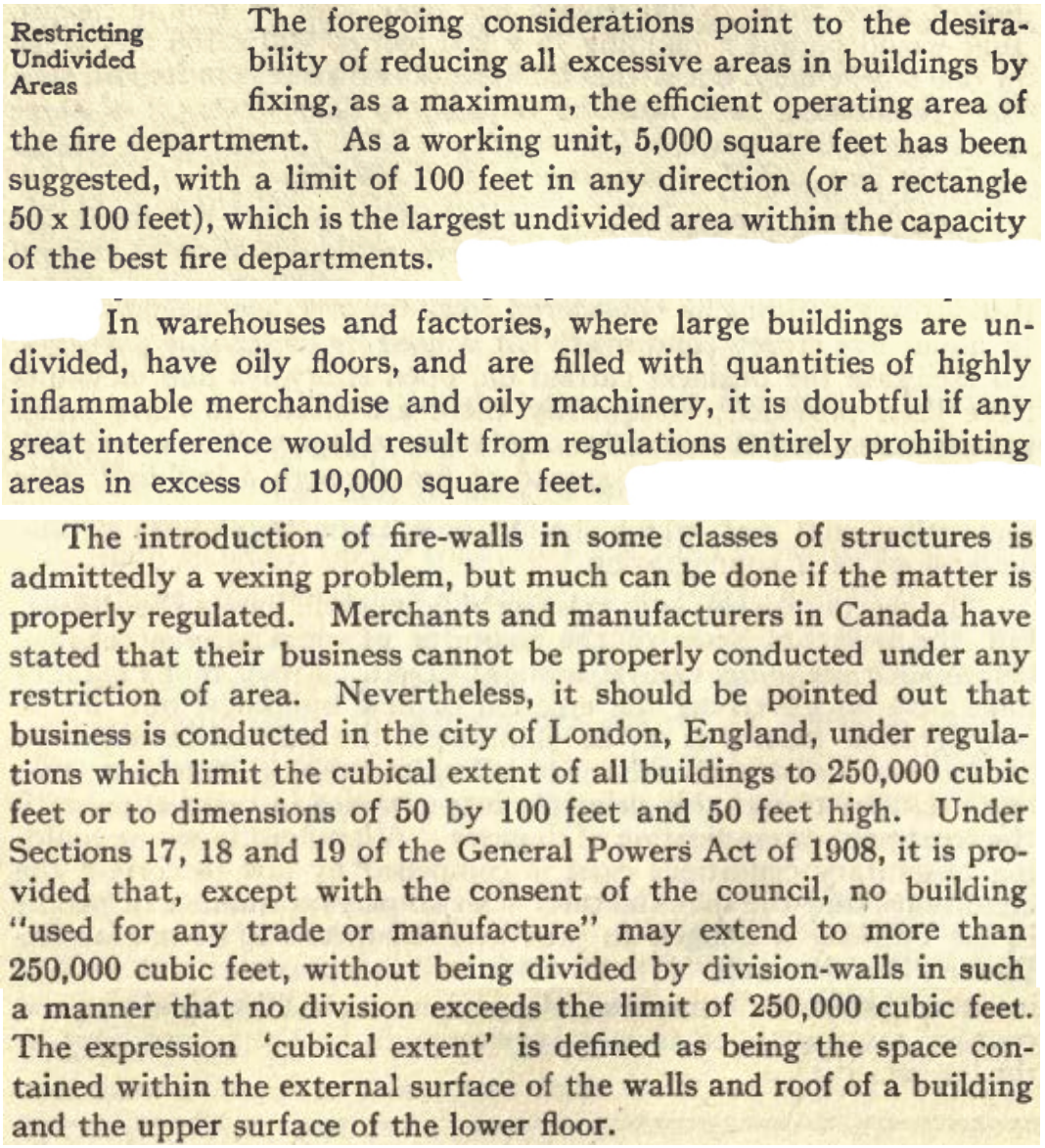
Laidlaw's method considers a total fire load distributed as a function of the number of storeys, on the assumption that the building is a single unit that may be subject to one fire as previously defined.

Laidlaw provided the following additional commentary relative to floor-to-floor fire spread and compartmentation [95] :

> **If, however, a building be so constructed that the floors are absolutely intact, so that there would be nearly as much probability of a fire being confined to the floor upon which it originates as that a fire originating in one building will not spread beyond the fire walls on either side, a larger ground area could then be allowed than if it were of ordinary construction, with open stairways and elevators. It will be readily admitted that a five story building with a total floor area of 25,000 feet all of which is burning at once will evolve a great deal more heat than would be generated by a fire burning on but one floor of not over 5,000 feet area.**

Following the considerations of Laidlaw, Mr. J. Grove Smith, Dominion Fire Commissioner of Canada, discussed height and area limits in his book "Fire Waste in Canada" [96]. Mr. Smith would eventually become one of the members of the Administrative Committee of the National Building of Canada in 1937 and chairman of the committee on Fire Protection. This is discussed in more detail in the next section of this report.

In his book, Mr. Smith discussed the 'unit area' approach, which was intended to confine a fire to a specific area and in doing so, limit the potential for conflagration. He suggested limiting areas out of concern that larger areas would result in greater fire intensity and spread and would require greater time for fire fighters to run hose lines, as well as reduce visibility due to smoke quantity, making it difficult to reach the seat of a fire. Mr. Smith notes that once smoke or heat exposure reach untenable limits, responding fire fighters are required to take a defensive strategy and the fire becomes uncontrollable [96].



Restricting Undivided Areas

The foregoing considerations point to the desirability of reducing all excessive areas in buildings by fixing, as a maximum, the efficient operating area of the fire department. As a working unit, 5,000 square feet has been suggested, with a limit of 100 feet in any direction (or a rectangle 50 x 100 feet), which is the largest undivided area within the capacity of the best fire departments.

In warehouses and factories, where large buildings are undivided, have oily floors, and are filled with quantities of highly inflammable merchandise and oily machinery, it is doubtful if any great interference would result from regulations entirely prohibiting areas in excess of 10,000 square feet.

The introduction of fire-walls in some classes of structures is admittedly a vexing problem, but much can be done if the matter is properly regulated. Merchants and manufacturers in Canada have stated that their business cannot be properly conducted under any restriction of area. Nevertheless, it should be pointed out that business is conducted in the city of London, England, under regulations which limit the cubical extent of all buildings to 250,000 cubic feet or to dimensions of 50 by 100 feet and 50 feet high. Under Sections 17, 18 and 19 of the General Powers Act of 1908, it is provided that, except with the consent of the council, no building "used for any trade or manufacture" may extend to more than 250,000 cubic feet, without being divided by division-walls in such a manner that no division exceeds the limit of 250,000 cubic feet. The expression 'cubical extent' is defined as being the space contained within the external surface of the walls and roof of a building and the upper surface of the lower floor.

By reference, Smith endorses the recommendations outlined in the paper by Woolson, "Allowable Heights and Areas For Factory Buildings", in establishing height and area limits.

8.3 1941 NBCC

Following Confederation, and based on the British North American (BNA) Act, the regulation of building construction in Canada was the responsibility of the Provinces, but was primarily delegated to municipalities. This resulted in a mixture of non-uniform building requirements across Canada, making it difficult for the construction industry to adapt construction methods and materials for each jurisdiction. This resulted in a movement to develop a model code applicable to all parts of Canada.

Uniform building regulations were first contemplated in Canada in the 1920's; however, this idea was abandoned because there was no Canadian organization in a position to write suitable specifications [97]. Development of model codes in the United States had already been underway for several decades. This was noted by J. Grove Smith at a Conference formed in connection with the preparation of a model code. Specifically [98]:

He traced the history of building codes during the past two centuries and stated that the project that a national building code be prepared in Canada had been an issue for the past twenty years. It was the lack of basic standards, he said, that had so far prevented the preparation of such a code. With the advent of the National Research Council together with the enlarged scope of activities of the Canadian Engineering Standards Association there was now an opportunity to proceed with this most important work. He offered his wholehearted co-operation to the National Research Council in bringing this about.

Consideration of model code development in Canada was re-initiated in the 1930's by several construction associations to address the non-uniform building regulations across the country. This resulted in the formation of an Administrative Committee by the National Research Council in 1932. One of the mandates of this committee was [97] "the consideration of standards and work in connection with the unifying of building codes throughout the country." At the same time, the Dominion Fire Prevention Association (now known as the Canadian Association of Fire Chiefs) was in the process of developing Canadian laboratories for fire hazard tests.

The National Research Council organized a conference on December 10, 1937, inviting many construction industry stakeholders with the intention of initiating the writing of a National Code [99]:

Representations have been received from numerous organizations calling attention to the desirability of the National Research Council's undertaking the preparation of a model building code. Organizations which have either adopted resolutions or made representations to the Council include:

The Canadian Construction Association,

The Canadian Hospital Council,

The Conference on Planning and Housing of the Conference of Mayors, held in March, 1937,

The Dominion Fire Prevention Association,

The Royal Architectural Institute of Canada.

At the December conference, Mr. A.F. Gill of the NRC presented a paper titled "A National Building Code," [100] outlining work at that time on development of a model code and recommended an approach to bringing such a code document together. Gill's paper identified the large amount of work completed in the United States relative to a model code and suggested that given the similarities between the United States and Canada, that [100]:

> *any building code authority in Canada could do no better than adhere to the procedure followed by American authorities and take advantage of their recommendations.*

Gill was referring to the development of model building regulations under the authority of the U.S. Department of Commerce in their "Elimination of Waste Series," comprised of several documents published between 1923 and 1935. These documents were prepared under the technical direction of the National Bureau of Standards (the predecessor to the National Institute of Standards and Technology), and based largely on existing "large city" regulations with refinements made where supported by technical information available at the time of their adoption [89].

The "Elimination of Waste Series" formed the basis of the first National Building Code of Canada, including the "Recommended Minimum Requirements for Fire Resistance in Buildings," [87] relative to the height and area limitations, which was discussed in **Section 7.4** of this report.

J. Grove Smith made a similar statement as Gill during the Conference formed in connection with the preparation of a model code [98]:

> He also observed that so far as authoritative standards of fire protection were concerned the committee on fire protection could probably do no better than to make use of the code of the National Board of Fire Underwriters. On the other hand, he said, for small communities there was need of a brief, simplified version of the code that could be used with facility by non-technical readers.

The 1941 National Building Code (1941 NBCC) [101] was the first model building code published in Canada. Members of the Administrative and Fire Protection Committees of the National Building Code included A.F. Gill (Secretary of both committees) and J. Grove Smith (member of the Administrative Committee and Chairman of the Fire Protection Committee).

As outlined previously, the height and area limitations in the 1941 NBCC were largely based on the "Recommended Minimum Requirements for Fire Resistance in Buildings" [87] (the "1930 NBSFR"). A copy of the height and area tables from the 1941 NBCC are included as **Appendix A** of this report. A copy of the height and area tables from the 1930 NBSFR were included in **Section 7.4** of this report. A comparison of the height and area limit tables from these documents indicates differences in the number and classification of occupancies, and similarities in the maximum heights and areas.

The number of occupancy types in the 1941 NBCC differed from those of the 1930 NBSFR. In addition, the 1941 NBCC had three types of fire resistive construction whereas the 1930 NBSFR had only two. In spite of these differences, the height and area limits in the 1930 NBSFR and 1941 NBCC were similar as shown in **Table 6** below. The ranges primarily relate to differences in occupancy classifications and the additional construction types in the 1941 NBCC.

Table 6: Height and Area Limit Comparison of the 1930 NBSFR and 1941 NBCC

Construction Type	1930 NBSFR		1941 NBCC	
	Height (ft.)	Area (sq. ft.)	Height (ft.)	Area (sq. ft.)
Fire Resistive	30 to unlimited	25,000 to unlimited	45 to unlimited	10,000 to unlimited
Heavy Timber	55 to 80	7,500 to 20,000	55 to 75	7,500 to 15,000
Masonry and Frame	45 to 55	5,000 to 10,000	35 to 55	5,000 to 7,500
Wood Frame	30 to 35	3,000 to 5,000	20 to 35	3,000 to 5,000
Unprotected Metal	1 storey	unlimited	1 storey	unlimited

8.4 1953 NBCC

Limited changes to the Canadian Building Code occurred between 1941 and 1948 primarily due to World War II and a focus on the development of a code for dwelling construction. The Division of Building Research of the NRC was formed in 1948 in conjunction with and supporting an Associate Committee on the National Building Code with the mandate to promote uniformity of building regulations throughout Canada and maintaining the NBCC as an up-to-date and progressive document [102]. The Associate Committee replaced the original Administration Committee responsible for the development of the 1941

NBCC. The Associate Committee held their first meeting [103] on March 1, 1949 and was chaired by Mr. R.F. Legget.

The principal changes to the 1941 height and area limits implemented into the 1953 NBCC relate to an attempt to rationalize the limits as a function of the hazards associated with fire load, type of construction and occupancy. These changes are discussed in the following sections of this report.

Minutes of the Second and Eighth Meetings of the Associate Committee

June 24, 1949 and December 5, 1950

The Associate Committee identified challenges related to the use of the 1941 NBCC in consultation with municipalities throughout Canada. This resulted in a plan for reorganization of the Code and establishment of several technical subcommittees responsible for key technical subjects of the Code [104]. The technical committees included Administration, Definitions, Climate, Use, Materials, Design, Services and Construction Safety Measures [105].

Minutes of the First Meeting of the Technical Committee on Use

December 14, 1951

The treatment of fire was covered by several of the technical committees, however, it was the primary focus of the Technical Committee on Use. This committee divided its work into four sections, Live Loads, Fire, Health and Exits [106], each administered by a panel of individuals knowledgeable on the subject matter. The Technical Committee on Use held their first meeting on December 14, 1951 and was chaired by Mr. D.C. Beam, Department of Trade & Commerce. Mr. Beam was one of the original 1941 NBCC Administrative Committee members, as well as a member of the Subcommittee on Masonry Construction, Subcommittee on Steel Construction and Committee on Fire Protection.

The height and area limits were examined by the Panel on Fire of the Technical Committee on Use (the "Fire Panel"). The Fire Panel held their first meeting on April 22, 1952, and was chaired by Mr. T.M. Jacobs, Office of the Ontario Fire Marshal.

Mr. R.S. Ferguson, of the National Research Council, was the Secretary of the Technical Committee on Use and a member of the Fire Panel.

Minutes of the First and Second Meetings of the Panel on Fire of the Technical Committee on Use

April 22 and May 20 and 21, 1952

Fire Load Concept

The first matter considered by the Fire Panel was the concept of fire load, described by Mr. G.W. Shorter of NRC as a measure of the severity of fire, primarily for furnishings, but can include combustible partitions as well as any other combustible material that would burn within a fire enclosure [107]. This concept was also previously discussed in **Sections 7.5.5** and **7.6.2** of this report.

Studies conducted by S.H. Ingberg at the National Bureau of Standards in the United States related burn-out of varying quantities of combustible fuel to times associated with the standard time-temperature curve through fire tests. The results of these studies provided a basic correlation between fire load and fire resistance.

The Fire Panel received the results of Ingberg's studies summarizing the fire load of 900 individual spaces and organized these results corresponding with the occupancy classifications in the 1941 NBCC [108]. The purpose of this exercise was to establish representative fire loads (combustible content in pounds per square foot) for each occupancy.

The result of the survey was a fuel load representing the maximum probable load for each occupancy type and was intended to [109] "establish the basis on which the construction of the building would be determined". Initially the Fire Panel considered the fuel load in units of 5 lbs./ft², but eventually changed it to 10 lbs./ft² for purposes of simplification. An appendix note in the 1953 NBCC provided the following relative to fire load values [110]:

> This value is used in the Code to determine the amount of fire protection which is necessary. It is obvious that the greater the severity of fire the greater must be the protection if the fire is to be contained. It has been found in actual burn out tests that a fire load of ten pounds per square foot can be contained by fire-resistive construction of roughly one hour. A fire load of twenty pounds can be contained by construction of two hours and so on. The values of resistance required for certain fire loads in the Code are based on these findings.

The resulting fire loads as a function of occupancy were [110]:

Fire Loads for Major Occupancies of Buildings

Column 1	Column 2
Major Occupancies	Fire Loads
Group A Assembly, Group B Institutional, Group C Residential, Group D Business, Group G Commercial and Industrial Division 3	10 pounds per square foot of *floor area*
Group E Mercantile and Group G Commercial and Industrial Division 2	20 pounds per square foot of *floor area*
Group F Hazardous and Group G Commercial and Industrial Division 1	30 pounds per square foot of *floor area*

Fire load was an important concept that would later be used to quantify the risk associated with different occupancies [107]:

> There was some discussion on heights and areas of buildings and the relationship which these had to the fire load and fire severity. In this connection the life versus property hazard was discussed and it was generally agreed that although life hazard was the major interest of building codes, at the same time there was an indirect relationship between life hazard and property hazard, so that it was impossible to ignore the latter.

Minutes of the Second Meeting of the Panel on Fire of the Technical Committee on Use

May 20 and 21, 1952

The subject of height and area limitations was initially addressed in May of 1952 based on notes prepared by Ferguson [108]. The notes suggest that areas are intended to be limited for purposes of fire fighting

and where life safety may be impacted by fire growth and spread. Height is limited as a function of both occupancy and construction.

Ferguson's notes outlined specific criteria for establishing height and area limits as recommended in B.L. Wood in his book, "Fire Protection Through Modern Building Codes" [91], previously discussed in **Section 7.6** of this report. Specifically, the area is limited by [108]:

1. The relative fire severity of the occupancy.
2. The relative fire severity of the structure.
3. Construction features which tend to retard fire.
4. The number of occupants and the ability of these to evacuate a building.

Based on the items above, the Fire Panel was working under the assumption that maximum areas would be based on a space that is completely protected, meaning the space would be compartmentalized with fire-resistive construction corresponding with the fuel load of the occupancy it contained. Similarly, it was assumed that the supporting structure would be similarly fire-rated. This addressed item 1. Item 2 was addressed based on the assumption that [108]:

> *With regard to the second [Item 2], the structure did not enter into the picture as long as the occupancy was completely protected.*

Where the occupancy was not "completely protected", a reduction of area would be considered. "Completely protected" from a structural standpoint was defined by the Panel as [108]:

> *Full structural protection means that the structural elements including floors, walls, columns, beams, can withstand without failure a complete burnout of the contents. Each floor, and in fact, each enclosed area should be so designed from the point of view of fire stopping and closing of vertical openings, etc. to prevent the fire spreading from any enclosed area to another, or from any floor to another.*

Specific to Item 3, the Panel considered that areas may be doubled if a space is sprinklered but did not provide any specific rationale associated with a factor of 2. However, the Panel members recommended that [111]:

> *it was beyond the scope of the code to require sprinklers in any occupancy.*

Similar to areas, height limitations resulting from inadequate structural protection would be addressed by provision of "complete protection" relative to the occupancy. However, it was acknowledged that it would be impossible to prevent multi-storey buildings of wood joist construction, and a limit of 4 storeys was suggested. Specific to height and firefighting, the Panel considered that [111]:

> *4 storeys was the effective limit for fire fighting, [and] fire fighters did not like high fire loads in tall buildings.*

It was further suggested that [111]:

> *No building, the structural elements of which are less than the fire load, shall be more than 50 feet high.*
>
> *It must be assumed that if the fire load is greater than the protection, as implied in the above paragraph, that the floors may collapse and that the fire load on the above floors will contribute to the total fire. It is further suggested, therefore, that in this case some proportion of the fire load of areas over unprotected floors be included in the fire load, and that the walls of such buildings be fully protected.*

The Panel also considered permitting non-bearing structure including, partitions, cupboards, paneled wall finishes, etc. to be of combustible construction in any occupancy provided the area was limited to 5,000 square feet and the area was completely protected by one-hour construction [111].

Minutes of the Fifth Meeting of the Panel on Fire of the Technical Committee on Use

September 26, 1952

A letter prepared by Ferguson for the Fifth Meeting of the Fire Panel, outlined a suggested method for establishing area limitations as a function of occupancy risk. The method was based on the recommended method in B.L. Wood's book; that the risks in different occupancies be equalized by defining the risks and assessing each occupancy relative to them. Combustible construction was considered as a supplementary factor in this method. Thus, areas were based on relative life and conflagration hazards in occupancies.

Using this method, Ferguson prepared a table of area limitations based on the following criteria [112]:

- The area of spaces, in which the fire protection equals the fire load, shall not exceed the tabulated value.
- Where the protection of a space is one hour in excess of the fire load, the area shall not be limited.
- Where a sprinkler system is installed, the tabulated value may be doubled.
- Where the protection of the space is less than the fire load, the tabulated values shall be reduced by the following percentages:
    - less 1 hour X% (50% suggested)
    - less 2 hours Y% (75% suggested)
    - less 3 hours Z% (90% suggested)
    - less 4 hours (not permitted)
    - Add 1 hour to fire load for combustible construction

The sample Table developed, based on Wood's method, compared the old NBCC and B.L. Wood's numbers with new NBCC values (Heavy Timber construction was assumed to equal 2 hours). A copy of this table is included in **Appendix B** to this report. A version showing only the proposed calculated values is included below [112].

Occupancy	Fire Load	Fire Resistive			Non-Combustible	Heavy Timber	Ordinary Unprotected	Wood Frame	Factors	
		3	2	1						
		Area limitations (sq. ft.)								
Residential	10	-	-	16000	8000	16000	4000	4000	2	1
School	10	-	-	16000	8000	16000	4000	4000	2	1
Institutional	10	-	-	12000	6000	12000	3000	3000	1½	1
Assembly	10	-	-	8000	4000	8000	2000	2000	1	1
Business	15	-	-	20000	10000	20000	5000	3000	3¼	2¼
Mercantile	20	-	18000	9000	4500	9000	2000	2000	2	2¼
Industrial	25	-	20000	10000	5000	10000	2000	2000	2½	3
Storage	30	24000	12000	6000	2500	6000	-	-	2	3

Minutes of the Fifth Meeting of the Panel on Fire of the Technical Committee on Use

October 1, 1952

The Chairman recommended, in consultation with B.L. Wood's book, that criteria for area limitations be established including [113]:

- choice of a basic area for a completely unprotected area and vary it in accordance with the hazards; and
- increasing the basic area with increasing protection.

It was suggested that areas of completely protected spaces not be limited, which was consistent with that recommended in B.L. Wood's book. This was contrary to 1941 NBCC, which limited areas in spaces considered fully protected. However, the members of the Fire Panel considered the prospect of unlimited areas as dangerous.

It was recommended by Ferguson that regulations be based on actual hazards and not arbitrarily determined. He noted that numeric risk values are attributed to each occupancy and maximum areas be computed based on these values. A small group of members of the Fire Panel was formed to attend to this task.

It was noted that criteria for height differed from that for area. Height was considered relative to getting people out of a space and fighting the fire. It was suggested that unprotected structures should be thought of as comprising only one space and the maximum area be a function of the number of storeys. Consequently, following the recommendation from the first Fire Panel meeting that 4 storeys was the effective limit for firefighting, it was noted that an unprotected wood frame structure 4 storeys in building height might collapse from a fire on the ground floor and endanger the lives of those on upper floors.

Relative to area for hazardous occupancies, it was suggested that "[w]here the protection of a space is one hour in excess of the fire load, the area shall not be limited" [113], preceded by "except in hazardous occupancies" [113] as a revision to the current wording associated with the Table. This was consistent with recommendations in B.L. Wood's book.

Minutes of the Fifth Meeting of the Panel on Fire of the Technical Committee on Use

March 31, 1953

Ferguson noted that the current draft of the height and area limitations was based on specific principles, and that in the revised table, the values were [114]:

> *determined as a ratio between the protection afforded and the protection which should be afforded for full protection. […] the values represented a reduction tied directly to a factor which was intended to be roughly proportional to the speed at which a fire could spread throughout a building.*

The Fire Panel members generally agreed with those principles, but suggested they should be modified in some cases. They considered that height and area limits were generally inseparable and the principles and policies developed by the Fire Panel generally applied to both. The table of limits was examined by the Fire Panel and the following changes were made [114]:

- The members of the Fire Panel did not consider slow burning construction (Mill Construction) to have a rating equivalent to 2 hours, and attributing 10 lbs. to Mill Construction was considered a conservative estimate. It was suggested that actual weights of Mill Construction in terms of contribution to fire may be higher.

- If any degree of fire resistance was required for floors of combustible construction, it was recommended that structural elements supporting such floors would need to have at least 2 hours of fire resistance.
- Buildings with no fire resistance and unprotected buildings were prohibited for some occupancies where they were considered to pose a significant risk to life.
- Areas for 1-storey buildings were considered separately as, by their nature, they were considered separate floor areas and were included as separate items in the table of limitations.

It was noted in the minutes of the meeting that [114]:

> *After much discussion the values for each combination of occupancy and construction were agreed upon and a number of changes were made resulting in values at variance with the principles.*

The revised table of values including those that were at variance with the principles was not available at the time of preparing this report.

Minutes of the Seventh Meeting of the Panel on Fire of the Technical Committee on Use and Occupancy

September 23, 1953

Ferguson noted to the Fire Panel members that earlier drafts of the height and area limits table had been based on the fire load concept. However, upon revision, specific heights and areas could no longer be correlated with fire load.

The Fire Panel members noted that the area limits in the draft table were more liberal (i.e., in institutional buildings) than those allowed by building codes in the United States. In addition, it was noted that a fire in a building with wood walls was difficult to fight and impossible to get a hose stream to the interior of an exterior wall. Based on these considerations, the following revisions were made to the height and area table [115]:

- Areas for institutional buildings were reduced, and not considered proportional to other values in the table.
- Areas for one-storey commercial buildings were reduced.
- The areas for single-storey buildings were considered too large in some cases and were reduced. Specifically, Group G division 3 (Storage) one-storey buildings were changed from unlimited area to 96,000 square feet.

Minutes of the Eighth Meeting of the Panel on Fire of the Technical Committee on Use

November 9, 1953

The original height and area limitation tables were developed (5th Meeting, September 1952) based on a consistent system of reasoning. As a result of the “rather arbitrary” changes being made to the Height and Area Limitations Table and the inconsistencies in the treatment of areas between different types of construction, Ferguson suggested the following [116]:

> *(a) Generally speaking the values should remain very much the way they were.*
>
> *(b) Adjustments should be made only to make one value consistent with another.*
>
> *(c) Life Hazards and conflagration were the two basic causes for limitation.*

(d) *Conflagration depended on the total amount of combustibles that could burn. Therefore, any occupancy which was not limited by a life hazard should, as a general rule, be given an area which would be roughly equivalent to this total amount of combustibles.*

(e) *At the last meeting it had been agreed that 96,000 sq. ft. was the maximum for a one storey building with a 10 lbs. fire load, because all one storey buildings are fully separated at their sides (required in articles on separation) and no separation is necessary above and below. There is no theoretical reason for allowing differences in area for different degrees of fire protection. The use of combustible construction, however adds 10 lbs. to the fire load and this would double the load in a one storey building of 96,000 sq. ft. For this reason in such a building of combustible construction the above area should be cut in half. Similarly for a non-combustible building one storey in height with a 20 lbs. load in combustible construction would be allowed one third the area. In effect these would be determined by the total load and would be calculated by dividing 96,000 sq. ft. by a factor having 10 lbs. in the numerator and the total load in the denominator.*

(f) *In multi storey buildings when combustible construction was a factor the same reduction in area should not be made in all cases. The reduction should be proportional to the ratio of the total fire load and the construction fire load. Thus if the occupancy had a 30 lbs. fire load the reduction in area for the construction should be one quarter.*

(g) *The Secretary [Ferguson] thought that all buildings should be calculated in this way after which those which required further limitations because of life hazards would be reviewed. He agreed that these two steps could be completed at the same time because the further limitations for life hazards had already been established.*

(h) *There was yet another limitation. In some occupancies it was recognized that severe limitations had to be made and in other occupancies increase in area had to be allowed, both of which were inconsistent with the two basic rules stated above. These further limitations could be termed arbitrary if that word was understood to mean that in practice they had been found to be necessary although it was not possible to state any exact reason.*

Ferguson noted that final limit values could only be defended if a consistent system of reasoning was used throughout the table, as outlined above. In addition to the suggestions by Ferguson, the Fire Panel suggested the following [116]:

- Multi-storey buildings, non-combustible unprotected, heavy timber and 1-hour combustible should be treated the same.
- Change the one hour combustible to ¾-hour combustible and allow an extra storey in height beyond that in the 1941 NBCC for combustible (protected) and heavy timber construction.
- Do not differentiate areas in single-storey according to combustible and noncombustible.
- Values given to wood and steel construction required revision to higher values.
- Fire walls should be of non-combustible construction.

At the conclusion of the meeting, it was decided that the Height and Area Limitations Table be revised by Ferguson and Beam. The revised version of this table was not available at the time of preparing this report.

Minutes of a Special Meeting to Discuss Proposed Table of Height and Area Limitations of Buildings other than 1 and 2 Family Dwellings

January 12 and 13, 1954

A Special Meeting was arranged at the request of representatives of the lumber industry to address concerns with the height and area limitations table [117]. The meeting was attended in part by representatives of the lumber industry including the Chairman and members of the Wood Panel; Mr. R.F. Legget, Chairman of the Associate Committee; and, Mr. R.S. Ferguson, Secretary of the Associate Committee and Member of the Fire Panel.

This meeting followed several informal meetings held between the Chairman of the Wood Panel, Mr. D. E. Kennedy of Forest Products Laboratories; Chairman of the Associate Committee, Legget; Chairman of the Technical Committee on Use, Beam; and, Secretary, Ferguson. Changes were made to the height and area limitations table based on these conversations and it was recognized that the table of limitations was a compromise between the "interests" of wood and steel construction. Representatives of the lumber industry agreed to accept the most recent revision of the table based on the following [117]:

- That the Associate Committee give top priority to revision of the part of the code including height and area limitations.
- A qualifying note be published with the table to indicate it was not final and subject to early revision.
- A note indicating a decision of acceptance of different types of construction under the provisions of the table is the responsibility of the local building authority.
- A study relative to including a note to cover light protection frame construction.
- Addition of a "light protection" combustible construction column in the Table and consider greater areas for this classification than for combustible non-protected.
- Increase in the area for single-storey Group G buildings.

Following the meeting, the Chairman of the Wood Panel agreed to the height and area limitation table as it was, with consideration of the proposed changes outlined above. He indicated he would submit the table to his Association with the recommendation to accept it as tentative, subject to early revision.

Minutes of the Ninth Meeting of the Panel on Fire of the Technical Committee on Use and Occupancy

February 18, 1954

The final (Ninth) Meeting of the Panel on Fire was held on February 18, 1954, and was specific to reviewing final changes to the height and area limitation table, which had already delayed publication of the Code by more than a year. The Chairman of the Associate Committee, R.F. Legget, attended and spoke at this meeting. He summarized the development of the height and area limitations table. Specifically [118]:

- The initial approach was to establish heights and areas based on formula without reference to types of construction.
- Representatives of the lumber industry viewed the height and area tables as too restrictive with regard to wood products.

- The height and area limitations table was revised several times in order to find a compromise acceptable to all concerned.
- The Wood Panel prepared a "brief" outlining recommended changes to the height and area limitations table. However, it was determined that should those recommendations be incorporated they would delay the Code by months.
- By January of 1954 the height and area table was not acceptable to the members of the wood industry and several alternatives were suggested [118]:

    (a) the present Table could be scrapped in favour of the Table in the 1941 Code;

    (b) the work could be scrapped and could be started all over again;

    (c) the Table could be left out altogether.

    (d) the table could be accepted with certain qualifications which had been agreed on;

- The wood industry representatives wanted to keep the 1941 NBCC height and area limits table. However, it was based on old information, whereas the current table was based on "more recent knowledge". Legget does not identify the source of the "more recent knowledge", but likely relates to B.L. Wood's method. Scrapping the current table and starting over was not practical given the extent of work completed by those involved in drafting the table. Leaving the table out altogether would result in every municipality preparing their own table, which would likely lead to regulations more restrictive than the current table.
- It was finally agreed that the table remain as it was, as outlined in item (d) above, with several minor modifications and additional matters contained in the brief prepared by the Wood Panel "be presented to the Fire Panel and the Associate Committee for further review, and that this should be a subject which should be given immediate attention for further revision after the printed Code was available" [118].
- The minor modifications to the table included:
    - Heavy timber multi-storey buildings were considered to be between non-protected noncombustible construction and one-hour protected noncombustible construction.
    - Non-combustible unprotected multi-storey buildings were treated the same as ¾-hour protected combustible buildings.
    - Non-combustible single-storey buildings remained unchanged.

The final version of the Height and Area Limitations Table was incorporated into the Code, which was completed in time to be issued at the Building Officials Conference on April 5 and 6, 1954 [119]. The problems associated with acceptance of the height and area limitation table delayed the publication of the 1953 NBCC by nearly two years.

Letter to Wood Panel by R.F. Legget dated May 5, 1954

Following publication of the 1953 NBCC, a letter was prepared by Mr. R.F. Legget, Chairman of the Associate Committee, addressed to the Members of the Wood Panel, focusing on the importance of immediate attention to the Height and Area Limitations Table in the next code cycle. In his letter Legget noted [118]:

> *As you know, the new Code has been prepared in such a form that it can be kept constantly under revision. As you have been advised in an entirely different connection, major questions and disputes can be and will be referred to special advisory groups which it is*

expected the Associate Committee will be appointing later this year so that such matters can be carefully considered, without the time limits under which we have recently been working, by completely representative groups in the fields of public health, fire, and structural design.

I can, therefore, give you my personal assurance as Chairman of the Associate Committee that the matter under review will be the first such matter to be referred to the advisory structural group just as will be the other matter which you questioned (the Heights and Areas table) to the advisory fire group. If this group recommends to the Associate Committee an immediate change in the tables as they now appear, you may be quite sure that this will immediately be done.

The Height and Area Table of Limits for the 1953 NBCC is included in **Appendix C** to this report. These values are a combination of the method described in B.L. Wood's book, summarized previously in this report, with arbitrary alterations as noted previously in this report.

8.5 1960 NBCC

Work on the height and area limitations was re-initiated in preparation of the 1960 NBCC. The key change to the height and area limits relate to the conversion from tabular format to a "spelled-out" format intended to allow greater design flexibility. In addition, two approaches were developed: a short-term approach involving basic revisions to the height and area limits; and a long-term approach involving a revision to the entire height and area limit format and values. These changes are discussed in more detail in the following sections of this report.

Minutes of the First Meeting of the Advisory Fire Group

November 24 and 25, 1955

It was recommended and approved at the Sixteenth Meeting of the Associate Committee on the National Building Code that advisory groups be formed to discuss general matters of technical policy concerning fire, health and structure [119]. The First Meeting of the Advisory Fire Group was held November 24 and 25, 1955, and was chaired by Mr. C.A. Thomson, Dominion Fire Commissioner [120].

Mr. R.S. Ferguson, of the National Research Council, was appointed Secretary to the Advisory Fire Group. Mr. D.C. Beam, Canadian Institute of Steel Construction Inc. was appointed as a member of the Committee.

The previous work of the Fire Panel was reviewed and it was noted that the resulting Height and Area Limitations Table was a compromise, accepted on the understanding that it would be reviewed following publication of the 1953 NBCC.

During the previous code cycle, the Panel on Fire of the Technical Committee on Use and Occupancy attempted to derive a formula to compute limitations specific to equalizing risk in each building. The formula related to separation requirements to prevent fire from spreading beyond a certain extent. Following many revisions, and as a result of comments and criticisms from industry, the Use and Occupancy Committee had to revert to arbitrary values for the 1953 NBCC to take into account intangible risks and safety measures that could not be evaluated numerically [120].

It was suggested that height and area Limits were the most significant in the Code, emphasizing the importance of the formation of a panel to specifically address any changes associated with them. At the conclusion of the meeting, formation of a Height and Area Panel was approved by the Advisory Fire Group.

Minutes of the Second Meeting of the Advisory Fire Group

October 23 and 24, 1956

The Second Meeting of the Advisory Fire Group was held almost a year following the First Meeting. This meeting had little discussion relative to height and area limits, since the Height and Areas Panel approved the previous year had not yet had their first meeting. Two papers were referenced [121]:

- A paper prepared by Ferguson relative to work done by others (B.L. Wood) on height and area limitations.
- A paper prepared by Mr. Hugh Thompson, Canadian Institute of Timber Construction outlining four points to be considered as a guide to the revision of the limitations.

These papers were not available for review at the time of writing this report.

Minutes of the First Meeting of the Panel on Heights and Areas of the Advisory Fire Group

November 21, 1956

The Panel on Heights and Areas of the Advisory Fire Group (H&A Panel) held their First Meeting on November 21, 1956 [122], and was chaired by Mr. C.A. Thomson, Dominion Fire Commissioner.

Mr. R.S. Ferguson, of the National Research Council, was appointed Secretary to the H&A Panel. In addition, the following members were appointed [122]:

- Mr. Donald M. Baird, Dominion Board of Insurance
- Mr. E. Brock Barley, Jonson and Higgins (Canada) Ltd.
- Mr. D.C. Beam, Canadian Institute of Steel Construction Inc.
- Mr. Aime Desautels, City Planning Department, Montreal
- Mr. D.J. MacMillan, Department of Buildings, Toronto
- Col. K.J. Partington, Provincial Fire Marshal, Halifax
- Mr. G. Bennett Pope, Durnford, Bolton, Chadwick & Ellwood, Montreal
- Mr. A.M. Thomson, Canada Cement Company Ltd.
- Mr. Hugh E. Thompson, Canadian Institute of Timber Construction

The H&A Panel reviewed the history and controversy in the development of the Height and Area Limitation Table in the 1953 NBCC. Following this, the H&A Panel outlined their approach to study the fire hazards of buildings and recommend realistic precautions to minimize the hazards to a safe degree. Four critical factors were identified: life, property, equipment, and the fire department. Equipment related primarily to heating appliances and was referred to a separate Panel for study.

Life safety was considered one of the most important aspects of the height and area limits. Stair towers were identified as a “prime consideration affecting areas and heights” [122], and whether they could be considered safe places of refuge in a fire, which was assumed in the Code. The H&A Panel agreed with this policy and at the conclusion of the meeting it was suggested that a small study group be formed to consider these matters further. The members of the “small study group” were not named.

Minutes of the Twenty-Third Meeting of the Associate Committee on the National Building Code

March 6, 1957

An update from the Advisory Fire Group on Heights and Areas noted that a small study group composed of members of the Advisory Fire Group was formed to address H&A limitations [123]. The H&A Panel considered limiting the size of buildings from the point of view of the maximum fire that could be

tolerated, and this would be tied to studies by the Division of Building Research of large fires in Canada and similar work in the US.

"Exits", Proceedings of the 1957 Building Officials Conference of Canada

D.C. Beam

A paper prepared by D.C. Beam, Chief Engineer, Canadian Institute of Steel Construction titled "Exits", presented at the 1957 Building Officials Conference of Canada included discussion relative to type of construction and height and area limits. Specifically [124]:

> *It is true that noncombustible construction largely eliminates the fire hazard due to fire starting in or being carried through enclosed spaces within combustible construction; it helps prevent the spread of fire rather than aiding; and also it does not add fuel to the fire. The combination of non-combustibility and fire resistance is important in buildings which are of such height and/or area as to be beyond the capabilities of the fire department to control the fire. Large or high buildings which cannot contain a burn-out of their contents could become conflagration hazards, dangerous to the lives of fire fighters and to people outside the building as well as to those who are sometimes caught unaware inside the building.*

Minutes of the Third Meeting of the Advisory Fire Group

October 29 and 30, 1957

The Third Meeting of the Advisory Fire Group discussed the report of the H&A Panel study group, which indicated that the new form of the height and area limits may not be tabular and [125]:

- *that there was no justification for a comprehensive table containing specific numerical values for area limitations although in a general sense the limitation of size of building appeared justified, and*
- *height limitation is essential and requires more study.*

In addition, the Advisory Fire Group discussed revising types of construction to be more modern, as well as exterior wall combustibility and the true meaning of mill and heavy timber construction.

A letter from Mr. R.E. Stopps, Technical Officer of the Canadian Standards Association (CSA), dated February 27, 1957 requested a response from the Building Code Committee (Advisory Fire Group) relative to whether the CSA test for combustibility would be useful in connection with the definition of combustible and non-combustible in the NBC. The letter noted the following limitations identified by the CSA Combustibility Sub-Committee to the Committee on Fire Tests on Building Construction and Materials relative to the proposed test method [126]:

1. *The method is practical only for homogeneous materials of a specific minimum thickness,*
2. *Certain materials by their nature cannot be tested in the form in which they are applied,*
3. *A variety of widely used materials, such as built up sections, laminated materials and coated materials, must be excluded from the scope,*
4. *Certain combustible materials, such as magnesium and its alloys, are also beyond the scope of the test.*

In addition, the CSA Combustibility Sub-Committee recommended that [126]:

> *the main committee recognize the limitations of defining non-combustibility by a simple furnace method as proposed, and study the application of such a test in relation to flame spread and fire resistance tests and the application of such a test for the Building Code.*

Based on the noted limitations of the proposed test method, CSA posed the following questions to the Advisory Fire Group [126]:

1. *Considering the numerous references in the code to combustibility and recognizing the limited use of the test, what is the possible application of the proposed specification in defining combustibility and non-combustibility?*
2. *Are certain references to these terms in the code more concerned with an interpretation related to constructional or mechanical properties rather than whether a material burns or not? If so, their definition may be more closely related to the term "fire resistance".*
3. *Because of the exclusion of so many building materials, will the application of the proposed specification be restricted to a point where it has virtually no practical value?*
4. *It is possible or practical to clarify or change certain references in the code to the terms "combustibility" or "non-combustibility"?*

The Advisory Fire Group responded to CSA noting that it intended to use the National Board of Fire Underwriters (NBFU) definition for combustibility, amended to allow more scope in testing. It was also noted that the proposed CSA test would be of value in defining materials classified under Part "A" and core materials classified under Part "B" of the NBFU definition.

The following definition of combustible from the 1955 National Board of Fire Underwriters (1955 NBFU) was provided by the Advisory Fire Group to the Associate Committee for reference [127]:

> **Noncombustible** as applied to a building construction material means a material which, in the form in which it is used, falls in one of the following groups (a) through (c). It does not apply to surface finish materials nor to the determination of whether a material is noncombustible from the standpoint of clearances to heating appliances, flues or other sources of high temperature. No material shall be classed as noncombustible which is subject to increase in combustibility or flame spread rating beyond the limits herein established, through the effects of age, moisture or other atmospheric condition. Flame spread rating as used herein refers to ratings obtained according to the Standard Test Method for Fire Hazard Classification of Building Materials of Underwriters' Laboratories, Inc., ASTM E84.
>
> (a) Materials no part of which will ignite and burn when subjected to fire. Any material which liberates flammable gas when heated to a temperature of 1,380 F., for five minutes shall not be considered noncombustible within the meaning of this paragraph.

(b) Materials having a structural base of noncombustible material, as defined in (a), with a surfacing not over ⅛-inch thick which has a flame spread rating not higher than 50.

(c) Materials, other than as described in (a) or (b), having a surface flame spread rating not higher than 25 without evidence of continued progressive combustion and of such composition that surfaces that would be exposed by cutting through the material in any way would not have a flame spread rating higher than 25 without evidence of continued progressive combustion.

Minutes of the Second Meeting of the Panel on Heights and Areas of the Advisory Fire Group

October 28, 1957

The H&A Panel reported on the results of the small study group. There was justification for limitation of size of buildings and for permitting unlimited areas in single-storey mercantile occupancies. The study group conclusions meant that [128]:

- If buildings could be adequately separated between floors to contain fire to any one floor, then there was little reason to limit areas.
- The importance of fire resistive construction[d] is to limit fire spread from floor to floor. Therefore, it is unimportant in single-storey buildings.
- For single-storey buildings, the difference in area for different types of construction was not justified.
- Some of the values in the 1953 Height and Area Limitation Tables were unrealistic.

Minutes of the Fourth Meeting of the Advisory Fire Group

November 25 and 26, 1958

A timing conflict with membership in other Committee panels resulted in a delay of the next meeting of the H&A Panel [129]. It was noted that the work of this Panel would need to be expedited in order to have revised Height and Area regulations by June 30, 1959.

Minutes of the Third Meeting of the Panel on Heights and Areas of the Advisory Fire Group

January 12, 1959

This meeting of the H&A Panel dealt primarily with three issues: height of apartments, combustible interior partitions and exterior cladding [130].

[d] The 1953 NBCC defined "Fire-resistive Construction" as follows:

> *that type of construction in which the structural elements and partitions are constructed of an protected where required with non-combustible materials to afford various degrees of fire resistance required in Table 4.1.3, "Minimum Required Fire-resistive Ratings for Structural Elements of Fire-resistive Types of Construction" except as otherwise specifically permitted herein.*
>
> *No combustible material shall be used in any fire-resistive type of construction except as permitted herein.*
>
> *Every storey in fire-resistive buildings shall be separated from every other storey by not less than Grades 1, 2 and 3 separations for Types A, B and C fire-resistive construction respectively.*

The panel recommended that apartment buildings of protected combustible construction (¾-hour rated) be permitted to be three storeys in height[e]. Specific technical rationale for permitting the additional floor was not provided in the documentation reviewed; however, it was noted that 3 storeys was the economical limit for walk-ups at that time.

It was recommended that combustible partitions be permitted in apartment houses and floor areas used for business. The H&A Panel did not consider this appropriate for apartment houses based on the potential for pipe and wire penetrations in combustible concealed spaces, allowing fire to spread from one fire compartment to another. It was recognized that these penetrations would require fire stopping, but acknowledged that in practice it does not always happen.

The H&A Panel agreed to permitting combustible partitions in floor areas used for business provided the combustible partitions have 1-hour fire resistance and do not contain any concealed spaces.

The following was recommended relative to exterior cladding [130]:

- *All buildings other than one and two family dwellings should have a non-combustible exterior finish.*
- *Cladding can be combustible if backed by fire resistive construction. Such cladding may be attached with or without furring strips.*
- *Cladding may be combustible without fire resistive backing in any building two storeys or 25 feet in height provided there is a space separation in accordance with the National Building Code.*

Following discussion on the proposed changes as outlined above, the H&A Panel recommended that the Division of Building Research of the NRC conduct a survey by writing to municipalities, architects and others requesting information on the workability of the figures in the current Height and Area Limitations Table.

Minutes of the Fourth Meeting of the Panel on Heights and Areas of the Advisory Fire Group

February 9, 1959

The survey of municipalities, architects and others outlined in the previous section of this report had 8 of 32 requests returned [131]. The results indicated a general satisfaction with the Code. Several respondents indicated a problem with the height and area limits for curling rinks and apartment buildings. However, it was noted that the survey results were few in number and should be reviewed in more detail when more are returned.

It was recommended that the requirements for fire stopping be made separate from types of construction so that it would apply to all types of construction, which wasn't currently the case. This was intended to clarify the requirements relative to construction, which was intended to provide structural stability under fire conditions.

Several revisions were proposed by H. Thompson and deliberated by the H&A Panel for the 1960 NBCC Height and Area Limitations Table including [131]:

(1) The area of buildings facing four streets may be increased by a factor of 2.

This was agreed to since it conformed with NBFU Code.

[e] The previous version of the Code (1953 NBCC) only permitted 2 storeys for apartment buildings of protected combustible construction.

(2) Sprinklered buildings may have their height increased by two storeys provided exterior wall finish is non-combustible for buildings greater than 2 storeys high.

There was disagreement relative to this proposal considering increase in area was already provided for sprinklers and difficulties in justification for 1-storey buildings, which were viewed differently.

(3) The area for sprinklered buildings may be increased by a factor of 3 for one-storey buildings and 2 for buildings more than one storey high.

No decision was made on this proposal other than a recommendation that it be considered further. In discussion of this proposal, it was noted that [131]:

> *The reason for permitting multi-storey fire resistive buildings of unlimited area is that the fire can be confined to one floor.*

(4) A building may be larger than the areas in the Height and Area Limitation Table provided the building is subdivided into compartments not exceeding the limiting areas by fire walls conforming to the requirements in the Code.

The Panel recommended that this be added as a note to the Code as it was explanatory rather than regulatory.

(5) The height of buildings of non-protected combustible construction may be increased from one to 2 storeys where the exterior wall is faced with brick veneer not less than four inches thick and floors, roof and interior walls have one-half hour fire resistive ratings.

The Panel recommended a different outcome than that proposed above. Specifically, it was agreed to give a concession for protected combustible buildings such that they could be 2 storeys in building height provided they had a non-combustible exterior finish and an interior finish having ¾-hour fire resistance, and floors would be required to be fire separations. The reason for the concession was as follows [131]:

> *it is apparent that some form of light construction for two-storey apartments was a necessity and it appeared better to achieve this in a light form of protected construction rather than unprotected construction. The Secretary pointed out that there were many buildings of ordinary construction but otherwise not very fire resistive. The regulations prepared for the 1953 National Building Code had the express purpose of providing fire-safe rather than the old ordinary type fire-proof building. Hence, rather than asking for heavy masonry walls with an unprotected combustible interior, the 1953 Code concentrated on compartmenting, separating floor from floor, closing exits, fire stopping, and providing separations between buildings that were deemed adequate whether they be space or construction. To permit unprotected apartments two storeys in height, provided some fire resistance was added to exterior walls, would in effect be going backwards. While it was agreed that many buildings were built of ordinary construction, Mr. Ferguson thought that the Code should continue to provide for safer buildings at a reasonable cost.*

(6) Areas may be doubled where non-protected combustible buildings have non-combustible exterior walls or cladding.

No decision was made relative to this proposal.

(7) Group C Residential buildings may be 35 feet or 2 storeys in height and 5,000 square feet in area when the exterior walls are finished in brick veneer, stucco or equivalent non-combustible cladding, provided the floors, roof, and interior walls are protected by fire resistive coverings having a fire resistance of not less than 45 minutes.

It was agreed that this proposal had already been covered under Item 5.

(8) Change maximum area from 4,000 to 8,000 square feet for Group A, Division 2 Schools and Churches of non-protected combustible construction, 1 storey high.

It was agreed that further study was required relative to Group A, Division 2 and 3 covering large open buildings one storey in height.

(9) Change maximum area from 4,000 to 10,000 square feet for Group A, Division 3, Curling Rinks and Arenas of non-protected combustible construction, 1 storey high.

See previous Item for Panel's response.

In addition to the information above, the following was also noted [131]:

- where sprinklers were provided in a building for purposes of increasing building area, it could be interpreted that sprinklers were required and intended to offset this increase. In this case, additional height allowance for the same provision was not recommended since they were already intended to offset the increase in area.
- single-storey buildings, regardless of their construction, were considered to be consistent with fully fire resistive and restricted to a single storey. Therefore, justifying larger areas.

Minutes of the Fourth Meeting of the Panel on Appendix 4.1.B of the Advisory Fire Group

February 10, 1959

A discussion of the Panel on Appendix 4.1.B., which was entitled "Fire Resistance Ratings", specific to protected combustible construction identified work being conducted by the National Fire Protection Association [132]:

> *Mr. Shorter reported for the information of the panel on a recommendation to the National Fire Protection Association that fire resistance classification of wall and floor constructions be modified to include 'one hour combustible and one hour noncombustible'. This classification had been in use some years ago but had been discontinued ... Mr. Beam thought that this classification should never have been abandoned as it is recognized that combustible material is of a lower category of fire resistance.*

In addition to in the minutes of the Twenty-Third Meeting of the Associate Committee and the Second Meeting of the Panel on Heights and Areas of the Advisory Fire Group, the perceived difference between combustible and noncombustible construction was highlighted during this meeting.

Minutes of the Fifth Meeting of the Panel on Heights and Areas of the Advisory Fire Group

March 23, 1959

Mr. Thompson of the Canadian Wood Development Council, a member of the H&A Panel, proposed changes to construction types and height and area limits relative to wood construction, where protective measures were provided [133].

"A Report on the National Building Code for 1960", Proceedings of the 1959 Building Officials Conference of Canada

S.G. Frost

A report prepared by S.G. Frost [134], Division of Building Research, National Research Council, noted that the limitations placed on the height and area of a building due to its use and type of construction were subjective. The survey of municipalities in Canada indicated a problem with the current height and area limits. One specific area of concern was with the limited height of residential buildings of ordinary type construction.

"A study of Limitations on the Height and Area of Buildings", Draft for Review by the Panel on Heights and Areas

R.S. Ferguson

A paper prepared by R.S. Ferguson [135], Secretary of the Associate Committee, the Advisory Fire Group and the Panel on Heights and Areas, was submitted to the H&A Panel. Ferguson provided a historical summary of the development of height and area limitations from the 1600's to the early 1900's.

Based on Ferguson's summary, the following general recommendations were proposed, including a breakdown of the related hazards [135]:

- The height associated with occupied or rentable floor spaces should be included as part of the measured building height.
- Height and area limits should be based on hazards that are known to exist.
- The height and area limits were previously based on balancing of risk where type of construction played a large role. However, it is not the business of municipal regulation to give credit for good construction.
- The previous method used to develop the Height and Area Limitation Table in the 1953 NBCC resulted in areas that did not relate to the hazards known to exist, resulting in meaningless and unrealistic values.
- Four hazards caused by size were identified including life hazard, inaccessibility, excessive combustible materials, and the increase that size causes to the danger of collapse.
- Inaccessibility, excessive combustible materials and danger of collapse are directly related to conflagration.
- Inaccessibility and excessive combustible material have the effect of creating a fire of such proportions that it may burn for a long time, require excessive separation distances and may become a fire that the fire department is powerless to limit.

Ferguson proposed the following, relative to the specific hazards associated with height and area of buildings[135]:

Life Hazard

- *Every building should be required to stand up and provide safe exit for the occupants during the period when it is being evacuated under fire conditions.*
- *It is suggested that ¾-hour construction protection and separation between floors and exits is satisfactory for offices, factories, schools, assembly buildings and stores.*

- *Hospitals, hotels and dormitories should have a fire resistance of the construction and a separation of 2 hours fire resistance between storeys if they are to be safe for exit purposes.*
- *Should apply to all buildings more than 2 storeys in building height.*

Inaccessibility

- *No building which is accessible from only one side should be more than 100' deep.*
- *No building with its least dimension greater than 200' shall be unsprinklered.*
- *Buildings more than 6 storeys shall have 2 hour fire resistive construction.*
- *Buildings over 2 storeys high shall have 1 hour fire resistive construction.*
- *In buildings over 6 storeys high the permissible compartment size shall be halved or sprinklers will be compulsory.*
- *In buildings over 2 storeys high, every storey shall be a separation except that under certain circumstances two storeys can be considered as one.*

Control of Fuel

- *In buildings over 6 storeys high, every storey above 6 storeys shall be a compartment, that is to say that every storey shall be capable of withstanding a burn-out.*
- *In the lower 6 storeys, the same shall apply except that two storeys can be included in any one compartment.*
- *For the General purpose of setting regulations, the maximum amount of fuel to be included in any one compartment, should be 1,000,000 lbs. This is approximately the figure used by the British and as a basis for the London by-laws. It is also an approximation of the basis used in the 1953 National Building Code. This Code sets a limit of area of 100,000 square feet but permits this only with 10 lb. fire load.*
- *This limit should refer to the total amount of fuel that might eventually be consumed; for example in a wood frame building the construction can become involved and even though it might have some fire resistance the whole building could be consumed.*
- *In a fire resistive building the degree of fire resistance might not be adequate and a severe fire might spread from floor to floor involving several floors.*
- *In both cases it is the total combustibles that can be involved that should be considered in the million lbs.*
- *The size of the compartment permitted should not vary directly on the basis of the combustible load. For example, a compartment having 3 hours fire resistance may present much the same hazard whether the load is 10 lbs. or 30 lbs. The intensity of fire and the rate at which the combustibles are consumed depends more on air supply and other factors than the actual amount of combustibles exposed.*

The Hazard of Large Size

- *the fire resistance of the structure of a building should be increased as the size of the building is increased (this is the converse of providing credit with greater size for buildings of better fire resistance).*

- *Since a bigger building is a bigger hazard, it is evacuated more slowly and it takes longer to reach the fire.*
- *If it collapsed, it would be a serious threat to adjoining buildings.*
- *Safety precautions should be in proportion to the size of a building.*
- *The writer suggests that the basis for establishing these limiting sizes should be the experience in the past.*

Ferguson prepared several tables incorporating the recommendations outlined above. The tables were organized by building height displaying areas as a function of occupancy, fire load, fire resistance and combustibility. These tables, included in **Appendix D** to this report, were organized differently from the original Height and Area Limitation Table from the 1953 NBCC.

Minutes of the Sixth Meeting of the Panel on Heights and Areas of the Advisory Fire Group

June 29 and 30, 1959

In discussing the proposal to increase height based on the provision of sprinklers, the H&A Panel [135] noted that there should be assurance that sprinklers be maintained, which was considered more suitable to insurance than building regulations. However, there was already precedent for maintenance of mechanical equipment in building regulations. The principle of increasing building height (storeys) with provision of sprinklers was accepted by the H&A Panel, provided it did not coincide with an area increase.

Ferguson's paper, outlined in the previous section of this report, was submitted to the members of the H&A Panel and presented to the H&A Panel by Ferguson. The H&A Panel accepted the approach suggested by Ferguson as a basis for evaluating height and area requirements. It was left to Ferguson to investigate the impact of the new approach on existing and proposed types of construction and occupancy combinations and report back to the H&A Panel.

In further refining the construction types, relative to protected wood frame construction and associated heights and areas, a comparison table was provided by Ferguson. This table included height and area limits for protected wood frame construction for the 1941 NBCC [101], 1953 NBCC [110], 1955 BOCA [136] (Building Officials Conference of America), 1955 NBFU [127] and 1955 UBC [137] (Uniform Building Code). The last three being US Codes. A copy of this table is included as **Appendix E** to this report.

"Private Report to the Associate Committee on the National Building Code on the subject of Heights and Areas"

R.S. Ferguson

August 24, 1959

A private report on Heights and Areas prepared by R.S. Ferguson [138] was submitted to the Associate Committee. Ferguson notes in the introduction of his paper that, after two years, some minor recommendations relative to heights and areas have passed, but that the fundamental difficulty the Code users have with the height and area limits has not yet been clarified. As a result, the purpose of Ferguson's paper was to follow from his previous paper and recommend policy on Heights and Areas for the Associate Committee.

Ferguson reports that the task of establishing height and area limits had become complicated since the conditions under which fire protection was being applied have changed radically. The number of occupancies have become many, and associated hazards, broad. While means for addressing specific hazards has evolved, macroscopic application of these means remains vague. Ferguson illustrates the simplicity of the past by noting that [138]:

> *At one time it was possible to classify buildings as fire-proof and other than fire-proof. If a building was not fire-proof, it was just an ordinary building and hence presumably the term "ordinary construction" came into use.*

Buildings of wood construction were often restricted from city centres and through designated fire zones, limited to the outskirts of cities.

The 1953 NBCC included 3 types of fire-resistive construction and 4 other types. Development of the 1960 NBCC considered an increase in the number of types even further. Building regulations developed on the premise of specifying construction to limit design flexibility and became a temporary fix to a complex situation.

The importance of development of a policy was highlighted in the following discussion by Ferguson [138]:

> *It must be admitted that by reducing sheer size a hazard may be reduced, but this is also a very crude approach. These hazards could be eliminated if we prohibited the building of buildings. While in some cases reduction in size is the only way to keep a hazard under control, it is important to consider each special hazard separately and to apply the safety measures which give the most effective result with the least interference on the activities of those concerned. Thus sprinklers, additional stairs, flame retardant treatments and other measures may be more appropriate to a particular hazard than simply a reduction in size. These are all accepted safety measures which already appear in most building regulations.*

Ferguson suggests that the policy of the Associate Committee should [138]:

- *Be a continuation of the trend in the development of fire protection, that is to say it should be an extension and development of the objective approach which has been commenced.*
- *It should deal adequately with the hazards of occupancy. A clear division should be made between those hazards which can be mitigated by protection incorporated in the construction of a building and those which can be regarded as housekeeping or maintenance. These latter should be left as the responsibility of the Committee on National Fire Codes.*
- *Some changes should be made which will have the effect of simplifying the types of construction and providing the means through construction whereby the greatest simplicity and flexibility in administration can be obtained. A positive suggestion to this effect is described separately below. It involves a change in the way that the provisions for limiting heights and areas are tabulated. By making the change it is possible to change the types of construction and steer a middle course between the views of some who would like to eliminate types of construction altogether and govern solely on performance and others who prefer to see matters left as they are.*

On this basis Ferguson suggests a method that embodies the three principles outlined above, starting with a re-definition of the problem as follows [138]:

1. Hazard appears to increase more with height than area and "hazards of buildings having different numbers of storeys are different in kind whereas the hazards of buildings of different areas are largely different in degree". A single-storey building is different from a multi-storey building because it has no occupancy above it. Buildings greater than 6 storeys in height are difficult to fight and are virtually on their own, which is not the case for buildings of 6 storeys or lower. Similar defining points do not generally exist for areas, which are more a degree of increasing hazard.

2. Size is regarded as the hazard, with construction as the safety precaution. This concept became reversed between 1900 and 1950 such that it was customary to specify particular types of construction and then indicate how big one is allowed to build them. This has led to the following problems:

    (a) Creates competition between types of construction.

    (b) Implicates construction as the hazard rather than size.

    (c) Assumes construction type as the starting point and size as the variable.

    The combination of these have resulted in an inflexible system of regulatory requirements where building size is concerned.

Ferguson's suggested solution to these problems is as follows [138]:

1. State a size and then establish the measures required and restrictions applied to make that size safe. This would eliminate classification such as "fire resistive", "wood frame", "heavy timber", etc.
2. The basis of the table should be height, with the area and type of construction as a function of height.
3. Prepare 3 limiting area sizes assuming:

    (a) that the building has enough fire resistance to contain any fire on one floor, the total limiting area would be permitted on that one floor, or in other words the plan dimensions of the building would equal the maximum area permitted.

    (b) that the construction is not sufficient to prevent a fire spreading from floor to floor. In this case the maximum area (100,000 square feet) would have to be divided among all the floors; hence if the building was 4 storeys high, each floor could have only 25,000 square feet. The effect of this would be to divide all buildings into compartments, each compartment being the same size whether it was a single or multi-storey compartment.

    (c) an area which is greater than the maximum area permitted in the other two, permitted only in special circumstances and when the design of the building had been certified by people competent to assess the risks and safety measures incorporated.

    (d) that the construction limitations which apply to a building which has a light fire load be permitted in a building of half the area when there is a heavy fire load in it.

Application of this method would result in a flexible system where the types of construction are incorporated into the table of height and area limits, providing a greater number of design choices. This would limit the comparison between different types of construction, and directly associate the construction measures intended to mitigate the hazards of building size. This approach is primarily based on that utilized in England at this time.

"Specific Values for Area Limits and Fire Resistive Requirements for Buildings of Different Storey Heights"

R.S. Ferguson

September 1, 1959

A supplemental report was prepared by Ferguson [138] to provide greater detail to supplement his proposed height and area limitation methodology, and advance useful comment from the Associate Committee.

The following established 6 fundamental rules relative to height and area determination [138]:

- **Rule 1: Required Fire Resistance**
  - Except for very small buildings, all buildings must have fire resistive construction which varies in degree from low to high depending on the number of storeys:

1 storey buildings (no basement)	0 hours
2 & 3 storey buildings (no basement)	¾ hour
4 & 5 storey buildings (no basement)	1 hour
6+ storey buildings (no basement)	2 hours

  - Grade 1 fire separation required between a basement and ground floor of all buildings.
- **Rule 2: Limiting Areas**
  - The total limiting area of all buildings shall be 50,000 square feet assuming the fire load is low (i.e., 10 lbs.).
  - The total limiting area should be reduced by half to 25,000 square feet for high fire load (i.e., 30 to 40 lbs.).
  - The basic areas outlined in the previous two points apply to the entire building. The area per storey is equal to the basic area divided by the number of storeys.
  - Where combustible construction is used, the basic area will be divided by 2.
  - If each storey in a multi-storey building can be designed and constructed to withstand a burn-out, then the area of the storey may equal the basic area. See Rule 1 for separation requirements.
  - Where no fire resistance is provided the area is severely limited to between 2,000 and 5,000 square feet.
  - The purpose of these points is not to limit building size, but to create fire-resistive compartments so that a fire may be contained within any one compartment until such time as the fire department can get to the scene and extinguish it.
  - Size must be determined based both on area and volume and amount of combustibles and the nature of the combustibles such that, the fire department could be expected to extinguish it without undue difficulty under normal conditions.
  - Reliance on the fire department is basic to this approach. It is unrealistic to attempt to provide barriers between buildings which are adequate under all circumstances to withstand a complete burn-out without the aid of the fire department at all.
- **Rule 3: Special Case for no Fire Resistance**
  - Buildings, either combustible or non-combustible, having no fire resistance may be built under special circumstances to be judged on its own merits.
- **Rule 4: Limitation on Combustible Construction - Fire resistance may be in combustible as well as non-combustible construction based on**
  - Area is further limited (See Rule 2).

- Combustible construction with no concealed spaces is permitted in buildings 5 storeys high except that joist floors are permitted to this height.
- Wood frame walls and partitions are permitted in buildings 3 storeys high.
- Restraints on combustible construction should be more related to height than area.

- **Rule 5: Exterior Wall Requirements**
  - All exterior walls are required to have fire resistance and be of non-combustible construction when buildings are more than 2 storeys in height.
  - See new spatial separation requirements. The expectation for these requirements is that the fire department arrives within 20 minutes of ignition as the peak values are otherwise 4 times greater and safe distances based on this value would be uneconomical.
- **Rule 6: Basic Fire Resistance Requirements**
  - Rule 1 should be specific for various structural and life safety components.

Ferguson detailed the rules in single sheets on a building height basis providing construction requirements associated with construction type and areas. These sheets, included as **Appendix F** to this report, "spelled-out" in detail construction requirements intended to address the identified hazards from what was previously limited by tabular format. This method provided both a rational methodology linking protective construction to the hazard of size as well as a departure from limited construction types [138]:

> *It makes possible an accurate statement of the required safety measures for a large variety of buildings, thus eliminating in large measure the objections to the present system that it is restrictive on construction. In bringing together all the regulations which are closely related it reduces the possibility of confusion and provides a regulating means which is easy to administer. It is thus straight forward, simple, to the point, and precise.*

Minutes of the Fifth Meeting of the Advisory Fire Group

September 30, 1959

The Fifth Meeting of the Advisory Fire Group was key to future changes in height and area limits. Revisions to the height and area limits were separated into short- and long-term approaches. Ferguson's reports, outlined previously, were adopted by the Advisory Fire Group and suggested as a long-term approach. Smaller revisions proposed in the 5 previous sets of minutes of the H&A Panel meetings were suggested as a short-term approach intended to be included in the 1960 NBCC. Most of the H&A Panel's meeting time had so far been associated with the short-term approach. The following comments were made specific to each approach [139]:

> ***Short Term Approach***
>
> *[T]he matters which had been discussed by the Panel in the last 5 meetings be referred to the Associate Committee for transmission to the Revision Committee and that, where no specific recommendation had been made by the Panel, further studies be conducted and the minutes of the Panel meeting be used as a guide, and further that these studies could be best done while a draft of the fire requirements was being prepared.*
>
> ***Long Term Approach***
>
> *[T]he Fire Group should be advised to recommend to the Associate Committee that these proposals be regarded as long term and carried over beyond the 1960 edition of the National Building Code; that the Secretary's original report and subsequent additions be*

published after further development and circulated generally for comment, and further that the Division of Building Research encourage the consideration of this approach to heights and areas by the building departments of municipalities in Canada.

As noted above, the Short Term Approach considered implementing revisions from the first five meetings of the H&A Panel. These revisions are summarized below [139]:

- Apartments permitted to be built of protected combustible construction up to three storeys in height.
- Floor areas used for business purposes can have combustible partitions of 1-hour fire resistance provided they have no concealed spaces. This is in reference to the 1953 NBCC for buildings required to be of fire-resistive construction (essentially noncombustible construction) with a floor area not exceeding 5000 square feet.
- All buildings other than 1- and 2-family dwellings should have restriction relative to exterior cladding.
- "Heavy timber construction" to be specified.
- Concealed spaces in assembly, commercial and institutional occupancies of combustible construction be subdivided into areas not more than 4,000 sq. ft.
- A2, Schools and churches, 1-storey non-protected combustible change from 4,000 to 8,000 square feet.
- A3, Curling rinks, arenas, 1-storey non-protected combustible change from 4,000 to 10,000 sq. ft.
- Additional types of construction added to Table 3.6, including:
    - Unprotected wood frame
    - Three-quarter hour protected wood frame
    - Unprotected ordinary (masonry and joist) construction
    - Three-quarter hour protected ordinary (masonry and joist) construction
- Occupied basements and roof structures be included in calculating building height.
- Tables presented by Ferguson, included as **Appendix F** to this report, considered for re-organization of Table 3.6.

Minutes of the Seventh Meeting of the Panel on Heights and Areas of the Advisory Fire Group

September 28 and 29, 1959

The H&A Panel discussed both the short- and long-term approaches and considered Ferguson's approach as long-term due to the time required to work it out in sufficient detail, and permit adequate review [138]. It was recommended by the H&A Panel that the Advisory Fire Group recommend to Associate Committee that Ferguson's proposals be regarded as long-term and carried beyond the 1960 NBCC.

The H&A Panel noted that relative to categories of construction, wood frame construction, as noted in the 1953 NBCC, is the same as ordinary construction in the 1941 NBCC. Following this it was recommended that the Height and Area Limitation Table be revised with respect to types of construction.

Minutes of the Twenty-Ninth Meeting of the Associate Committee

December 7, 1959

At the Twenty-Ninth Meeting of the Associate Committee, it was agreed that the recommended changes by the H&A Panel be implemented into the 1960 NBCC, and a broader study for changes be deferred to the development of the 1965 NBCC [140]. The short-term changes were referred to a Revision Committee, which is discussed in more detail in the next section of this report.

A study had been conducted relative to the definition of "combustible" and "noncombustible" and it was determined that the definition of "noncombustible" in the 1955 edition of the National Board of Fire Underwriters Building Code (1955 NBFU) be used with minor modifications based on the CSA Specification B54.1-1960. The definition from the 1955 NBFU is as follows [127]:

> *Noncombustible as applied to a building construction material means a material which, in the form in which it is used, falls in one of the following groups (a) through (c). It does not apply to surface finish materials nor to the determination of whether a material is noncombustible from the standpoint of clearances to heating appliances, flues or other sources of high temperature. No material shall be classed as noncombustible which is subject to increase in combustibility or flame spread rating beyond the limits herein established, through the effects of age, moisture or other atmospheric condition. Flame spread rating as used herein refers to ratings obtained according to the Standard Test Method for Fire Hazard Classification of Building Materials of Underwriters' Laboratories, Inc. , ASTM E84.*
>
> *(a) Materials no part of which will ignite and burn when subjected to fire. Any material which liberates flammable gas when heated to a temperature of 1,380 °F, for five minutes shall not be considered noncombustible within the meaning of this paragraph.*
>
> *(b) Materials having a structural base of noncombustible material, as defined in (a), with a surfacing not over 1/8-inch thick which has a flame spread rating not higher than 50.*
>
> *(c) Materials, other than as described in (a) or (b), having a surface flame spread rating not higher than 25 without evidence of continued progressive combustion and of such composition that surfaces that would be exposed by cutting through the material in any way would not have a flame spread rating higher than 25 without evidence of continued progressive combustion.*

Minutes of the First Meeting of the Revision Committee on Use and Occupancy

December 15 and 16, 1959

The First Meeting of the Revision Committee was held December 15 and 16, 1959, and was chaired by Mr. J. Lovatt Davies, Architect, Vancouver [141].

Mr. R.S. Ferguson, of the National Research Council, was appointed Secretary to the Revision Committee. In addition, the following members were appointed:

- Mr. G.H. Brundige, Deputy Fire Chief, City of Halifax
- Mr. P Dovell, Central Mortgage and Housing Corp.
- Mr. T.R. Durley, Manufacturers Mutual Fire Insurance Co.
- Mr. K. Izumi, Izumi, Arnott & Sugiyama

- Mr. D.F. Jones, Ontario Department of Labour
- Mr. L.A. Kay, Dept. of Health & Public Welfare, Manitoba
- Mr. R.L. Montador, Deputy City Building Inspector, Vancouver
- Mr. R.A.W. Switzer, Office of the Dominion Fire Commissioner
- Mr. H.E. Thompson, Canadian Timber Development Council
- Mr. D.C. Beam, Canadian Institute of Steel Construction Inc.

Ferguson summarized the short- and long-term approaches for the Revision Committee and noted that [141]:

> *The short term program were stop-gap changes to make the Code workable until 1965.*

The short-term changes were reviewed and had been incorporated into a draft version of the code, including the Height and Area Limitation Table, for purposes of simplifying review. A copy of the revised Height and Area Limitation Table is included as **Appendix G** to this report.

A discussion came up during this meeting related to height and area limits and sprinklering in a question from Mr. C. Hanna, a building inspector for the City of Vernon, BC. Mr. Hanna asked whether any provisions were being contemplated in the 1960 NBCC for allowances in wall, floor and roof ratings where sprinklers are used. In response to this, Mr. Ferguson provides the following [141]:

> *[W]hen sprinklers are used, it is possible to design a building of such a size which without sprinklers would require greater fire resistance in the walls, floors and roof… allowance for sprinklers is most suitable when applied to areas since the difference between a small area and a large area is almost solely one of degree. With respect to height, however, things are different. A one-storey basement-less building is an entirely different thing from a multi-storey building. The hazards increase far more rapidly with height than with area. Certain types of construction are possible with two-storey but; not with 3, and some with 3 but not with 4. Beyond 3 or 4 storeys it seems that combustible construction is practically eliminated, and above 6 or 7 storeys a fundamental change takes place, since rescue and fire fighting must be done from within rather than outside the building. Because of these and other reasons it will require a lot of careful consideration before it would be possible to permit increases in height for sprinklers.*

Minutes of the Second Meeting of the Revision Committee on Use and Occupancy

March 3 and 4, 1960

The tabular format for height and area limits was discussed, and as noted previously, this format was considered difficult to use [142]. The requirements were spelled-out in draft form [**Appendix F** to this report] in a manner that detailed the construction requirements associated with building size. Ferguson cautioned that one of the problems with spelling-out the Table was the degree of interpretation that would be required and that these interpretations may not be uniform.

The spelled-out version of the height and area limits mirrored the format suggested by Ferguson in his paper “Specific Values for Area Limits and Fire Resistive Requirements for Buildings of Different Storey Heights” [138], but retained the height and area limits of the revised Table from the 1953 NBCC [**Appendix G** to this report]. The new format was termed the “boxes” as it represented a “spelled-out” version of each of the boxes of the 1953 NBCC table format. The “spelled-out” version is what is used, with minor modifications, in the current version of the Code (2010 NBCC).

An excerpt of the discussion of the evolution of the “boxes”, included in a paper prepared by Ferguson for the 1966 Building Officials Conference, is included below [143]:

The "Boxes" is a convenient term to identify Articles 3.2.3.4. to 3.2.3.56. These requirements to resist fire spread and collapse were at one time in the form of a Table known as the "Height and Area Limitations" table. The table plotted occupancy against "type of construction" from which one found in each "box" two figures giving the area and number of storeys permitted. Since the real intent of the Code is not to limit height or area but to require safety measures for buildings depending on their height and area, in the 1960 edition the Height and Area Table was really turned inside out. Each little "box" was greatly enlarged to include a descriptive statement of occupancy, height, and area, followed by the necessary fire protection requirements for a building of that size and occupancy. Because of their relationship to the original Table these regulations (3.2.3.4. - 3.2.3.56) are known now as the "Boxes".

Minutes of the Fourth Meeting of the Revision Committee on Use and Occupancy

August 9 and 10, 1960

The Fourth Meeting of the Revision Committee reviewed public comments on the draft version of the proposed Code changes [144]. Comments related to specific height and area limits were reviewed, and for the most part were rejected. Thus, following the public review period, the height and area limits remained unchanged from the draft version.

In preliminary discussions relative to structural requirements due to building size, it was suggested by the Revision Committee that non-combustible, and possibly fire resistant construction, should be made a type of construction.

“The 1960 Code – Part 3, Use and Occupancy”, Proceedings of the 1961 Building Officials Conference of Canada

R.S. Ferguson

A paper prepared by Ferguson, included in the Proceedings of the 1961 Building Officials Conference [145], discussed the changes resulting in the 1960 NBCC. He noted the significant change from the table format to detailed “boxes” format, and the changes being based on a historical study he had conducted. Specific to the height and area limits presented in the 1960 NBCC, Ferguson noted that building codes are not intended to limit the size of buildings, but indirectly require protective features as a function of building size.

Minutes of the Thirty-Second Meeting of the Associate Committee

April 5, 1961

At the Thirty-Second Meeting of the Associate Committee [146], the Chairman asked the members of the Associate Committee for formal approval for public release of the 1960 NBCC [147]. The release date was proposed to be April 15, 1961.

The Chairman of the Associate Committee, Legget, noted that Appendix 4.1.B., “Fire Resistance Ratings” of the 1953 NBCC contained the fire-resistance ratings of certain materials but did not include interpretations of fire test results. He recommended that a Fire Test Board be formed to bring Appendix 4.1.B. up to date “since such ratings are often a matter of judgment” [146]. The Fire Test Board would report directly to the Associate Committee.

8.6 1965 NBCC

Work on the height and area limits was re-initiated in preparation of the 1965 National Building Code (1965 NBCC), but to a lesser extent than the previous Code Editions. The key changes in the 1965 NBCC included minor adjustments to area limits for some occupancies and changes to the construction criteria for the "boxes" as a result of a change in the definition of the term "noncombustible". Two construction types were defined: combustible and noncombustible. These changes are summarized in the following sections of this report.

Minutes of the Sixth Meeting of the Revision Committee on Use and Occupancy

October 11, 1961

In the Sixth Meeting of the Revision Committee, several revisions were suggested for the height and area limits in the 1960 NBCC including [148]:

- Minor editorial changes intended to clarify the requirements.
- An area increase was suggested by Beam for unsprinklered steel framed buildings, and to the basic areas for Group F, Division 2 and 3 occupancies.

The minor editorial changes were considered short-term and suggested as immediate changes. The suggested area increases were considered long-term and referred to the appropriate advisory group.

Minutes of the Sixth Meeting of the Advisory Fire Group

April 11, 1962

The Advisory Fire Group continued with their work relative to preparation of the 1965 NBCC. The membership of the Group changed as follows [149]:

- Mr. J. Lovatt Davies (Chair), Architect, Vancouver
- Mr. D.M. Baird, Fire Protection Engineering Department, Canadian Underwriters Association
- Mr. D.C. Beam, Canadian Institute of Steel Construction Inc.
- Fire Chief L.A. Burch, Fire Department Headquarters, St. Catharines, ON
- Mr. R.S. Ferguson, Division of Building Research, NRC
- Mr. D.F. Jones, Ontario Department of Labour
- Mr. E.S. Horning, Dominion Fire Commissioner's Office
- Mr. M.J. Jones, Chief Building Inspector, Burnaby
- Mr. C.W. Morgan, Building & Maintenance Engineer, Assumption University of Windsor
- Col. K.J. Partington, Provincial Fire Marshal, Halifax
- Mr. G.B. Pope, Architect, Durnford, Bolton, Chadwick & Ellwood, Montreal
- Mr. E.F. Tabisz, General Manager, Underwriters' Laboratories of Canada
- Mr. M. Galbreath (Secretary), Division of Building Research, NRC

The First Meeting of the Revision Committee was held April 11, 1962. The Committee questioned the definition of non-combustible and the provision permitting combustible partitions in a building required to be of noncombustible construction. It was noted that combustible partitions are assumed to be part of the fire load.

It was noted that the area permitted for unprotected non-combustible construction was greater in the 1953 NBCC (50,000 square feet) than the 1960 NBCC (48,000 square feet). It was suggested that a provision be included in the Code to permit the authority having jurisdiction to allow up to 96,000 square feet where the fire load is 10 lbs./sq. ft. The Committee agreed to review this change through the Revision Committee.

A discussion specific to height and area limits summarized the benefits of the new "box" format [149]:

- The new format focused on the protective features intended to limit the fire hazard attributed to building size, rather than arbitrarily limiting height and area.
- What was originally in a single table is now spelled-out in 25 pages with detailed descriptions of the construction required to control the hazards associated with occupancies. This was previously limited to 7 types of construction, which was found to be too rigid.
- The new system contained 61 boxes instead of the 196 in the 1953 NBCC table format, eliminating the full "balanced-risk" format (that proposed in B.L. Wood's book) and subsequently removing values previously there only for purposes of filling in the table.
- The previous format was crafted on the premise that risk could be addressed with increased fire resistance, which is akin to saying that "because narrow roads are a hazard, roads can be made entirely safe if made wide enough" [149].
- The limitation of the new "box" system is the lack of information to quantify the nature and extent of risk caused by height and area. Construction specifications are provided for each occupancy and size of building. The specifications are based on the limited information from the previous table format, previous specification for types of construction and experience of the Committee members.
- The new "box" format has been developed to promote realistic feedback from across the country to modify and develop the requirements. It is anticipated that this could be achieved through surveys of the size of buildings, the hazards, and safety measures used to mitigate the hazards.

The fundamental intent of the new "box" format was to [149]:

> *regulate directly according to the hazards caused by the occupancy of the building. The construction could be assumed to provide protection for the hazards but there would have to be further requirements to offset any hazards introduced by the construction itself. If such a method is ever adopted, types of construction and all other package specifications would practically disappear and instead the Code would become a set of regulations directed against hazards which had been recognized and identified.*

Letter from Robert F. Legget to the Associate Committee

August 31, 1962

A letter by Robert F. Legget, Chairman of the Associate Committee, to the Associate Committee members summarized key issues related to the Committee's upcoming meetings. One such item related to austerity measures implemented by the Government of Canada [150]:

> *I should mention briefly the Austerity Programme recently introduced by the Government of Canada in view of the financial emergency. You will be wondering what effect, it may have had upon our operations. Although current operating budgets have been reduced, our current Committee operations should not be interfered with. On the other hand our budget for next year cannot exceed our amended budget for this year and so we shall not be able to plan for any new activities which involve the expenditure of public funds.*

These measures would eventually impact formal activities related to height and area limits, as no new task group had been formed during this Code cycle or future cycles to initiate the long-term program identified during the development of the 1960 NBCC.

Minutes of the First Meeting of the Fire Test Board

September 11, 1962

A Fire Test Board (FTB) was formed under direction from the Associate Committee, and held their First Meeting on September 11, 1962 [151]. The members of the Board were as follows:

- Dr. N.B. Hutcheon (Chair), NRC
- Mr. J.E. Breeze, BC Research Council, BC
- Mr. A. Desautels, City of Montreal
- Mr. W.J. MacNeill, Manufacturers Mutual, Toronto
- Mr. G.B. Pope, Architect, Durnford, Bolton, Chadwick & Ellwood, Montreal
- Mr. J.J. Ruane, City of Toronto
- Mr. R.C. Wilson, Dominion Fire Commissioners Office
- Mr. M. Galbreath (Secretary), Division of Building Research, NRC

The terms of reference of the FTB was to be responsible for [151]:

a) the contents of Supplement No. 2, "Fire Resistance Ratings" of the NBCC;

b) the study and recommendations for publication of fire classification of building materials and constructions for which the results of full-scale test data are not directly available; and

c) recommendations regarding the addition of fire tests necessary for use with the NBCC.

The work of the FTB relative to "combustible" and "non-combustible construction" was directly related to the development of the subsequent height and area limits, and is discussed in the next section of this report.

Minutes of the Fourth Meeting of the Fire Test Board

February 1963

The term "non-combustibility" was discussed as it pertained to the height and area limits. The maximum heights and areas permitted to be of combustible construction at the time of this meeting are shown in the table below [152]:

Maximum Areas for Combustible Construction in NBC	1 Storey Area Sq. Ft.	2 Storeys Area Sq. Ft.	3 Storeys Area Sq. Ft.	4 Storeys Area Sq. Ft.
Theatres	10,000	-	-	-
Schools	16,000	8,000	-	-
Arenas	20,000	-	-	-
Nursing Homes	2,500	-	-	-
Hospitals	12,000	8,000	-	-
Apartments, Hotels	10,000	6,000	6,000	-
Offices	30,000	16,000 (6,000 O.P.)	16,000	16,000
Stores	24,000	10,000 (5,000 O.P.)	10,000	-
Industrial and Storage	48,000	24,000	18,000 (with sprinklers)	18,000 (with sprinklers)

It was established in the 1953 NBCC that the means of differentiating between combustible and noncombustible construction was to use the statement "the building shall be of fire resistive construction" [152]. Fire resistive construction was defined originally in the 1953 NBCC and included the statement that “the entire building shall be non-combustible” [110], but permitted some minor combustible components such as finishes, trim, non-bearing partitions to name a few.

Minutes of the First Meeting of the Revision Committee on Use and Occupancy

March 28 and 29, 1963

Since publication of the 1960 NBCC, experience and feedback relative to the use of the “box” format allowed for some refinements and adjustments. Specifically, the following was suggested for the 1965 Code cycle [153]:

- Changes to Group B occupancies suggested by a committee that prepared the Hospital Standards of the Department of National Health and Welfare.
- Changes to Group F commercial and industrial buildings, specific to grain elevators.
- Increased areas for noncombustible buildings of very low fire load.

Minutes of the Thirty-Sixth Meeting of the Associate Committee

May 8 and 9, 1963

A letter prepared by Ferguson to Legget, Chairman of the Associate Committee on the National Building Code noted the following relative to 1965 NBCC [154]:

> *The Revision Committee on Use and Occupancy has been formed and one meeting has been held. The policy has been adopted that the 1965 Code will be an adjusted version of the 1960 Code and no major changes will be made.*

This reference to limited changes may be related to the austerity measures noted earlier by Legget.

Minutes of the Second Meeting of the Revision Committee on Use and Occupancy

December 9 and 10, 1963

A paper prepared by Ferguson, relative to the new “box” format of the height and area limits of the Code noted the following [155]:

> *[T]he difference between the new and old regulations was the difference between pre-packaged prepared food mixes and the basic ingredients such as flour, baking soda, etc. The first were easy to use, you just add water but they were inflexible. The second permitted greater flexibility but a good result could only be obtained when used by a good cook. The new elemental codes were becoming a necessity in order to provide for the great variety of design which was now possible and to avoid a Code that was so lengthy that it was impossible to read. At the same time the new Codes demanded greater understanding. They provided freedom only for those with the knowledge of design.*

In addition, in the same paper, the following was recommended by Ferguson for consideration by the Revision Committee relative to the terms “unprotected noncombustible construction”, “fire-resistive construction” and “noncombustible construction” [155]:

- The 1953 NBCC had no definition for noncombustible. Defining “noncombustible” was considered to not improve matters. The 1960 code provided a definition for “noncombustible”, which was considered to be making matters worse. This was a result of the term being referenced

through an intermediary definition of “fire resistive” construction and its application to the “boxes”.

- The purpose of defining “noncombustible” was to quantify a noncombustible building. However, it is not practical to eliminate all combustibles in the construction of a noncombustible building. The result is buildings which are defined as noncombustible, but are more fittingly buildings of limited combustion.
- Where the 1953 NBCC regulated specific types of construction, the 1960 NBCC regulates a variety of construction combinations, more representative of what is actually being built. This approach is more along the lines of regulating construction rather than dictating it.
- Fire-resistive construction should be regulated on an elemental level rather than a macroscopic building level. This is complicated by the standard test for fire resistance, which does not distinguish between combustible and noncombustible. This could be overcome through use of the term “noncombustible” for certain elements and accept certain combustible elements such as paint.
- The purpose of the boxes is to regulate only the loadbearing members of a building, and combustible finishes and trim are addressed through provisions for flame spread, making the requirements relative to unprotected noncombustible and fire-resistive construction somewhat redundant. More specifically [155]:

  > *The clause about partitions of wood and glass in floor areas used by a single tenancy for business purposes would be much better placed in Section 3.3 Requirements for Fire Safety within Floor Areas. It has nothing to do with a building and certainly nothing to do with a fire-resistive building. It regulates a hazard but it is a life safety hazard. The fire load of such partitions has already been looked after under the structural and fire separation provisions in Section 3.2. for these reasons.*

- The recommendation based on the points above was to eliminate the requirements in the Code relative to unprotected noncombustible construction and fire-resistive construction.

The Committee members agreed that these provisions created confusion, but identified the following concerns relative to the suggestion to eliminate these requirements [155]:

- “The division of offices into areas 5,000 square feet where combustible partitions are used”.
- “The fire load in large and particularly high office buildings”.

It was decided that the confusion regarding unprotected noncombustible and fire-resistive construction could be eliminated by using the term “noncombustible construction” in place of the term “fire-resistive construction”. The benefit of this was discussed by Ferguson in a paper presented at the 1966 Building Officials Conference [143]:

> To avoid the confusion the National Building Code now does not include the category "Fire Resistive Construction". Fire resistive construction is effectively achieved in the "Boxes", however, where certain buildings are required to be of noncombustible construction and where the specific fire resistance of each kind of assembly is specified. This change is a major improvement because matters which were in doubt in previous editions are now made clear.

Minutes of the Third Meeting of the Revision Committee on Use and Occupancy

January 14 and 15, 1964

During the Third Meeting of the Revision Committee, it was agreed that the following changes be made to the Code [156]:

- The areas for Group A, Division 2 buildings, protected wood-frame construction (Articles 3.2.1.12. and 3.2.1.15.) be reduced by half.
- The basic area for Group A, Division 3 buildings (Articles 3.2.1.20.) be increased from 20,000 to 24,000 square feet to be consistent with a decision made by the Toronto Area Building Code Committee. It was agreed that the roof could be heavy timber, but not wood frame.
- The basic area for Group F, Division 3 buildings be increased from 48,000 to 56,000 square feet for heavy timber and noncombustible construction.
- It was agreed to redefine the term "noncombustible" and replace the term "fire-resistive construction" in the boxes with "noncombustible construction".
- The previously defined term "noncombustible" was altered to delete (b) and (c) to read as follows [156]:

> *as applied to a structural member, would comply with the definition of noncombustible except that paper and finishes less than one-eighth of an inch could be put into the assembly.*

Minutes of the Fourth Meeting of the Revision Committee on Use and Occupancy

April 29, 30 and May 1, 1964

During the Fourth Meeting of the Revision Committee it was recommended that a noncombustible building be defined as follows [157]:

> *A noncombustible building is one*
>
> *(a) in which the building members and assemblies, including every load-bearing member or assembly and any exterior non-load-bearing panel or curtain wall, are of noncombustible construction, and*
>
> *(b) in which interior non-load-bearing partitions are of noncombustible construction, except that in any floor area or part of a floor area occupied by a single tenancy, partitions of wood and glass or other approved materials and having no concealed spaces may be built.*

Wood frame construction was considered to be adequately addressed by the provisions for fire-resistive ratings except where excluded by the requirements for noncombustible construction. Therefore, the specification for wood frame construction was suggested to be deleted from the Code.

"Workshop Session No. 1, Part 3 – Use and Occupancy, National Building Code, Principles of Fire Protection"

R.S. Ferguson

June 1964

A workshop paper prepared by Ferguson outlined the principles of fire protection in Part 3 of the National Building Code. Ferguson described the historical development of the fire load concept and intent of fire-resistance ratings as follows [158]:

> Until 1940 this link was missing. It was known that the intensity and duration of a fire was related to the amount of fuel, but it was not until the late 1930's that authorities in Washington made any real surveys of combustibles in buildings. This material was available after the war. The combustible content of about 60 buildings of different occupancies was measured and the results were tabulated in the form of weight per unit of floor area. This new measure was termed the fire load - the weight of combustible load per sq. ft. of floor area.
>
> The fire load of the cord of wood of the original test, or its equivalent fuel supply in later tests, could be determined. This was the link between the test fires and real fires. The figures that can be given here are very rough. The fire load in a 1 hour fire test is about 10 lbs. per sq. ft. and in a 2 hour test about 20 lbs. per sq. ft. (1 cord of wood spread out evenly over 100 sq. ft. is about 10 lbs. per sq. ft.) Thus construction with a 1 hr. fire resistance will withstand a burn-out where the fire load of the space is 10 lbs. and construction having a 2 hr. fire resistance can withstand a burnout when the fire load of the space is 20 lb. The relationship between fire load and fire resistance was established and it was possible then to predict the minimum fire resistance for buildings of different occupancies.

As noted previously in this report, the excerpt above suggests that fire-resistance ratings for occupancies were established on the basis of testing associated with burnout of fuel loads attributed to those occupancies. Ferguson related the degree of fire resistance with the hazard of increased building height as follows [158]:

> On the basis of experience but in the language of fire science it can generally be assumed that a greater assurance of stability under fire conditions is required for a larger than a smaller building. This is particularly true in the case of height. The larger structure takes longer to evacuate and is more often difficult for the fire department to control. Time is the equalizer. Through greater fire resistance the fire department can have more time to operate. There are some buildings such as very tall ones which would create intolerable havoc if they collapsed. In such cases this risk must be reduced to an infinitesimal quantity. For these buildings therefore a very high degree of fire resistance is required, so that the normal relationship to the fire load is lost.[6]

[6] Despite the higher factor of safety in larger buildings it is the practice in many building by-laws to take further precautions by restricting the combustible load and requiring non-bearing partitions, interior trim and even furniture to be non-combustible and sometimes sprinklers are required on top of all this. To the author of this paper this appears to be a malpractice. The correct way to regulate is to assess the risk and apply regulations accordingly. It should be unnecessary as a sequel to apply further requirements to diminish the risk. If it is necessary, these further regulations should have been considered as part of the initial risk.

Ferguson provided historical context to explain the additional precautions in many building by-laws and rationale for reconsideration of the risk [158]:

> To those who are impatient for a change, and question what appears to be abnormally high requirements for fire resistance, it must be remembered that the present requirements are based on some bad past experiences. Conditions may have changed but it takes time to assess these changes. The risks now are quite different from what they were 50 years ago. The time has come when we can move cautiously towards eliminating precautions against risks which are no longer apparent but there has been insufficient time to assess the nature and extent of the new risks involved in changes in occupancy and the shape and size of the buildings of today. During the last century, North America was alarmed by conflagrations. There was one in almost every city. Yet in many cities a potential conflagration existed for almost a hundred years before the accidental circumstances happened to make it a fact. Occupancies have changed rapidly in the past 20 years, and it would be imprudent to reduce the requirements until the new hazards are fully comprehended.

As a summary to the discussion of building size, Ferguson notes that [158]:

> *[i]n general terms [the basic policy regarding resistance to collapse] accepts that the time design period of endurance is related to building size and is particularly critical with height.*

Minutes of the Seventh Meeting of the Revision Committee on Use and Occupancy

October 5, 6, 7 and 8, 1964

The final (Seventh) Meeting of the Revision Committee on Use and Occupancy identified the following changes to the 1965 NBCC [159]:

- The term “fire resistive” be deleted and replaced with the term “noncombustible” throughout the Code.
- The term “protected wood frame construction” be deleted throughout the Code.
- The areas for Group A, Division 2 buildings (Articles 3.2.1.8. and 3.2.1.15.) be reduced by half.
- The area for Group A, Division 2 buildings (Articles 3.2.1.23.) be increased slightly.
- Street width be deleted from section 3.2.1. (the “boxes”).
- The area for Group D buildings (Article 3.2.1.41.) be increased by 33%.
- The area for Group E buildings (Article 3.2.1.45.) be increased slightly.
- The area for Group F, Division 3, 1-storey buildings (Article 3.2.1.54.) be increased.

These changes were proposed to the Associate Committee and approved for the 1965 NBCC.

“The Problem of ‘Noncombustible’”, National Research Council, Division of Building Research, Technical Note No. 428

December 1964

R.S. Ferguson

A paper prepared by Ferguson relative to the term “noncombustible” identified concerns regarding bulk application of this definition to buildings as a solution to address the hazards of fire [160]:

The real issue now is the prospect of using almost immediately combustible materials that are able to perform as well as the traditional noncombustible materials in a load-bearing or non load-bearing capacity. If the materials serve the purpose there are two possibilities for control.

1. The definition of noncombustible can be written (as in the 1960 National Building Code of Canada) so that the materials in question become noncombustible.
2. The definition of noncombustible can remain in the CSA Specification, but the concept of the traditional noncombustible building can be changed to one of limited combustibility.

Of these two possibilities the second is preferable. Noncombustibility is an elemental concept, but noncombustible construction is only a standard that has proved satisfactory for tall buildings and some other situations. When construction using combustible materials is developed that satisfies the conditions, the standard should be changed to permit it.

The reader will undoubtedly appreciate the significance of this suggestion. It reveals that there is no preamble to the present regulations outlining the hazards they are intended to mitigate or the conditions they are intended to satisfy. What are these conditions? They may be known, but it is not general knowledge. Lacking a satisfactory diagnosis of the problem, responsible authorities place their trust in noncombustibility. Where one can truly eliminate all combustibles there can be no fire.

This solution cannot be justified much longer. Attention should be directed to the hazards that size, and particularly height, introduce. Agreement on what the hazards are and the degree of risk acceptable will pave the way for alternate solutions "deemed to satisfy" these conditions. Non-combustibility will always be one, but not necessarily the only, solution. If eventually a performance criterion for fire safety in large or tall buildings is accepted, materials and components will probably have to be judged on the basis of fuel contributed, in addition to stability under fire conditions, heat transfer, flame spread, and smoke and toxic contributions as well as performance criteria to satisfy structural and health hazards.

The determination of performance criteria for materials for buildings of different sizes would be a major step ahead in the regulation of heights and areas of buildings.

The key point highlighted in Ferguson's paper was the importance of the relationship between the size (height) of a building and associated hazard. He suggested the move toward a performance-based approach once the hazards and acceptable degree of risk are established, to which the current approach of regulating combustibility (or lack thereof) of a building was only one solution.

"Fire Protection of Buildings Under the National Building Code", Proceedings of the 1965 Building Officials Conference of Canada

April 7, 8 and 9, 1965

D.C. Beam

A paper prepared by Beam relative to fire protection of buildings under the National Building Code addressed various concepts including types of construction and combustibility [161]:

> It has been customary in building codes to combine an occupancy with a specification type of construction and then setting a limitation on the building size such as in the table of heights and areas in the 1953 National Building Code.

Beam noted the importance of the Code moving from primarily a specification document to performance-based. This had largely been through reference to performance standards such as the standard of fire-resistance rating. In addition he noted that [161]:

> Perhaps the most important innovation in the 1965 revision is the classifying of construction into two basic types only, combustible and noncombustible, either of which may have inherent fire resistance, or which may have fire protection added. As a result of this reclassification fire-resistive construction as a named type has disappeared.

Beam suggests that the new approach defines a minimum level of safety as a function of occupancy and building size. Each building element is required to meet this level of safety, eliminating the old system by which construction types are pitted against each other.

He further suggests that some of the difficulties in drafting the 1965 NBCC related to the use of combustible construction in buildings where it was considered to increase the risk associated with size by potentially contributing to a fire. This was addressed by reverting to the definition of noncombustibility by test for certain building sizes and permitting combustibles by specification only. Defining "noncombustible" significantly limits the amounts of combustible material in the structural members and assemblies of a noncombustible building and finishes on the inside of the building. Beam comments that combustible construction is considered to contain a "destructive element within it" [161], which adds to the fuel of a fire, whereas noncombustible construction does not burn and the "destructive element" [161] comes from without (i.e., contents).

To illustrate the benefits of the recommended system, Beam proposed a weighting scheme whereby points are added or deducted based on the use of certain elements considered to contribute to or protect from the fire risk. The following considerations are suggested by Beam in establishing the weighting system [161]:

Unprotected Combustible Construction

This type of construction is combustible and not considered to have any fire resistance. It is therefore not assumed to provide any positive characteristics relative to fire safety, and as a result is considered to have 2 minuses (-2).

Protected Combustible Construction

This type of construction is combustible and has some fire resistance usually based on provision of a protective membrane. However, it is considered to have an inherent weakness related to the potential for fire to initiate within a combustible concealed space. The fire resistance is considered to be a positive, whereas the potential contribution of the combustible content to a fire and concealed spaces are considered a minus (+1,-1). This type of construction is considered to have a modest degree of inherent safety over unprotected combustible construction.

Heavy Timber Construction

This type of construction is combustible and also has some degree of fire resistance based on its size. The fire resistance is considered to be a positive, whereas the potential contribution of the combustible

content to a fire is considered a minus (+1,-1). This type of construction is also considered to have a modest degree of inherent safety over unprotected combustible construction.

Unprotected Noncombustible Construction

This type of construction is not combustible but is not considered to have any fire resistance. The noncombustibility is considered to be a positive, and the lack of fire resistance a minus where fire loads are high (+1,-1). Where fire load is low, this type of construction is considered to have two positives based on the degree of inherent fire safety (+2).

Protected Noncombustible Construction

This type of construction is considered to have the most inherent fire safety as is practical to obtain and as a result is considered to have positives that increase as a function of the degree of protection (+2 to +5).

The values outlined above are summarized in the following table [162]:

TABLE 2: COMPARISON OF THE FIRE SAFETY CHARACTERISTICS OF CONSTRUCTION TYPES UNDER MAXIMUM FIRE CONDITIONS

GROUP	CONSTRUCTION SUB-TYPE	CHARACTERISTICS (Re Fuel Contribution and Stability)	POSITIVE OR NEGATIVE CHARACTERISTICS
I	Unprotected wood frame Post and beam Other combustible types	Fuel contributing Unstable	2 minus
II	Protected wood frame Heavy timber	Fuel contributing Stable (to ± ¾-hour)	1 minus 1 plus
	Unprotected steel Other noncombustible construction under ¾-hour	Non-fuel contributing Unstable	1 plus 1 minus
III	Protected steel Concrete Masonry Other fire-resisting noncombustible construction	Non-fuel contributing Stable (up to 3 hours)	2 plus to 5 plus *

* NOTE — 1 for non-fuel contribution and 1 for each ¾-hour fire endurance period.

Beam concluded the following in his paper [161]:

> Our ultimate aim is to be able to specify all performance requirements for each element of the building by referring only to:
>
> Combustible construction, with or without fire resistance, and as a separation if required.
>
> Noncombustible construction with or without fire resistance, and as a separation if required.
>
> With reference to noncombustible construction as illustrated in the last example we have reached that aim. With reference to combustible construction there is still one catch, "combustible" is a dirty word. Consequently the basic type cannot yet be referred to as "combustible construction" but perhaps the day will come.

Minutes of the Fortieth Meeting of the Associate Committee

March 31 and April 1, 1965

At the Fortieth Meeting of the Associate Committee, the 1965 Code was accepted by the Associate Committee and distribution was authorized on April 1, 1965 [163].

8.7 1970 NBCC

The changes to the height and area limits for the 1970 National Building Code (1970 NBCC) were limited to incorporation of provisions for covered malls and clarification of the area limits for the "boxes" to reduce the potential for erroneous interpolations.

The following sections of this report summarize the committee deliberations relative to the development of the height and area limitations in the 1970 NBCC.

Minutes of the First Meeting of the Standing Committee on Use and Occupancy

June 8, 9 and 10, 1966

The First Meeting of the Standing Committee on Use and Occupancy considered three issues related to height and area limits [164]:

- Addition of a new "box" specific to storage garages with height and area limits consistent with that of Article 3.2.3.56. for Group F, Division 3, and unlimited where sprinklered.
- Increase of areas by 25% for Article 3.2.3.54. (Group F, Division 1) where the building is used as an open-air parking garage.
- As well, they discussed the reduction of a separation with a 4-hour fire-resistance rating over a basement in Article 3.2.3.56. (Group F, Division 2 and 3) to a 3-hour fire-resistance rating. This was agreed to by the Committee.

Minutes of the Second Meeting of the Standing Committee on Use and Occupancy

October 13 and 14, 1966

The Second Meeting of the Standing Committee on Use and Occupancy considered two issues related to height and area limitations [165]:

- The trend in the Code permitting a greater degree of combustible material on the exterior of high buildings. It was suggested that this should be limited to six storeys, as in previous editions of the Code.
- The need for a review of the relationship of fire load to building components and contents since the publication of the fire load study by the National Bureau of Standards several decades earlier.

Minutes of the Second Meeting of the Subcommittee on Structural Fire Protection of the Standing Committee on Use and Occupancy

December 7, 8 and 9, 1966

During this meeting Ferguson noted that the Subcommittee on Structural Fire Protection should be considering a fire separation concept that would become a performance-type requirement in order to improve the situation and reduce specifications in the Code [166].

Minutes of the Third Meeting of the Subcommittee on Structural Fire Protection of the Standing Committee on Use and Occupancy

February 13, 14 and 15, 1967

The Third Meeting of the Subcommittee on Structural Fire Protection considered the following relative to height and area limits [167]:

- Updating of the definition of "firewall" and "heavy timber" for purposes of clarification and application. An exception to the provision of a firewall to extend above the roof surface was proposed and agreed to where the roof assembly has a fire-resistance rating at least half that of the fire wall.
- Updating spatial separation requirements to consider the construction and fire separation of exterior walls.
- Permitting combustible construction in a building required to be of noncombustible construction for residential apartment units that are no greater than 2 storeys in height and separated from the remainder of the building by a fire separation with a 2-hour fire-resistance rating.

"Report on the History of Building Regulations", Proceedings of the 1967 Building Officials Conference of Canada

R.S. Ferguson

May 1, 2 and 3, 1967

A paper prepared by Ferguson on the history of building regulations summarized how traditions shape the development of buildings regulations. His discussion identified several points relative to height and area limits in the Canadian Codes as they relate to combustibility and building density. Relative to combustibility, Ferguson noted the following [168]:

> Another example is the definition of non-combustible. Everybody knows (traditionally) what non-combustible means, but this general unwritten understanding does not solve the problems of modern technology. A written definition is necessary for modern technological building but such a definition in a traditional context is of little value, as was found out with the 1960 edition of the National Building Code. It is necessary to re-examine the concept of fire resistance in buildings, define both fire resistance and non-combustible as elemental concepts and then in the regulations build up combinations of these as required for purposes of control.

This discussion illustrates the desire for a transition from a specification-based to a performance-based Code and the considerations in that transition. Relative to building density, Ferguson noted the following [168]:

> The tradition encompassed the process of building, not the areas of no building. Thus from the trade point-of- view there was no consciousness of the value of space or the danger in its absense. During the history of building regulations controls providing for space or more often some construction as a substitute for its loss were always developed by civic authorities and not by the trade. A city exists because of buildings and these are the responsibility of the owner. The main responsibility of civic authority involves the spaces between the buildings. This includes sewer and water supply, roads, drainage, refuse disposal, health service and fire protection.

This discussion highlights the relationship between hazard and space in cities as a driving force in development of building regulations.

Minutes of the Fourth Meeting of the Subcommittee on Structural Fire Protection of the Standing Committee on Use and Occupancy

May 29, 30 and 31, 1967

The Fourth Meeting of the Subcommittee on Structural Fire Protection considered several items relative to height and area limitations including the "mall" concept, noncombustible construction and consistency of the structural requirements in the "boxes" [169]. The "mall" concept was proposed by R.V. Hebert, Codes Engineer, Canadian Sheet Steel Building Institute, who was the Chairman of the Subcommittee on Structural Fire Protection.

Mall Concept

The proposed Mall concept existed in the Metro Winnipeg Building By-law and addressed the condition by which two otherwise separate buildings are joined with some extent of protective cover/enclosure. The Mall area/enclosure was considered by the Winnipeg Metro Code as equivalent to an open space, and permitted to be used on the same basis (i.e., comparatively safe) with the provisions of sprinklers and other protective features.

It was suggested that the structural requirements could be maintained in accordance with the "boxes" in the Code for each individual connected building. However, it was suggested that this would be "deficient" without provision of adequate separation of the occupancies fronting onto the mall in conjunction with use of only noncombustible construction for the buildings and connecting mall construction, and sprinklering throughout.

Noncombustible

It was recommended that references to specific materials in the Code be eliminated and the Code refer to two basic types of construction being noncombustible and combustible. It was recognized that this was not possible in all respects, heavy timber being an example that had characteristics that were not adequately addressed through defining it as combustible.

It was suggested that permitting combustible elements in a building required to be noncombustible construction "detracted from the desire to encourage the noncombustible nature of the building" [169]. It was suggested that fire-retardant treated wood could be considered to perform similar to unprotected steel in partitions in residential occupancies. However, this was considered by others to be an increase in hazard for Group C occupancies where occupants could potentially be asleep.

"Boxes"

The following was recommended relative to the "boxes" [169]:

- Suggestion to revise the numbering system in the "boxes".
- The 1-hour fire resistance requirement in Article 3.2.3.26., Group C, Division 1 (residential), heavy timber construction, for loadbearing walls, columns and arches was suggested to be reduced to ¾-hour for consistency with the requirement for floor assemblies.
- The construction of roof assemblies was discussed relative to the use of heavy timber and unprotected steel. It was agreed that a specification for heavy timber was still warranted for roof assemblies. The Committee agreed that heavy timber construction has an inherent fire resistance of ¾-hour.

Minutes of the Third Meeting of the Standing Committee on Use and Occupancy

May 29 to 31, 1967

Relative to height and area limits, the Third Meeting of the Standing Committee on Use and Occupancy discussed open air parking garages and firewalls [170].

Open air parking garages were discussed, related to whether it would be appropriate to include provisions for this type of structure as a separate "box". It was noted that open air parking garages should be used only for parking and not servicing.

The following items were discussed relative to firewalls [170]:

- Firewalls were noted to be necessary where a major fire break is required and also when the building is constructed along the property line.
- The importance of the wall to remain in place following a fire when the building is located along a property line.
- Ferguson suggested removing the requirements for the traditional firewall and utilizing an appropriate fire separation instead as a means of dealing with construction complexities.
- Beam noted the importance of providing the fire-resistance of firewalls with noncombustible materials.
- It was noted that firewalls are important to life safety, but primarily contain the fire in an area that the fire department could handle and limit the potential for conflagration.

Minutes of the Forty-Fourth Meeting of the Associate Committee

March 5, 1968

The following changes, relative to height and area limits, were reviewed and approved in the Forty-Fourth Meeting of the Associate Committee [171]:

- Consolidation of some of the "boxes" in Articles 3.2.3.4. to 3.2.3.56., including some changes to structural fire protection requirements for certain heights and areas in some occupancies.
- Draft requirements prepared for the structural fire protection of shopping (covered) malls.

Minutes of the Fourth Meeting of the Standing Committee on Use and Occupancy

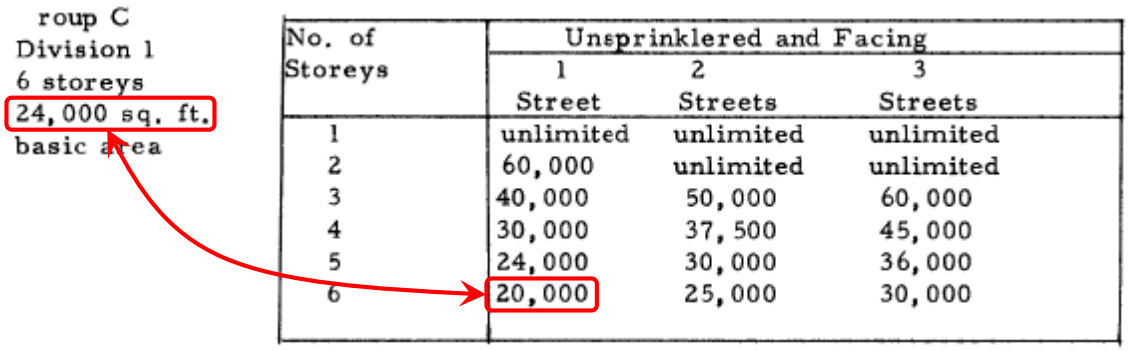
April 3 to 5, 1968

At the Fourth Meeting of the Standing Committee on Use and Occupancy [172], updates to the "boxes" were discussed and included simplification of the requirements and expansion of the area and height limits to reduce interpolation errors. The expansion resulted in intermediate heights and areas as a function of building height (i.e., "wedding cake approach"). This approach was noted as being similar to that of the Pittsburg Code.

In addition to the change noted above, a change was suggested relative to the provision in the Code permitting unprotected steel construction, which would otherwise require a ¾-hour fire-resistance rating if of combustible construction. This was questioned as not equal relative to fire endurance, and it was noted that the intent of the provision was to permit unprotected steel where structural stability of the building is not in danger.

As part of the proposed changes to the "boxes", an inconsistency was identified relative to Group C Buildings regulated by Sentence 3.2.3.21.(1). The inconsistency relates to the table of areas and the "basic

area" associated with the Group C buildings, not more than 6 storeys in height. The "basic area" is identified in the margin of the Code as 24,000 square feet, and this was the value in the 1960 Code. However, the corresponding value in the area table is 20,000 square feet[172]:



No. of Storeys	Unsprinklered and Facing		
	1 Street	2 Streets	3 Streets
1	unlimited	unlimited	unlimited
2	60,000	unlimited	unlimited
3	40,000	50,000	60,000
4	30,000	37,500	45,000
5	24,000	30,000	36,000
6	20,000	25,000	30,000

Other "boxes" were checked for consistency and all had corresponding values. There were no notes associated with this change having occurred or rationale for the change. The value of 20,000 square feet eventually became the default for this classification in later versions of the Code.

Minutes of the Forty-Fifth Meeting of the Associate Committee

December 4, 1968

The following changes, relative to height and area limits, were reviewed and approved at the Forty-Fifth Meeting of the Associate Committee [173]:

- New provisions for walkways and covered walkways.
- Reference to only two types of construction: combustible and noncombustible.
- Expansion of the "boxes" to include intermediate values for lesser heights. This change resulted in fewer "boxes" through reduction of inconsistencies and overlap. The change was primarily intended to eliminate the incorrect interpolation that was previously occurring.

Minutes of the Forty-Seventh Meeting of the Associate Committee

July 29, 1970

A news release included as part of the minutes of the Forty-Seventh Meeting of the Associate Committee noted that the 1970 edition of the National Building Code of Canada was issued on July 29, 1970 [174].

8.8 1975 NBCC

The changes to the height and area limits for the 1975 National Building Code (1975 NBCC) were limited to minor revisions for purpose of clarity. The following sections of this report summarize the committee deliberations relative to these revisions.

Minutes of the Second Meeting of the Special Task Group Appointed by the Associate Committee on The National Building Code (Reviewing Comments on Explanatory Paper on Control of Smoke Movement in High Buildings)

February 25 and 26, 1971

Minutes of the Second Meeting of the Special Task Group Appointed by the Associate Committee to review comments on an explanatory paper on control of smoke movement in high buildings examined comments of the Urban Development Institute concerning the legal implications of providing installations

for controlling smoke movement and occupants in buildings. Comments on the legal implications suggested that [175]:

> We understand that Fire Departments generally regard the preservation of the structural integrity of buildings and the control and prevention of the spread of fire within structures and from building to building to be their prime and sole responsibilities. They do not consider it their responsibility to ensure safe evacuation under fire conditions.

Minutes of the Ninth Meeting of the Standing Committee on Use and Occupancy

April 15, 1971

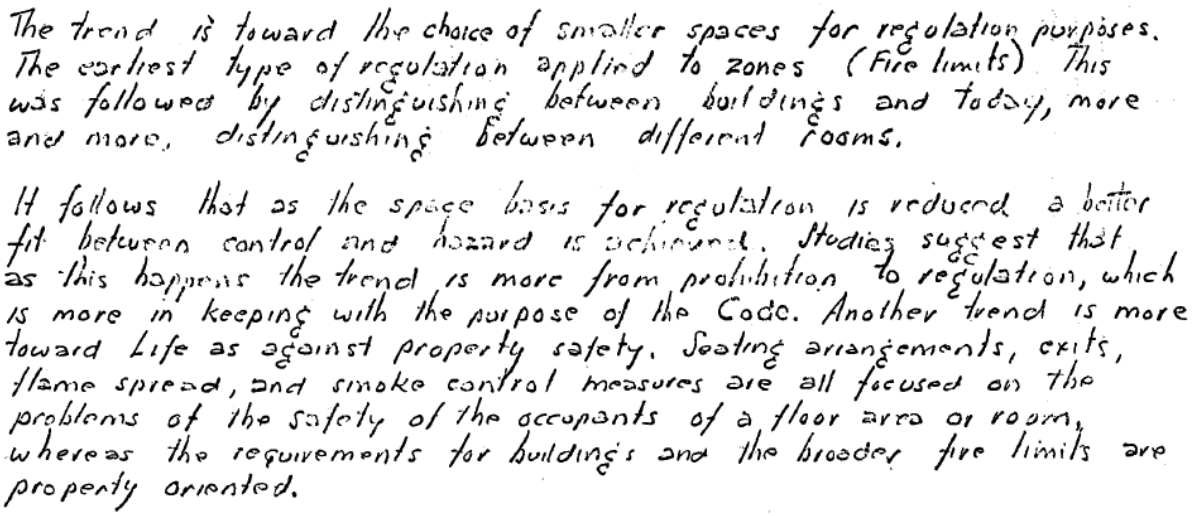
Ferguson presented a preliminary document at the Ninth Meeting of the Standing Committee on Use and Egress intended to become Supplement No. 3 to the Code, and was an early version of the Guide to Part 3 of the NBCC. The version was hand written and titled "Part 3 Statements of Intent of Individual Clauses & Explanations of Regulations"[176]. Ferguson noted that Part 3 was intended to be "an integral component of a performance code", but became "a grouping of fire and health regulations". The intent of the regulations relative to fire protection and spaces was noted as follows [176]:

> The problems of fire protection in buildings are always related to spaces. The three principle measures of control are:
> 1. evacuating the occupants from the space
> 2. confining the fire to the evacuated space
> 3. extinguishing the fire in the space.

As previously discussed in this report, the concept of a building as a fire compartment for means of control dates back thousands of years. As early as the late 1700's, building size was limited to an area that fire departments could handle. Ferguson discussed the concept of "building" as follows [176]:

> It is necessary to define the space for purposes of control. Historically the "building" has been chosen as the space to which control measures have been applied but in recent years the size and configuration of buildings and multiple building use has lessened the usefulness of "building" for this purpose. This continuing trend can best be explained historically.
>
> A trend, which will probably strengthen, is the integration of all the design criteria that affect space size including the criteria of fire safety. Thus, instead of limiting compartment size to a traditional building size (50,000 cu.ft.) size may be determined by space use and the hazards involved. If a large space is necessary because of "use" and if the hazard increases with size then appropriately different fire protection measures would be part of the design criteria.

Ferguson suggested that the trend was moving away from the "building" as the means of control towards smaller spaces, and the benefit from the perspective of controlling hazard as noted below [176]:


The trend is toward the choice of smaller spaces for regulation purposes. The earliest type of regulation applied to zones (Fire limits) This was followed by distinguishing between buildings and today, more and more, distinguishing between different rooms.

It follows that as the space basis for regulation is reduced a better fit between control and hazard is achieved. Studies suggest that as this happens the trend is more from prohibition to regulation, which is more in keeping with the purpose of the Code. Another trend is more toward Life as against property safety. Seating arrangements, exits, flame spread, and smoke control measures are all focused on the problems of the safety of the occupants of a floor area or room, whereas the requirements for buildings and the broader fire limits are property oriented.

Minutes of the First Meeting of the Fire Protection Subcommittee of the Standing Committee on Use and Occupancy

June 2 and 3, 1971

The First Meeting of the Fire Protection Subcommittee addressed a question regarding the 30-foot minimum dimension of a (covered) mall [177]. It was noted that if the minimum dimension was less than 30 feet, the structure would be considered one single building. This matter was referred to the Subcommittee on the Fundamentals of Occupancy for further consideration and clarity.

Minutes of the Second Meeting of the Fire Protection Subcommittee of the Standing Committee on Use and Occupancy

July 22 and 23, 1971

The following changes were proposed and agreed to during the Second Meeting of the Fire Protection Subcommittee [178]:

- Group A, Division 3 (Article 3.2.2.20.): Delete the words "not exceeding two storeys in building height" to permit multiple-storey A3 buildings to be built with combustible roof assemblies provided the 20 ft. criteria is made. A task group to consider further requirements for roof construction was formed.
- Group B, Division 2 (Article 3.2.2.25.): Delete Clause 3.2.2.25.(2)(c), which related to a 1-hr fire-resistance rating for floor assemblies over crawl spaces.
- Group C (Article 3.2.2.27.): delete "but not less than 1 hour".
- Group D, E, F, Division 2 (Article 3.2.2.29., 3.2.2.33., 3.2.2.41.): Add "this requirement is waived for crawl space if the building is of non-combustible construction" to Clause 2(a).
- Group D (Article 3.2.2.32.): Add "except that in buildings of one storey in building height this requirement is waived, and" to Clause 3.2.2.32.(2)(f).
- Group F, Division 3 (Article 3.2.2.46.): Add "if all combustible construction" after the word "have" in the first line of Clause 3.2.2.46.(2)(c). The occupancy was one of low hazard storage and was

the smallest building size dealt with and also that it was not always valid to compare unprotected non-combustible with protected combustible.

Several references were made during the discussion to the potential formation of a Task Group on Heights and Areas.

Minutes of the Tenth Meeting of the Standing Committee on Use and Occupancy

October 13 – 15, 1971

Mr. Baird, Chairman of the Fire Protection Subcommittee presented his Committee's report [179]:

> He noted in particular that the Subcommittee was concerned that more consideration had to be given to establishing a more satisfactory system of relating construction requirements pertaining to heights and areas to building use.
>
> Mr. Ferguson said that the present requirements were arbitrary answers to problems that were not completely identified and which required further consideration.

The Fire Protection Subcommittee recommended the formation of two task groups: one dealing with structural requirements based on heights and areas, and the other dealing with fire performance requirements for roof assemblies [179]:

> 1. Recommend formation of two task groups to work on problems concerning the following matters:
>
> (a) Structural requirements based on heights and areas
> Terms of Reference - to consider and prepare changes respecting Articles 3.2.2.9. to 3.2.2.52. and that the work be completed by September 1972. Membership suggested is Messrs. Brundige, Collins, Hebert, Pearce and Thomson.
>
> (b) Fire performance requirements for roof assemblies
> Terms of Reference - to examine the present situation for regulating the construction of roof assemblies and recommend means of regulating such matters as fire resistance above and below a roof deck including consideration of temperature limits; flame spread for components making up roof assembly; control of combustible materials including BUR and plastics; potential heat of materials used in roof deck.

Minutes of the First Meeting of the Review Committee on Part 3

October 5 and 6, 1972

The First Meeting of the Review Committee on Part 3 identified the following issues relative to considerations for the future in approaches to addressing changes to the Code [180]:

- It was suggested to provide a definition of the problem and develop specific terms of reference for task groups to address the problem. This would limit the re-hashing of items such as the height and area requirements.
- Large tasks such as heights and areas were identified as a problem requiring further study.

In addition to the considerations above, the Review Committee considered the following specific issues related to height and area limits within the Code [180]:

- A task group was formed to address structural requirements for heights and areas and roof assemblies.
- Division of Building Research (DBR) staff also identified a need to address the criteria for noncombustibility in structures on a short- and long-term basis. It was agreed that the DBR staff would prepare a paper listing all the combustible items permitted in noncombustible construction.
- Consideration for sprinklering of all buildings six storeys or more in height. It was agreed that DBR staff would prepare a paper outlining the issue.
- Group C, up to 6 storeys (Article 3.2.2.27.): Deleted additional requirement of fire-resistance rating not less than 1 hour for loadbearing walls/columns/arches, keeps only requirement for equivalent to supported assembly.
- Group D, Any height any area (Article 3.2.2.32.): Permitted waiving the 1-hour roof assembly rating for 1-storey buildings.
- Group F, Division 3 - Storage garages up to 6 storeys (Article 3.2.2.50.): Replaced maximum unsprinklered area table with general maximum value of 100,000 sq. ft. Added requirements of: “(b) not more than 70 feet above grade”, and “(e) designed so that every portion of each floor area is within 200 ft of an exterior wall opening”.

Minutes of the Fifth Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy

May 22 and 23, 1973

Minutes of the Fifth Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy reviewed a paper submitted by H.D. Collins, Director, Building Inspection Branch, City Planning Department, Edmonton, Alberta regarding “Fire Protection Requirements for High-Rise Buildings." The paper suggested the following [181]:

Definition of a High-Rise Building:

Various definitions have been offered by building and fire officials throughout the country. The criteria that have been used include the following:

1. Any building of such a height as to be beyond the reach of Fire Department equipment operated from the ground.
2. Any building of such a height as to pose an unreasonable evacuation time.
3. Any building in which stack effect is a significant factor.
4. Any building in which fire must be fought internally because of height.

If these criteria are given due weight, any building having an occupied floor 60' or more above grade must certainly be considered a high-rise building.

In reviewing this paper, the Committee noted that all of these comments had been considered in the development of the high building requirements.

Minutes of the Task Group Meeting on Heights and Areas and on Flame Spread on the Underside of Roof Decks

November 5, 1973

The meeting of the Task Group on Heights and Areas and on Flame Spread on the Underside of Roof Decks, held on November 5, 1973, was discussed at the Fourteenth Meeting of the Standing Committee on Use and Occupancy. The following "major decisions" were made by this Task Group relative to heights and areas [182]:

1. All major recommendations and overhauling of the existing heights and areas to be completed for 1980 code. Any minor alterations should be recommended for inclusion as 1975 or 1977 code revisions if possible.

2. Factory Mutual should be written for current information on the high roof question, the sprinklering of such areas and the fire loading aspects. This information would be of interest when evaluating storage occupancies in particular.

3. Group A, Division 1. It was tentatively agreed that the areas permitted for one storey buildings with H.T. or N.C. (U) roofs should be those recommended in the 1965 code i.e. 10,000 sq. ft. and 20,000 sq. ft. sprinklered. The question of use of sprinklers for this type of occupancy should be reassessed.

In addition, the following outlines the "major points of discussion" from the meeting [182]:

- Criteria for assessing a roof:
  - Fire resistance,
  - Spread of flame on the underside,
  - Utilization of a high roof, and
  - The size of the building (i.e., for 1 storey).
- Relationship between fire-resistance rating of the floor and the fire-resistance rating of the roof and how single-storey buildings are addressed.
- Potential progressive collapse (floor to floor) in high rise buildings resulting in wall collapse and debris on the street.

Minutes of the Thirteenth Meeting of the Standing Committee on Use and Occupancy

November 14 and 15, 1973

Minutes of the Thirteenth Meeting of the Standing Committee on Use and Occupancy reviewed and accepted a change relative to sprinklering every floor area in a high building exceeding 10,000 square feet. The reasoning, as noted below, was that fire in large open areas in high buildings is difficult to fight [183]:

Provision of sprinklers

3.2.6.6.(1) The following spaces shall be *sprinklered*:
- (a) every *storey*, or part thereof, intended for a Group E or Group F, Division 1 or Division 2 *occupancy*,
- (b) every *restaurant* or licensed beverage establishment, and
- (c) every *storey* or part thereof intended for the storage or handling of hazardous substances. (See Article 3.3.1.1.)

(Sprinklering of below grade storey is covered in Article 3.2.2.8)

PROPOSED CHANGE

In Clause (b), delete "and". In Clause (c), add the word "and" at the end of the clause. Add new Clause (d) as follows:

"(d) every floor area exceeding 10,000 sq ft except when the floor area is divided into fire compartments not exceeding 10,000 sq ft in area and separated from the remainder of the floor area by fire separations having at least a 1 hr fire resistance rating."

REASON

Fires in large open floor areas is considered difficult to fight in high buildings. It is considered necessary to have sprinkler assistance when the area exceeds 10,000 sq ft.

Minutes of the Task Group Meeting on Heights and Areas and on Flame Spread on the Underside of Roof Decks

April 16, 1974

The meeting of the Task Group was held on April 16, 1974 and recommended the following [182]:

3.2.2.1.(3) In buildings not exceeding 1 storey in building height of Group F, Division 2 or 3 major occupancy, the building area may be increased by 25% when automatic roof vents and curtain boards are installed in accordance with the requirements of NFPA 204-1968 "Guide for Smoke and Heat Venting" and, in addition, when the building is sprinklered, the building area permitted for a sprinklered building may be increased by 50%.

(4) In buildings not exceeding 1 storey in building height of Group F, Division 2 or 3 major occupancy, where a floor area or part thereof is undivided by fire separations and exceeds 120,000 sq. ft., automatic roof vents and curtain boards shall be installed in accordance with the requirements of NFPA 204-1968 "Guide for Smoke and Heat Venting", except that this requirement need not apply to buildings constructed under Articles 3.2.2.49. and 3.2.2.40."

Minutes of the Fourteenth Meeting of the Standing Committee on Use and Occupancy

May 30 and 31, 1974

The changes proposed by the Task Group on Heights and Areas and on Flame Spread on the Underside of Roof Decks (as described above) were discussed and all were defeated based on concerns of some of the Standing Committee members. Only the concerns of Mr. Stanley Cumming, Manager, Canadian Codes and Standards of the Portland Cement Association were expressed explicitly [182]:

Tolerable Hazards Due to Combustibility of Structure

With respect to the tolerable limits of fire hazards inherent in building construction, fire safety regulations are a compromise within the bounds of economic feasibility. Thus combustibility of construction can be tolerated in certain buildings if the overall size of the building is limited to such that the Fire Department can effectively contain and/or control fires.

Combustibility of construction also can be tolerated in medium sized, relatively low buildings, provided that a modest degree of fire resistance is introduced to partially offset combustibility and thus provide a greater opportunity for firemen to take over before the fire gets out of hand.

In noncombustible construction, for example unprotected structural steel, there is no combustibility of structure hence in the medium sized building there is no necessity to add a factor to facilitate control by firemen because of increased fire load. This is the reason why non-combustible construction is generally treated in the same intermediate hazard group as combustible construction with approximately 3/4-hour fire resistance.

It appears to be philosophically unsound to propose to equate fire-retardant treated wood with unprotected non-combustible construction. The fact that the 1970 Code included provisions for FRTW in a clause written originally to provide, not a flame spread restriction, but "a modest degree of fire resistance designed to partially offset combustibility", is unfortunate. However, presumably because of this, only half areas were permitted in this form of construction. The proposed amendments, which would entirely remove the 1970 area restrictions, and many of the height restrictions from the boxes in question, thus making no allowance for the fact that FRTW is combustible and will contribute fuel to a fire, do not appear to be sound and therefore are not worthy of support.

Following the defeat of the proposed changes, the following was noted [182]:

Under new business H. Locke raised the question of the Task Group report which made recommendations relative to fire retardant treated wood. (Secretary's Note: inserted at this point in the minutes for continuity of subject matter.) He felt that if a task group is appointed to look into a problem it is wrong for a senior committee to summarily reject its recommendations, without considering what the Task Group is trying to achieve, and that some consideration be given to working out an interim compromise and salvage the acceptable parts. Mr. Cumming did not agree, pointing out that the Task Group had made their recommendations and these were rejected by the senior committee.

However, changes to Articles 3.2.2.14., .18., .30., .34., .42., and .47., including the addition of "or a fire-retardant treated wood roof assembly" to the structural requirements were considered. The use of fire-retardant-treated wood was intended to limit fire spread on the underside of a roof assembly, and slow the destruction of a roof in a fire.

8.9 1977 NBCC

The changes to the height and area limits in the 1977 National Building Code (1977 NBCC) were limited to minor revisions as noted below.

- 'Balconies' removed from the requirement for a fire-resistance rating (3/4 hr or 1 hr) of mezzanines/balconies.
- Removed previous exception waiving roof rating requirement for Group A buildings in areas where the roof is 20 ft or more above the main floor and carries no loads other than roof loads.
- Added an exception waiving roof rating for Group A or other 1-storey buildings based on if electrically supervised/monitored sprinklers are present and required roof rating is 1 hour or less (3.2.5.5).
- Where basements/crawlspaces are required to be sprinklered (or where sprinklers are permitted to be omitted in crawl spaces based on a different specified floor assembly rating above the crawl space), the general floor assembly requirement for (¾ hr, 2 hr, 3 hr, etc.) fire separation was waived above the crawlspace.
- Group A, Division 1, 1 Storey (Article 3.2.2.9.): Added "except for floors above crawl spaces", to "¾ hour fire separation for floor assemblies".
- Group A, Division 2, up to 5 storeys, any area (Article 3.2.2.15.): Added exception to allow heavy timber roof and columns for 1 storey building less than 64,000 sq. ft (sprinklered), or 32,000 sq. ft (unsprinklered), in lieu of 1 hr roof rating and column rating.
- Group A, Division 3, 1 and 2 storeys (Article 3.2.2.19.): Added exception to allow heavy timber construction for roof assembly in lieu of ¾ hour rating.
- Group D, 1 and 2 storeys (Article 3.2.2.29.): Added requirement for floor assemblies (other than above basements or cellars) to be fire separations, and have ¾-hour rating if of combustible construction.
- Group E, up to 6 storeys, sprinklered (Article 3.2.2.35.): 'Sprinklered' added to title, removed clause allowing building to be unsprinklered if not more than 3 storeys and under 15,000 sq. ft.

A significant change that occurred during the development of the 1977 NBCC was the conversion from imperial to metric units.

In addition to the changes noted above, additional changes were made as noted in the following sections of this report.

Minutes of the Second Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy in Preparation for the 1977 Code

February 5 and 6, 1975

During the Second Meeting of the Coordinating Committee it was recommended that the Task Group on Structural Requirements for Heights and Areas of Roof Assemblies (formerly known as the Task Group on Heights and Areas and on Flame Spread on the Underside of Roof Decks) be reactivated to review previous decisions [184]. It was noted that the previous proposals were not accepted, and suggested that the Task Group not be reactivated. However, it was agreed that the rejected proposals would be reviewed by the Coordinating Committee.

A letter from G. Adams, Director for Uniform Building Standards for the Province of Ontario proposed limits to basement areas for assembly buildings up to 5,000 square feet, or mandatory sprinklering. The reason for the proposed change related to the risks in fighting basement fires and associates the risks with area [184]:

> 1. Basement and cellar construction in Assembly occupancies (Articles 3.2.2.14. to 3.2.2.20.)
>
> These changes include limiting basement areas to 5000 sq ft before sprinklers are required and making sprinklers mandatory in all cellars.
>
> The reasons for these changes are that basements and cellars are too large at 10,000 sq ft for efficient fire fighting methods. It is common to have many combustibles in these areas in Assembly occupancies. Visibility is poor for firemen during a fire because of poor venting conditions. The integrity of fire separations is not always maintained in these areas. The majority of fire fighter casualties have occurred in basements and cellars.

The Committee considered the proposed change and recommended that it be incorporated into the NBCC relative to basements and cellars [184]:

> The Committee agreed that basements exceeding 5000 square feet should be sprinklered or be separated into fire compartments not exceeding 5000 square feet. It was noted that the Code required this in most instances but in certain occupancies larger areas were permitted and these larger areas were considered to be excessive. The suggestion that all cellars be sprinklered was considered too stringent. This suggestion was rejected.

After considerable discussion, it was agreed that the Articles in Subsection 3.2.2. should be revised to require that all basements and cellars be subdivided into areas not exceeding 5000 square feet or be sprinklered.

At this point, no specific rationale was provided in choosing 5,000 square feet as the limit. However, later Committee discussions provided some rationale for this value.

Minutes of the Fourth Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy in Preparation for the 1977 Code

May 1 and 2, 1975

The Minutes of the Fourth Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy for the Preparation of the 1977 Code proposed and accepted changes to the area limits, requiring sprinklers where basements exceeded 5,000 square feet in area. The reasoning was that open floor areas greater than 5,000 square feet were considered too large for effective firefighting, and area greater than this was considered to be beyond the capability of most fire departments. Additional changes were proposed and accepted for other occupancies. These changes were made to the basements of all occupancies. The following is an example for a Group A, Division 1 occupancy [185]:

EXISTING REQUIREMENT

Group A, Division 1,
Any Height, Any Area

3.2.2.11.(1) A *building* classified as Group A, Division 1 shall conform to Sentence (2) provided the *building*

(a) is not limited in *building height*, and
(b) is not limited in *building area*.

(2) The *building* shall be of *noncombustible construction*, and

(a) basements and cellars shall be subdivided by a 2-hr *fire separation* into areas not exceeding 10,000 sq ft (930 m²), or they shall be *sprinklered*,
(b) floor assemblies immediately above basements or cellars shall be a 2-hr *fire separation*,
(c) floor assemblies immediately above crawl spaces shall have a 1-hr *fire-resistance rating*, except that this requirement is waived if the crawl space is subdivided by a 1-hr *fire separation* into areas not exceeding 10,000 sq ft (930 m²), or they are *sprinklered* (see Article 3.2.2.3.),
(d) other floor assemblies shall be a 2-hr *fire separation*,
(e) balconies and *mezzanines* shall have a 1-hr *fire-resistance rating*,
(f) except as provided in Clause (g), roof assemblies shall have a 1-hr *fire-resistance rating*, but this requirement is waived where every part of a roof assembly is 20 ft (6.1 m) or more above the main floor or balcony and carries no loads other than normal roof loads, including access walks and ventilating, sound and similar equipment,
(g) the restriction in Clause (f) concerning minimum distance shall not apply to
  (i) an inclined and stepped floor ascending from the main floor, and which is used for seating purposes only,
  (ii) a balcony used for seating purposes only, or
  (iii) a *walkway* used only as a *means of egress*, and
(h) all *loadbearing* walls, columns and arches shall have a *fire-resistance rating* at least equivalent to that required for the supported assembly but in no case should there be a *fire-resistance rating* of less than 1 hr.

PROPOSED CHANGE

In the second line of Clause (2)(a), and the third line of Clause (2)(c), change "10,000 sq ft (930m^2)" to read "5,000 sq ft (465m^2)".

REASON

Open areas greater than 5,000 sq ft are considered too large for effective fire fighting.

Committee Action:
Mr. Richardson reported that Mr. J.T. O'Hagan, Fire Commissioner, City of New York, had stated that fires in uncompartmented areas larger than 5000 square feet are beyond the capabilities of most fire departments. He also stated that the City of New York requirements for uncompartmented areas are 7500 square feet.

Minutes of the Seventh Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy in Preparation for the 1977 Code

October 8 and 9, 1975

The Coordinating Committee reviewed a memorandum from Mr. J.F. Berndt, Codes and Standards Group, suggesting some relaxation in the requirements for firewalls based on an interpretation of the NBCC prepared by the Codes and Standards Group of NRC. The interpretation related to a firewall between a 12-storey office tower and a two-storey office complex with a common garage beneath them. It was proposed by the designer that the floor slab between the common garage and 12- and two-storey buildings be considered a "horizontal" firewall. This was not accepted by the local authority. The interpretation by the Codes and Standards Group was [186]:

> that the real purpose of the firewall in this case was to limit the movement of smoke from the two storey building, through the garage, into the office tower.
>
> Although the floor slab cannot be considered as a "firewall" as defined in the NBC, it could provide the necessary structural stability of a firewall and would appear to serve the purpose of limiting the movement of smoke. This, of course, is assuming adequate fire-stopping, vestibules and smoke tight assemblies are used.
>
> Since it is highly unlikely that fire could spread from one area to the other, and if adequate air locks were provided I feel that there should be some relaxation or exemption in the Code for this situation.
>
> This same relaxation could also apply to a townhouse development with the units built on top of a common garage. With proper vertical firewalls separating the units and a reinforced concrete floor slab providing a smoke tight fire separation I feel that this situation should be acceptable.

Minutes of the Ninth Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy for the Preparation of the 1977 Code

January 20 and 21, 1976

Proposed changes to Part 3 of the Code were reviewed at the Ninth Meeting of the Coordinating Committee of the Standing Committee on Use and Occupancy for the Preparation of the 1977 Code [187]. One of the proposed changes was relative to consideration of a subgrade storage garage being considered as a separate building. The proposed requirement was as follows [187]:

PROPOSED CHANGE

Add new Article 3.2.1.3. as follows:

"3.2.1.3.(1) Where a storage garage is located below grade and is connected to 2 or more spatially separated portions of the same building extending above grade, each such portion above grade may be considered as a separate building provided

(a) the building does not exceed 3 storeys in building height, and

(b) the storage garage is separated from the above-grade portions by a noncombustible fire separation having a fire resistance rating of not less than 2 hr."

REASON

To permit portions of above-grade buildings connected by underground storage garages to be constructed to lesser structural fire protection requirements.

STAFF NOTE:

The Part 9 Committees are presently studying the problem described above and it is recommended that the Part 3 Committees wait until such requirements are written for Part 9 and study them for possible reference in Part 3.

This proposed change followed from the previous meeting where the interpretation by the Codes and Standards Group was reviewed relative to firewalls and storage garage separation.

Minutes of the Eighteenth Meeting of the Standing Committee on Use and Occupancy

April 20 and 21, 1977

The Minutes of the Eighteenth Meeting of the Standing Committee on Use and Occupancy outline a discussion relative to reconsidering the reduction from the previous Code cycle and firefighting capabilities [188]:

> (7) Sentence 3.2.2.11.(2) - Reduction of Open Areas from 10,000 to 5,000 sq. ft.
>
> Mr. McConnell objects to the reduction of 10,000 sq. ft to 5, 000 sq ft. as he is of the opinion that fire fighting techniques have improved and he does not think that 10,000 sq. ft. is too large for effective fire fighting.
>
> It appears that the main concern is whether the 5,000 sq ft. area is too small. It was pointed out that the New York Fire Department considered 6,000 sq ft. was the largest area they could justify for effective fire fighting. After considerable discussion it was agreed that no action be taken as the 5,000 sq ft. appears adequate.

The reference to 6,000 square feet as the largest area the New York Fire Department could justify for effective firefighting was used to support not reconsidering this change, and leaving the limit at 5,000 square feet.

The 5,000 square foot limit was further discussed relative to crawl spaces in Part 9 buildings in a letter from R.H. Dunn, Secretary of the ACNBC to Mr. A.J.M. Aikman as follows [189]:

> The 5,000 sq. ft. compartmentation requirement for crawl spaces in basements in Part 3 was an arbitrary decision based on the information that was available. The Part 9 Committees did not consider an extension to 6,000 sq. ft. as greatly affecting the fire safety of the building. The separation of basements and crawl spaces into smaller areas is reuuired to enable firefighters to contain a fire more easily since firefighting from outside the building is limited, if not impossible in some situations.

Minutes of the Fifty-Ninth Meeting of the Associate Committee on the National Building Code

May 3 and 4, 1977

The Fifty-Ninth Meeting of the Associate Committee referenced the metric conversion of the areas in Subsection 3.2.2. of the Code [190]:

> In converting the requirements for heights and areas of buildings, for example, one square metre was assumed to be equivalent to ten square feet. This greatly simplified the conversion of the many Tables of heights and areas in the Code and is considered sufficiently accurate for its purpose.

8.10 1980 NBCC

The changes to the height and area limits in the 1980 National Building Code (1980 NBCC) were limited to minor revisions as noted below:

- Area requirements listed in tables/text in rounded metric (small increase from previous maximum areas due to conversion – new metric area values were 1/10 of previous imperial area

values whereas conversion factor was 1/10.76. This is the same conversion as in the Metric Values table for the 1977 NBCC).

- "or be a combination thereof" deleted from the general statement in most Subsection 3.2.2. Articles that "All loadbearing walls, columns and arches supporting an assembly required to have a fire-resistance rating shall have a fire resistance rating of [value]/be of heavy timber construction or shall be of noncombustible construction or be a combination thereof". This change was editorial to clarify intent.
- Group E, up to 6 storeys (Article 3.2.2.35.): 'Sprinklered', which was added to title in the 1977 NBCC, was removed. Added a clause allowing buildings to be unsprinklered if not more than 3 storeys and not more than 1,500 sq. metres in size (reversing changes in 1977 NBCC).
- Group F, Division 3, Storage garages up to 22 m in Height (Article 3.2.2.50.): Added "between grade and the ceiling level of the top storey" to the requirement of not more than 22 m in height.

In addition to the changes noted above, additional changes were made as noted in the following section of this report.

Minutes of the Fifth Meeting of the Revision Subcommittee of the Standing Committee on Use and Occupancy

November 28 and 29, 1977

The Fifth Meeting of the Revision Subcommittee considered spatially separated buildings above a connected storage garage as separate buildings to be incorporated into the firewall requirements as shown below [191]:

EXISTING REQUIREMENT

3.1.8.1. (6) Every *firewall* shall extend from the ground continuously through all *storeys* of a *building* or *buildings* so separated.

PROPOSED CHANGE

Add at the end:

"except that where a firewall is located above a basement containing only a storage garage separated from the remainder of the building by a noncombustible fire separation having a fire-resistance rating of at least 2 hr., the firewall may terminate at the floor assembly immediately above the storage garage."

REASON

To extend the principle in Article 3.2.1.3. to case where firewalls separate portions of buildings. In effect, the 2 hr. assembly above a parking garage is treated as a "horizontal firewall".

COMMITTEE ACTION

Accepted.

As noted in the reason for the change listed above, the 2-hour rated assembly above the parking garage was considered as a "horizontal firewall". This proposed change followed a change to the 1977 NBCC permitting a storage garage to be considered a separate building outlined in **Section 8.9** of this report.

Minutes of the Twentieth Meeting of the Standing Committee on Use and Occupancy
November 22 to 24, 1978

The change to the firewall requirements noted above were revised and approved during the Twentieth Meeting of the Standing Committee on Use and Occupancy [192]:

EXISTING REQUIREMENT

3.1.8.1. (6) Every *firewall* shall extend from the ground continuously through all *storeys* of a *building* or *buildings* so separated.

PROPOSED CHANGE

Add at the end:

"except that where a firewall is located above a basement containing no occupancy other than ~~only~~ a storage garage that is separated from the remainder of the building by a ~~noncombustible~~ fire separation of reinforced concrete having a fire-resistance rating of at least 2 hr., the firewall may terminate at the floor assembly immediately above the storage garage."

REASON

To extend the principle in Article 3.2.1.3. to the case where firewalls separate portions of buildings. In effect, the 2 hr. assembly above a parking garage is treated as a "horizontal firewall".

STAFF NOTE: This change was approved by this Committee at the last meeting. See attached change proposed by the Part 9 Committee amending this revision (Appendix C-51)

Committee Action

Accepted as amended above

A similar change made to Part 9, was also reviewed during this meeting [192]:

EXISTING REQUIREMENT

NONE

PROPOSED CHANGE

Add new Article 9.10.11.9. as follows and renumber the remaining Articles.

"9.10.11.9. Firewalls located above a basement containing only a storage garage that is separated from the remainder of the building by a fire separation of ~~noncombustible construction~~ reinforced concrete having a fire-resistance rating of at least 2 hr may terminate at the floor assembly immediately above the storage garage."

REASON

A 2 hr assembly above a parking garage performs adequately as a "horizontal firewall".

Conforms to proposed changes to Sentence 3.1.8.1.(6).

Minutes of the Twenty-First Meeting of the Standing Committee on Use and Occupancy

May 7 and 8, 1979

A proposal reviewed in the Twenty-First Meeting of the Standing Committee on Use and Occupancy, related to changes to the definition of grade and implicated location of the first storey and limits on building height, noted limited understanding of the rationale for establishment of those limits [193]:

The Committee noted there had been sufficient adverse comment on the existing definition to warrant the proposed change. The revision was intended to prevent known abuses of the present loophole in the existing requirement in the 1977 Code. The building height of the majority of buildings will not be affected by the proposed change. By way of background information it was noted that it has been the convention of the Code for years to establish limits of heights and areas but the rationale for establishing these limits has never been defined. It was therefore AGREED that no action be taken.

8.11 1985 NBCC

The changes to the height and area limits in the 1985 National Building Code (1985 NBCC) were limited to the revisions as noted below.

- Floor assemblies over basements (Article 3.2.1.4.): Added general requirement, "Floor assembly above a basement must be constructed as a fire separation having a fire-resistance rating conforming to floor assembly requirements of 3.2.2.9 to 3.2.2.53, but not less than ¾ hour". (Specific basement floor assembly requirements were listed in 3.2.2.9 to 3.2.2.53).
- Added general requirement for loadbearing walls/columns to have rating at least equivalent to assembly they support (requirement was previously listed in each 3.2.2.9 to 3.2.2.53 classification group)
- Crawl spaces as basements (Article 3.2.2.3.): Floor assemblies over crawl spaces not required to be constructed as fire separation and not required to have fire-resistance rating if it is not considered a basement in conformance with Article 3.2.2.3.
- Roof Occupancy (Article 3.2.2.6): Added requirement for portion of roof supporting a roof-occupancy to be in conformance for fire separation requirements for floor assemblies.
- Heavy timber roofs permitted (Article 3.2.2.8.): Added a provision permitting roof assemblies in buildings up to 2 storeys to be heavy timber regardless of building area provided the system is sprinklered/monitored.
- Group B, Division 2, up to 3 storeys, sprinklered, noncombustible construction (Article 3.2.2.25.): New Article added, did not exist in the 1980 NBCC.
- Group F, Division 3, any height any area (Article 3.2.2.53.): Added an exception permitting 2-hour floor assembly to be reduce to 1-hour in open-storey storage garage.

In addition to the changes noted above, additional changes were made as noted in the following sections of this report.

Minutes of the First Meeting of the Task Group on Covered Malls and Public Concourses of the Standing Committee on Use and Occupancy

January 30, 1980

The First Meeting of the Task Group on Covered Malls and Public Concourses noted that in preparation of the 1977 and 1980 Editions of the Code, the Part 3 Committee questioned [194] the validity of the "mall" concept and associated requirements developed in the 1970 NBCC. As an example of the concern, it was noted that a combustible building could be built of unlimited size if a sufficient number of 30-ft. malls were provided. Relative to height and area limits, the following concerns were expressed [194]:

- The validity of permitting a structural trade-off for buildings connected by a 30-ft. covered mall. Fuel loads were permitted within mall areas, increasing the potential for fire spread by means of leapfrog from one side of the mall to the other.
- The structural tradeoff waiving a 1-hour rating for the roof where 20 ft. above the floor and for sprinklered floor areas. Sprinklers also permitted the use of heavy timber roof assemblies.

Minutes of the Second Meeting of the Revision Subcommittee A of the Standing Committee on Use and Occupancy

April 16 and 17, 1980

The Minutes of the Second Meeting of Revision Subcommittee A of the Standing Committee on Use and Occupancy summarized discussions permitting combustible roof assemblies on buildings required to be of noncombustible construction, which had been rejected in the 1980 Code. The following summarizes the reason for rejection in the previous code cycle and suggestions for acceptance, including firefighting considerations [195]:

> As noted at the last meeting, the reason why the Standing Committee rejected this change for the 1980 Code was that it was considered to be a major change in Code philosophy related to noncombustible buildings and that it was premature to recommend such a requirement for inclusion in the Code without considering such aspects as limitations on height and also whether combustible material should be permitted on the top of non-combustible buildings.
>
> After considerable discussion, the consensus of this Committee was that since this is now a universal problem which appears to deserve special code consideration, that additional requirements should be added.
>
> It was therefore Moved and Seconded to accept in principle the requirements in Appendix C which had previously been rejected for the 1980 Code with additional amendments at this meeting as noted in the Appendix.
>
> It was suggested that this type of construction apply to buildings of 60 ft. maximum height, as it may be difficult for fire fighters in the event of a fire if the height exceeds 60 ft. It was noted however there should be adequate roof access from the interior of the building. A vote on limiting the height to 60 ft was therefore defeated. It was agreed however that DBR be requested to examine the code requirements to determine if access for fire fighters is provided in buildings over 3 storeys in building height.

As noted above, the result of the discussion was that combustible roof assemblies were permitted where interior access was provided to the roof. This was considered adequate to address the risk of height for firefighting involving a potential roof fire.

Minutes of the Third Meeting of the Task Group on Covered Malls and Public Concourses of the Standing Committee on Use and Occupancy

September 9, 1980

The Third Meeting of the Task Group on Covered Malls and Public Concourses summarized the proposed changes up to the time of the meeting [196]:

Present Concept	Proposed for the 1985 Code
Portions of a building which contain a 30' wide covered mall may be considered as separate buildings	The separate building concept is no longer valid. The mall will be treated like a public corridor with more stringent construction requirements except that heavy timber construction will be permitted for all roofs if the building is sprinklered

A roof in a 1 or 2 storey mall may be unrated if it is sprinklered and the mall is 20' high	Ratings are to be relaxed for rated roofs in any size building if it is sprinklered
No occupncy is assumed in the mall	The mall has a mercantile occupancy and occupant load

In addition to permitting unrated roofs, heavy timber was proposed to be permitted as part of the roof assembly where the building was fully sprinklered. The new concept, as outlined above, did not permit portions of a building to be considered as separate buildings.

Minutes of the Twenty-Seventh Meeting of the Standing Committee on Use and Occupancy

October 14, 15 and 16, 1981

During a review of Subsection 3.2.2. in the Twenty-Seventh Meeting of the Standing Committee on Use and Occupancy, the following was noted specific to basements and crawl spaces [197]:

> The use of the phrase "shall be of combustible or noncombustible construction" appeared to cause confusion and it was agreed that the use of this phrase be reviewed for the 1985 Code for simplification of the requirements.

This issue was not addressed in the remainder of the 1985 Code cycle. However, it was addressed again during the 1990 Code cycle, and will be discussed in more detail in **Section 8.12** of this report.

Minutes of the Twenty-Seventh Meeting of the Standing Committee on Housing and Small Buildings

June 28, 29 and 30, 1982

A change to the definition of grade in the 1980 NBCC resulted in confusion regarding its application to buildings located on sloping sites when determining building height [198]. This was particularly problematic in the early 1980's in British Columbia where the Building Code Appeal Board had received several requests for interpretation and application of the definition of grade for determining first storey and building height on sloping sites. As a result of the number of requests, the BC Building Standards Branch sent a letter dated April 15, 1982 to the Codes and Standards Group at NRC, seeking an interpretation.

The definition of grade at that time was as follows [199]:

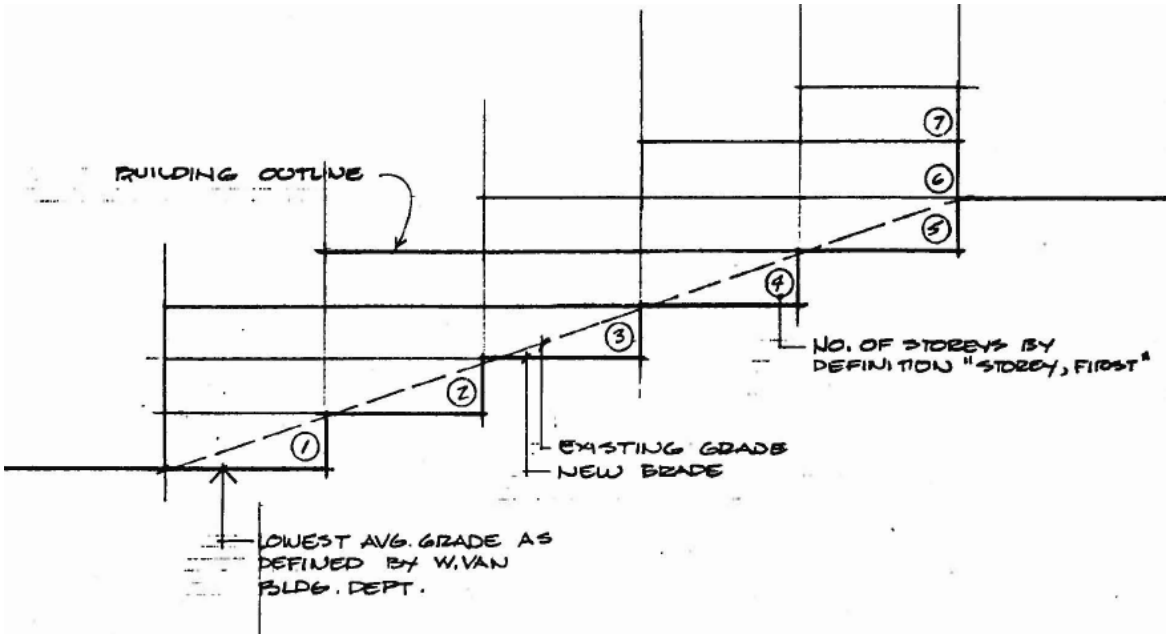
> *Grade* (as applying to the determination of *building height*) means the lowest of the average levels of finished ground adjoining each exterior wall of a *building*, except that localized depressions such as for vehicle or pedestrian entrances need not be considered in the determination of average levels of finished ground. (See *Storey, first.*)

The maximum building height for residential buildings of combustible construction in the NBCC and BCBC at this time was 3 storeys, and depending on building area, could be designed and constructed in accordance with Part 3 or Part 9.

The BC Building Standards Branch provided examples to illustrate the problem [197]. The first example was a 3-storey building on a flat site that could be built under Part 9 of the Code. The second example was the same building, but located on a sloping site and composed of 5 parts (see diagram below). Each part of the building was only 3 storeys, but with increasing slope was offset vertically from the adjacent

part by a storey (stepped). Application of the definition of grade to the stepped building resulted in the building being considered 7 storeys in building height, which would require that it be built [197]:

- under Part 3,
- of noncombustible construction, and
- in conformance with Subsection 3.2.6. (High Building Requirements)



A letter from A.T. Hansen, Head of the Technical Section of the Codes and Standards Group, NRC dated May 6, 1982 was prepared in response to the BC Building Standards Branch request for interpretation indicated that [197]:

- The identified problem is not new, just magnified with the change of definition of grade.
- The specific objectives of limiting height and area have not been defined satisfactorily to express the requirements in performance terms to apply to this case. See the excerpt below:

  The specific objectives for limiting heights and areas have not been satisfactorily articulated to my knowledge. There is a general appreciation that the extent of potential damage from fire in combustible buildings is greater than with non-combustible buildings. The degree to which escape, rescue, or fire fighting operations might be affected by the combustibility of the building could also be a factor in limiting the size of combustible buildings. Not having clearly defined objectives in establishing height and area limits, however, makes it difficult to express the requirements in performance terms to achieve the perceived objectives.

- The example identified by the BC Building Standards Branch could be considered as a staggered 3-storey row house.
- If the example building had roadway frontage for all of the parts, it could be considered separate properties (i.e., 1-hour separation between units, with any exterior wall portion constructed as a ¾-hour separation without openings and with noncombustible cladding).

- Since the centre units of the example building do not have road access and a common roof, they can not be considered as comparable separate properties, and a firewall may be the only feasible trade-off.

Note that the row house suggestion and associated 1-hour fire separation requirement identified between residential units was permitted in Article 9.10.11.2. of Part 9 of the 1980 NBCC as an alternative to the provision of a firewall. The requirement was as follows [199]:

Party walls between dwelling units

9.10.11.2. In a *building* of *residential occupancy* in which there is no *dwelling unit* above another *dwelling unit*, a *party wall* on a property line between *dwelling units* need not be constructed as a *firewall* provided it is constructed as a *fire separation* having not less than a 1 h *fire-resistance rating*. Such wall shall provide continuous protection from the top of the footings to the underside of the roof deck. Any space between the top of such wall and the roof deck shall be tightly sealed by caulking with mineral wool or *noncombustible* material.

This provision existed in Part 9 of the NBCC since the 1970 Edition, Supplement No. 5 to the 1960 and 1965 NBC, and the 1950 "Code for Dwelling Construction for Buildings Housing One or Two Families," which required the following [200]:

16. Separation of Dwelling Units

The walls, floors, or ceilings, which separate two dwelling units shall conform to the following provisions.

(i) A party wall shall extend from the footings to the underside of the roof boarding.

(ii) No opening shall be made through such separation.

(iii) Such separation shall have a fire-resistive rating of not less than one hour in accordance with Article 25.

(iv) No combustible party wall or common wall shall extend below the first storey.

The issue raised by the BC Building Standards Branch was discussed at the Twenty-Seventh Meeting of the Standing Committee on Housing and Small Buildings. The Committee noted that there would always be designs that would represent special cases requiring discretional interpretation, and agreed that no action be taken.

Minutes of the Tenth Meeting of the Revision Subcommittee A of the Standing Committee on Use and Occupancy

August 10 and 11, 1982

The issue raised by the BC Building Standards Branch was again discussed at the Tenth Meeting of the Revision Subcommittee A of the Standing Committee on Use and Occupancy [201]. The Committee noted that it was not possible to provide a definition of grade that would be adequate in all cases and agreed that the definition not be changed. It was also recommended that the proposed issue could be addressed through the development of an equivalency on a case-by-case basis.

Minutes of the Thirty-Third Meeting of the Standing Committee on Use and Occupancy

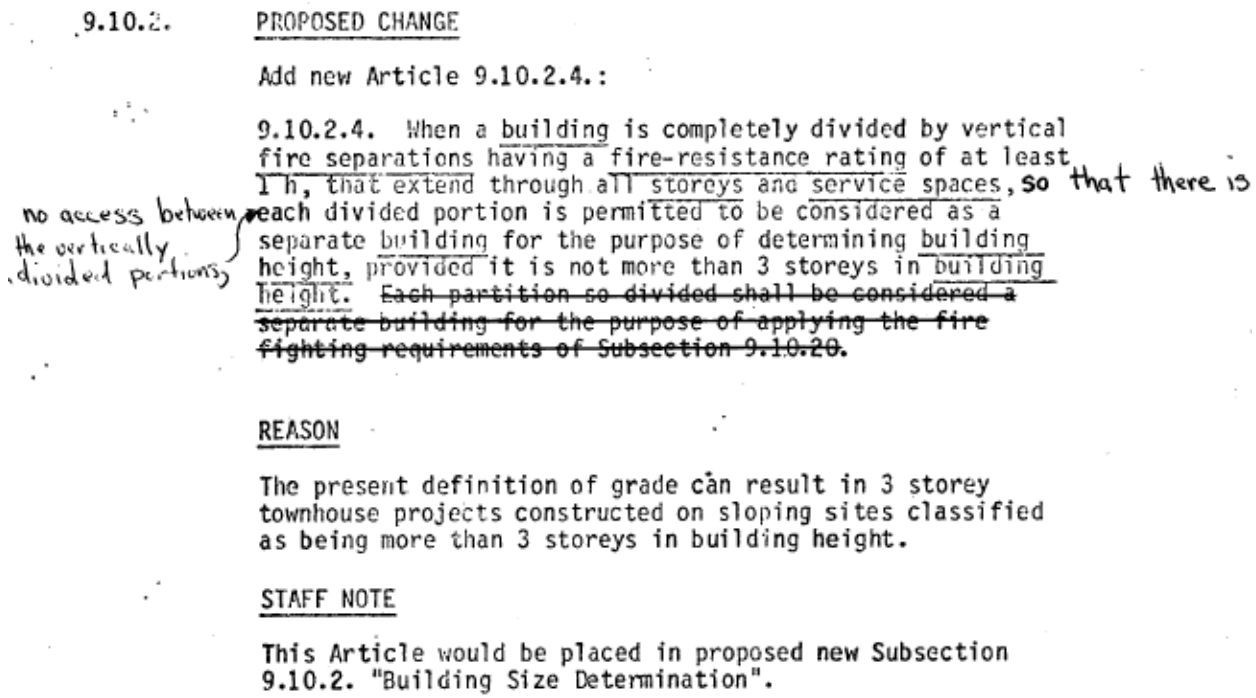
March 7, 8 and 9, 1983

Several letters to the Codes and Standards Group, NRC in January and February of 1983 noted the continued concerns in BC with the definition of grade resulting in increased cost of construction and recommended a revised definition of grade be added to the Code on an emergency basis. A letter from

A.T. Hansen, Head of the Technical Section of the Codes and Standards Group, NRC dated February 4, 1983 responded to these letters with the following considerations [202]:

- The proposed definition of grade may be difficult to interpret and apply.
- Another approach would be to consider the case of a row house which is completely divided by a fire separation, each subdivided section could then be considered as a separate building for the purpose of determining building height of each segment.

The issue outlined above was discussed at the Thirty-Third Meeting of the Standing Committee on Use and Occupancy. The Committee did not consider that the problem applied to Part 3 buildings. It was agreed that no action be taken for Part 3. The Committee reviewed the proposed change to Part 9 relative to this issue and suggested revisions, which are shown below [202]:



9.10.2. PROPOSED CHANGE

Add new Article 9.10.2.4.:

9.10.2.4. When a building is completely divided by vertical fire separations having a fire-resistance rating of at least 1 h, that extend through all storeys and service spaces, so that there is no access between the vertically divided portions, each divided portion is permitted to be considered as a separate building for the purpose of determining building height, provided it is not more than 3 storeys in building height. ~~Each partition so divided shall be considered a separate building for the purpose of applying the fire fighting requirements of Subsection 9.10.20.~~

REASON

The present definition of grade can result in 3 storey townhouse projects constructed on sloping sites classified as being more than 3 storeys in building height.

STAFF NOTE

This Article would be placed in proposed new Subsection 9.10.2. "Building Size Determination".

Minutes of the Twenty-Eighth Meeting of the Standing Committee on Housing and Small Buildings

March 22 and 23, 1983

The issue related to the interpretation of grade relative to sloping sites was discussed at the Twenty-Eighth Meeting of the Standing Committee on Housing and Small Buildings [203]. The Committee discussed the implications of the proposed change (i.e., subdivided sections of the building) and whether this type of construction presents risks which warranted the suggested “relaxation”. It was agreed that a 1-hour separation was adequate since it was basically the same as if it were built on the flat where it would pose no problem. A new Article was proposed, and is included below [203]:

9.10.2. PROPOSED CHANGE

Add new Article 9.10.2.4.:

9.10.2.4. When a building is completely divided by vertical fire separations having a fire-resistance rating of at least 1 h, that extend through all storeys and service spaces, each divided portion is permitted to be considered as a separate building ~~for the purpose of determining building height,~~ provided it is not more than 3 storeys in building height. When a storage garage in a basement is separated form the remainder of the building in conformance with Article 9.10.5.2., the vertical separation may terminate at the floor assembly immediately above the storage garage.

For the purpose of determining building height,

REASON

The present definition of grade can result in 3 storey townhouse projects constructed on sloping sites classified as being more than 3 storeys in building height.

STAFF NOTE

This Article would be placed in proposed new Subsection 9.10.2. "Building Size Determination".

Committee action

Approved as amended.

Minutes of the First Meeting of the Revision Subcommittee A of the Standing Committee on Use and Occupancy for the 1990 Code

October 4, 1983

A letter from Mr. J.A. Cran of the Canadian Steel Construction Council to the Secretary of the Associate Committee on the National Building Code recommended an emergency change to the requirements for air-supported structures suggesting that they be classified as combustible construction conforming to the requirements of Section 3.2 of the NBCC. The concern was that air-supported structures would have an unwarranted advantage over other types of construction. The rationale in the commentary to exclude air-supported structures from Subsection 3.2.2. was not considered valid [204]:

> The "Commentary on Part 3...." goes on to suggest that this concession is acceptable for air-supported fabric construction because interior walls, mezzanines, intermediate floors, or similar constructions are not permitted in the building. Yet a building of similar height and area, also without these interior constructions, but of either combustible or non-combustible construction would, however, have to comply with section 3.2. A more inequitable situation is hard to imagine!
>
> The preceding comments are not intended to be a criticism of the new "Commentary on Part 3....". The commentary is, as we understand it, simply a synopsis of the thinking of the Standing Committee on Use and Occupancy at the time when provisions for tents and air-supported structures were first introduced into the Code in 1970. The development of air-supported fabric structures since then, however, has been such that they are no longer used as an alternative to a tent. Therefore, the NBC 80 provisions are inadequate. This is borne out by the fact that we understand that the present Standing Committee on Use and Occupancy turned down a proposed change for NBC 85 that would have specifically stated that air-supported fabric structures need not be constructed in conformance with section 3.2.

> The situation, of course, would not have arisen if one of the basic concepts of the Code had not been disregarded in the first place. That concept is that all forms of construction be classified as either combustible or non-combustible and the provisions of the Code, particularly section 3.2, be applied accordingly. To allow a new type of construction to be exempted undermines the whole basis of the Code with respect to combustibility and structural fire protection.

It was agreed to add an Appendix Note to the Code identifying the limited intent of the requirements for air-supported structures and that they were not intended to cover roof assemblies in covered stadia.

Minutes of the Twenty-Ninth Meeting of the Standing Committee on Housing and Small Buildings

February 7 and 8, 1984

A letter from R.J. Desserud, Technical Advisor, Standing Committee on Housing and Small Buildings and J.B. Berndt, Technical Advisor, Standing Committee on Use and Occupancy, NRC dated February 4, 1983 to J.K. Summers, Acting Secretary, Standing Committee on Use and Occupancy, NRC noted differences between Parts 3 and 9 of the NBCC [205]. This letter was reviewed at the Twenty-Ninth Meeting of the Standing Committee on Housing and Small Buildings and the following excerpt noted the potential problems that could arise as a result of Part 9 addressing determination of building height on sloped sites, but not Part 3 [205]:

> **An additional difference to those described in the attached memorandum, between the proposed revisions to Part 3 and Part 9 (Second Series) was discovered recently. A new requirement is proposed to be added to Part 9 (9.10.5.4.) that will permit portions of a building separated by a vertical fire separation to be considered as separate buildings for the purposes of determining building height. This was done to accommodate combustible buildings on sloping sites on the basis that each divided portion does not exceed 3 storeys. Part 3 has not incorporated such a requirement.**
>
> **The user of the Code will thus be faced with a dichotomy. Part 2 of the Code establishes the application of Parts 3 and 9 to buildings, in part, on the basis of building height and building area. In terms of establishing building area the Code user would have 2 sets of requirements; if he looks at Part 3, the building becomes a 4, 5 or even 6 storey building and must be constructed of noncombustible construction; if he looks at Part 9, the building is a 3 storey building that can be constructed entirely of combustible materials.**
>
> **To avoid problems related to the determination of building area, new Subsection 2.1.5. was added in 1983 to clarify that a firewall creates 2 buildings throughout the Code. It would seem reasonable to use the same philosophy with respect to the determination of building height; in other words to incorporate this type of requirement in Part 2 for general application throughout the Code.**
>
> **In discussing this question the Part 3 and Part 9 Committees should recognize that the height of a building in storeys affects requirements other than combustibility. For example, it is used to:**
>
> - **rate fire doors,**
> - **establish temperature rise limits on certain exit fire doors,**
> - **determine the need for fire alarm systems,**
> - **establish fire department access routes,**
> - **require standpipe and hose systems, and**
> - **establish the width of certain exit stairs.**

Would you please bring this letter to the attention of your respective Standing Committees prior to completion of work for the 1985 NBC.

Public comments relative to new Article 9.10.2.4. were reviewed. Most of the comments indicated that Article 9.10.2.4. had been misinterpreted by those commenting, and it was agreed to add an appendix note providing clarification. In addition, as noted below and following the excerpt above, the Part 3 Committee agreed to include a similar requirement [205]:

Article 9.10.5.4., page 43
It appeared to the Committee that the intent of the relaxation was being misinterpreted. It was therefore agreed to add a note to the

Appendix (see pages 47 and 48) including diagrams to illustrate the application of the Article and to clarify that this relaxation applies to the determination of building height only.

SECRETARYS' NOTE:
At a subsequent meeting, Part 3 agreed to include a similar requirement with revisions. A revised action sheet was therefore included in a special letter ballot to Part 9.

The proposed requirement and new appendix note relative to the determination of building height for buildings on sloped sites are included below [205]:

9.10.5. PROPOSED CHANGE DBA

Add new Article 9.10.5.4.:

9.10.5.4. For the purpose of determining building height, when a building is completely divided by vertical fire separations having a fire-resistance rating of at least 1 h that extend through all storeys and service spaces, each divided portion is permitted to be considered as a separate building provided it is not more than 3 storeys in building height. Where a storage garage in a basement is separated from the remainder of the building in conformance with Article 9.10.5.2., the vertical separation may terminate at the floor assembly immediately above the storage garage. (see Appendix A)

REASON

The present definition of grade can result in 3 storey townhouse projects constructed on sloping sites classified as being more than 3 storeys in building height.

This Article would be placed in proposed new Subsection 9.10.5. "Building Size Determination."

STAFF NOTE:
An Appendix note clarifying the requirement was added after a review of public comment.

Appendix A

PROPOSED CHANGE

Add new Note:

cBB

A-9.10.5.4. BUILDINGS ON SLOPING SITES

Appliction of the definition of grade to stepped buildings on sloping sites often results in such buildings being designated as being greater than three storeys in building height even though there may be only two or three storeys at any one location. The diagrams below illustrate the application of Article 9.10.5.4. compared to a similar building on a flat site.

Under Article 9.10.5.4. building A can be considered as being 3 storeys in building height instead of six storeys in building height. Both building A and building B are comparable in view of fire safety and egress.

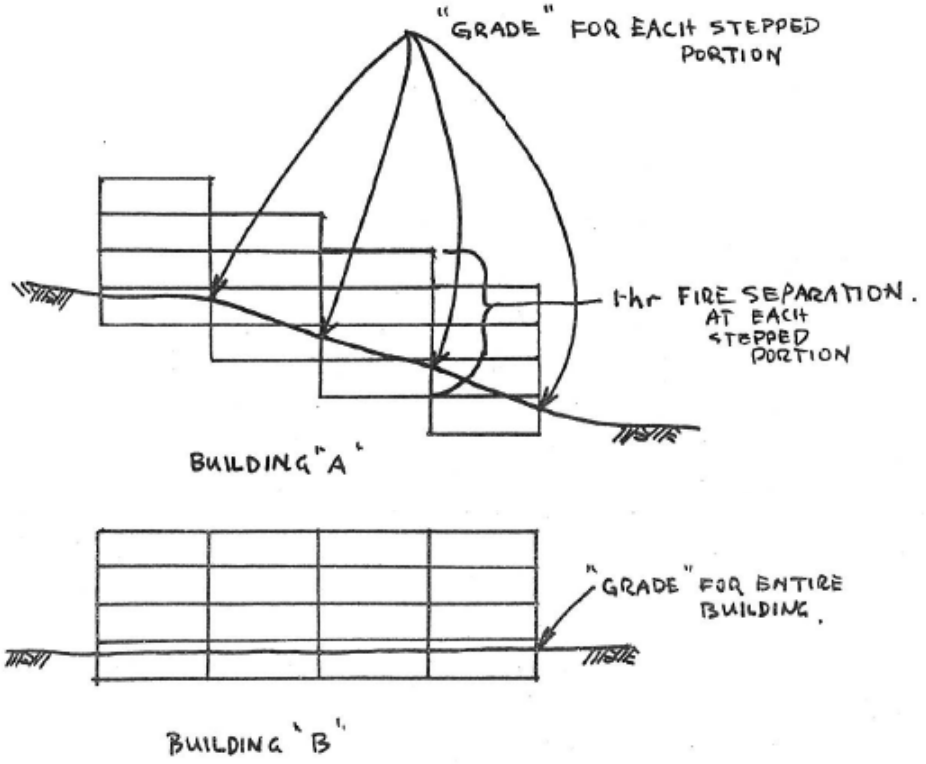
This relaxation applies to determination of building height only. All other requirements continue to apply as appropriate.

REASON

Clarification of requirement

STAFF NOTE:

Explanatory note added as a result of review of public comment.



Minutes of the Thirty-Seventh Meeting of the Standing Committee on Use and Occupancy

February 14, 15 and 16, 1984

The addition of Article 9.10.5.4. to Part 9 was discussed at the Thirty-Seventh Meeting of the Standing Committee on Use and Occupancy [206]. It was noted that the proposed change had been discussed at the 33rd Meeting of the Standing Committee on Use and Occupancy and it was agreed at that meeting that a similar requirement was not necessary for Part 3. That decision was reconsidered at this meeting.

A motion to accept the principle of Article 9.10.5.4. was agreed after considerable discussion and drafted as Article 3.1.1.4., but with the following exceptions [206]:

a) it applies only to residential occupancies,

b) fire fighters travel distance be limited to 45 m, and

c) access through the vertical fire separation other than onto an adjacent roof be prohibited.

It was further recommended that [206]:

- the change be included in the 1985 NBCC on an emergency basis,
- the Part 9 requirement be revised accordingly for consistency, and
- a recommendation be made to the ACNBC that the requirement be included in Part 2 since it was common to Parts 3 and 9.
- It was noted that including the requirement in Part 2 "would be consistent with the inclusion of new Subsection 2.1.5. which was added in 1983 to clarify that a firewall creates 2 buildings throughout the Code."

The proposed new Article 3.1.1.4. was as follows [206]:

3.1.1. PROPOSED CHANGE EBB

Add new Article 3.1.1.4.:

3.1.1.4.(1) Except as permitted in Sentence (2), where portions of a building are completely separated by a vertical fire separation that has a fire-resistance rating of at least 1 h, extends through all storeys and service spaces, and terminates at the underside of the roof of the uppermost storey of the separated portions, each separated portion is permitted to be considered as a separate building for the purpose of determining building height provided

(a) each separated portion is not more than 3 storeys in building height and is used only for residential occupancies,

(b) the unobstructed path of travel for the fire fighter from the nearest street to one entrance of each separated portion is not more than 45 m, and

(c) there is no pedestrian access through the vertical fire separation other than to a roof area.

(2) The vertical fire separations in Sentence (1) may terminate at the floor assembly immediately above a basement provided the basement is located completely below the adjoining finished ground, is used primarily as a storage garage and is separated from the remainder of the building by a fire separation conforming to Article 3.2.1.3.

REASON

The present definition of grade can result in the classification of 3 storey townhouse projects constructed on sloping sights as being more than 3 storeys in building height. This proposed change allows for separated 3 storey portions of such a project to be considered as separate buildings for the purposes of determining building height thus the overall project would be considered as a 3 storey building.

This proposed change is considered to be of an emergency nature in that it is needed to alleviate an undue hardship on the construction industry.

395

Minutes of the Seventy-Second Meeting of the Associate Committee on the National Building Code

May 29 and 30, 1984

The Seventy-Second Meeting of the Associate Committee reviewed responses to Letter Ballot Nos. 167 and 168, which included consideration of the new building height determination requirements as an emergency change and their respective transfer from Parts 3 and 9 to Part 2 [207].

Following review of the responses to the Letter Ballots, the Committee agreed that the proposed Article 3.1.1.4. be approved for inclusion in the 1985 NBCC on an emergency basis, and that the corresponding Part 9 requirement be revised to be consistent with Part 3. It was further agreed that the requirement be added to Part 2 of the NBCC rather than Parts 3 and 9, and that Clause 3.1.1.4.(1)(c) be excluded from the change.

The final version of the requirement, with minor revisions, was included as Sentence 2.1.6.2.(1) and corresponding appendix note in the 1985 NBCC, as shown in the excerpt included below (Appendix diagram not included) [208]:

2.1.6.2.(1) Except as permitted in Sentence (2), where portions of a *building* are completely separated by a vertical *fire separation* that has a *fire-resistance rating* of at least 1 h and extends through all *storeys* and *service spaces* of the separated portions, each separated portion is permitted to be considered as a separate *building* for the purpose of determining *building height* provided

(a) each separated portion is not more than 3 *storeys* in *building height* and is used only for *residential occupancies*, and

(b) the unobstructed path of travel for the fire fighter from the nearest *street* to one entrance of each separated portion is not more than 45 m.

(See Appendix A.)

A-2.1.6.2.(1) Buildings on Sloping Sites. Application of the definition of grade to stepped buildings on sloping sites often results in such buildings being designated as being greater than 3 storeys in building height even though there may be only 2 or 3 storeys at any 1 location. The diagrams below illustrate this application compared to a similar building on a flat site.

Under this Sentence, Building A can be considered as being 3 storeys in building height instead of 6 storeys in building height. Both Building A and Building B are comparable with regard to fire safety and egress.

This relaxation applies to the determination of building height only. All other requirements continue to apply as appropriate.

This requirement has remained unchanged, other than reference numbering, to the current Sentence 1.3.3.4.(2) of the 2010 NBCC.

8.12 1990 NBCC

The 1990 edition of the National Building Code (1990 NBCC) incorporated changes to the "boxes" including an examination of types of construction, area and height increases for Group C (residential) buildings and an exemption for roof rating for arena type buildings. These changes are discussed in more detail in the following sections of this report.

Minutes of the Second Meeting of the Standing Committee on Fire Protection

September 17, 18 and 19, 1985

DBR staff reviewed all actions of the Standing Committee on Use and Occupancy that did not appear to be completed during the 1985 Code cycle. As part of this review, the following was identified and added to a list of action items [209]:

Minute	Action	By
27.8(7)(a)	Structural Requirements In Subsection 3.2.2., examine the requirements for loadbearing walls, columns and arches for possible consolidation and simplification.	DBR
27.8(7)(e)	Combustible & Noncombustible Construction Review the use of the terms combustible and noncombustible construction in the Code for possible simplification (Subsection 3.2.2.).	
8.26	Combination of Combustible Construction in Subsection 3.2.2. Clarify that the permission for combinations of combustible and noncombustible construction applies to individual components of an assembly such as a wood deck on steel joists as well as to the combination of major building materials such as a wood roof assembly on steel columns.	
Committee Action		
	It was noted that a Committee Paper is currently under preparation. It is not, however, expected to be completed until some time next year. At that time, it will be brought to the Committee for consideration.	

Minute Item 8.26 above was identified in the previous Code cycle, as described in the previous section of this report in a summary of the Minutes of the Twenty-Seventh Meeting of the Standing Committee on Use and Occupancy.

Minutes of the Seventh Meeting of the Standing Committee on Fire Protection

May 20, 21 and 22, 1987

Outstanding actions for the Standing Committee on Fire Protection included an update of the "Combination of Combustible Construction in Subsection 3.2.2." item as follows [210]:

8.26 Combination of Combustible Construction in Subsection 3.2.2.

Clarify that the permission for combinations of combustible and noncombustible construction applies to individual components of an assembly such as a wood deck on steel joists as well as to the combination of major building materials such as a wood roof assembly on steel columns.

Committee Action

P. Higginson will make a proposal on this subject for consideration at a future meeting. The ULC fire test committee is currently investigating this subject. It was the consensus that this action is high priority.

Minutes of the Eighth Meeting of the Standing Committee on Fire Protection

December 1, 2 and 3, 1987

The outstanding action "Combination of Combustible Construction in Subsection 3.2.2." was addressed at this meeting in a letter prepared by Mr. Peter Higginson, Chief Engineer, ULC. Higginson notes that [211]:

The distinction between combustible and noncombustible construction was originally based on a concept that distinguished between construction types that were:

i) Of a limited vs unlimited combustible loading.

ii) Were based on noncombustible vs combustible structural elements.

As a result of developments in the Codes, there has been a substantial dilution of the distinction that may be made in terms of the combustible loading associated with combustible vs noncombustible construction, and some reduction in the distinction between the combustibility of structural elements and claddings permitted in certain instances.

Following this, Higginson recommended a reexamination of the current requirements in Subsection 3.2.2. to establish a simpler, more rational approach. Rather than define two distinct construction types, he recommended limiting combustible structural systems to a certain height in storeys and addressing additional combustible components on a performance basis. The Committee's review of Higginson's letter noted the following [211]:

(1) Distinction Between Combustible and Noncombustible Construction

At the seventh meeting (see Min. 7.4, page 29), while reviewing the outstanding actions from previous meetings and the last code cycle, the Committee discussed 'Min. 8.26 Combinations of Combustible and Noncombustible Construction in Subsection 3.2.2.'. At that time Mr. Higginson agreed to develop a proposal on this subject for consideration at a future meeting.

At this meeting, the Committee considered the response from Mr. Higginson (Appendix R), in which he points out that there has been a substantial dilution of the distinction that may be made in terms of the combustible loading associated with combustible versus noncombustible construction and that there is some reduction in the distinction of combustibility of structural elements and claddings permitted in certain instances. He recommends that there is a need to re-examine the current requirements in Subsection 3.2.2. in order to assess the value of the concept of combustible versus noncombustible construction and to determine whether a simpler, more rational approach to limit the use of building materials having a combustible component may be developed. Further, he suggests that rather than defining two distinct construction types and listing exceptions that become increasing convoluted, it may be more simple to talk in terms of limiting combustible structural systems in terms of building size, and address the performance requirements of insulations, claddings, etc. in terms of occupancy and other use considerations.

In discussion, it was stated that what Mr. Higginson has proposed has merit but that there is a lot of work that would have to be done as a whole new philosophy involving the development of a building hazard classification would have to be undertaken. It was the consensus of the Committee that this item be retained as a high priority item in the list of outstanding actions although it was acknowledged that this issue is unlikely to be resolved before the production of the 1990 Code and that the 1995 NBC is a more likely target date.

Minutes of the Tenth Meeting of the Standing Committee on Fire Protection

March 29 and 30, 1988

A letter from C.R. Thomson, Vice President Codes and Standards of the Canadian Wood Council, dated December 16, 1987 included several code change proposals [212]. Two of the proposals related to height and area limits for Group C (Residential) buildings. The first of these proposals related to existing Article 3.2.2.27., which permitted a residential building of combustible construction to be up to 3 storeys in building height based on the height and area limits included below (twice the areas for a sprinklered building) [212]:

Table 3.2.2.E.
Forming Part of Sentence 3.2.2.27.(1)

No. of *Storeys*	Unsprinklered Maximum Area, m^2		
	Facing 1 *Street*	Facing 2 *Streets*	Facing 3 *Streets*
1	1 200	1 500	1 800
2	900	1 125	1 350
3	600	750	900
Column 1	2	3	4

The proposal noted that the 1965 NBCC permitted proportioning of existing areas to buildings of the same major occupancy and construction, but lesser storeys. Using proportioning, Article 3.2.3.27. of the 1965 NBCC allowed a 1-storey, unsprinklered, Group C building, of combustible construction to be 1800 m^2 in building area. However, the 1985 NBCC only permitted 1200 m^2, which dated back to the 1970 NBCC. It was also noted that the original proposal for the 1970 NBCC suggested a maximum area of 1800 m^2, which was subsequently changed with no substantiation.

This proposal was approved by the Standing Committee and issued for public review.

The second of the proposals recommended the addition of a new Article to allow Group C (residential) buildings of combustible construction up to 4 storeys in building height with the following building areas [212]:

Building Height in Storeys	Unsprinklered Maximum Building Area, m^2		
	Facing 1 Street	Facing 2 Streets	Facing 3 Streets
1	2400	3000	3600
2	1200	1500	1800
3	800	1000	1200
4	600	750	900
Column 1	2	3	4

In addition, the proposal suggested floor assembly to be constructed as 1-hour rated fire separations. The rationale supporting this proposal is summarized as follows [212]:

- The 1985 NBCC permits buildings of 1-hour rated noncombustible construction and 1 storey in building height to be of unlimited building area and 4 storeys in building height to be up to 3000 m^2 in building area.
- The building area for the proposed Article is 1/5 (20%) that permitted for 1-hour noncombustible construction.
- A 1-hour fire-resistance-rated wood frame assembly will perform as well as a 1-hour fire-resistance rated noncombustible assembly in a prescribed fire test.
- An analysis of fire loss statistics indicates that the percentage of fire beginning in a structural area is significantly low for multi-unit residential occupancies, and the existing fire stop requirements in combustible concealed spaces have limited fires in such spaces.
- The NBCC recognizes the 1-hour fire-resistance rating for wood frame construction in residential occupancies as providing adequate life safety relative to sloped grades, which would otherwise be considered greater than 3 storeys in building height.

- All Model Building Codes in the United States permit 4-storey residential buildings to be constructed using 1-hour fire-resistance rated wood frame construction.
- A study conducted by the National Association of Home Builders in the U.S. concluded that the fire death rate is very low in newly-built, multi-family residential construction.

This proposal was approved by the Standing Committee and issued for public review with an alteration to the first rationale item indicating that 1-hour rated construction for noncombustible buildings permits 2000 m^2 in building area and 6 storeys in building height.

In addition to the proposals above, a change was proposed relative to waiving the requirement for a roof rating for gyms, swimming pools, arenas and rinks [212]:

NO EXISTING REQUIREMENT

PROPOSED CHANGE

Add new Sentence 3.2.2.8.(3): permanent

(3) The requirements in Articles 3.2.2.12 to 3.2.2.20. for a roof assembly to have a *fire-resistance rating* are permitted to be waived for gymnasia, swimming pools, arenas, and rinks if every part of the roof assembly is not less than 6 m above the main floor or balcony and carries no loads other than normal roof loads, including access walks, ventilating and sound or similar equipment, except that the restriction concerning minimum distance shall not apply to

(a) an inclined and stepped floor ascending from the main floor, which is used for seating purposes only, or

(b) a balcony used for seating purposes only.

REASON

Earlier editions of the NBC made an exception for the fire-resistance rating of roof assemblies of certain assembly buildings. Some provinces have maintained the exception and have not experienced adverse effects as a result. It has been requested that the exception be reinstated in the NBC. The proposed wording is based on earlier editions of the NBC modified in conjunction with requirements in provincial Codes.

This proposed change was approved by the Committee and included in the 1990 NBCC, but as Sentence 3.2.2.14.(1) rather than Sentence 3.2.2.8.(3).

Minutes of the Eleventh Meeting of the Standing Committee on Fire Protection

January 17, 18 and 19, 1989

A report of an analysis of Public Comments by IRC (Institute for Research in Construction) relative to noncombustible cladding addressed “Combustible versus Noncombustible Construction”. This report noted the following [213]:

- The concept of noncombustible construction was introduced in the late nineteenth century as “fireproof” buildings.

- The fireproof concept had shortcomings. It did not address structural stability (unsafe) and it was too restrictive, limiting many products that did not present a life hazard.
- Structural integrity was addressed in the first half of the twentieth century through the development of performance-based fire-resistance tests.

The report of the IRC study noted the following relative to the approval of combustible materials with respect to the noncombustibility requirements [213]:

> When no scientific tool is available to measure the impact of allowing certain combustible materials for a particular application, the Committees will usually apply common sense and often will reject the proposal. In the case of combustible cladding systems, a tool has been developed on the basis of many years of research and development and this tool can be used to ensure that permitted systems do not present a life safety hazard. As fire protection engineering develops further as a discipline and scientifically-based fire risk assessments become more common place, it is expected that additional changes to the noncombustibility requirements in the Code will be considered if found technically appropriate .

The proposal to permit four-storey wood frame residential buildings (originally proposed during the Tenth Meeting of the Standing Committee on Fire Protection) was discussed, including a review of public comments on the proposal. Mr. Rodney McPhee, Canadian Wood Council, made a presentation noting the following [213]:

- U.S. codes are very conservative and allow much larger residential buildings than Canada.
- U.S. codes mandate sprinklers in 4-storey residential buildings, but not as a function of construction type.
- There is no relationship between type of construction and fire deaths, thus requiring sprinklers in a Canadian context would be onerous.

Several individuals expressed views of the proposal. These views are summarized as follows [213]:

- All U.S. model codes require mandatory sprinklers in 4-storey residential buildings whereas 3-storey buildings do not [Mr. A. Geraghty, City of Vancouver].
- For 3 years the City of Vancouver Building Code has permitted 4-storey residential buildings, but only if sprinklered. Berming, depending on the definition of grade, may allow for 5- and 6-storey combustible residential buildings. This would support mandatory sprinklers [Mr. R.V. Hebert, City of Vancouver].
- 15 minutes of fire-resistance rating was insufficient to permit 4-storey residential buildings [Mr. R.J. Light, Township of Richmond].

An IRC “Analysis of the Impact of the Proposed Change and Public Comments” was discussed. A comparison between the existing and proposed requirements was provided as summarized in **Table 7** below.

Table 7: IRC Comparison [213]

1985 NBCC	**Proposed for the 1990 NBCC**
3 storeys in building height and do not exceed 600 m^2 in building area	**4** storeys in building height and do not exceed 600 m^2 in building area
¾-hour structural fire-resistance ratings	**1**-hour structural fire-resistance ratings
¾-hour suite to suite and suite to corridor fire-resistance ratings	**1**-hour suite to suite and suite to corridor fire-resistance ratings
Smoke detectors in corridors and smoke alarms in suites	Smoke detectors in corridors and **heat detectors** and smoke alarms in suites
	Fire alarm system
	Standpipe and hose system
	Rating of the roof assembly

In addition, the IRC study noted the following [213]:

> **Currently there appears to be little evidence of fires spreading beyond the suite of fire origin. The proposal to permit 4 storey combustible residential buildings allows for 15 minute increase in the level of structural fire-resistance rating and other fire protection systems will also be required.**

The Committee noted that much of the negative public comment was associated with inadequate 'Reason' relative to the proposed change, and there was a lot of confusion regarding a reference in the 'Reason' to U.S. codes.

The proposal to change Article 3.2.2.28. to permit a 4-storey residential building to be constructed in either combustible or noncombustible construction with basic fire-resistance ratings of 1-hour when the building is fully sprinklered was moved, seconded and carried by the Committee. The Committee noted that [213]:

> *it is evident that the compartment to compartment fire separations are performing as intended and that the problem associated with fires in residential occupancies is that of life loss in the room of fire origin.*

The addition of the requirement for sprinklering, which was beyond that included in the original code change wording, was based on the limited statistics on fires in combustible construction to support the height increase without provision of sprinklers to address any perceived or apparent increase in fire risk.

As a result of the acceptance of the proposal, with modifications, the following new "box" was added (Article 3.2.2.36.), permitting residential buildings of combustible construction with a building height of four storeys, where floor assemblies and supporting elements are 1-hour rated, provided the building is sprinklered. This re-established use of a 1-hour-rated structural solution for buildings of combustible construction that was originally part of the first (1941) NBCC. The maximum permitted areas for the four-storey buildings were as follows [213]:

- 1200 m^2 facing 1 street
- 1500 m^2 facing 2 streets
- 1800 m^2 facing 3 streets

A new "box" was also added permitting increased area limits for unsprinklered residential buildings of combustible construction, up to 3 storeys (Article 3.2.2.35.) where floor and roof assemblies and supporting elements are 1-hour rated. This change was linked to the change permitting four-storey combustible construction (Article 3.2.2.36), both of which were based on a variation of existing Article 3.2.2.34, which applied to ¾-hour rated construction. For unsprinklered buildings of 1-3 storeys, the variations were as follows [213]:

- 1800/2250/2700 m² (¾-h) to 2400/3000/3600 m² (1-h) for 1 storey facing 1/2/3 streets
- 900/1125/1350 m² (¾-h) to 1200/1500/1800 m² (1-h) for 2 storeys facing 1/2/3 streets
- 600/750/900 m² (¾-h) to 800/1000/1200 m² (1-h) for 3 storeys facing 1/2/3 streets

8.13 1995 NBCC

The changes to the height and area limits in the 1995 National Building Code (1995 NBCC) primarily related to outcomes from consideration of mandatory sprinklering requirements. These changes are discussed in more detail in the following sections of this report.

Minutes of the Thirteenth Meeting of the Standing Committee on Fire Protection

March 27 and 28, 1990

A letter from Mr. Bob Rush, P.Eng., dated January 20, 1988, proposed the following [214]:

1. Revise Table 3.2.2.M., which was the height and area limit table for Article 3.2.2.44. of the 1990 NBC, Mercantile Buildings, up to 3 storeys. The rationale for the revision was consistency with the rule of building area as a function of building height (i.e., consistent building volume). This change had been made for Article 3.2.2.27., Residential Buildings, as discussed in the previous section of this report based on the Minutes of the Tenth Meeting of the Standing Committee on Fire Protection in March 29 and 30, 1988.
2. Permit combustible construction under Subsection 3.2.2. for all major occupancies of any height and any area based on the rationale that fire separations have not less than a 1 hour fire-resistance rating, the building is sprinklered, electrically supervised and connected to a central alarm agency.

The Committee reviewed these proposals and as noted below, it was suggested that both comments be dealt with at the time of a potential IRC study to rationalize the requirements for heights and areas in Subsection 3.2.2. [214]:

> 1] The committee observed that the 1500 m^2 area limit for mercantile buildings in Table 3.2.2.M. is based on the limit of area before a building is required to have an automatic sprinkler system installed. It was noted that this Table includes substantially larger areas for a sprinklered building, which follow the general rule of doubling the area and then keeping the gross floor area constant when summed for all floors. It was pointed out that it is an outstanding action of this committee for IRC staff to undertake a study to rationalize the requirements for heights and areas in Subsection 3.2.2. It was considered that the writer's concerns will be dealt with at that time. It was agreed that no further action be taken.
>
> 2] The committee considered that to permit combustible construction for all buildings regardless of size, even though sprinklered, would be a major departure from current practice. It was noted that combustible construction

> is currently permitted for unsprinklered four storey buildings of medium and low hazard industrial occupancy. It was observed that the writer's suggestion will be dealt with as a part of the IRC study to rationalize the requirements for heights and areas in Subsection 3.2.2. It was considered that the writer's suggestion will be dealt with at that time. It was agreed that no further action be taken.

Minutes of the Fourteenth Meeting of the Standing Committee on Fire Protection

November 6 and 7, 1990

During a review of the public comments on the third series of proposed changes in the 1990 NBCC, several comments were identified as containing information or suggestions that was not germane to the specific change, but that constituted new business. One such public comment relative to the change to permit four-storey wood frame residential construction noted the following [215]:

> I support the change and recommend that commercial and industrial buildings also be included.

The Committee concurred with the commenter and agreed to revise Subsection 3.2.2. accordingly.

Minutes of the Fifteenth Meeting of the Standing Committee on Fire Protection

February 6 and 7, 1991

A letter Mr. Wayne Drover, Plan Review Engineer, Office of the Fire Commissioner, Newfoundland dated November 24, 1988 identified conflicting articles in the 1985 NBCC. Specifically [216]:

- Article 3.2.2.4. require that every building face a street located in conformance with Sentences 3.2.5.2.(1) to (5)
- Articles 3.2.2.9. to 3.2.2.53. define requirements for all occupancies based on several factors including streets facing.
- Article 3.2.5.1. requires access for firefighting purposes to every storey less than 25 m above grade. This requirement is waived for any storey that is sprinklered.
- Article 3.2.5.2. requires access routes for fire department vehicles to the building face having a principle entrance only.
- Article 3.2.2.4. connects the two sets of requirements together.

A letter of response from Mr. R.B. Chauhan, Technical Advisor, Associate Committee on the National Building Code dated February 8, 1989 noted that the issue raised by Mr. Drover is planned for review during the next code cycle (1995 NBCC Cycle), relative to rationalizing the requirements of Subsection 3.2.2.

The Committee reviewed Mr. Drover's comment, noting that the anomaly had been identified previously and [216]:

> *the solution requires a complete revision to Section 3.2 through examination of the impact of sprinklering on the different requirements. It was considered that it would be preferable to settle the question of the extent to which mandatory sprinklering might be considered in Part 3 before undertaking this study.*

This issue was identified as part of the terms of reference of, and referred to, the Part 3 Joint Task Group on Automatic Sprinkler Systems.

Minutes of the Sixteenth Meeting of the Standing Committee on Fire Protection

October 29, 30 and 31, 1991

Proposed changes originating from previous actions of the Committee were identified, reviewed and resolved. Two changes proposed the addition of new Articles to Subsection 3.2.2. for sprinklered 4-storey Group D and Group E Occupancies permitted to be of combustible construction [217]:

- The Committee approved 4-storey Group D buildings permitted to be of combustible construction and 2400 m^2, 3000 m^2 and 3600 m^2 if facing 1, 2 and 3 streets respectively, provided the building is fully sprinklered and has fire-resistance ratings of floors, roof and supporting elements of not less than 1-hour.
- The Committee approved 4-storey Group E buildings permitted to be of combustible construction and 1200 m^2, 1500 m^2 and 1800 m^2 if facing 1, 2 and 3 streets respectively, provided the building is fully sprinklered and has fire-resistance ratings of floors, roof and supporting elements of not less than 1-hour.

Minutes of the Seventeenth Meeting of the Standing Committee on Fire Protection

June 10, 11 and 12, 1992

The changes proposed during the Sixteenth Meeting of the Standing Committee on Fire Protection to permit 4-storey Group D and E buildings to be of combustible construction were recommended by the Committee as interim revisions to the 1990 edition of the NBCC [218].

Minutes of the Eighteenth Meeting of the Standing Committee on Fire Protection

December 2, 3 and 4, 1992

A key change proposal by Technorm Inc. of Montreal was reviewed during the Eighteenth Meeting. The following was proposed [219]:

> Sprinklered buildings should be considered as facing 3 streets in determining the maximum allowable area regulated by articles 3.2.2.16. to 3.2.2.62.

The reason for the change was noted as follows [219]:

> Consequently to the derogation for access to sprinklered buildings provided in article 3.2.5.3., the presence of streets do not add or reduce any advantage to a sprinklered building facing 1 or 3 streets. That increase in building area should encourage the installation of sprinklers in buildings.

The Committee reviewed the proposal and noted the following [219]:

> The committee reviewed the writer's suggestion that sprinklered buildings should be considered as facing three streets in determining maximum permissible area for the purposes of Articles 3.2.2.16. to 3.2.2.62. It was observed that this concept will be included in the report of the Task Group on Automatic Sprinklers. It was concluded that the committee will await that report before reaching final conclusions on this proposal.

In addition, another proposal by Technorm proposed the following [219]:

Add a second paragraph to art. 3.2.2.12. to permit relaxation of floor assembly rating from 3 hrs to 2 hrs in commercial and industrial occupancies where: a) the building is sprinklered; b) the sprinkler system is electrically supervised in conformance with sentence 3.2.4.16. (5); c) the operation of the sprinkler system will cause a signal to be transmitted to the fire department in conformance with sentence 3.2.4.7. (3).

The reason for the change was noted as follows [219]:

Considering the reliabity of the sprinkler system, 3 hrs fire rating for floor assemblies seems unjustified.

The Committee reviewed the proposal and noted the following [219]:

The committee noted that writer's request that the required fire-resistance rating for some floor assemblies that are currently required to be 3 hours should be relaxed to 2 hours in a sprinklered building. It was observed that this bears on the requirements for major occupancies in the major part of Subsection 3.2.2. It was agreed to revise Article 3.2.2.12. to permit a relaxation of floor assembly ratings from 3 h to 2 h in Group E and Groups F1 and F2 occupancies where:

- the building is sprinklered,
- the sprinkler system is electrically supervised in conformance with Sentence 3.2.4.16.(5), and
- the operation of the sprinkler system causes a signal to be transmitted to the fire department in conformance with Sentence 3.2.4.7.(3).

Minutes of the Nineteenth Meeting of the Standing Committee on Fire Protection

March 24, 25 and 26, 1993

The report of the Joint Task Group on Automatic Sprinklers was presented. The terms of reference of the Joint Task Group were as follows [220]:

1) Review existing National Building Code of Canada (NBC) requirements for the mandatory installation of automatic sprinkler systems to determine if they are still valid.

2) Consider the degree to which the installation of automatic sprinkler systems can permit a designer to modify or waive other requirements of the NBC.

3) Review regulations of jurisdictions that have additional requirements for the installation of automatic sprinkler systems in buildings and analyze the differences.

4) Analyze available data utilizing the results of studies and experience from those jurisdictions who have regulations affecting automatic sprinkler system requirements in one or more categories of buildings to determine if the NBC should make any additions to the requirements for the installation of automatic sprinkler systems.

5) Review the practice of installing partial sprinkler systems in buildings and determine if this practice should continue to be accepted in the NBC in lieu of complete sprinklering of a building.

6) Examine the cost and reliability aspects of the various smoke control measures for high buildings in relation to the cost and effectiveness for Measure A - a fully sprinklered building - taking into account modified requirements that affect other areas of the building.

7) Examine the benefits of other fire suppression and compartmentation techniques in comparison to automatic sprinkler systems to determine those that provide an equivalent level of safety for building occupants.

The report made broad recommendations relative to Parts 3 and 9 of the 1990 NBCC, and specific code change recommendations for Part 3. The broad recommendations are summarized as follows [220]:

That supervised and monitored automatic sprinkler systems be installed in all buildings constructed under Part 3, except:

a) Group A, Division 2 buildings, neither more than 1 storey nor more than 600 m^2 in building area.
b) Open air buildings of Group A, Division 4.
c) Group F, Division 3 buildings,
   i) Article 3.2.2.61 and
   ii) Article 3.2.2.62.

That supervised and monitored automatic sprinkler systems be installed in all buildings constructed under Part 9, except:

a) Group C houses which are defined to include single family dwellings, attached and semi-detached dwellings, row houses, duplexes and triplexes where a primary common feature is the absence of shared egress facilities. (Houses does not include "board and care" facilities)
b) Group D buildings, containing 3 storeys or less.
c) Group E buildings, containing 3 storeys or less.
d) Group F, Division 2 buildings, containing 2 storeys or less.
e) Group F, Division 3 buildings, containing 3 storeys or less.

That Part 3 and the Appendix to the National Building Code be revised in accordance with the draft changes as set out in Appendix B.

That Chapter 3 of the Supplement to the National Building Code of Canada be discontinued.

That NFPA 25, "Standard for the Inspection, Testing and Maintenance of Water Based Extinguishing Systems" be referenced in the National Fire Code for purposes of assuring the continuing performance level of automatic sprinkler systems.

In addition, the Task Group identified the following topics of further study [220]:

1 A further modification of Subsection 3.2.3. to reflect recommendations of NFPA 80A, "Recommended Practice for Protection of Buildings from Exterior Fire Exposures" indicating that a building with an automatic sprinkler system has a low probability of being involved in a substantial internal fire and consequently has little impact on the spread of fire to adjacent buildings.

2 A complete revision of Subsection 3.2.2. to modify structural fire protection requirements to categorize buildings by height and area only and not by occupancy category, except for high hazard industrial buildings.

3 A further examination of fire alarm system requirements, Subsection 3.2.4., to determine the manner in which fire alarm and detection systems should be designed in response to fire safety planning for buildings that are fully sprinklered, and to determine the need for specific fire detection devices and manual pull stations in each class of building occupancy.

4 An examination of separation requirements between different major occupancies, based upon the premise that a complete electrically supervised and monitored automatic sprinkler system will have sufficient reliability in the control of fires that specific ratings for separations between different major occupancies are not required.

5. An examination of the concept of smoke separations to replace the concept of a fire separation with a zero fire-resistance rating. Specific proposals are included in Appendix C which could be adopted by the standing committees responsible for Part 3.

Numerous changes to specific requirements in Part 3 were proposed by the Joint Task Group and accepted in principle by the Committee. The proposed changes are not summarized in detail in this report; however, key proposed changes are summarized as follows [220]:

- Mandatory sprinklering of several occupancies.
- Reductions in frequency and rating of internal fire separations.
- Reductions in fire-resistance ratings for roof assemblies.

In addition, the following was proposed relative to firefighting access to buildings, and relates to a Code Change Proposal reviewed in the Eighteenth Meeting of the Standing Committee on Fire Protection [220]:

> It was noted that sprinklered buildings that face three streets are given extra credit in permitted area (normally permitted on the basis of increased access for fire fighting) and yet the fire fighting access requirements are waived for sprinklered buildings. It is recommended that Subsection 3.2.2. be changed to permit the same total building area for facing three streets, but not require the three streets.

The Committee agreed to include the proposed changes in the Second Series of proposed changes for public review.

Minutes of the Twentieth Meeting of the Standing Committee on Fire Protection

March 21, 22 and 23 and April 20, 21 and 22, 1994

Following several presentations, Committee deliberations and a review of the public comment from the Second Series of proposed changes developed by the Joint Task Group on Automatic Sprinkler Systems, it was recommended to reconsider the original code change proposals. The following items were recommended upon reconsideration [221]:

General

- "Boxes" to be split into "sprinklered" and "not sprinklered" classifications, whereas they were included as single "box" in the 1990 NBCC.
- Modification of Clause 3.2.2.16.(3)(b) to provide a consistent level of access opening for all storeys of residential occupancy in a building that is not sprinklered.
- Maximum areas for sprinklered buildings no longer vary as a function of number of streets faced, and the permitted areas now to correspond to what were the "facing 3 streets" permitted values from 1990 NBCC. Sprinklered buildings are otherwise required to face one street, with the main entrance required to be located within 15 m of the street. This increased the previous sprinklered area increase ratio (discussed earlier in the report) from 1:2 to 1:3.

Group A, Division 1

Due to the high transient occupant loads and potentially low lighting levels in these buildings, the Committee agreed to require mandatory sprinklering for this type of building regardless of size.

Group A, Division 2

As a result of the diversity of occupancies in this group, it was difficult to assess risk. It was believed that smaller buildings presented a lesser hazard than Division 1 occupancies and would be easier to evacuate. The Committee agreed to require sprinkler systems in buildings greater than two storeys in building height.

In addition, it was agreed that Group A, Division 2, any area, sprinklered be permitted up to 6 storeys (was previously 5 storeys).

Group A, Division 3

It was considered unreasonable by the Committee to require all Group A, Division 3 buildings to be sprinklered. The Committee agreed that sprinklers be an option for certain buildings 2 storeys or less and be mandatory for buildings over two storeys in building height.

Group A, Division 4

It was noted that sprinklers are not normally required in open air seating structures. The Committee agreed to not require sprinklers in open air parts of a structure, but that they should be installed in enclosed areas (i.e., below tiered seats).

Group B, Division 1 and 2

Unassisted evacuation was considered a high risk with these occupancies that may result in substantial loss of life. The Committee agreed that all Group B occupancies be sprinklered regardless of size.

In addition, it was agreed that Group B, Division 1, up to 3 storeys, sprinklered, noncombustible be added as a new Article. The 1990 NBCC only had any height/any area specification for Group B, Division 1 occupancies.

Group C

This occupancy Group prompted the most substantial degree of comment, primarily due to the identified risks. Residential occupancies are where the most number of fires occur, most likely to have occupants or visitors with physical disabilities, and can contain the very young and old, who would be at risk from a fire in the premises they occupy. As a result of these considerations, there was support to require sprinklers in all residential buildings; however, there was concern relative to the feasibility of sprinklers

in small municipalities and rural areas. The Committee agreed that all residential buildings over three storeys in building height be required to be sprinklered throughout.

In addition, it was agreed that Group C, up to 4 storeys, combustible construction, sprinklered building areas for 1, 2, 3 storeys, facing one street be increased in proportion to the 4-storey areas incorporated into the 1990 NBCC.

Group D

The Committee considered that Group D buildings presented a lower risk to human life than most other occupancies. The Committee agreed that sprinkler systems would be optional in Group D buildings up to six storeys in building height.

Group E

The Committee agreed not to change the existing requirements relative to Group E buildings since they already required sprinklers for buildings in excess of three storeys and 1500 m^2 in building area.

In addition, the Committee agreed to modify the area limit for a three-storey mercantile building facing three streets by increasing the value from 1200 to 1500 m^2, allowing noncombustible or 45-minute-rated combustible construction for this size of building without having to develop a new Article. This change did not go to public review. It originated from a proposal by Rush during the Thirteenth Meeting of the Standing Committee on Fire Protection in March 27 and 28, 1990, discussed earlier in this section.

The Committee also agreed to change Group E, any height, any area, sprinklered floor assembly and mezzanine fire ratings as follows:

- Reduced floor assembly rating from 3 hour to 2 hour.
- Reduce mezzanine rating from 1.5 hour to 1 hour.

Group F, Division 1

It was noted that small high hazard buildings are normally in remote areas and the hazard associated with these occupancies relates to explosions, for which sprinklers would not likely be beneficial. Therefore, the Committee agreed that only buildings greater than 1 storey in building height and 800 m^2 in building area require sprinklers.

In addition, it was agreed that Group F, Division 1, up to 4 storeys, sprinklered floor assembly and mezzanine fire ratings be changed as follows:

- Floor assembly rating reduced from 3 hours to 2 hours.
- Mezzanine ratings reduced from 1.5 hours to 1 hour.

Group F, Division 2

The fire load of this classification resembled that of mercantile (Group E). Therefore, the Committee agreed to require sprinklers in these buildings where greater than three storeys in building height and 1500 m^2 in building area.

In addition, it was agreed that Group F, Division 2, any height, any area, sprinklered floor assembly and mezzanine fire ratings be changed as follows:

- Floor assembly rating reduced from 3 hours to 2 hours.
- Mezzanine ratings reduced from 1.5 hours to 1 hour .

With the lowering of the assembly ratings under Article 3.2.2.67., this necessitated removal of redundant classification for Group F, Division 2, up to 6 storeys, which also required 2-hour rated construction.

Group F, Division 3

The fire load of this classification resembled that of office occupancies (Group D). Therefore, the Committee agreed to require sprinklers in these buildings where greater than 6 storeys in building height.

Occupancy Summary

The following table was provided in the meeting minutes to summarize the building heights and areas for different occupancies that would be required to be fully sprinklered (S) [221]:

Occupancy	1 storey	2 storeys	3 storeys	4 storeys	5 storeys	6 storeys	over 6 storeys
A Division 1	S	S	S	S	S	S	S
A Division 2	2 400	1 200	S	S	S	S	S
A Division 3	6 000	3 000	S	S	S	S	S
A Division 4	Usually	not	required				
B Division 1	S	S	S	S	S	S	S
B Division 2	S	S	S	S	S	S	S
C	No limit	No limit	6 000	S	S	S	S
D	No limit	No limit	7 200	5 400	4 320	3 600	S
E	1 500	1 500	1 500	S	S	S	S
F Division 1	800	S	S	S	S	S	S
F Division 2	1 500	1 500	1 500	S	S	S	S
F Division 3	No limit	10 800	7 200	5 400	4 320	3 600	S

The Committee recommended that all proposed changes be incorporated into the 1995 NBCC.

8.14 2005 NBCC

In 2005, the National Building Code (2005 NBCC) was substantially revised to incorporate an objective-based framework. This framework defined the high-level Code objectives, derived from the existing legacy requirements. This change was intended to improve clarity of the requirements, reduce complexity and be more responsive to innovation.

The objective-based format was developed through a bottom-up analysis where the existing legacy requirements were analyzed by defining the underlying application, intent, functional requirements and objective(s) of the requirements. The development of the intent statements was predicated on acceptance of the existing requirements.

The result was a formulation and grouping of congruent objectives considered inherent to the existing requirements. It is these objectives that define the high-level goals of the code. Thus, by inference, the existing requirements meet these objectives and are deemed acceptable solutions.

No specific changes were made during the preparation of the 2005 code relative to height and area limits, other than identification of future study relative to an analysis of the existing requirements in Subsection 3.2.2. However, these were deferred due to limited time and resources.

During this Code change cycle, the objectives, functional statements and intents related to Subsection 3.2.2. of the Code were defined and provided additional information that could be used to better understanding the application of the height and area limits.

Minutes of the First Meeting of the Standing Committee on Fire Safety and Occupancy

March 6 and 7, 1997

A "triage" of outstanding issues was included in the minutes of the First Meeting of the Standing Committee on Fire Safety and Occupancy, but were deferred for future consideration. One of the outstanding items was "Fire protection for structural elements of buildings by height and area". The priority, disposition and outstanding action related to this item was as follows [222]:

Number 1 **CodeRef** B—3.2.2. **Letter...min** public comment 1988 27.8(7)(e) FP **Committee** FP

Subject

Fire protection for structural elements of buildings by height and area

Priority

high

Work to do

Disposition

Pending

Analyze existing requirements for anomalies and lack of uniformity. Review classification system. Separate out sprinklered building requirements. Develop a more concise and logical system.
Consider using categories for construction types rather than spelling out in detail all the variations
Review the use of the terms combustible and noncombustible construction in the code for possible simplification.

Progress and comments

WhoDoes staff **TimeRequired** **CompletionDate**

Minutes of the Third Meeting of the Standing Committee on Fire Safety and Occupancy

February 15, 16 and 17, 1998

Subsection 3.2.2. was reviewed during the Third Meeting of the Standing Committee on Fire Safety and Occupancy relative to the development of intent statements. The following was considered at the meeting [223]:

> **3.8.5. Review of portions of Subsection 3.2.2.**
>
> Staff summarized the content of Subsection 3.2.2. and the intent records that had been circulated to the committee. The chair asked the committee to use this introductory group of records as an exercise to identify the intents to be used throughout Subsection 3.2.2.
>
> The following general intents were considered by the committee in conjunction with their review.
>
> - An intent to protect property in the building.
> - An intent to limit fire spread from one building to another by limiting building size.
> - An intent to limit the spread of fire throughout a floor area.
> - An intent to provide time for fire emergency responders to be able to attack a fire.
> - An intent to prevent conflagration.
> - An intent "to reduce the probability that occupants will not have sufficient time to safely evacuate the building".
> - An intent to minimize economic dislocation associated with protection of the building stock - i.e., socio-economic impacts of homelessness and job loss.

Two draft intent statements were originally reviewed and it was agreed that a more productive approach would be to establish intent statements based on an analysis of specific provisions. Following this, seven intent statements were developed.

Minutes of the Fourth Meeting of the Standing Committee on Fire Safety and Occupancy

May 10, 11 and 12, 1998

The Committee reviewed the seven intent statements developed during the previous meeting. Two additional intent statements had been added since the meeting, resulting in nine intent statements. The nine intent statements are as follows [224]:

1a To reduce the probability of collapse caused by fire during the time required to achieve occupant safety. Root objective is "safety".
1b To reduce the probability of collapse caused by fire during the time required for emergency responders to perform their duties. Root objective is "safety".
1c To reduce the probability of damage to property resulting from collapse caused by fire. Root objective is "subject property protection".

2a To reduce the probability of fire spreading from a lower storey of a building to an upper storey during the time required to achieve occupant safety. Root objective is "safety".

2b To reduce the probability of fire spreading from a lower storey of a building to an upper storey during the time required for emergency responders to perform their duties. Root objective is "safety".
2c To reduce the probability of damage to property resulting from fire spreading from a lower storey of a building to an upper storey. Root objective is "subject property protection".

3a To reduce the probability of fire spreading within a storey during the time required to achieve occupant safety. Root objective is "safety".
3b To reduce the probability of fire spreading within a storey during the time required for emergency responders to perform their duties. Root objective is "safety".
3c To reduce the probability of damage to property resulting from fire spreading within a storey. Root objective is "subject property protection".

The applicability of the intent statements was tested by examining sample requirements from Subsection 3.2.2. The analysis identified additional items to be considered by the Task Group. These are summarized as follows [224]:

Is it valid to relax the fire-resistance rating of building elements of noncombustible construction in a building that could be of combustible construction?

In Clauses 3.2.2.40.(2)(b), and 3.2.2.59.(2)(b) and (c), and in the preamble to Sentence 3.2.2.80.(1) the NBC establishes an equivalency between combustible construction with a fire-resistance rating and unrated noncombustible construction. The standing committee would like to be convinced of the validity of this considering that the former resists collapse but might contribute to spread of fire while the latter does not contribute to the spread of fire but is not designed to delay collapse.

It was agreed that staff had sufficient direction to complete a full analysis of Subsection 3.2.2. relative to attribution of the intent statements. This was completed, revised and agreed through the development of a table of 3.2.2. provisions and attributed intent statements.

Minutes of the Tenth Meeting of the Standing Committee on Fire Safety and Occupancy

September 27, 28 and 29, 2000

At the Tenth Meeting, the Compartment Work Group of the Committee on Fire Safety and Occupancy considered two outstanding items related to the "boxes" in Subsection 3.2.2. as shown below [225]:

Work Group	Compartmentation	Work Group Supp.	Status	Pending
NBC—3.2.2.	**Fire protection for structural elements of buildings by height and area**			public comment 1988
032	Analyze existing requirements for anomalies and lack of uniformity. Review classification system. Separate out sprinklered building requirements. Develop a more concise and logical system.			
2 To be incorporated in next edition if approved		**b** Change will facilitate conversion to objective based code {includes reconciliation discrepancies; deletion of unnecessary provisions; addition of omissions		

Work Group	Compartmentation	Work Group Supp.	Status	Pending
NBC—3.2.2.	**Reorganization of 3.2.2.**			
033	Analyze existing 3.2.2. for discrepancies and similarities. Develop an alternative approach preferably in tabular form. Consider using categories for construction types rather than spelling out in detail all the variations.			
2 To be incorporated in next edition if approved		**b** Change will facilitate conversion to objective based code {includes reconciliation discrepancies; deletion of unnecessary provisions; addition of omissions		

As noted below, the Workgroup deferred these items due to insufficient time [225]:

> **3.2.2** The work group recommended that all proposals to reorganize or review the technical content of Subsection 3.2.2. be deferred until the next code cycle. The committee agreed that there was insufficient time to give this material a thorough review.

8.15 2010 NBCC

The 2010 edition of the National Building Code (2010 NBCC) incorporated a new classification, Group B, Division 3, Care Occupancies. Height and area limits were established for buildings of this occupancy classification. Five “boxes” were added, all required mandatory sprinklering, heights ranging from 1 to unlimited storeys, and areas ranging from 600 m² to unlimited. Two of the new “boxes” required noncombustible construction.

9.0 IMPLICIT RISK ANALYSIS

This report presents a chronological compilation of the development of fire-related building size limits from early Rome to the present in Canada, and is intended to provide a basis to establish the implicit risk associated with the building size limits in the current National Building Code of Canada.

The development of these limits was based on some degree of risk assessment; however, in some cases, they were based on risk perception or without any risk basis whatsoever, and formulated through arbitrary means. Knowledge of this approach provides the information necessary to re-address the risk of building size in light of current knowledge, capability, materials and methods.

The implicit risks, mitigating measures and intended impact of those measures are summarized in the following sections from each significant era covered in this report.

9.1 EARLY TIMES

The risk of conflagration in Rome and Early London was addressed through limitations on building height and type of construction. Nero's regulations required every building to be enclosed by "its own proper walls", which implied a degree of spatial separation in reducing the risk of fire spread. The Assize of Buildings in early London, conversely, permitted neighbouring buildings to be connected provided they are separated by a common stone wall 3 feet thick. This wall was one of the earliest references to a firewall and was intended to act as a barrier to limit the risk of fire spread where is was not practical to physically separate buildings.

Following the great fire of London in 1666, an act was passed for rebuilding the City of London, with requirements to reduce the risk of fire spread and conflagration. These requirements included noncombustible exterior walls and roofs, limits on location of hazardous occupancies, building height relative to type of construction, and party walls; and were intended to more precisely address the hazard of fire spread associated with differing conditions. These requirements were further refined and broadened in scope until the 1774 Act.

Following the great fires of Rome and London, building regulations were developed primarily to address the risk of conflagration and limit this risk by requiring noncombustible exterior construction, spatially or physically separating structures. The risk basis for this era is summarized in **Table 8**.

Table 8: Risk Basis - Early Times.

Consideration	Overview
Implicit Risk:	• Fire spread from building to building resulting in conflagration
Mitigation:	• Spatially separated buildings • Stone or brick walls between buildings (primarily houses) and stone or brick exterior building walls
Intended Result:	• Limit fire spread to building of origin (primarily houses)

9.2 AREA AND CUBIC CAPACITY CONCEPT

The Building Act of 1774 was the first in London to limit building area and height as a function of type of construction. These limits were revised and refined up to the Building Act of 1844, which was the first act to limit cubical capacity of warehouses to 200,000 cubic feet, following several large warehouse fires. This cubic value was approximately equivalent to the combined height and area limit of warehouses in the

1774 Act. The intent of the development of the early height and area limits was not specified in any of the documentation reviewed. However, their development coincides with a general increase in building size and the proliferation of storage warehouses in London in the late eighteenth and early nineteenth centuries. The increase in building size resulted in fires growing beyond the ability of responding fire services to control, increasing the risk of conflagration.

The cubic capacity was further refined in the Building Act of 1855 in consultation with James Braidwood, the first Chief of the London Fire Brigade. Braidwood had been studying fire brigade capability and concluded that "with a well-organized and properly equipped fire brigade it is found that sixty feet is the greatest height at which a building can be quickly protected, and that the cube of 60, or 216,000 cubic feet, is the largest cubical capacity which can be protected with reasonable hope of success after a fire has once come to a head". This was an important concept, providing a direct link between the limit in the Building Act and the capability of a "well organized" and "properly equipped" fire brigade. Braidwood does not qualify what is meant by "well organized" and "properly equipped"; however, given his affiliation at the time, the London Fire Brigade is assumed to be the benchmark in terms of "well organized" and "properly equipped". In addition, the work done by Braidwood in setting building size limits would be carried forward to today.

A Bill in the early 1870's proposed an increase in the cubic capacity of buildings to 300,000 cubic feet and consideration of the concept of horizontal party-walls, which was a precursor to floor-to-floor fire separations. The Bill was eventually defeated in parliament; however, the greater cubic capacity became an acceptable risk in the insurance industry relative to underwriting of existing warehouses and sheds. It would also become the basis for limits imposed by the insurance industry following the Chicago and Boston conflagrations in the early 1870's.

The risk basis for this era is summarized in **Table 9**.

Table 9: Risk Basis – Cubic Capacity Concept.

Consideration	Overview
Implicit Risk:	• Increased potential for conflagration • Single buildings' (warehouses') sizes resulting in fire size beyond the capability of the responding fire department
Mitigation:	• Containment by limiting height/volume assuming fire service intervention • Height of 60 to 65 ft and cubic capacity of 216,000 feet
Intended Result:	• Limit fire spread to individual buildings

9.3 INSURANCE RATING SYSTEM AND MODEL BUILDING CODES

The insurance rating schedule considered building size variations as a function of risks associated with occupancy and type of construction, balanced against measures intended to limit fire growth and spread.

The Chicago and Boston conflagrations occurred just over a year apart in 1871 and 1872, resulting in insolvency of a large number of insurance companies. A large number of the remaining insurance companies were based in London and had significant influence over reforms to the system of rate setting relative to building construction, which was intended to reduce their losses (risk). The reforms resulted in the development of a schedule of rates with an acceptable level of risk inherent to certain building characteristics. These combined characteristics were considered the standard to which basic rates were set and any building with these characteristics was referred to as a "standard building". Any deviation from the standard was considered to increase the fire hazard of the building, resulting in higher rates.

Design features beyond those of a standard building that were considered to reduce the fire hazard resulted in reduced rates.

The “Standard Rate Schedule” was issued in January of 1873 by the New York Board of Fire Underwriters and defined a height limit of 60 ft and area limit of 5,000 square feet for a standard building (warehouse). These limits combined are volumetrically equivalent to the 300,000 cubic feet considered acceptable at that time by London-based insurers relative to existing warehouses. At the time these limits were established, the city of New York had a standard lot size of 25 ft wide by 100 ft deep, and warehouse district buildings were permitted to cover 100% of a lot and in many cases covered more than one lot. Thus, buildings covering two lots could have maximum footprint areas of 5,000 square feet, which rationalized specifying the building size limits in terms of height and area rather than cubic capacity.

From 1873 to 1905, in addition to height and area limits, the rating system evolved to consider additional features such as occupancy, type of construction, access and sprinklers and alterations to the rates associated with those features. Occupancies were classified as a function of hazard and attributed rates accordingly. Two types of construction developed, fireproof and non-fireproof. Fireproof buildings were considered a reduced fire hazard and attributed lower rates than non-fireproof, the difference being a function of contents and building. Accessibility was identified as a key factor in reducing the consequences of fire and having an associated rate reduction on the basis that access to more than one side of a building enhanced the fire departments ability to reach and control the fire.

The efficiency and reliability of sprinklers took several decades to become fully appreciated by underwriters. Reductions in rates were initially small, but increased within a short period of time following the development of the first sprinkler standard (NFPA 13) in 1896. Design of systems in conformance with this standard increased reliability and permitted a 30 percent reduction in rates. This later became fifty percent for standard sprinkler equipment and up to sixty-six percent for a supervised system. This gradual increase in rate reduction was attributed to an increase in reliability and system experience in reducing the hazard of fire spread.

Building area was attributed a rate as a function of type of construction and building height. The standard area for non-fireproof buildings was 5,000 square feet. The standard area for fireproof buildings was 10,000 square feet. Increases in area beyond the standard resulted in increased rates as a function of type of construction and building height. These increases were incremental and gradual. However, there were areas at which the risk was considered too high to insure. These were not explicitly stated, but based on underwriter judgment.

The risk associated with area was related to potential fire size and fireproof buildings were considered to be half the risk (permitted double the area) of non-fireproof buildings. However, the risk associated with area was considered more gradual than for height, which is discussed below.

Building height was also rated as a function of type of construction. However, the risk was considered to increase significantly where the height exceeded the capability of the responding fire service. For non-fireproof buildings, the rating schedule considered heights above the seventh floor as beyond the reach of responding fire service and assumed that any contents above this level would perish in a fire. For fireproof buildings, the rating schedule considered heights at and above the 15th floor as hazardous and significantly increased the rate. At the time the rating schedule was developed, the typical reach of a fire hose stream from the exterior was approximately 7 storeys. Thus, the risk was based on fire service capability, and the limits were based on interior and exterior reach of a hose spray from the street, corresponding with the capabilities of the fire service in the late 19th and early 20th centuries.

The rating system deterred substandard construction and associated risk through monetary penalties, which for many was a key motivating factor. Over 40 years of development and experience, the rating

system evolved to address the specific risks associated with fire growth and spread, and more precisely linked mitigating measures to those risks. These measures were translated into city-based regulations over the same time period, and would eventually become the basis of the requirements and limits in US and Canadian Model Codes.

The first US Model Code was developed between 1890 and 1905, when it was published by the National Board of Fire Underwriters. The basis of the requirements in this Code was the set of mitigating measures developed as part of the insurance rating schedule, data from a survey of building regulations in foreign countries, fire loss experience and firefighting capability at that time. The resulting Model Code limits had the same base building height and area limits as the insurance rating schedule, but permitted a greater range of variations to those limits based on occupancy, type of construction, access and sprinklering. The base limits were 5,000 square feet for non-fireproof buildings, and 10,000 square feet for fireproof buildings, both at a maximum height of 55 feet. These limits were considered to be within the capability of most city fire departments.

A report prepared in 1913 by Ira H. Woolson, Consulting Engineer for the National Board of Fire Underwriters, summarized the results of a study of allowable heights and areas for factory buildings in the United States. The study was based on a survey of fire marshals and fire chiefs in the United States representing cities of over 20,000 population. The results were consistent with those of the insurance rating schedule, 1905 NBFU Model Code, New York City and Chicago City limits. The similarities were not surprising given the time since the development of the insurance rating schedule limits, the number of buildings constructed in conformance with those limits and the experience of the fire departments fighting fires in those buildings.

The National Board of Fire Underwriters published several editions of their Model Building Code between 1905 and the 1940's, and the base limits in all these editions remained relatively unchanged. The 1915 edition of the NBFU Model Code provided an important discussion linking firefighting capability to building size, noting that "five stories is the maximum height to which water can be thrown effectively by a fire department from the street level, and that 50 feet is the maximum distance inside a building which can be reached by a stream through a window". A handbook published at approximately the same time period noted that 5,000 square feet, or a rectangle 50 by 100 feet "is as large an undivided area as the experience of the New York Fire Department indicates to be within the capacities of effective fire department operations".

A model code, "Recommended Minimum Requirements for Fire Resistance in Buildings" was developed by the National Bureau of Standards in the United States in the 1930's, and included height and area limits consistent with those published by the National Board of Fire Underwriters and National Fire Protection Association at that time. The height and area limits in the first National Building Code of Canada (1941 NBCC) were largely based on the limits in these documents.

The risk basis for this era is summarized in **Table 10**.

Table 10: Risk Basis – Insurance Rating System and US Model Codes.

Consideration	Overview
Implicit Risk:	• Fire size beyond the capability of the responding fire department • Significant property loss • Increased potential for conflagration
Mitigation:	• For buildings of non-fireproof construction, height of 5 to 6 storeys (50 to 60 ft) and base area of 5,000 square feet • For buildings of fireproof construction, height of 10 to 12 storeys (100 to 125 ft) and base area of 10,000 square feet • Increases in height and area based on type of construction, occupancy, streets facing and sprinklering
Intended Result:	• Limit fire spread to individual buildings

9.4 CANADIAN BUILDING SIZE LIMITS

The risk basis associated with the modern height and area limits are discussed in a Canadian context. Minutes of committee meetings for the development of US Codes were not available at the time of writing this paper. However, it is assumed that the risk considerations in the development of the NBCC were similar enough to be also representative of those of the US Model Codes.

The first Canadian model building code was published in 1941 and the building size limits were substantially based on a report published by the National Bureau of Standards (the predecessor to the National Institute of Standards and Technology in the US).

The height and area limits were revised during the development of the 1953 NBCC based on the concept of risk associated with fire load and occupancy. The risk was addressed based on a methodology developed by B.L. Wood.

Wood differentiated height as a function of type of construction and linked height limits for combustible construction to firefighting capability. Wood noted that the height limit for noncombustible construction was not necessary where the structure was intended to withstand burnout. For combustible construction, Wood noted that 4 storeys was the limit associated with firefighting capability and above that height hose trajectory through a window was nearly vertical.

Wood's method considered the hazard of area as a combination of conflagration and life risks and developed a risk index to quantify the risk in a relative manner as a function of occupancy and type of construction. The conflagration risk was based on a quantification of occupancy (fuel load) and combustibility of structure balanced against measures to resist fire spread (i.e., fire-rating of the compartment intended to contain burn-out). The life risk was based on occupant load and ability to evacuate.

Wood's method was used as the basis to develop the initial table of height and area limits intended for the 1953 NBCC; however, the committee and industry were concerned with the resulting number, as these limits were considered a significant departure from the limits in the 1941 NBCC. The result was a table of limits that were a combination of Wood's method with arbitrary alterations to address the concern of departure from the previous table of limits (1941 NBCC), and a commitment to review the limits during the 1960 NBCC code cycle. These new limits had the same basis as the old limits, but re-interpreted relative to Wood's consideration of fire load and occupancy.

The result in the 1953 NBCC was a set of height and area limits established somewhat on the risk that some buildings may become completely involved and should be limited in height and area to a size within the capability of the responding fire department, and that other buildings were considered sufficiently resistant to contain the complete burn-out of a storey and permitted greater heights and areas accordingly. These revisions were not universally acceptable, but were considered a temporary and reasonable compromise.

Similar to previous Codes, the 1953 NBCC retained the area increases for number of streets facing and provision of sprinklers. In addition, increased areas and heights were permitted where the construction was considered more resilient (i.e., noncombustible and fire-resistant).

Development of the 1960 NBCC considered several significant conceptual changes to the height and area limits, including simplification of the arrangement of the limits to be more realistic and consideration of short-term and long-term approaches to the limits. The table of limits was changed into “spelled-out” versions, which allowed the deletion of unrealistic limits that previously existed for the purpose of filling in table squares. The spelled-out versions contained detailed construction specifications that eliminated the previous 7 types of construction in the 1953 NBCC, which were considered to be too rigid. The new construction specification format introduced the concept of combustible and noncombustible construction and definitions/standard tests to differentiate between the two types.

In developing changes to the construction specifications, it was noted that fire resistive construction was intended to limit fire spread from floor to floor and where floors of buildings could be adequately separated, there was little reason to limit areas. At that time fire resistive construction was required to be noncombustible in addition to having a rating. It was suggested that buildings that cannot contain a burn-out pose a conflagration risk, endangering the lives of firefighters and people within and adjacent to the building. Buildings greater than 6 storeys in height were considered difficult to fight and “virtually on their own”. However, similar defining points did not exist for increasing areas, which were considered to present more of a degree of increasing hazard.

Two approaches to height and area limits were considered in the development of the 1960 NBCC in recognition of that the 1953 Height and Area Limitations Table was a compromise. A short-term approach was developed to consider relatively minor revisions to the existing limits, and was considered to be achievable within the current code cycle. A framework for a long-term approach was developed to consider a revision to the entire height and area limit format and values. The long-term approach was structured to directly address the hazards associated with building size, but was considered to require additional study that would carry beyond the current code cycle.

The long-term approach to establishing limits was premised on identifying hazards known to exist. Four hazards related to building size were life, inaccessibility, excessive combustible materials, and danger of collapse for larger buildings. Several considerations were identified for each of the four hazards, and sample tables of limits provided to illustrate application of the approach. In developing the long-term approach, a fundamental consideration was that the hazard of area is more gradual than height, which is considered to have more defined points of increased hazard. The points of increased hazard primarily relate to firefighting capability and equipment.

Changes to the height and area limits during the 1965 NBCC code cycle were relatively limited as a result of an economic downturn and austerity measures implemented by the Government of Canada. It was determined that the 1965 NBCC would be “an adjusted version of the 1960 Code and no major changes will be made”. The changes were limited to minor adjustments to area limits for some occupancies and changes to the construction criteria for the “boxes” as a result of a change in the definition of the term

"noncombustible". The two construction types introduced during the 1960 NBCC code cycle, noncombustible and combustible, were more definitively prescribed.

During the 1965 NBCC code cycle, Ferguson presented a workshop paper on the principles of fire protection at the 1964 Building Officials Conference. Ferguson identified the complementary nature of fire protection and firefighting, and suggested that the structural integrity of a building be maintained for a period of time required for occupant escape and the protection of firefighters, but no specific times were noted. It was noted that greater structural stability is required for higher buildings than for smaller buildings, particularly relative to height, and increased fire-resistance would provide the fire department with more time to operate. It was suggested that for buildings of a certain height, collapse is considered unacceptable and the risk of collapse be reduced to an "infinitesimal" quantity by providing a high degree of fire-resistance. However, it was cautioned that risk be re-examined before taking further precautions beyond those initially developed to address the risk. This comment was specific to the consideration of sprinklering in addition to fire-resistance in addressing the risk of fire load in high buildings.

The development of the 1970 NBCC included provisions for covered malls, which required reconsideration of the definition of a building as a single unit. The provisions of a covered mall permitted the joining of two buildings by a protective cover/enclosure. In addition, areas were re-interpreted on a reduced storey basis to reduce the potential for erroneous interpolations.

As part of the development of the 1975 NBCC, Ferguson committed to develop a guide to Part 3 and developed a hand-written draft version. The draft included some basic concepts related to building size. Ferguson noted that the fire protection of buildings related to spaces: evacuating occupants from a space, confining fire to the evacuated space, and extinguishing fire in the space. He further noted that the building has historically been identified as the space upon which the control measures have been applied; however, the trend was moving away from the building as the control space to the compartment. He noted that a better fit between control and hazard is achieved as the space basis for regulation is reduced.

Two committees were formed in preparation of the 1975 NBCC to address structural requirements based on heights and areas and fire performance requirements for roof assemblies. The committee dealing with roof assemblies developed several recommended changes, which were not adopted by the Standing Committee. However, the Standing Committee did accept minor changes to roof assemblies to consider fire retardant treatment in lieu of a fire-resistance rating. No specific recommendations from the structural height and area committee were adopted.

In addition, it was recommended by the Standing Committee on Use and Occupancy and incorporated into the 1975 NBCC that all floor areas in high buildings exceeding 10,000 square feet be sprinklered, recognizing the difficulty of fighting fires in large open floor areas in high buildings. In addition, high buildings were required to be constructed of non-combustible construction.

Development of the 1977 and 1980 NBCCs included conversion from imperial to metric units, and minor revisions to the construction specifications associated with the height and area limits. In addition, basements and cellars were limited to 5,000 square feet in area. Areas larger than this were considered too large for effective firefighting and the City of New York considered 6,000 square feet the largest area they could justify for effective firefighting in a basement or cellar. It was also decided that a storage garage could be considered a separate building under certain conditions where separated from the remainder of the building by a substantial fire separation considered a "horizontal firewall".

Development of the 1985 NBCC considered changes to the covered mall requirements, moving away from the concept of the mall covering as connecting two buildings to it forming a large public corridor in one single building. In addition, the determination of building height for residential buildings was considered relative to sloping sites.

A list of action items was developed during the initial stages of the 1990 NBCC cycle. These action items included review of structural fire-resistance requirements and terms, and combinations of combustible construction in Subsection 3.2.2. The topic of combinations of combustible construction was considered a high priority item, that could not be addressed within the time period of the development of the 1990 NBCC. It was noted that the 1995 NBCC code cycle was a more likely target.

A significant code change in preparation of the 1990 NBCC proposed that Group C buildings of combustible construction be permitted to be 4 storeys in building height. The proposal was based on provision of 1-hour floor assembly fire separations, 1-hour suite-to-suite and suite-to-corridor fire separations. The National Research Council of Canada at the time noted the following relative to this change:

> *Currently there appears to be little evidence of fires spreading beyond the suite of fire origin. The proposal to permit 4 storey combustible residential buildings allows for 15 minute increase in the level of structural fire-resistance rating and other fire protection systems will also be required.*

It was further noted by the Standing Committee on Fire Protection that:

> *it is evident that the compartment to compartment fire separations are performing as intended and that the problem associated with fires in residential occupancies is that of life loss in the room of fire origin.*

In addition to the increase in height, an increase in area was also permitted for residential buildings 3 storeys and lower where enhanced fire resistance is provided.

Development of the 1995 NBCC involved consideration of mandatory sprinklering requirements and increase in building height to 4 storeys for Group D and E occupancies in buildings of combustible construction. In addition, as part of the mandatory sprinklering analysis, it was noted that sprinklered buildings that face three streets are given extra credit in permitting area, but the fire fighting access requirements are waived for sprinklered buildings. It was recommended that Subsection 3.2.2. be changed to permit the same total building area for facing three streets where the building is fully sprinklered, but not require the three streets.

Development of the 2005 NBCC involved a substantial revision to the format of the Code to incorporate an objective-based framework. As part of the development of this framework, several intent statements related to the construction requirements of the Code were developed and intended to provide additional information that could be used to better understanding the application of the height and area limits. These intent statements related to life safety within a storey, limiting fire spread from storey-to-storey, reducing the probability of collapse, reducing the probability of damage to property, and preventing conflagration.

Changes to the 2010 NBCC were limited to the addition of a new occupancy type, Group B, Division 3, Care Occupancies, and associated height and area limits, which ranged from 1 to unlimited storeys and 600 m^2 to unlimited area.

The risk basis for this era is summarized in **Table 11**.

Table 11: Risk Basis – Canadian Height and Area Limits.

Consideration	Overview
Implicit Risk:	• Inadequate evacuation • Full building involvement • Fire size beyond the capability of the responding fire department • Collapse of high buildings • Increased potential for conflagration
Mitigation:	• For buildings of combustible construction, height of 4-6 storeys (50 to 60 ft) • For buildings of noncombustible construction, no rating, height of 4-6 storeys (50 to 60 ft) • Area limits vary as a function of occupancy, type of construction, fire-resistance, streets facing and sprinklering. Areas greater for buildings of noncombustible construction • Maximum area of single fire compartment limits consistent with insurance rating system
Intended Result:	• Combustible buildings: limit fire spread to the building of origin • Noncombustible buildings (no rating): limit fire spread to building of origin • Noncombustible buildings (rating): limit fire spread to the storey of origin. • Reduce the probability of building collapse

10.0 CONCLUSION AND RECOMMENDATIONS

The risk associated with building size has historically been the spread of fire to involve more than one building (conflagration). Risk perceptions evolved over the historic development of the codes to include limiting full building involvement and collapse of high buildings. For lower buildings of combustible construction, where the assumption has been that smaller buildings may become fully involved and spread fire to adjacent buildings, the association of risk has remained largely unchanged since the limits were conceptualized.

Building size has been slightly adjusted over time through a balance of passive fire protective features and active firefighting measures as a function of occupancy type, with the objective of limiting fire size to within the capability of a responding fire department. This has been effected through limitation on building height and area and variations to those limits with additional beneficial features such as construction resilience, sprinklering and improved access.

The base height and area limits have remained relatively constant for nearly 160 years, with some variation in concept recognizing containment of fire to a single storey under certain conditions and greater area permitted in sprinklered buildings, but only required to face one street. Therefore, the height and area limitations evolved as reflected in the fire department's ability to limit conflagrations given the fire service capabilities in London and New York dating back the origin of the requirements in the late nineteenth and early twentieth centuries.

The basic height limit consistently specified over this period of time was 5 to 6 storeys or 50 to 60 ft (15 to 18 m) and primarily related to the reach of firefighting equipment from the building exterior. Beyond this height it was assumed that fire fighters would be required to fight the fire from the building interior, requiring an additional degree of safety to do so, or allow the fire to burn-out. This additional degree of safety was considered to be provided by construction considered to be more fire resilient.

Similarly, the basic area limit consistently specified over this period of time was 5,000 ft^2 for buildings of combustible construction and 10,000 ft^2 for buildings of noncombustible construction and primarily related to experiential firefighting ability to control fires of a certain size.

Over the period of time the building size limits have been established:

- firefighting techniques, equipment, response and overall capability have advanced significantly;
- construction methods and materials have advanced; and,
- analysis techniques have evolved significantly.

Knowledge of the implicit risk associated with the development of the building size limits allows for reconsideration of those limits in light of these advancements, and facilitates the development of alternative solutions to limit the risk of building size consistent with that intended by the prescriptive building size limits.

The current building size limits were founded on the assumption of the building as the unit of control, which was an appropriate assumption at a time when the risk of conflagration as a result of building-to-building fire spread was clear and probable. However, industry advancements have reduced the risk of conflagration to such an extent that consideration of the building as the unit of control may no longer be appropriate. This was noted by Ferguson in the 1970's as follows [21]:

> *The trend is toward the choice of smaller spaces for regulation purposes [and] as the space basis for regulation is reduced, a better fit between control and hazard is achieved.*

Ferguson further noted that this trend is in keeping with the purpose of the NBCC – not that buildings be smaller, but that the concept of building as the control unit be abandoned and that a more effective unit of control be smaller spaces within the building.

Based on the information presented in this report, the following is recommended relative to further research relating to the building size limits in the National Building Code of Canada:

- Examine how the degree of acceptable risk has changed during the period of time the building size limits were developed. Acceptable risk is not finite and can change as society's aversion to risk changes. What may have been acceptable 100 years ago may no longer be acceptable today and vice versa.
- Developed many years ago, the current building size limits have become static relative to industry advancements. This warrants consideration of the knowledge, materials, means and methods developed to limit fire spread that have evolved since the development of the building size limits.
- Reconsider the "long term" approach to building size limits, developed during the 1960 NBCC code cycle, but abandoned during the 1965 code cycle due to austerity measures. This approach provided a quantifiable risk basis to building size limits, and could be updated and implemented based on advancements since its proposal almost 50 years ago.
- Reconsider whether the "building" as the unit of control is appropriate, or whether individual fire compartments or storeys are more appropriate units of control. As a comparison, the New Zealand building code considers total calorific value relative to firefighting capability and considers this value on a "firecell" basis rather than a "building" basis in setting size limits.
- Reconsider the benefit and reliability of sprinklers in limiting fire growth and spread and develop more representative quantifiable modifiers for building size limits.
- Revise the building size limits in the NBCC (Subsection 3.2.2.) including reconsideration of the requirements related to type of construction (Subsections 3.1.4. and 3.1.5.) and firewalls (Subsection 3.1.10.).
- Re-examine fire department capability relative to the following:
    - Firefighting strategies relative to interior versus exterior attack and degree of safety required to support each approach.
    - Hose stream reach and effectiveness. It is our understanding that this type of research has been conducted or is being conducted at the National Institute of Standards and Technology in the United States.
    - Analysis of new equipment, technologies and methods in firefighting relative to limiting fire size developed since those available when the building size limits were established. An example is aerial ladders with monitors.
- Building areas in the NBCC were established as a function of the capability of a "typical fire department". Note that a "typical fire department" was not defined or quantified in the NBCC in terms of capability. Confirmation that it is reasonable to correlate building area with fire department capability is recommended. This consideration relates to fire load and building height and was originally based on cubic capacity.
- The current area limits were established partly on a fuel load basis, using data from fire load surveys conducted in the 1920's to 1950's. Fire load surveys have been conducted more recently

in Canadian occupancies and could be used to establish statistically representative densities expressed in weight or energy content as a function of floor area.

- Determine of the fire size within the capability of the responding fire department in light of the recommendations outlined above.

Reconsideration of the building size limits in the current NBCC based on the recommendations outlined above will facilitate innovation in Canada without compromising safety.

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Appendix A

Height and Area Tables from the 1941 NBCC

A.1 1941 NBCC Height Limits

TABLE 1 (SECTION 4.5)

MAXIMUM PERMISSIBLE HEIGHTS OF BUILDINGS FOR A GIVEN OCCUPANCY CLASSIFICATION

Note: The more restrictive requirement, either *height* in feet or in *storeys*, shall govern.

Occupancy Group		Division of Occupancy Group (See Art. 4.2.1 for full details)	Types of Construction						
			1A Fire Resistive	1B Fire Resistive	1C Fire Resistive	2 Heavy Timber	3 Masonry and Frame	4 Wood Frame	5 Unprotected Metal or Fire-retardant treated Wood
A	1	*Theatres* and *motion picture theatres*(d)	Unlimited	75 ft.(a)	45 ft.(a) 3 *storeys*	45 ft. 3 *storeys*	35 ft. 2 *storeys*	35 ft. 1 *storey*	35 ft. 1 *storey*
	2	Auditoriums, community halls, etc., including non-residential colleges and schools(c)	Unlimited	75 ft.(a)	55 ft.(a) 4 *storeys*	55 ft. 4 *storeys* (b)	45 ft. 3 *storeys*	35 ft. 1 *storey*	1 *storey*
B	1	Asylums, jails, etc.	Unlimited	75 ft.	Not permitted				
	2	Children's shelters, hospitals, etc.	Unlimited	75 ft.	45 ft. 3 *storeys*	45 ft. 3 *storeys*	35 ft. 2 *storeys*	35 ft. 1 *storey*	1 *storey*
C	1	Dry-cleaning plants employing flammable or explosive solvents	1 *storey*	1 *storey*	Not permitted				
	2	High hazard industrial occupancies	75 ft.(g)	75 ft.	45 ft. 3 *storeys*	45 ft. 3 *storeys*	35 ft. 2 *storeys*	25 ft. 1 *storey*	1 *storey*
	3	Medium hazard industrial and commercial occupancies excluding office buildings	Unlimited	75 ft.	75 ft.(c)	55 ft. 4 *storeys*	45 ft. 3 *storeys*	35 ft. 2 *storeys*	1 *storey*
		Office buildings	Unlimited	Unlimited	75 ft.	75 ft.	55 ft. 4 *storeys*	35 ft. 2 *storeys*	1 *storey*
	4	Low hazard industrial occupancies	Unlimited	Unlimited	75 ft.	75 ft.	55 ft. 4 *storeys*	35 ft. 2 *storeys*	1 *storey*
D	1	Convents, dormitories, etc.	Unlimited	Unlimited	55 ft. 4 *storeys*	55 ft.(b) 4 *storeys*	45 ft.(b) 3 *storeys*	35 ft. 1 *storey*	1 *storey*
	2	Apartment houses, *hotels*, etc.	Unlimited	Unlimited	75 ft.(e) 6 *storeys*	55 ft. 4 *storeys*	45 ft. 3 *storeys*	35 ft.(h) 2 *storeys*	1 *storey*
	3	*One-* and *two-family dwellings*	Unlimited	Unlimited	55 ft. 4 *storeys*	55 ft. 4 *storeys*	45 ft. 3 *storeys*	40 ft. 3 *storeys*	1 *storey*
E	1	Open sheds, *private* barns, *garages*, etc.	Unlimited	Unlimited	55 ft.	55 ft.	45 ft.	20 ft.	45 ft.
	2	Towers, water tanks	Unlimited	Unlimited	Unlimited				
	3	Stands and stadiums, etc.	Unlimited	Unlimited	55 ft.	55 ft.	45 ft.	35 ft.(f)	45 ft.

(a) The *height* in feet of one-storey buildings shall not be limited when such buildings are of *incombustible* construction throughout; also, in one-storey buildings of Type 1C Construction in which *combustible* construction is limited to wood roof *sheathing*, trusses, or purlins, (see Sub-item 4.3.3.2 (d)), the allowable *height* in feet may be increased to a maximum of 75 feet.
(b) Schools and colleges including university buildings shall not exceed two *storeys in height*, and convents or monasteries other than those accommodating only adults shall be considered schools.
(c) When the height exceeds 55 feet or 4 *storeys*, whichever is the more restrictive, all floors shall be constructed of *incombustible* materials; floors immediately above the *basement* or *cellar* shall have a *fire-resistance rating* of at least two hours; and the building shall be subdivided into areas not exceeding 5,000 sq. feet by separations having a *fire-resistance rating* of at least two hours, with all openings in such separations protected by *self-closing* or *automatic fire-resistive closures*.
(d) The main floor of every *theatre* or *motion picture theatre* located in any building of other than Type 1A or 1B Construction shall be located at or near *grade* level when its seating capacity including any balcony or galleries exceeds 300.
(e) The floor level of any room and the exhibition ring of any arena, designed or intended as a *place of assembly* for more than 500 persons, shall be located at or near *grade* level when the building in which it is located is of other than Type 1A or 1B Construction.
(f) In the case of a stand or stadium having a roof, the *height* may be measured from the top of *incombustible* construction where such construction is used for the support of seats.
(g) The *height* of grain elevators and flour mills in Type 1A Construction shall not be limited.
(h) The *height* of buildings of D2 occupancy in Type 4 construction may be 3 *storeys*, but not more than 35 feet if plank walls having a thickness of not less than 3 inches exclusive of any, *sheathing* are used. (See Article 3.2.17).

A.2 1941 NBCC Area Limits

TABLE 2 (SECTION 4.5)

MAXIMUM PERMISSIBLE AREAS (SQ. FT.) OF BUILDINGS FOR A GIVEN OCCUPANCY CLASSIFICATION(a)

Note: Where seats are installed or moved into an *assembly building*, their number in any one room shall be limited as indicated in this table.

Occupancy Group		Division of Occupancy Group (See Art. 4.2.1 for full details)	Types of Construction						
			1A Fire Resistive	1B Fire Resistive	1C Fire Resistive	2 Heavy Timber	3 Masonry and Frame	4 Wood Frame	5 Unprotected Metal or Fire-retardant treated Wood
A	1	*Theatres* and *motion picture theatres*	Unlimited	10,000[b] 1000 seats	10,000[b] 750 seats	7,500 500 seats	5,000 500 seats	3,000 300 seats	5,000 500 seats
	2	Auditoriums, community halls, etc., including non-residential schools, and colleges	Unlimited	20,000[b] 1500 seats	10,000[b] 1000 seats	10,000 750 seats	5,000 500 seats	3,000 300 seats	Unlimited[c]
B	1	Asylums, jails, etc.	Unlimited	25,000	- - - - -	- - - - - Not permitted - - - - - - - - - -			
	2	Children's shelters, hospitals, etc.	Unlimited	25,000	10,000	10,000	5,000	3,000	Unlimited
C	1	Dry-cleaning plants employing flammable or explosive solvents or cleaners	Unlimited	25,000	- - - - - - - - - - Not permitted - - - - - - - - - -				
	2	High hazard industrial occupancies	Unlimited	25,000	10,000	10,000	5,000	5,000[f]	5,000[d]
	3	Medium hazard industrial and commercial occupancies, excluding office buildings	Unlimited	25,000	10,000	10,000	5,000	5,000	Unlimited
		Office buildings	Unlimited	Unlimited	25,000	15,000	7,500	5,000	Unlimited
	4	Low hazard industrial occupancies	Unlimited	Unlimited	25,000	15,000	7,500	5,000	Unlimited[e]
D	1	Convents, dormitories, etc.	Unlimited	Unlimited	20,000	12,000	5,000	5,000	Unlimited
	2	Apartment houses, *hotels*, etc.	Unlimited	Unlimited	25,000	15,000	5,000	5,000	Unlimited
	3	*One-* and *two-family dwellings*	Unlimited	Unlimited	25,000	15,000	5,000	5,000	Unlimited
E	1	*Private* barns and *garages*, etc.	Unlimited	Unlimited	25,000	10,000	5,000	5,000[e]	Unlimited
	2	Towers, water tanks	Unlimited	Unlimited	25,000	10,000	5,000	1,000	Unlimited[e]
	3	Stands and stadiums, etc.	Unlimited	Unlimited	25,000	15,000	7,500	3,000	Unlimited[c]

(a) The maximum permissible *areas* set forth in this table may be increased in accordance with Article 4.5.3.
(b) The *area* and number of seats in a one-storey building shall not be limited when the conditions for unlimited *height* as given in footnote (a) of Table 1 of this Section are fulfilled; provided that the building is unsubdivided except for minor *partitions*, ticket booths, and necessary rooms for sanitary facilities and administrative purposes.
(c) If the building is located in Fire Zone No. 2 or Fire Zone No. 3, and if the *area* is limited to 20,000 sq. feet, untreated wood may be used:
  (i) For roof *beams* or purlins having a minimum nominal size of 6 by 10 inches provided that no part of any such member is closer than 14 feet to any floor or balcony; provided, however, that proximity within the 14-foot limiting distance of an inclined or stepped balcony or tier with fixed seats, or of a level mezzanine or balcony not more than 5 feet wide, shall be permitted.
  (ii) For roof *sheathing* having a minimum nominal thickness of 2 inches, provided all such *sheathing* is not less than 14 feet above any floor or balcony.
  (iii) For girts having a minimum nominal size of 3 by 6 inches.
(d) In Fire Zone No. 3, aircraft hangers may be of unlimited *area* if draft stops are provided so as to divide the roof area into sections not exceeding 3500 square feet. Such draft stops shall extend to the bottom chords of roof trusses.
(e) The *area* shall be limited to 1,000 square feet in the case of a *garage* other than a *private garage*.
(f) The *area* shall be limited to 600 square feet in the case of gasoline service stations, paint shops or factories, *public garages* and storage buildings for paint or petroleum products.

Appendix B

Calculated Height and Area Table and Comparison

OCCUPANCY	LOAD	FIRE RESISTIVE 3 hour	2 hour	1 hour	Non Combustible	Heavy Timber	Ordinary Unprotected	Wood Frame	Factors
Residential	10	-	-	-	8000	8000	5500	4000	2, 1
New NBC		-	-	16000	8000	16000	4000	4000	
Old NBC		-	-	25000	-	15000	5000	5000	
School	10	-	-	-	8000	8000	5500	4000	2, 1
		-	-	16000	8000	16000	4300	4000	
		-	20000	10000	-	10000	5000	3000	
Institutional	10	-	-	-	6000	6000	4000	3000	$1\frac{1}{2}$, 1
		-	-	12000	6000	12000	3000	3000	
		-	25000	10000	-	10000	5000	3000	
Assembly	10	-	-	-	4000	4000	3000	2000	1, 1
		-	-	8000	4000	8000	2000	2000	
			20000	10000	-	10000	5000	3000	
Business	15	-	-	29000	11500	11500	9500	9500	$3\frac{1}{4}$, $2\frac{1}{4}$
				20000	10000	20000	5000	5000	
		-	25000	10000	-	10000	5000	5000	
Mercantile	20	-	-	18000	7000	7000	5500	4000	2, $2\frac{1}{4}$
		-	18000	9000	4500	9000	2000	2000	
			25000	10000	-	10000	5000	5000	
Industrial	25	-	30000	15000	7500	7500	6500	5000	$2\frac{1}{2}$, 3
		-	20000	10000	5000	10000	2000	2000	
		-	25000	10000	5000	10000	5000	5000	
Storage	30	-	24000	12000	6000	6000	5000	4000	2, 3
		24000	12000	6000	2500	6000	-	-	
		-	25000	10000	5000	10000	5000	5000	

Appendix C

Height and Area Table of Limits for the 1953 NBCC

TABLE 3.6
Height and Area Limitations of Buildings According to Classifications of Occupancy and Construction

Column 1		Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Major Occupancy of Building		Type of Construction						
		Non-protected Combustible	Protected Combustible ¾ hour rating	Non-protected Non-combustible	Heavy Timber	Protected Non-combustible 1-hour rating	Protected Non-combustible 2-hour rating	Protected Non-combustible 3-hour rating
Group "A" Assembly	Div. 1	NP	NP	NP	NP	(3) 8,000	(6) 24,000	UN 50,000
		NP	(1) 10,000	(1) 10,000	(1) 10,000	(1) 20,000	(1) 40,000	(1) UN
	Div. 2	NP	(2) 6.000	(2) 6,000	(2) 8,000	(4) 16,000	(6) 32,000	(UN) UN
		(1) 4,000	(1) 16,000	(1) 16,000	(1) 20,000	(1) 32,000	(1) UN	(1) UN
	Div. 3	(1) 5,000	(1) 20,000	(1) 30,000	(1) 24,000	(1) 40,000	(1) UN	(1) UN
	Div. 4	(1) 4,000	(1) 15,000	(1) UN	(1) 20,000	(1) UN	(1) UN	(1) UN
Group "B" Institutional	Div. 1	NP	NP	NP	NP	(3) 18,000	(6) 32,000	(UN) 48,000
		NP	NP	NP	NP	(1) 24,000	(1) 48,000	(1) 60,000
	Div. 2	NP	(2) 6,000	NP	(2) 10,000	(4) 18,000	(6) 32,000	(UN) 48,000
		NP	(1) 12,000	(1) 18,000	(1) 15,000	(1) 24,000	(1) 48,000	(1) 60,000
Group "C" Residential*	Div. 1	NP	(2) 6,000	(2) 6,000	(3) 8,000	(6) 24,000	(UN) 42,000	(UN) 60,000
		(1) 5,000	(1) 18,000	(1) 27,000	(1) 24,000	(1) 36,000	(1) 54,000	(1) 72,000
Group "D" Business and Personal	Div. 1	(2) 6,000	(3) 16,000	(4) 16,000	(4) 18,000	(6) 28,000	(UN) 48,000	(UN) 60,000
		(1) 10,000	(1) 24,000	(1) 36,000	(1) 28,000	(1) 48,000	(1) 60,000	(1) 96,000
Group "E" Mercantile	Div. 1	(2) 5,000	(2) 9,000	(3) 9,000	(3) 10,000	(4) 15,000	(6) 25,000	(UN) 40,000
		(1) 8,000	(1) 18,000	(1) 24,000	(1) 22,000	(1) 36,000	(1) 54,000	(1) 72,000
Group "F" Hazardous	Div. 1	NP	NP	NP	NP	NP	NP	NP
		NP	NP	NP	NP	NP	(1) 18,000	(1) 24,000
	Div. 2	NP	(2) 4,000	(2) 4,000	(3) 5,000	(3) 6,000	(4) 8,000	(4) 12,000
		(1) 4,000	(1) 12,000	(1) 12,000	(1) 14,000	(1) 16,000	(1) 20,000	(1) 24,000
Group "G" Industrial and Storage	Div. 1	(2) 5,000	(3) 8,000	(3) 8,000	(3) 10,000	(4) 12,000	(6) 16,000	(6) 24,000
		(1) 8,000	(1) 24,000	(1) 36,000	(1) 32,000	(1) 48,000	(1) 64,000	(1) 80,000
	Div. 2	(2) 6,000	(3) 10,000	(4) 10,000	(4) 15,000	(6) 18,000	(6) 24,000	(UN) 32,000
		(1) 12,000	(1) 32,000	(1) 48,000	(1) 40,000	(1) 64,000	(1) 80,000	(1) 96,000
	Div. 3	(2) 8,000	(4) 15,000	(4) 15,000	(4) 18,000	(6) 24,000	(UN) 32,000	(UN) 48,000
		(1) 16,000	(1) 48,000	(1) 96,000	(1) 56,000	(1) 96,000	(1) 96,000	(1) 96,000
Group "H" Accessory	Div. 1	(2) 5,000	(3) 6,000	(3) 6,000	(3) 8,000	(6) 24,000	(UN) UN	(UN) UN
		(1) 7,500	(1) 18,000	(1) 27,000	(1) 24,000	(1) 36,000	(UN) UN	(UN) UN

NOTES TO TABLE 3.6:

1. NP means "not permitted"; UN means "unlimited". Figures or letters in brackets refer to storey heights and are shown before the maximum permissible areas in square feet.
2. For definitions of types of construction, see Section 4.1.
3.* There are no limiting heights and areas for *one- and two-family dwellings*. The requirements for *separation* for this *occupancy* are included in Subsection 3.17.1.
4. For *buildings* facing two streets not less than 30 feet in width, the limiting areas may be increased by the factor 1.33. For *buildings* facing three such streets, the limiting areas may be increased by the factor 1.66.
5. For *buildings* having *approved* automatic sprinklers installed throughout all usable space, the limiting areas may be increased by a factor of 2 provided such sprinklers are not otherwise required by this By-law. In any *building* of mixed *occupancy*, a governing *major occupancy* may have its area (as limited by the maximum area of the *building*) increased by a factor of 2 by the installation of *approved* sprinklers throughout that *occupancy* only.
6. For industrial *buildings* of non-combustible types of construction not exceeding one *storey* in height, the limiting areas may be increased at the discretion of the *administrative official* provided the fire load does not exceed 2 pounds per square foot, all *hazardous substances* involved in the process are segregated in accordance with Subsection 3.4.10 and also provided that the *building* is surrounded on at least three sides with open spaces not less than 30 feet in width and available for fire-fighting purposes.

GENERAL NOTE: In preparing this Table, the values for heights and areas were determined taking into account the requirements for the *separation* of *buildings* in Subsection 3.4.6. No further requirements for fire-resistive construction should be necessary through zoning which could be limited to the regulation of exterior cladding and trim.

Appendix D

Ferguson's Proposed Height and Area Limit Rationale

D.1 2 Storeys

2 STOREY BUILDINGS - FIRE SAFETY

	Fire Load	Fire Resistance				Area limit if each floor a compartment	Area limit if each floor no a compartment
		Life	Access	Fuel	Size		
Assembly	1	3/4	-	-	-	100,000 sq. ft.	Non-combustibl 50,000 sq. ft Combustible 25,000 sq. ft
Institutional Residential	1	3/4 with sprink.	-	-	-		
Business	1	3/4	-	-	-		
Mercantile	2	3/4	-	-	-	50,000 sq. ft.	Non-combustibl 25,000 sq. ft and 12,000 (H) Combustible 12,000 sq. ft and 6,000 (H)
Industrial Storage	1	3/4	-	-	-	Hazardous 25,000 sq. ft.	
	2	3/4	-	-	-		
	3	3/4	-	-	-		

See 6 storey for limiting dimensions.

D.2 3 Storeys

3 STOREY BUILDINGS - FIRE SAFETY

	Fire Load	Fire Resistance				Area limit if each floor a compartment	Area limit if each floor not a compartment	Combustibles
		Life	Access	Fuel	Size			
Assembly Institutional Residential Business	1	3/4	1	1	No requirement	100,000 sq. ft. (2 floors may be treated as one)	Non-combustible 30,000 sq. ft. Combustible 15,000 sq. ft.	Structural elements may be combustible of heavy timber sizes. Also joist floors and stud partitions allowed.
		3/4 with sprink.						
Mercantile	2	3/4				50,000 sq. ft. Hazardous 25,000 sq. ft. (2 floors may be treated as one)	Non-Combustible 15,000 sq. ft. and 7,500 (H) Combustible 7,500 sq. ft. and 3,000 (H)	
Industrial Storage	1 2 3							

See 6 storey for limiting dimensions.

D.3 4 Storeys

4 STOREY BUILDINGS - FIRE SAFETY

	Fire Load	Fire Resistance				Area limit if each floor a compartment	Area limit if each floor not a compartment	Combustibles
		Life	Access	Fuel	Size			
Assembly	1	3/4	1	1	1	100,000 sq. ft. (2 floors may be treated as one)	Non-combustible 20,000 sq. ft. Combustible 10,000 sq. ft.	Structural elements may be combustible of heavy timber sizes. Joisted floors permitted.
Institutional		2						
Residential								
Business								
Mercantile	2	3/4				50,000 sq. ft.	Non-combustible 10,000 sq. ft. and 5,000 (H)	
Industrial	1					Hazardous 25,000 sq. ft. (2 floors may be treated as one)	Combustible 5,000 sq. ft. and 2,000 (H)	
Storage	2							
	3							

See 6 storey for limiting dimensions.

D.4 5 Storeys

5 STOREY BUILDINGS - FIRE SAFETY

	Fire Load	Fire Resistance				Required Separations & Compartments	Limiting Dimensions	Combustibles
		Life	Access	Fuel	Size			
Assembly	1	3/4				Each storey must have at least 1 hour separation.		
Institutional	1	2						
				1		If every storey makes a compartment, area limit = 100,000 sq.ft. If not, area limit 20,000 square ft.	Same	Same
Residential	1	2						
Business	1	3/4	1		1		as	as
Mercantile	2					Each storey must have at least 1 hr. separation. If every storey a compartment, area limit 50,000 sq. ft. If not, area limit 10,000 sq. ft.	for	for
Industrial	1	3/4		1			6 ÷	6 ÷
Storage	2							
	3							

See 6 storey for limiting dimensions.

D.5 6+ Storeys

6+ STOREY BUILDINGS - FIRE SAFETY

	Fire Load	Fire Resistance				Required Separations & Compartments	Limiting Dimensions	Combustibles
		Life	Access	Fuel	Size			
Assembly	1	3/4	2	1	2	Above 6th Floor Limiting Area 50,000 sq. ft. All floors must be compartments. Below 6th Floor Every second floor a compartment. Limiting area 100,000 sq. ft.	If accessible from one street only, depth limited to 100 feet. --- If least dimension above 200 feet, building must be sprinklered.	Solid combustible partitions permitted.
Institutional		2						
Residential		3/4						
Business								
Mercantile	2			2		Above 6th Floor Limiting Area 25,000 sq. ft., except high hazard which is 10,000. All floors compart. Below 6th Floor Limiting Areas 50,000 and 20,000 (high hazard). Every second floor a compartment.		
Industrial	1			1				
Storage	2			2				
	3			3				

Appendix E

Comparison of Height and Area Values from the 1941 NBCC, 1953 NBCC, 1955 BOCA, 1955 NBFU and 1955 UBC for Ordinary and Wood Frame Constructions

APPENDIX A-1

COMPARISON OF MODEL CODE REQUIREMENTS FOR LIMITATION
ON THE HEIGHTS AND AREAS OF ORDINARY AND WOOD
FRAME CONSTRUCTIONS IN TYPICAL CONSTRUCTIONS

OCCUPANCY	CONSTRUCTION	NBC '53	NBC '41	BOCA '55	NBFU '55	UBC '55
		Stories Hts. Areas	Stories Hts. Areas	Stories Hts. Areas	Stories Hts. Areas	Stories Hts. Areas
GROUP A - ASSEMBLY						
DIVISION 1	Ordinary	NP	2 35' 5000 500 seats	1 20' 4000	45' 6000	2 10500
	Wood Frame	NP	1 35' 3000 300 seats	NP	35' 4000	NP
	Wood Frame Protected			1 20' 5000		
DIVISION 2	Ordinary	2 6000	3 45' 5000 500 seats	2 30' 6500	45' 6000	2 10500
	Wood Frame	NP	1 35' 3000 300 seats	1 20' 3500	35' 4000	1 6000
	Wood Frame Protected			1 20' 5000		
DIVISION 3	Ordinary	NP	3 45' 5000 500 seats	2 30' 6500	45' 6000	2 10500
	Wood Frame	NP	1 35' 3000 300 seats	1 20' 3500	35' 4000	1 6000
	Wood Frame Protected			1 20' 5000		
DIVISION 4	Ordinary	NP	3 45' 5000 500 seats	45' 7500	45' 6000	2 10500
	Wood Frame	NP	1 35' 3000 300 seats	35' 3000	35' 4000	1 6000
GROUP B - INSTITUTIONAL						
DIVISION 1	Ordinary	NP	NP	1 20' 5000	45' 6000	NP
	Wood Frame	NP	NP	NP	35' 4000	NP
	Wood Frame Protected			1 20' 3500		
DIVISION 2	Ordinary	2 6000	2 35' 5000	1 20' 6000	45' 6000	2 5250
	Wood Frame	NP	1 35' 3000	NP	35' 4000	NP
	Wood Frame Protected			1 20' 4000		

A-2

OCCUPANCY	CONSTRUCTION	NBC '53 Stories	NBC '53 Hts.	NBC '53 Areas	NBC '41 Stories	NBC '41 Hts.	NBC '41 Areas	BOCA '55 Stories	BOCA '55 Hts.	BOCA '55 Areas	NFPU '55 Stories	NFPU '55 Hts.	NFPU '55 Areas	UBC '55 Stories	UBC '55 Hts.	UBC '55 Areas
GROUP C - RESIDENTIAL																
DIVISION 1	Ordinary	2		6000	*3	45'	5000	3	40'	7500		45'	6000	3		10500
	Wood Frame		NP		1	35'	5000	2½	35'	4000		35'	4000	2		6000
	Wood Frame Protected							3	40'	6000						
DIVISION 2	Ordinary	No limiting hts. & areas			3	45'	5000	3	40'	7500		45'	6000	Unlimited		
	Wood Frame	No limiting hts. & areas			3	40'	5000	2½	35'	4000		35'	4000	Unlimited		
GROUP D - BUSINESS & PERSONAL SERVICES	Ordinary	3		16000	3	45'	5000	3	40'	11000		45'	6000	3		14000
	Wood Frame	2		6000	2	35'	5000	2	30'	6000		35'	4000	2		8000
	Wood Frame Protected							3	40'	9000						
GROUP E - MERCANTILE	Ordinary	2		9000	3	45'	5000	2	30'	7500		45'	6000	3		14000
	Wood Frame	2		5000	2	35'	5000	1	20'	4000		35'	6000	2		8000
	Wood Frame Protected							2	30'	6000						
GROUP F - HAZARDOUS																
DIVISION 1	Ordinary		NP			NP		1	20'	3500		45'	6000	1		4375
	Wood Frame		NP			NP			NP			35'	4000	1		2500
	Wood Frame Protected							1	20'	3000						
DIVISION 2	Ordinary	2		4000	2	35'	5000					45'	6000	2		4375
	Wood Frame		NP		1	25'	5000					35'	4000	1		2500
GROUP G - COMMERCIAL, INDUSTRIAL AND STORAGE OTHER THAN HAZARDOUS																
DIVISION 1	Ordinary	3		8000	4	55'	7500					45'	6000	2		8750
	Wood Frame	2		5000	2	35'	5000					35'	4000	1		5000

Appendix F

“Spelled-Out” Tables

2 STOREY BUILDINGS.

APPENDIX A-11

ASSEMBLY INSTITUTIONAL RESIDENTIAL BUSINESS + LIGHT INDUSTRY.

BUILDING AREA 25-50,000 SQ. FEET

For the above area the following construction regints are mandatory.-

- Every floor shall equal a Grade 1 construction separation
- Columns and other vertical load-bearing members = 2 hours fire resist.
- Every load-bearing element and non-load-bearing elements of exterior walls shall be non combustible
- Exterior wall surfaces shall form a construction separation of Grade 1. This may be pierced by openings if the wall is distant from the lot line an amount required in table 1 for the percentage which the windows are of the total wall area.

TABLE I SHOWING DISTANCE OF WALLS TO LOT LINE FOR DIFFERENT WALL LENGTHS AND % of WINDOW OPENING.

% WINDOW OPENING		0	20	40	60	100
LENGTH of WALL.	30	0				
	50	0				
	100	0				
	200	0				

BUILDING AREA. 12,000-25000 SQ FEET.

- All load bearing elements, and non-load-bearing elements of exterior walls non-combustible.
- Load bearing elements except roof 3/4 hour fire resistance
- Exterior wall surfaces shall form construction separation of Grade I. This may be pierced by openings if the wall is distant from the lot line an amount as required in table B. for the % window opening of the total wall surface.

TABLE 2. SHOWING DISTANCE OF WALLS TO LOT LINE FOR DIFFERENT WALL LENGTHS AND % of WINDOW OPENING.

% WINDOW. OPENINGS.		0	20	40	60	100
LENGTH of WALL.	30	0				
	50	0				
	100	0				
	200	0				

WHOLESALE + WAREHOUSE STORAGE + INDUSTRY.

Building Area. 12000-25000 SQ. FT.

For the above area the following construction requirements are mandatory -:

- Every floor shall be a GRADE 3 CONSTRUCTION SEPARATION
- Columns and other vertical load-bearing 4 hours fire resistance.
- Roof 2 hours fire resistance.
- Exterior walls. shall equal a GRADE 3 construction separation This may be pierced by openings if a space separation is also provided of an amount equal to that shown in Table 3 for the length of wall and % of its area which is window.

TABLE 3 DISTANCE SEPARATIONS for given length of wall and % window open.

% WINDOW. OPENING.		0	20	40	60	100
Length of Wall.	30	0				
	50	0				
	100	0				
	200	0				

Building AREA. 9000-12000 SQ feet

for the above area the following construction regnts are mandatory.

Floors. 3/4 hr. Fire Resistance Non. Comb.

Columns. 3/4 hr. " " " "

Roof. non combustible

Exterior Walls. shall equal a Grad 3 construction separation. This may be pierced by openings if a space separation is also provided of an amount equal to that shown in Table 4. for the length of wall and % of its area. which is window.

TABLE 4. DISTANCE SEPARATIONS for given length of wall and % window open.

% Window opening.		0	20	40	60	100.
Length of Wall.	30	0				
	50	0				
	100	0				
	200	0				

2 STORY BUILDING CONT.

APPENDIX A-12

ASSEMBLY INSTITUTIONAL. RESID.-ENTIAL. BUSINESS. + LIGHT INDUSTRY.

BUILDING AREA. UP TO 12,000 SQ FT

for the above area the following CONSTRUCTION REQMTS are mandatory.

Floors 3/4 hr. Fire Res. Comb or N.C.

Columns 3/4 " " " " " "

Roof. 3/4 " " " " "

(Equivalent solid timber may be substituted.).

Exterior Walls. Shall equal a Grade 1 construction separation Non-Comb. This may be pierced by openings if a space separation is also provided of an amount equal to that shown in Table 2 for the length of wall and % of its area which is windows.

NOTE 1 With special permission. Small buildings having no interior fire resistance may be built for business and industrial occupancy provided these are no greater than 4000 sq feet

Exterior Walls must be Non-combustible or combustible with 3/4 hr. Fire Resistance. Where there is no fire Resis. the ext. wall must be distant from the lot line an amount determined by Table 2.

NOTE 2 Exterior Walls of Residential buildings. Not more than 4000 sq ft in area may be of combustible construction.

WHOLESALE + WAREHOUSE. STORAGE + INDUSTRY.

Building AREA. Up to 9000 sq feet.

for the above area the following construction requirements are mandatory.

Floors. 3/4 hr. Fire Res. Comb. or NC.

Columns. 3/4 " " " " " "

Roof 3/4 " Fire Resis Comb., or NC (no fire Resis)

Exterior Walls. shall equal a Grad 3. construction Separation This may be pierced by openings if a space separation is also provided of an amount equal to that shown in Table 3, for the length of wall and % of its area which is windows.

NOTE 3. similar to NOTE 1 but area = 2000 sq ft.

3 STOREY BUILDINGS.

APPENDIX A-13

ASSEMBLY, INSTITUTIONAL, RESIDENTIAL, BUSINESS + LIGHT INDUSTRY.

BUILDING AREA 17-50,000 SQ FEET

SAME AS FOR 2 STOREY BUILDINGS (25-50,000).

BUILDING AREA. 8-17,000 SQ FEET.
all load-bearing elements + non load-bearing elements of exterior walls non-combustible
Floors 3/4 hour Fire resistance
Columns " " " "
Roof. non-comb.
Exterior walls shall equal a grade 1 construction separation. This may be pierced by openings if a space separation is also provided of an amount equal to that shown in table 5 for the length of wall and % of its area which is window.

TABLE 5. SHOWING DISTANCE OF WALL TO LOT LINE FOR DIFFERENT WALL LENGTH and % of WINDOW OPENING.

% of WINDOW OPENING.		0	20	40	60	100
Length of wall.	30	0	14.5	22	25.5	33.5
	50	0	17.5	25	32.5	41.5
	100	0	26	33.5	42.5	57
	200	0	22.5	40.5	53.5	74.

BUILDING AREA UP TO 8000 SQ FT.
Floors 3/4 Hour Fire Resis. or NC
Columns. 3/4 Hour Fire Resis. or NC
Exterior walls shall equal a Grade 1 Construction separation NC.
This may be pierced by openings as permitted in Table. 5.

WHOLESALE, WAREHOUSE + INDUSTRY.

BUILDING AREA 8-25,000 SQ feet.

SAME AS FOR 2 STOREY BLDGS. (12.-25000)

BUILDING AREA. 6-8000 SQ feet.
all load-bearing elements, + non load-bearing elements of exterior walls N.C.
Floors 3/4 hr. Fire Resis. NC.
Columns. 3/4 hr. Fire Resis. NC.
Roof. NC.
Exterior walls shall equal a GRADE 3 CONSTRUCTION SEPARATION. THIS MAY BE PIERCED BY OPENINGS IF A SPACE SEPARATION IS ALSO PROVIDED. OF AN AMOUNT EQUAL TO THAT SHOWN IN TABLE 6. for THE LENGTH OF WALL and % of its area. which is WINDOW.

TABLE 6. SHOWING DISTANCE OF WALL TO LOT LINE FOR DIFFERENT WALL LENGTHS AND % OF WINDOW OPENING.

% of WINDOW OPENING.		0	20	40	60	100
LENGTH of wall.	30	0	21	31	36	47.
	60	0	26	39	47.	59.
	100	0	34	52	65	84.
	200	0	41	66	86.	114.

BUILDING AREA. UP to 6000 SQ FEET.
Floors 3/4 Hr. FIRE RESIS. C or NC.
Columns 3/4 " " " C or NC.
EXTERIOR WALLS, SHALL equal a Grade 3 CONSTRUCTION SEPARATION NC
This may HE PIERCED BY OPENINGS. AS PERMITTED IN TABLE 5.

1 STOREY BUILDINGS.

APPENDIX A-14

ASSEMBLY, INSTITUTIONAL, RESIDENTIAL, BUSINESS + LIGHT INDUSTRY

BUILDING AREA. 6 - 50,000 sq ft.
Floors - Grade 1 construction separation.
Columns + other vertical load-bearing members 2 hours fire resistance.
Roof: Non-Combustible.
Exterior walls shall equal a Grade 1 construction separation and may be pierced by openings accord. to Table I

BUILDING Area. up to 6000 sq ft
floors - 1hr. F.R. C or NC.
Columns. 1hr. F.R. C or NC.
Roof. 1hr. FR. C or No FR. NC.

Exterior Walls: NC ONLY, GRADE 1 CONSTRUCTION SEPARATION. THIS MAY BE PIERCED BY OPENINGS ACCORDING TO TABLE. 7.

TABLE. 7 SHOWING DISTANCE OF walls to LOT LINE FOR DIFFERENT wall LENGTHS and % WINDOW OPENING

% WINDOW OPENING.		0	20	40	60	100
LENGTH of wall.	30	0	16.5	23	29.5	37.5
	50	0	19	30	37	48
	100	0	24	39	50	66.
	200	0	28	49.	64	88.

INTERIOR Bearing walls + PARTITIONS of Combustible Construction, shall be. solid.

WHOLESALE WARE HOUSE + INDUSTRIAL.

BUILDING AREA. 6 - 25000 sq ft.
floors, GRADE 3 CONSTRUCTION SEPARATION.
Columns + other vertical load-bearing members - 4hours fire resis
Roof: 2 hours fire resis.
Ext Walls SHALL EQUAL GRADE 3 CONSTRUCTION SEPARATION and may be pierced by openings in accordance with Table 3.

BUILDING AREA 1-6000 sq ft.
floors. 1hour. fire resis. NC.
Columns. 1hour fire resis NC.
Roof: N.C.
EXTERIOR. WALLS. NC and Grade 1 CONSTRUCTION SEPARATION This may be pierced by openings according to TABLE 8.

TABLE 8. SHOWING DISTANCE OF WALLS TO LOT LINE FOR DIFFERENT WALL LENGTHS AND % WINDOW OPENING.

% WINDOW OPENING.		0	20	40	60	100
LENGTH of wall.	30	0	24	35	42	53.
	50	0	31	44	54	67.
	100	0	40	59	75	95.
	200	0.	50	78	100	134.

BUILDING AREA up to 4000 sq ft.
floors. 1hr fire Resis. C or NC.
Columns. 1hr fire RESIS. C or NC.
Roof: 1hr fire Resis. C or - No fire Resis NC.
EXT. walls. NC and Grade 1 Construction SEPARATION These may be Pierced by openings according TO TABLE 8.

APPENDIX-A-15

6 STOREYS OR MORE.

ASSEMBLY. INSTITUTIONAL RESIDENTIAL BUSINESS + LIGHT. INDUSTRY.	WHOLESALE WAREHOUSE. + INDUSTRY.
BUILDING AREA. UP TO 50,000 SQ.FT floors. (CONSTRUCTION) 2 hours NC fire resistance. OPENINGS MUST be protected to provide a Grade 1 CONSTRUCTION SEPARATION Columns. and other vertical load bearing members - 3 hours. NC. Roof. N.C. EXTERIOR WALLS. SHALL EQUAL A GRADE 1 CONSTRUCTION SEPARATION NC and MAY BE PIERCED BY OPENINGS ACCORDING TO TABLE1	BUILDING AREA UP TO 25,000 SQ FT floors. Grade 3 Construction separ. Columns. 4 hours fire resis. Roof. 2 hours fire resis. Exterior walls Grade 3 Construction separation NC MAY Be pierced by openings according to table 3.

Appendix G

Revised 1953 NBCC Height and Area Limitations Table

TABLE 3.6
Height and Area Limitations of Buildings According to Classifications of Occupancy and Construction

Column 1		Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Major Occupancy of Building		Type of Construction						
		Non-protected Combustible	ORDINARY. ~~Protected Combustible ¾ hour rating~~	Non-protected Non-combustible	Heavy Timber	Protected Non-combustible 1-hour rating	Protected Non-combustible 2-hour rating	Protected Noncombustible 3-hour rating
Group "A" Assembly	Div. 1	NP	NP	NP	NP	(3) 8,000	(6) 24,000	UN 50,000
	Div. 2	NP (2) 4000 (b). (1) 8000.	(1) 10,000 (a) (2) (b) 6,000 (1) 16,000	(1) 10,000 (a) (2) (b) 6,000 (1) 16,000.	(1) 10,000 (2) 8,000 (1) 20,000	(1) 20,000 (4) 16,000 (1) 32,000	(1) 40,000 (6) 32,000 (1) UN	(1) UN (UN) UN (1) UN
	Div. 3	(1) 5,000	(1) 20,000	(1) 30,000	(1) 24,000	(1) 40,000	(1) UN	(1) UN
	Div. 4	(1) 4,000	(1) 15,000	(1) UN.	(1) 20,000	(1) UN	(1) UN	(1) UN
Group "B" Institutional	Div. 1	NP NP	NP NP	NP NP.	NP NP	(3) 18,000 (1) 24,000	(6) 32,000 (1) 48,000	(UN) 48,000 (1) 60,000
	Div. 2	NP. (1) 4,000 (c).	(2) 9,000 (c). (1) 12,000 (c)	(2) 9,000 (c). (1) 18,000 (c)	(2) 10,000 (1) 15,000	(4) 18,000 (1) 24,000	(6) 32,000 (1) 48,000	(UN) 48,000 (1) 60,000
Group "C" Residential'	Div. 1	(2) 4,000 (b). (1) 8000.	(3) 6,000 (A) (1) 15,000 (C).	(3) 6000 (d). (1) 27,000.	(3) 8,000 (1) 24,000	(6) 24,000 (1) 36,000	(UN) 42,000 (1) 54,000	(UN) 60,000 (1) 72,000
Group "D" Business and Personal	Div. 1	(2) 6000 (1) 10,000.	(4) 13,000 (e). (1) 24,000	(4) 16,000 (e). (1) 36,000	(4) 18,000 (1) 28,000	(6) 28,000 (1) 48,000	(UN) 48,000 (1) 60,000	(UN) 60,000 (1) 96,000
Group "E" Mercantile	Div. 1	(2) 5,000 (1) 8,000	(3) 8,000 (e) (1) 18,000	(3) 10,000 (e) (1) 24,000.	(3) 10,000 (1) 22,000	(4) 15,000 (1) 36,000	(6) 25,000 (1) 54,000	(UN) 40,000 (1) 72,000
Group "F" Hazardous	Div. 1	NP (1)	(2) (f) (1)	(2) (f) (1)	NP NP	NP NP	NP (1) 18,000	NP (1) 24,000
	Div. 2	NP (1) 4,000.	(2) 4,000 (f) (1) 12,000	(2) 4,000 (f) (1) 12,000.	(3) 5,000 (1) 14,000	(3) 6,000 (1) 16,000	(4) 8,000 (1) 20,000	(4) 12,000 (1) 24,000
Group "G" Industrial and Storage	Div. 1	(2) 6,000 (1) 8,000	(3) 8,000 (g) (1) 24,000	(3) 8,000 (g) (1) 36,000	(3) 10,000 (1) 32,000	(4) 12,000 (1) 48,000	(6) 16,000 (1) 64,000	(6) 24,000 (1) 80,000
	Div. 2	(2) 6,000 (1) 12,000	(4) 10,000 (g) (1) 32,000	(4) 10,000 (g) (1) 48,000	(4) 15,000 (1) 40,000	(6) 18,000 (1) 64,000	(6) 24,000 (1) 80,000	(UN) 32,000 (1) 96,000
	Div. 3	(2) 8,000 (1) 16,000	(4) 15,000 (g) (1) 48,000.	(4) 15,000 (g) (1) 96,000	(4) 18,000 (1) 56,000	(6) 24,000 (1) 96,000	(UN) 32,000 (1) 96,000	(UN) 48,000 (1) 96,000
Group "H" Accessory	Div. 1	(2) 3,000 (1) 7,500.	(3) 6,000 (g) (1) 18,000.	(3) 6,000 (g) (1) 27,000.	(3) 8,000 (1) 24,000	(6) 24,000 (1) 36,000	(UN) UN (UN) UN	(UN) UN (UN) UN

NOTES TO TABLE 3.6:

1. NP means "not permitted"; UN means "unlimited". Figures or letters in brackets refer to storey heights and are shown before the maximum permissible areas in square feet.
2. For definitions of types of construction, see Section 4.1.
3. There are no limiting heights and areas for one- *and two-family dwellings*. The requirements for *separation* for this *occupancy* are included in Subsection 3.17.1.

(a). All floors and roof and their supports shall have 3/4 hour fire resistance.
(b). In two storey buildings all floors and roofs shall have 3/4 hour fire resistance or equivalent. [fire resistance
(c). All floors and roofs shall have 3/4 hour fire resistance.
(d). All floors separating dwelling units and all roofs of buildings exceeding one story in height shall have 3/4 hour
(e). All buildings exceeding two storeys in height shall have floors and roofs with 3/4 hour fire resistance.
(f). All buildings exceeding one storey in height shall have floors and roofs of not less than 3/4 hour fire resistance.
(g). All buildings exceeding two storeys in height shall have floors and roof of not less than 3/4 hour fire resistance.