Fire Waste in Canada

J. Grove Smith

Commission of Conservation
Canada

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CANADA

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By

J. GROVE SMITH

OTTAWA: 1918

Commission of Conservation

Constituted under "The Conservation Act," 8-9 *Edward VII, Chap.* 27, 1909, *and amending Acts,* 9-10 *Edward VII, Chap.* 42, 1910, *and* 3-4 *George V, Chap.* 12, 1913.

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May it Please Your Excellency:

The undersigned has the honour to lay before Your Excellency the attached report entitled "Fire Waste in Canada," by J. Grove Smith.

Respectfully submitted

CLIFFORD SIFTON,

Chairman

Ottawa, May 15, 1918

OTTAWA, May 14, 1918.

SIR:

I have the honour to transmit herewith a report entitled "Fire Waste in Canada," prepared by Mr. J. Grove Smith.

I have the honour to be, Sir,

Your obedient servant,

JAMES WHITE,

Assistant to Chairman

SIR CLIFFORD SIFTON, K.C.M.G.,
Chairman,
Commission of Conservation

Contents

Illustrations

Corrigenda

On page 39, Table No. 4, value of property destroyed in 1915 in Ontario should read $7,884,317, and in Saskatchewan, $973,024.

On page 51, lines 8 and 9, the figures should read 11.6, 9.3, 4.2 and .5, respectively.

On page 52, Table No. 6, the total annual cost of fire departments should read $5,053,010, and the grand total $49,396,166.

On page 259, footnote, line 13, "agent" should read "applicant."

DESTRUCTION OF CANADA'S PARLIAMENT BUILDINGS, OTTAWA, FEB. 3, 1916
Fire-resisting walls often hide highly combustible interior construction.

FIRE WASTE IN CANADA

CHAPTER I

Summary of Conclusions

FIRE WASTE in the Dominion of Canada constitutes a problem of paramount and far-reaching importance. Continuation of the present tremendous loss of property and life by fire cannot but vitally affect the economic future of the country. If, with the cessation of war in Europe, we are to enter successfully upon a period of rapid expansion, it is imperative that rational conservation go hand in hand with development. It is as necessary to conserve created wealth as it is to prevent the waste of natural resources. Nature in time may restore devastated forest areas, but only human toil can raise a new city from the ashes of the old. Re-creation arrests productive effort, and the replacement of values destroyed by fire absorbs energies that would otherwise be devoted to industrial and economic progress.

Fire Waste Unnecessary

There is a growing recognition of the fact that fire waste is needless and that definite measures should be taken for its avoidance. Numerous individuals, municipal councils, boards of trade and other organizations throughout the Dominion urged the Commission of Conservation to investigate the problem.* Accordingly, an investigation was begun and an attempt was made to gather into a well-rounded whole the experiences and technical knowledge of fire-prevention experts, and to apply it to existing conditions.

To the average citizen fire prevention implies a vaguely outlined means of curtailing fire waste by the simple expedient of preventing fires. How this desirable end is to be accomplished is not made clear. The well-informed go further and analyze the problem into at least five distinct factors, *viz.*, (1) the engineering, (2) the underwriting, (3) the legislative, (4) the commercial, and (5) the individual. Co-ordination of these varied interests in united reformative endeavour is the first step in any programme designed to deal effectively with the question.

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*The Canadian Manufacturers' Association passed the following resolution:
"Resolved, that the Canadian Commission of Conservation be requested to interest itself in the solution of this problem which is so obviously cognate to the purposes for which it was created, and endeavour to stimulate and to co-ordinate the work to be done by the provinces, by municipalities and individuals."

Sources of Information

Preliminary to the main enquiry, advice was sought of persons qualified to give an opinion upon the scope and character of such an investigation. To obtain a clear idea of the views commonly held by those most closely in touch with the situation, a questionnaire was sent to managers and general agents of insurance companies and to loss adjusters throughout Canada, asking:

(1) What they considered the principal causes of Canada's large fire waste.

(2) What proportion of fires they thought due to incendiarism, and the relation of over-insurance thereto.

(3) What practical remedies they proposed?

Chief Causes of Fire Waste as given by Insurance Interests

This questionnaire was sent to 179 fire insurance companies, 92 general agents and 38 loss adjusters and the answers were intelligible and complete. The statements made in reply to the first question have been classified as follows:

	No. of Replies in which Specified
Carelessness	
Carelessness in general	66
Matches	32
Smoking	23
Accumulations of rubbish	23
Indifference because of insurance	18
Hot ashes in wooden receptacles	14
Careless handling of gasolene	14
Lighting fires with coal oil	12
Ignorance of fire hazards	9
Total	211
Insurance	
Moral hazard	24
Non-inspection of property by agents	19
Attitude of courts toward fraudulent claims	14
Over-insurance	13
Unscrupulous agents	13
Fire insurance in general	12
Too prompt payment of losses	12
Over-payment of losses	11
Agents' desire for large commissions	8
Inexperienced loss adjusters	6
Adjusters for the assured	5
Total	137

	No. of Replies in which Specified
Building Construction	
Poor construction in general	35
Defective chimneys	34
Shingle roofs	29
Frame buildings	17
Exposure	13
Total	128
Inadequate Laws	
Want of laws to fix personal responsibility	21
Inadequate building by-laws	16
Lack of municipal inspection laws	16
Poor enforcement of building laws	15
Lack of investigation of causes of fires	12
Indifference of municipal councils	11
Lack of regulations in regard to explosives and combustibles	8
Total	99
Heating and Lighting	
Defective electric wiring	25
Defective stovepipes	23
Defective furnaces	21
Defective gas appliances	4
Over-heated stoves and furnaces	8
Unprotected gas jets	3
Total	84
Public Fire Protection	
Inadequate fire protection	14
Defective fire protective appliances	12
Total	26
Miscellaneous	
Lightning	25
Climatic conditions	18
Total	43

Incendiarism and Over-Insurance

A considerable difference of opinion exists regarding the extent of incendiarism and over-insurance. Figures are obviously unobtainable, and any statement respecting their prevalence must necessarily be based upon conjecture. In a general way, thirteen correspondents were of the opinion that incendiary fires were few and seven stated that they constituted a large proportion of the total number. Twenty-one companies thought that over-insurance was common and twenty-four that it was uncommon. The majority of correspondents and companies objected to giving a definite opinion on this, but actual figures were submitted in thirty-three replies and have been summarized as follows:

Estimated Proportion of Incendiary Fires	*No. of Replies Specifying Percentage*
50 per cent	4
40 " "	4
30 " "	3
25 " "	3
20 " "	1
15 " "	6
10 " "	6
5 " "	3
2 " "	2
1 " "	1

Remedies Suggested

Replies to the third question were both comprehensive and valuable. The remedies suggested for checking the fire waste, with few exceptions, advocated compulsory measures as follows:

Laws to enforce personal responsibility	114
Laws to enforce better care and maintenance of buildings	98
Laws to compel better building construction	93
Laws to regulate the insurance business in the interests of fire prevention	67
Laws to compel improved public fire protection	49
Education by publicity and in schools	38

Statistical Survey

The data appearing in this report represent careful study of the statistics and reports of various underwriters' associations, the records of individual insurance companies, so far as these were available, and the by-laws and ordinances of all municipalities in Canada relating to building construction and fire hazard.

As no reliable figures were available showing the annual fire loss, or the extent of fire protection, it was necessary to obtain official records from every city, town and village in the Dominion. Rural losses were compiled from figures furnished by insurance companies and loss adjusters.

The response to circulars sent to municipalities was at first somewhat discouraging and replies to letters of reminder indicated that, in numerous instances, the information was not readily available and would take a considerable time to compile. The greatest difficulty appeared to be in showing separately the losses on frame and brick buildings, on buildings and contents, and the losses on buildings other than those in which fires originated. Finally, however, over 90 per cent of the places circularized made complete returns. These form the statistical basis of this report and are included in classified form in Chapter III.

General Conclusions

The conclusions reached may be briefly summarized as follows:

1. That the annual loss of life and property by fire in Canada—the latter averaging $2.73 per capita annually for the years 1912-1915—is greater per capita than in any other country in the world, and constitutes an enormous and increasing drain upon the resources of the Dominion, besides most seriously affecting the economic prosperity and general well-being of the people.

2. That such losses can be very materially reduced. This is clearly shown by the experience of European countries which have attacked the problem at its source.

3. That the loss by fire is chiefly ascribable to
   - (a) Carelessness due largely from a sense of security created by the present system of fire insurance.
   - (b) Faulty building construction.
   - (c) Arson.
   - (d) Lack of adequate fire prevention laws, such laws as exist being poorly enforced.

4. That, for immunity from the danger of fire losses, the people of Canada are relying largely upon elaborate and expensive systems of fire-fighting and are giving too little attention to the prevention of fire.

5. That our fire departments, while among the best in the world in both apparatus and personnel, are not preventing the steady growth of losses.

6. That the monetary indemnity provided by fire insurance does not restore the values destroyed, but merely distributes the loss, through the channels of commerce, over the whole people.

7. That the cost of fire insurance and fire prevention is, in a large measure, determined by the amount of the fire loss and cannot be expected to decrease except as the fire waste declines.

8. That, although the aggregate loss by fire constitutes a national problem, all fires are local in origin and are, therefore, locally preventable and controllable.

9. That property owners generally have not been sufficiently influenced by their own interests or the welfare of the country at large to use effective means to correct fire-waste conditions.

10. That existing legislation respecting the prevention of fire is inadequate and lacking in uniformity.

11. That such legislation is almost entirely confined to cities and more important towns, and that the dangers and hazards of fire in small communities and rural districts are without regulation or control, despite the occurrence of a large proportion of the fire waste in rural districts.

12. That the only possible solution of the national fire-waste problem lies in the adoption of compulsory measures which, by reducing to a minimum the fire hazards in all communities and properties, will prevent the occurrence of fires.

13. That, owing to the failure of local authorities to deal adequately with the situation, the Provincial governments should undertake the removal of a burden imposed upon the whole people and should safeguard the lives and property which, in the final analysis, constitute the true wealth of the country.

Legislation Needed

The need for legislative control of fire waste in Canada is, from every point of view, too strong to be denied. Specious arguments as to the rights of property have no force. To maintain public order, experience has shown that a permanent and adequate police force is imperative. To preserve sanitation, health and purity of food and water, vigilantly administered controlling laws are essential. Fire waste is real enough, widespread enough, important enough and sufficiently controllable in the light of experience to be regarded as a common danger that must be regulated for the common good. Heroic or revolutionary measures are not required. Relief does not lie along lines of drastic police control such as obtains in Europe. Our people do not wish to be governed in that way, nor will they. There must be a more elastic method of regulation, one that does not make for more law but for better laws.

Legislation designed to curtail fire waste must necessarily follow two lines, *viz.*, physical improvement of fire hazard and moral improvement of fire hazard. Existing conditions in Canada lead to the conclusion that such legislation should be framed to deal especially with the following points:

COMMUNITY PLANNING—Every community should be divided into districts, wherein rules limiting, defining and regulating the use of property may be legally imposed, with due regard to the prospective development of such districts in relation to the community as a whole.

Every community should be safeguarded by provisions regulating extra hazardous pursuits and industrial occupancies, and restricting the use of property for such pursuits and occupancies to properly delimited areas.

Community Protection—Every community should be provided with an adequate water supply and a modern fire-fighting organization, proportionate to its character, area and population.

All fire departments should be efficiently organized in enduring form, under control and discipline, established by law, and their morale and requirements should be solely influenced by community considerations. The training of fire departments should be constant and adequate for efficient operations, and should include fire-prevention inspection and the maintenance of special mechanical apparatus.

Building Construction—Fires always originate from definite causes in definite locations and, therefore, every building, in relation to its size, its character, its use and the congestion of its location, should be so constructed as to prevent the communication of fire to adjacent properties.

In each province, minimum requirements for building construction should be adopted for the adequate protection of buildings outside urban limits and in small communities where the enforcement of local building laws is impracticable.

Uniform standards of fire resistance in structural materials should be established for Canada, and should be adopted and enforced by local authorities having jurisdiction over building construction and equipment.

Safety to Life—All building construction and re-construction should include, in design and specification, adequate safeguards against danger to life in case of fire.

The occupants of buildings should be educated regarding exit in a quick and orderly manner, and should be organized to make proper use of apparatus for extinguishing incipient fires.

Building Equipment—Every building, in accordance with its location, character and use, should be equipped with proper mechanical aids to discover and to extinguish fire.

All equipment for lighting and heating buildings should be adequately designed and constructed with respect to fire hazard, and its use should be reasonably safeguarded by legal requirements.

Occupancy and Management of Buildings—The hazard attending the occupancy of any given building should be definitely and continuously controlled so as to assure reasonable safety from fire.

As approximately 70 per cent of all fires is caused by the ignorant and careless use of property, requirements for the suppression of dangerous nuisances, such as storage of rubbish, ashes, etc., should be imposed by every municipality.

Systematic inspection of all buildings, to insure the vigourous enforcement of rules for cleanliness and good housekeeping, should be one of the ordinary functions and duties of all fire departments.

FIRE INSURANCE—The insurance departments of the Dominion and Provincial Governments should not only assure the financial stability of fire insurance, but should regulate (1) the issuance of policies on property; (2) the licensing of agents and brokers; (3) the licensing of adjusters, to the end that only reasonable insurance contracts be issued on property and that only men of sound character and ability be admitted to the business of writing fire insurance and adjusting fire losses.

INCENDIARISM—Each provincial legislature should enact and enforce a fire marshal law enjoining official investigation of the causes of all fires with the object of suppressing the crime of arson.

EDUCATION—Education of the public respecting fire dangers should be provided for by law and all interests concerned should co-operate in disseminating accurate and authoritative data to the end that the people may not only accept but demand proper regulation of fire waste.

GOVERNMENTAL CONTROL

There is little necessity for the creation of new and complex forms of administrative machinery or for large expenditures of public money to carry out a programme such as that suggested. The means of putting into effect comprehensive fire prevention measures already exist and only need co-ordination and direction.

(*a*) DOMINION GOVERNMENT—The relationship of the Dominion Government to the work of fire prevention should be primarily educational and advisory, following two lines of activity.

1. A bureau for the purpose of formulating standards of fire resistance and testing structural materials and building equipment should be established in connection with one of the existing departments of the government. The Mines Branch of the Department of Mines carries on work of a somewhat similar character at the present time, and has laboratory facilities especially adapted for testing the fire-resisting qualities of materials.

2. An advisory bureau should be charged with the collection of information regarding legislation and administration both

in Canada and abroad, comparing the results obtained under various measures, co-operating with provincial and municipal bodies in Canada to secure uniformity in regulations designed for the control of fire waste, disseminating information in regard to fire hazards and the means of safeguarding them, and generally acting as a central intelligence department in connection with all matters affecting fire and its prevention.

Such a bureau, if attached to the Commission of Conservation, in connection with its Town Planning Branch, would have special facilities for carrying on the work.

(*b*) PROVINCIAL GOVERNMENTS—The provincial governments are the units of legislative and administrative control. For the purposes of regulating fire waste in each province legislation is needed in respect to the following:

1. *Town Planning*—Provincial control should be exercised through an act substantially following the Draft Town Planning Act, Commission of Conservation, 1915. This act is largely permissive in character, but is mandatory in respect to the appointment of local town-planning boards and the adoption of partial town-planning schemes restricting the improper use of land.

Town Planning Acts are at present in force in Nova Scotia, New Brunswick, Manitoba and Alberta. Similar legislation is under consideration in the provinces of Ontario, Quebec and Saskatchewan.

2. *Building Construction*—Provincial control should be exercised through the adoption of standard minimum requirements, provision for adequate inspection and the licensing of architects.

At present, there is little direct provincial control of building construction. Power to regulate the erection of buildings is granted to cities and towns under specific clauses in the various municipal acts. Ordinances of miscellaneous character are enforced in all the larger cities, but in the small towns, villages and rural districts throughout Canada, building construction is without proper regulation or supervision.

3. *Public Fire Protection*—Provincial control should be exercised through the adoption of standard minimum requirements and provision for adequate inspection of waterworks systems and fire departments.

There is at present no provincial control of public fire protection facilities. Certain powers are vested in boards of public health in some provinces by which water-supply schemes must be approved before debentures for construction are issued. Questions of adequacy of supply and pressure for fire-protection purposes are not dealt with. The organization and equipment of fire departments is entirely a matter for municipal regulation under powers granted by the various municipal acts.

4. *Safety of Life*—Provincial control should be exercised through the adoption of standard minimum requirements and provision for adequate inspection.

The safety of the occupants of buildings is at present partly regulated under provincial Factory Acts, Public Safety Acts, Fire Escape Acts and Moving Picture Theatre Acts. Enforcement of statutory provisions is scattered in various departments of the provincial legislatures. In many cases, municipal building ordinances supplement provincial laws in regard to exits from buildings.

5. *Manufacture, Storage, Transportation and Use of Explosives and Combustibles*—Provincial control should be exercised through the adoption of standard minimum requirements, the issuing of licenses and provision for adequate inspection.

Acts are at present in force in Manitoba and British Columbia. In other provinces, power to make regulations is granted to the fire marshals. Local ordinances are enforced in all the cities and larger towns throughout Canada under powers conferred by municipal acts.

6. *Electrical Inspection*—Provincial control should be exercised through the adoption of standard minimum requirements, provision for adequate inspection and the licensing of electrical contractors.

Provincial inspection of electrical installations is provided for in Ontario and British Columbia. A number of the larger cities throughout Canada have municipal ordinances dealing with the matter. The fire insurance companies maintain an inspection service in connection with insured property. The National Electric Code is universally used as a standard of requirements in regard to the installation of electrical wiring. This code specifies that all devices and equipment must have received the approval of the Underwriters' Laboratories, Chicago.

7. *Fire Marshal Law*—A fire marshal law should be administered in each province as a separate branch of a department which should have a responsible head. This branch should be charged with the following duties: (*a*) gathering statistics of fire losses; (*b*) investigating the causes of fires; (*c*) prosecuting cases of arson; (*d*) educating the public.

Provincial fire prevention acts are in force in Ontario, Manitoba, Saskatchewan, Alberta, British Columbia and Quebec. In Manitoba, Saskatchewan, Alberta and British Columbia, the acts are administered by the superintendents of insurance, and, in Quebec, by the Minister of Public Works.

(*c*) *Municipal Governments*—Provincial control of the fire-waste situation should, as far as possible, be confined to the establishment of minimum requirements, leaving local authorities the right to administer the laws through departments of their own and the power to increase the requirements if thought advisable. By this general control, municipalities would not have their powers diminished but, in addition, the provincial departments would give them advice and assistance. The power to enforce fire-protection regulations should be centralized in one official or in one official body in every community. Where, through a factory or labour department or fire marshal, a province undertakes to inspect and supervise buildings of a certain class in all communities within that province, it is the general experience that inefficiency results. There is a clashing of authority between the provincial and municipal officials which invariably results in permitting dangerous hazards to exist. When the responsibility for fire extinguishment and safety of life in a block is placed entirely upon the shoulders of the local fire department, it is illogical to enact legislation which places twenty buildings in that block under the jurisdiction of the chief of that fire department, and two or three buildings in the same block under the exclusive jurisdiction of provincial officials. The safeguarding of lives and property in a community is primarily the function of the officials of the community itself. So far as fire prevention and protection are concerned, every building should be under the immediate supervision of the local fire department, and that department should be held strictly to account for existing conditions.

At the present time, approximately 4,200 men are employed by Canadian municipalities in the work of extinguishing fires, at a cost of over $4,000,000 per annum. This energy and money might better be utilized in the work of inspecting property, enforcing proper regulations and preventing the occurrence of fires. It is not intended to convey the impression that fire departments as extinguishing agents may be dispensed with, for the tremendous proportion of inflammable construction in Canada precludes any suggestion of lowering the present standards of public protection. It should not be overlooked, however, that while, up to a certain point, the fire loss of any municipality decreases as the strength of the fire department increases, beyond that critical point, further enlargement or equipment of the department cannot reduce the loss. There is a critical point in respect to expenditure upon fire protection beyond which the cost is comparable to the direct fire waste itself. If the present volume of loss is to be diminished, it can only be done by preventing the occurrence of fires, in addition to providing means for their extinguishment. The most appropriate agency for this work is admittedly the municipal fire department.

(*d*) Public Co-operation — Sufficient power to initiate measures of fire prevention rests with those who have most to gain. The people of Canada, merchants, manufacturers and property owners, can demand with authority the enactment of uniform laws to enforce improved conditions throughout the entire country. Through distribution by means of insurance, fire waste is a public matter and the real responsibility for improvement in conditions rests upon the people as a whole. The logical course of action, then, appears to be to arouse the public to their collective responsibility, to urge the adoption of restrictive legislation in regard to all matters affecting loss by fire and to penalize in every possible way the irresponsibility and negligence which are the principal causes of fire waste in Canada. This task presents a field for the interest and activity of associations of every description, working with the governments (the sources of power), the insurance companies (the sources of facts relative to fire waste), and the press (the sources of public information).

Hitherto, every safeguard against fire has been very largely a matter of voluntary adoption. Insurance influence has confined itself to protesting in general terms against fire waste, to the preparation of standards for its measurement and to a method of underwriting which penalizes bad conditions by charging high rates for insurance. Commercial fire insurance cannot directly compel the adoption of improvements, and voluntary progress in the matter has not brought reasonable nor adequate relief. The individual who invests money in property to obtain the greatest possible return upon his investment will not, of his own volition, build properly because it is for the ultimate benefit of the community. First-class buildings will not be erected so long as cheap construction is permitted and insurance is available to cover possible loss. Neither, without some measure of compulsion, will due care be exercised in regard to fire-breeding conditions. Cleanliness is one of the greatest fire-prevention agencies, but annual clean-up campaigns are spasmodic efforts of limited value. Improvement must be universally enforced to achieve even a measurable reduction in life and property waste and in the cost of insurance and fire protection.

CHAPTER II

Fire Waste in General

IN attempting any systematic study of fire waste, certain broad but indisputable facts must be clearly borne in mind for an adequate appreciation of the tremendous importance of the subject to Canada at the present time. Fire waste causes useless loss of life, of employment, of created property, of natural resources and of commercial prosperity. It imposes an economic burden upon the whole people in the expense of fire-extinguishment and insurance. This loss has reached such alarming proportions in Canada that it constitutes one of the most vital problems in any rational plan for the conservation of our national wealth and imperatively demands adoption of effective measures for its control.*

The Dominion of Canada, since confederation, has suffered direct loss from fire to the extent of over $350,000,000, exclusive of forest losses. To this sum must be added the cost of public and private protection, $150,000,000, and the amount of insurance premiums paid in excess of indemnity returned, $197,000,000. These figures in the aggregate represent the direct fire cost to the Dominion and show that, during the last half century, the ravages of fire have taxed the people of Canada to the extent of nearly $700,000,000.† The indirect cost involves interrupted business relationships, loss of earnings by employees, loss to property owners through vacancy of dwellings caused by removal of tenants to seek work elsewhere, loss to municipalities from destruction of taxable values and, most important of all, the loss of human lives. These costs, even regarded solely in their economic effects, are beyon the power of figures adequately to represent.

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*"Commendable as is the effort to conserve natural resources, I am impressed with the greater necessity of conserving the properties of our people. Our natural resources merely awaited the discoverer. Timber, minerals and water-powers stood at the door of our forefathers. None of these things required a single ounce of energy, a single moment's time or a penny of money. Not so with the builded properties of our people. Every building in this country represents energy and money, and every one of these buildings destroyed by the red plague of fire represents an irretrievable loss to the community at large."—*Hon. Chas. S. Deneen, Governor, state of Illinois.*

†Owing to the paucity of information available it is impossible to estimate with any degree of accuracy the amount of forest fire waste. Statements have been frequently published giving $8,000,000 to $15,000,000 per annum as an average, but it is obvious that these figures are merely guesses. In addition, such guesses only include the merchantable timber, as measured by current standards, that has been destroyed. They ignore the enormous, but incalculable, potential values of the timber which has not attained merchantable dimensions.

Increase of Fire Waste In Canada

The situation becomes more alarming when it is realized that the fire waste in Canada is increasing with great rapidity. For instance, in 1890, losses reached a total of approximately $5,500,000; in 1914, they amounted to $21,500,000, or an increase of 290 per cent. The only reliable index of the increase over a number of years is to be found in the figures furnished by insurance companies operating in Canada. The losses of these companies, as reported to the Insurance Department of the Dominion Government, are given in the following table, together with the population for each year since 1870:

TABLE No. 1.—COMPARATIVE INCREASE OF POPULATION AND INSURANCE LOSSES OF COMPANIES OPERATING UNDER DOMINION LICENSES.

Year	Estimated population	Insurance loss	Average loss per annum	Average loss per capita
1871	3,485,761*	$1,549,199		
1872	3,611,000	1,909,975		
1873	3,668,000	1,682,184		
1874	3,825,000	1,926,159		
1875	3,887,000	2,563,531	$1,928,209	$0.52
1876	3,949,000	2,867,295		
1877	4,013,000	8,490,919		
1878	4,079,000	1,822,674		
1879	4,146,000	2,145,198		
1880	4,215,000	1,666,578	3,398,533	0.83
1881	4,324,810*	3,169,824		
1882	4,384,000	2,664,986		
1883	4,433,000	2,920,228		
1884	4,485,000	3,245,323		
1885	4,539,000	2,679,287	2,935,929	0.66
1886	4,589,000	3,301,388		
1887	4,638,000	3,403,514		
1888	4,688,000	3,073,822		
1889	4,740,000	2,876,211		
1890	4,793,000	3,266,567	3,184,300	0.68
1891	4,833,239*	3,905,697		
1892	4,889,000	4,377,270		
1893	4,936,000	5,052,690		
1894	4,984,000	4,589,363		
1895	5,034,000	4,993,750	4,583,754	0.92
1896	5,086,000	4,173,501		
1897	5,142,000	4,701,833		
1898	5,199,000	4,784,487		
1899	5,259,000	5,182,038		
1900	5,322,000	7,774,293	5,323,030	1.02
1901	5,371,315*	6,774,956		
1902	5,532,000	4,152,289		
1903	5,673,000	5,870,716		
1904	5,825,000	14,099,534		
1905	5,992,000	6,000,519	7,379,803	1.30

* Census Years.

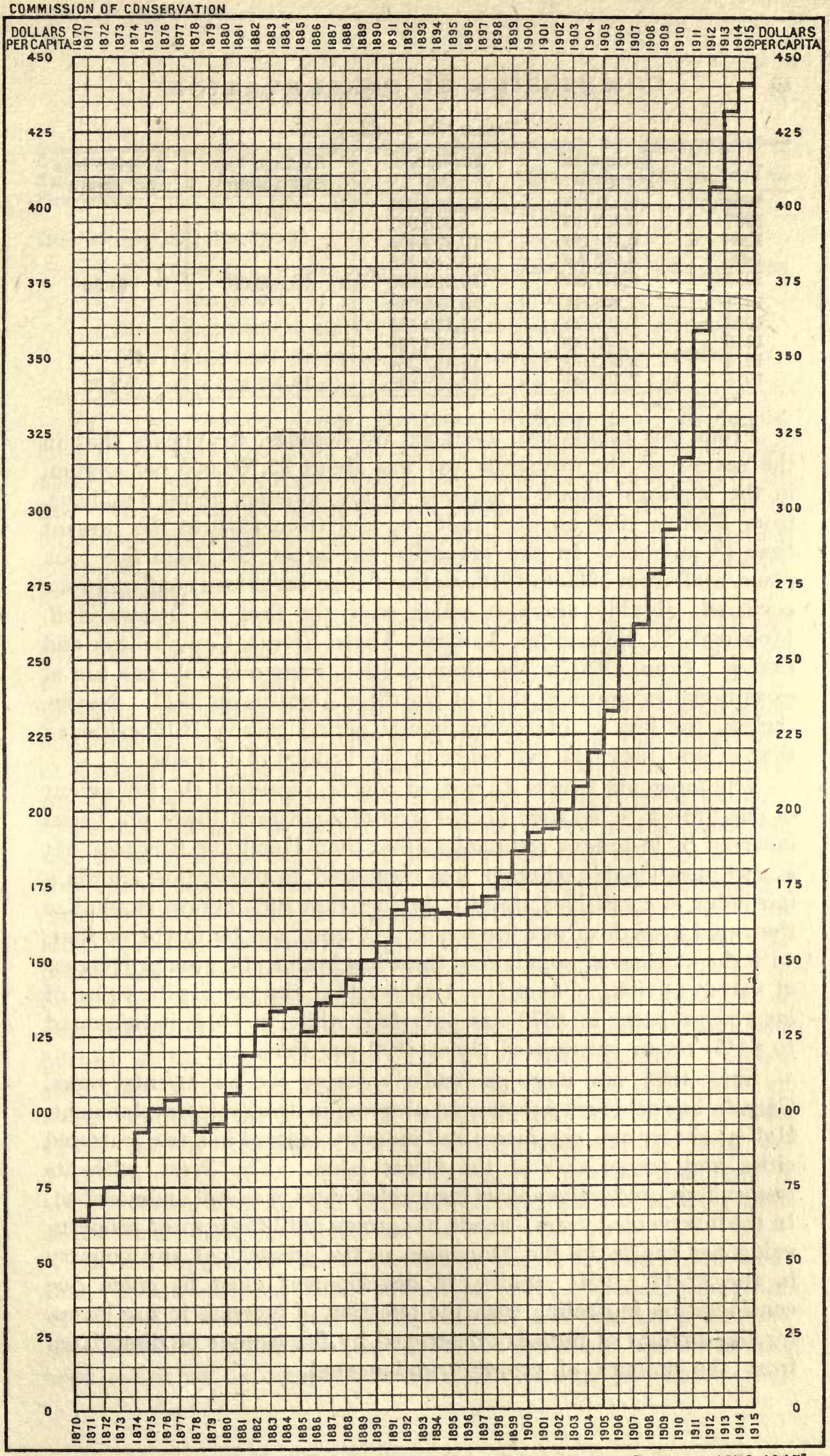


CHART NO. 1—PER CAPITA GROWTH OF INSURED PROPERTY IN CANADA, 1870-1915

TABLE No. 1—*Continued*

Year	Estimated population	Insurance loss	Average loss per annum	Average loss per capita
1906	6,171,000	$6,584,291		
1907	6,302,000	8,445,041		
1908	6,491,000	10,279,455		
1909	6,695,000	8,646,826		
1910	6,917,000	10,292,393	$8,849,601	$1.35
1911	7,206,643*	10,936,948		
1912	7,467,000	12,119,581		
1913	7,758,000	14,003,759		
1914	8,000,000	15,347,284		
1915	7,750,000	14,030,298	13,287,572	1.73

*Census year.

From this tabulation, averaged by decades, it appears that in the 'seventies' the insurance loss was about $2,700,000 per annum, in the 'eighties' about 3 millions, in the 'nineties' about 5 millions, from 1900 to 1910 about 8 millions, and from 1910 to the present time 13 millions. In the 'seventies' the great St. John fire took place, and, from 1900 to 1910, no fewer than seventeen conflagrations occurred, notable amongst which were the fires at Ottawa-Hull, Montreal, St. Hyacinthe, Toronto, Three Rivers, Campbellton and Fernie. From 1910 to the close of 1915, there was only one fire of exceptional magnitude, that of Northern Ontario, in 1911. Nevertheless, the loss of the quinquennial period ending 1915 exceeded that of any previous five years in the history of Canada.

The foregoing figures do not, of course, represent the full extent of our fire waste, as they do not include uninsured losses nor losses incurred by insurance companies other than Dominion licensees. It is also questionable whether loss compared to population affords a fair index of conditions, despite the fact that such figures emphasize the rapid growth of our fire waste. It must not be forgotten that, with the increase of population, there has been a still greater increase of values at risk. Chart No. 1 shows that the per capita value of insured property in 1870 was only $64, while, in 1915, it amounted to $441, or an increase of almost 590 per cent.

Since 1870, and more particularly during the last twenty years, Canada has achieved substantial progress in economic development. Half a century ago, commerce and industry centred in a few scattered cities and towns east of the Great lakes. The West, with its tremendous productiveness of insurable values, was still undeveloped. In the intervening years Canada has grown until the insured property value per capita in the Dominion is the greatest of any country in the world. This rapidity of development must be given due consideration in dealing with the question of increase in fire losses, for the amount of property destroyed by fire cannot be dissociated from the amount of property endangered.

Economic Significance of Fire Waste

Fire waste, while always local in inception, is national in its incidence. Its real significance to the community is most clearly shown by a consideration of its effects upon:

(1) Natural resources, by the destruction of building materials
(2) Commercial credit, by the impairment of security
(3) Industrial progress, by its handicap upon production
(4) The people, who finally pay the cost of fire.

(1) Its Effect Upon Natural Resources — Materials, labour and time, the basic elements of our real created values, are absolutely and irrevocably lost in the destruction of property by fire. The enormous insurance tax imposed upon the people to indemnify and replace property is powerless to re-create the materials destroyed. This fact is of large significance to the future prosperity of the country.

Of the material resources chiefly affected by fire, forests furnish the most conspicuous example. The standing timber of portions of Canada is fast approaching exhaustion. Hon. Senator W. C. Edwards, addressing the eighth annual meeting of the Commission of Conservation, drew attention to the fact that the importance of Canada as a lumbering country and the extent of her forest resources have been much over-estimated. Referring particularly to eastern Canada, he stated that, within a few years, lumbering will be so reduced that it will be of much less importance. In this connection it was pointed out and especially emphasized that the great enemy of Canadian forests has been fire. This latter statement is true in regard to other than forest fires. No fewer than 20,700 buildings of frame construction were destroyed by fire in Canada during the last four years, with a total loss of over $14,000,000. Approximately $8,000,000 of lumber value was burned in buildings of other than frame construction. Lumber yard fires contributed another $6,500,000 and the destruction of wood products in process of manufacture, $3,725,000. These figures merely represent readily ascertainable values and are doubtless incomplete. They demonstrate, however, that fire is largely responsible for the depletion of our lumber supply, even apart from forest conflagrations.

As the supplies of timber become further exhausted it is evident that Canada must substitute some other form of building material. The supplies of stone, gravel, clay, cement and lime are practically inexhaustible. While the use of these materials has heretofore been restricted by competition with the cheaper and more easily fabricated wood products, improved methods of manufacture and wider markets are rapidly diminishing the difference in cost. Careful investigation by the Government as to the structural qualities of the more permanent materials would undoubtedly enlarge their use, and thus have an important influence on the preservation of our diminishing timber supplies. There is the strongest justification for such immediate action. If it be the duty of the state to promote the public welfare by the prevention of forest waste, the broadest application of the principles of conservation should extend to the protection of created values. In the last analysis the loss by fire of a city dwelling is even more important to the people of Canada than the loss by fire of timber in the public domain. Both the building and the timber are assets of the nation. If they are destroyed, these assets are wiped out. No system of taxation will serve to restore them, whether the tax be collected by constituted authorities under the law or by private interests as premiums on policies of insurance. Re-forestation costs money, which must be levied through taxation in some form. Replacing buildings destroyed by fire costs money, a large proportion of which, by means of insurance, is assessed against property which has not been burned. In both cases, the cost is borne by the people of Canada as a whole and is, therefore, a matter of public concern.*

(2) Its Effect Upon Commercial Credit—The commercial assets of a country are largely its created and improved resources. Their sale and exchange have necessitated elaborate systems of credit. The enormous domestic and foreign commerce of Canada would be hopelessly wrecked in any attempt to conduct business upon a cash basis. We have outgrown the monetary system and cannot restrict our buying and selling to the limits of our gold reserve. Modern commercial organization and methods are dependent upon a highly developed credit system. If cash were demanded for all our obligations the nation would be bankrupt.

The extent of our business having outgrown our cash assets, it follows that in the integrity of our credit system lies the stability of the whole commercial fabric. Every form of currency given or received in the course of barter or exchange represents actual value

*"The large destruction of values in fixed capital and the absorption of floating capital in repairing the damage must necessarily have a widespread financial effect, but the very fact that it is widespread will serve to mitigate its force. Material interests have become so closely knit together over a wide area, extending even beyond the limits of any one country, that the burden of loss and the task of recovering, which would crush the community directly afflicted, are borne by vast constituencies whose interests are more or less implicated with its own in the network of modern industry and commerce. This involves a wide community of interest and a policy which is the necessary result of a complication of individual self-interests."—*Journal of Commerce and Commercial Bulletin*, New York, 1906.

either of fixed property or merchandise. If this property is in any manner destroyed the great fabric of credit is directly impaired to the amount of the loss. Under such conditions fire insurance is practically compulsory. There must be some guarantee that all basic securities are safe from the risk of elemental destruction. Credit is not extended to a merchant, manufacturer, or business man unless his stock of goods, merchandise in transit, or material in process of manufacture are covered by insurance. Neither can loans be obtained on real estate unless all buildings are insured. In principle and practice, insurance and sound credit are inseparable, and the business of insurance is directly interwoven with the entire commercial and financial activitities of the country.*

While the losses due to fire may be indemnified by insurance, frequent and excessive losses adversely influence the extension of credit. The individual having frequent fires upon his property is regarded with distrust in commercial circles. The city with a high average fire loss is at a disadvantage in municipal financing. No bond broker cares to sell the debentures of a community whose taxable values are continually disappearing in smoke.† The assets of a well-governed municipality, that does not permit its citizens to endanger their own or their fellow-citizens' property, are considered better security. When, year after year, the created resources which sustain all credit relationships are needlessly wasted by fire, the very foundation of the commercial standing of the country is being profoundly affected.‡

(3) Its Effect Upon Industrial Progress—The cost of production of manufactured articles in Canada is largely increased by the extent of the fire loss. Competition with foreign countries in many lines is hampered. It is estimated that the cost of fire insurance in Canada is five times greater than in Europe. This extra cost of insurance is largely the result of Canada's excessive fire waste, and constitutes a fixed charge entering into the selling price of every commodity. The taxation levied for the maintenance of municipal fire departments also increases the cost of manufacturing in all protected cities in Canada. In a general way this tax may

*"From nearly every standpoint fire insurance seems to be interstate in its nature—perhaps more so now than any other business. It is based upon averages and distribution, and, if we take into account large conflagrations, neither average or distribution can be intelligently applied within the limits of any single state."—Illinois Fire Insurance Investigating Committee, 1911.

†" 'Commercial suicide' would be a good term for the refusal of an individual, or a corporation, or a municipality to adopt reasonable recommendations for the improvement of hazardous conditions that encourage loss by fire."—*Insurance Engineering*, 1912.

‡"No self-respecting community can find consolation in the thought that the evil consequence of its failure to take ordinary precautions against a general waste of capital caused by fire are shared by the world at large."—*New York Sun*, 1906.

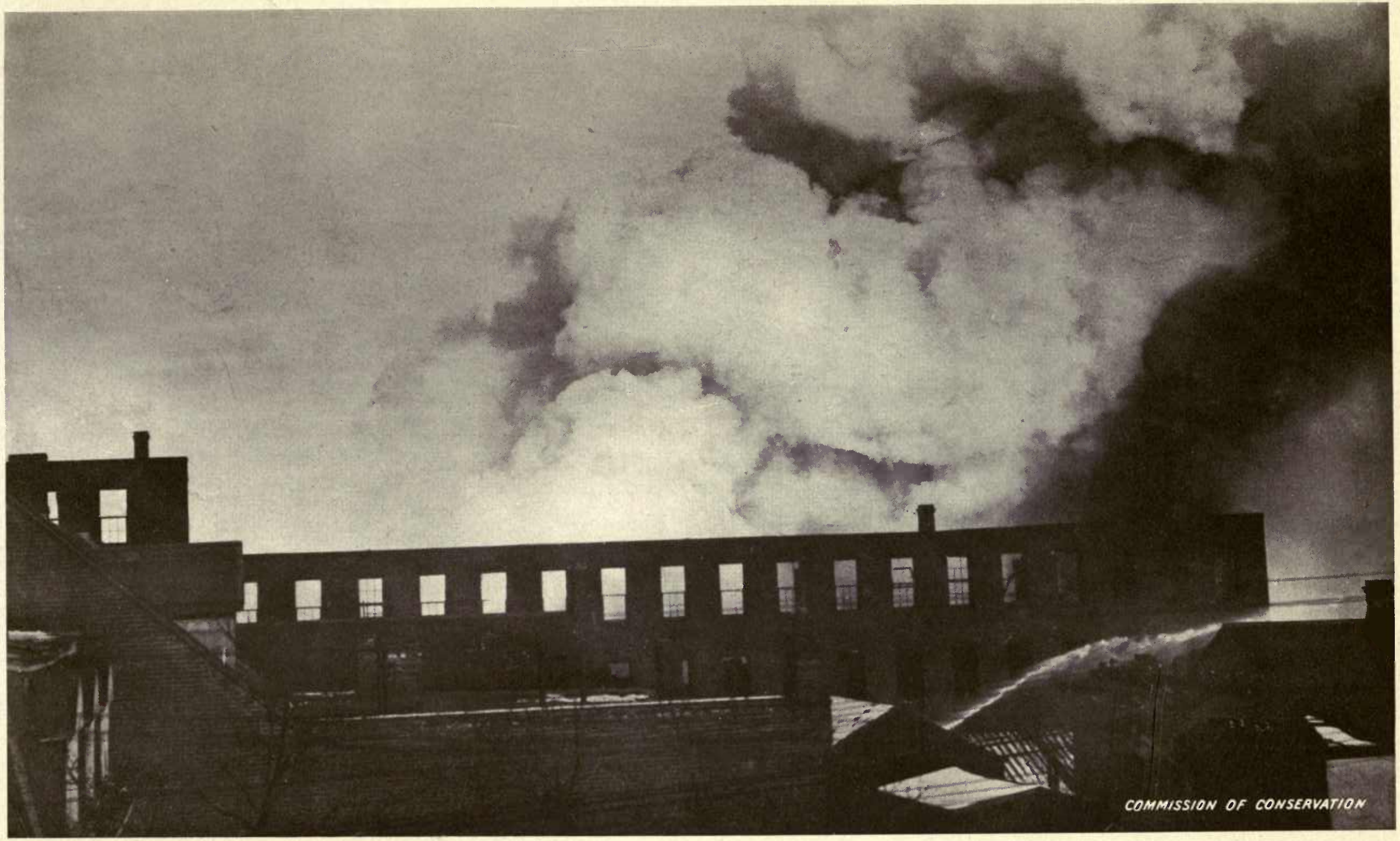
be said to be six times greater than in Europe. Such a comparison is not entirely reliable, however, as fire brigades in many continental cities are government institutions and in consequence, are maintained without directly affecting the property owner.

To illustrate in a concrete manner the extra overhead charges imposed upon the Canadian manufacturer through the excessive cost of insurance, English and Canadian rates on a number of specific industries are compared in the following table:

Class of property insured	Rates in England		Rates in Canada
	Per £100 per annum	Per $100 per annum	Per $100 per annum
Biscuit factory	7/6	$0·37 cents	$1·80
Boot and shoe factory	9/6	0·47 "	2·05
Brewery	2/–	0·10 "	0·90
Clothing factory	3/6	0·17 "	0·87
Flour mill	11/–	0·53 "	2·75
Fur garment factory	9/–	0·45 "	1·45
Harness factory	3/6	0·17 "	1·45
Hat factory (felt)	8/6	0·42 "	1·50
Hat factory (straw)	7/6	0·37 "	1·63
Machine shop	3/–	0·15 "	1·00
Planing mill	25/–	1·25 "	3·18
Tannery	7/6	0·37 "	1·52
Whitewear factory	3/–	0·15 "	0·85
Wood box factory	31/6	1·57 "	3·10
Woollen mill	18/6	0·92 "	3·25

Taking the case of a boot and shoe factory as an example: On every $250,000 of insurance carried, the Quebec manufacturer pays a premium of $5,125, as compared with $1,150 by the manufacturer in Leicester, Eng. This difference must enter into the selling cost of the factory product to wholesale distributors in the same way as the differences in insurance cost upon hide warehouses, tanneries and stock in transit were charged in the cost of the manufacturer's raw materials. Upon the assumption that the cost of materials and cost of production are the same in both cases, the Quebec factory must charge $3,975 extra for the same quantity of finished goods, or lose $3,975 from business profits. If competition prevents an extra charge, and profits cannot be decreased, then, upon a selling cost of $3 per pair, of which 33 1-3 per cent is profit on turn-over, the rate of production in the Quebec factory must be increased to the point of producing nearly 4,000 pairs of boots per annum more than the English factory.

Moreover, it must not be forgotten that all surplus production to meet the tax of fire waste represents the loss of the productive power of so much capital. Because a large proportion of the fire



FIRES IN FACTORIES AND BUSINESS ESTABLISHMENTS CAUSE EIGHTY PER CENT OF CANADA'S FIRE WASTE

Every fire in a factory or store reflects upon Canada's business men. Herculean efforts are being made to reduce the high cost of doing business. Yet fire waste constitutes an annual charge of over $20,000,000, which is calmly accepted as inevitable.

tax is carried as overhead charges, manufacturers have given little attention to the matter. The cost must be met, however, whether directly or indirectly, and its significance must be faced if Canada is to compete in the open markets of the world.

(4) Its Effect Upon the Community—The destruction by fire of any one insured property taxes every policy holder and, ultimately, every individual in Canada. Fire insurance is merely an agency for the distribution of losses, and the companies are trustees of a common fund. Insurance rates, fundamentally, are a nation-wide assessment of the cost of fire. About one-half of all insurance premiums collected is returned to the insured for loss sustained. The balance is retained by the companies to defray expenses incidental to conducting the business, and as profits. If unduly numerous or large fires swell the total loss to a dangerous extent, insurance rates are automatically raised everywhere throughout the country until the half of all collections is adequate to pay the loss.

The public regards disastrous fires with but little concern, holding the popular but erroneous conception that the insurance companies pay the loss. The absurdity of such an assumption is manifest. They could not do so and remain solvent. In the event of a conflagration, such as that in Toronto in 1904, the insurance companies poured into the city $10,000,000 that had been gathered from all parts of Canada. The people of Halifax and of Vancouver helped to rebuild Toronto. It is this comity of interests through fire insurance that enables recovery from the effects of fire.

Every individual in Canada is made to contribute directly or indirectly his or her share of the loss. The average policy holder is inclined to consider the question of fire insurance rates as affecting only the cost of the policies upon his own property. The fact is generally ignored that the price of every article necessary to existence is charged with a proportion of the fire cost. The tax is indirect and the exact amount is difficult to determine. The average consumer pays it unconsciously and, therefore, willingly. A loaf of bread bought at a retail store bears the cost of insurance upon the buildings and stock of a retail store, bakery, flour warehouse, flour mill, terminal elevator, country elevator and farmer's barn. In this manner, something is taken from the earnings of every man to pay the cost of fire; a portion of all labour and industry represents the unproductive effort of restoring values that have been carelessly destroyed. The burning every year of millions of dollars of created value increases the cost of living and is, therefore, of vital interest to the community.

Fire Waste in Foreign Countries

Were the enormous fire losses of Canada unavoidable, speculation and attempts at reform would be futile. That the condition is capable of improvement, however, is evidenced by reference to the losses of other countries. Special reports gathered by the National Board of Fire Underwriters of the United States show that the average per capita loss in fourteen European countries during the period 1912-1915 was $0.71, and in the United States $2.26. For the same years, the average loss in fifty-six Canadian cities amounted to $2.96 per capita. The respective returns for each country are shown in Table No. 2.

TABLE NO. 2.—FIRE LOSSES PER CAPITA FOR VARIOUS COUNTRIES.

Country	No. of cities reporting				Fire loss per capita				
	1912	1913	1914	1915	1912	1913	1914	1915	Average
CANADA	56	56	56	56	2·74	3·22	3·38	2·49	$2·96
United States	300	298	298	333	2·55	2·25	2·32	1·94	2·26
Philippine Islands	—	1	1	1	—	4·41	1·28	1·00	2·23
Scotland	2	3	1	3	0·49	0·36	5·35	1·62	1·95
Spain	—	1	1	1	—	2·30	0·15	3·13	1·86
South Africa	—	—	1	—	—	—	1·77	—	1·77
Belgium	1	1	—	—	0·69	1·36	—	—	1·02
Russia	2	2	1	1	0·84	0·89	1·19	0·95	0·97
France	6	5	3	3	0·84	0·49	0·63	1·02	0·74
Hawaii	—	1	—	—	—	0·69	—	—	0·69
England	12	14	9	8	0·54	0·33	0·67	1·03	0·64
Norway	1	1	1	1	0·69	0·32	0·48	0·72	0·55
Italy	3	5	5	3	0·90	0·25	0·37	0·62	0·53
Japan	—	3	10	—	—	0·59	0·44	—	0·51
Ireland	2	2	2	2	0·57	0·28	0·39	0·55	0·45
Chile	—	1	—	1	—	0·30	—	0·58	0·44
Sweden	1	1	1	1	0·13	0·74	0·54	0·29	0·42
Austria	4	4	1	—	0·30	0·25	0·42	—	0·32
Germany	9	8	4	2	0·20	0·28	0·17	0·49	0·28
Switzerland	1	1	1	—	0·04	0·15	0·19	—	0·13
Netherlands	2	1	1	1	0·12	0·11	0·07	0·14	0·11

Average annual loss per capita:

United States and Canada	$2·61
European countries	0·71
All other countries	1·13

According to this record the average losses in Canada are approximately four times the losses in Europe. As the comparison is confined to the more important cities, where fire protection is provided, it does not represent general conditions.

Statistics gathered from a number of European and Canadian towns of less than 4,000 population show that the loss for the years 1910 to 1914, inclusive, was sixteen times greater in Canada. This striking difference may be accounted for largely by our excessive exposure losses and the fact that towns in Canada have a much greater property value per capita subject to fire. Many important industries are situated in small places in Canada. These often provide the sole reason for the existence of a town and, in the event of their destruction, the per capita loss of that particular town is increased out of all proportion to the normal average of the country. A somewhat similar qualification should accompany any attempt to compare the loss records of Canadian and foreign cities. The fact that values at risk are approximately four times greater per capita in Canada than in Europe obviously leads to the conclusion that the same fire causes will, in all probability, produce losses four times as great. This provides no excuse for the extent of our fire loss, but it is an essential factor that is apt to be overlooked in making the comparison.

The true difference that exists between Canadian and foreign fire waste conditions is best indicated by a comparison of the frequency of fires and the extent of damage caused by each fire. Available statistics show that fires occur in Canada in the ratio of one to every 600 people and in Europe in the ratio of one to every 3,000 people. That is, Canada stands with potentialities for conflagration five times as great as in Europe. Accurate returns of the number of fires in foreign countries are difficult to obtain, but figures showing alarms per ten thousand population and losses per capita in the largest cities of the world are given in Table No. 3.

TABLE NO. 3.—ALARMS PER THOUSAND POPULATION AND LOSSES PER CAPITA IN THE LARGEST CITIES OF THE WORLD.

City	Country	Estimated population	No. of fire alarms	Total property loss	Alarms 10,000 pop.	Fire loss per capita
New York*	United States	5,333,537	16,245	$8,217,811	30	$1·44
London†	England	4,522,961	6,125	2,750,000	14	0·60
Paris	France	2,888,110	4,366	1,730,943	15	0·61
Chicago	United States	2,393,325	14,977	6,018,589	63	2·46
Tokio	Japan	2,186,079	521	684,346	2	0·34
Petrograd	Russia	1,907,708	2,884	1,194,570	15	0·62
Philadelphia	United States	1,657,810	5,061	2,791,130	30	1·68
Moscow	Russia	1,468,563	1,228	1,926,525	8	1·19
Osaka	Japan	1,226,590	203	373,623	2	0·28
Hamburg	Germany	932,080	2,300	207,730	25	0·21
St. Louis	United States	734,667	4,674	2,900,522	64	3·42
Boston	United States	733,802	5,679	3,044,627	77	4·06
Milan	Italy	670,000	988	320,104	15	0·48
Montreal	**Canada**	**650,000**	**3,574**	**1,800,000**	**55**	**2·76**
Cleveland	United States	639,431	3,096	1,756,863	48	2·66
Baltimore	United States	579,590	2,360	704,138	40	1·17
Madrid	Spain	571,539	820	92,000	14	0·15
Pittsburg	United States	564,878	2,160	1,750,437	39	3·10
Marseilles	France	550,619	500	433,528	9	0·79
Detroit	United States	537,650	3,602	1,675,261	67	2·99
Birmingham	England	525,960	1,042	1,051,580	19	1·25
Lyons	France	523,796	258	933,170	5	1·78
Toronto	**Canada**	**470,144**	**2,137**	**1,457,479**	**47**	**3·10**

* Greater New York. † Metropolitan Fire Brigade District only.

TABLE NO. 3—*Continued*

City	Country	Estimated population	No. of fire alarms	Total property loss	Alarms 10,000 pop.	Fire loss per capita
Sheffield........	England.......	454,653	382	$110,950	8	$0·23
Buffalo.........	United States..	454,112	2,279	1,167,996	50	2·54
San Francisco...	United States..	448,502	2,645	1,037,486	59	2·30
Leeds..........	England.......	445,568	298	377,080	7	0·84
Kyoto.........	Japan........	444,462	110	293,740	3	0·58
Los Angeles....	United States..	438,914	2,573	850,635	58	2·43
Milwaukee.....	United States..	417,054	2,206	834,649	54	2·11
Frankfort......	Germany......	414,598	334	71,189	8	0·16
Cincinnati......	United States..	402,175	2,217	699,473	55	1·74
Newark........	United States..	389,106	1,913	1,280,110	41	3·20
Yokohama.....	Japan.........	388,303	116	252,264	3	0·65
Belfast.........	Ireland........	385,492	164	181,385	4	0·46
Nagoya........	Japan.........	378,231	104	345,182	3	0·77
Kobe..........	Japan.........	378,197	156	165,037	4	0·37
New Orleans....	United States..	361,221	889	935,614	25	2·60
Washington....	United States..	353,378	1,374	779,792	39	2·21
Minneapolis....	United States..	343,466	2,474	1,086,225	73	3·10
Edinburgh......	Scotland......	320,315	522	127,120	16	0·40
Seattle.........	United States..	313,029	2,081	896,688	67	2·96
Dublin.........	Ireland........	309,272	251	78,250	8	0·22
The Hague.....	Netherlands...	303,430	634	21,240	21	0·07
Hanover.......	Germany......	302,384	404	112,408	13	0·37
Jersey City.....	United States..	293,921	1,045	372,327	36	1·24
Stuttgart.......	Germany......	285,589	188	29,533	7	0·10
Kansas City....	United States..	281,911	780	169,414	28	1·78
Bordeaux.......	France........	261,678	391	158,958	15	0·61
Portland.......	United States..	260,601	1,855	1,762,493	71	6·78
Indianapolis....	United States..	259,413	2,132	1,004,823	82	3·86
Christiania.....	Norway.......	243,801	388	121,386	16	0·48
Rochester......	United States..	241,518	1,158	306,832	48	1·23
Florence.......	Italy..........	232,860	193	40,132	8	0·17
Trieste.........	Austria........	229,475	457	220,839	19	0·92
Manila........	Philippine Isl..	219,928	134	299,618	6	1·28
Lemberg.......	Austria........	206,574	455	31,015	21	0·15
Columbus......	United States..	204,567	912	162,700	46	0·80
Winnipeg.....	**Canada.......**	**203,255**	**1,328**	**662,549**	**66**	**3·26**
Cardiff.........	Wales.........	182,280	168	99,770	9	0·55
Bolton.........	England.......	180,885	63	175,745	3	0·93
Atlanta........	United States..	179,292	1,571	661,128	87	3·73
Nagasaki.......	Japan.........	176,480	6	13,058	—	0·08
Ghent.........	Belgium.......	166,445	174	114,365	11	0·69
Birmingham....	United States..	166,154	2,338	1,252,842	146	7·37
Aberdeen.......	Scotland......	163,084	169	110,055	10	0·67
Worcester......	United States..	157,732	1,466	604,720	91	3·66
Posen..........	Germany......	156,696	370	28,432	22	0·17
Gratz..........	Austria........	155,668	120	6,576	8	0·04
Syracuse.......	United States..	149,353	609	296,587	40	1·85
Memphis.......	United States..	143,231	1,429	822,938	100	5·67
Basel..........	Switzerland....	131,914	91	27,993	7	0·19
Birkenhead.....	England.......	130,832	148	155,250	11	1·13
Messina........	Italy..........	126,172	142	40,936	11	0·32
Fall River......	United States..	125,443	530	321,699	44	2·57
Grand Rapids...	United States..	123,227	571	157,848	47	1·26
Roubaix........	France........	122,723	75	96,000	6	0·78
Nancy.........	France........	119,949	90	97,615	7	0·81
Southampton...	England.......	119,039	72	94,720	6	0·77
Utrecht........	Netherlands...	119,006	99	7,892	8	0·06
Vancouver.....	**Canada.......**	**115,000**	**642**	**677,771**	**53**	**5·89**

TABLE NO. 3—*Continued*

City	Country	Estimated population	No. of fire alarms	Total property loss	Alarms 10,000 pop.	Fire loss per capita
Nashville.......	United States..	114,899	663	380,972	60	3·31
Dallas.........	United States..	111,986	764	546,301	69	4·87
Middlesborough	England.......	104,787	56	102,540	5	0·97
Tacoma........	United States..	103,448	1,110	368,133	110	3·61
Albany........	United States..	102,961	1,003	600,788	98	5·46
Hamilton.....	**Canada.......**	**101,808**	**433**	**314,314**	**42**	**3·08**
Ottawa........	**Canada.......**	**101,795**	**522**	**342,792**	**51**	**3·36**
Springfield.....	United States..	100,375	996	325,104	99	3·19
Hukuoka.......	Japan.........	100,210	16	9,046	—	0·09
Calgary.......	**Canada.......**	**84,000**	**417**	**142,536**	**49**	**1·69**
Brescia........	Italy..........	83,323	134	21,146	16	0·25
York..........	England.......	82,277	35	6,740	4	0·08
Quebec........	**Canada.......**	**80,000**	**662**	**290,301**	**82**	**3·63**
Edmonton.....	**Canada.......**	**72,516**	**550**	**159,643**	**76**	**2·20**
Ravenna.......	Italy..........	71,690	22	17,980	3	0·24
Flensburg......	Germany......	60,931	99	12,663	16	0·19
London.......	**Canada.......**	**55,026**	**264**	**200,457**	**48**	**3·64**
Halifax........	**Canada.......**	**55,000**	**251**	**88,304**	**45**	**1·60**
Lancaster......	England.......	41,414	12	1,490	3	0·04
Torquay.......	England.......	38,772	16	23,695	4	0·62
Saskatoon.....	**Canada.......**	**25,000**	**182**	**301,719**	**73**	**12·06**

In Canada, taken as a whole, the number of fires has increased much more rapidly than the population. For instance, the city of Toronto had 385 alarms in 1890, 746 alarms in 1900, 1,267 alarms in 1910 and 2,080 alarms in 1916, an increase in the twenty-six years of 440 per cent. Toronto, in this respect, is representative of practically every other municipality in the Dominion. Fires have also increased in frequency of recent years in such European cities as London, Berlin and Paris, due, no doubt, to the complexities of modern life, but the number has remained practically stationary in the smaller European towns.

The real significance of the comparison lies in the fact that, whereas, in Canada, the property loss per alarm has increased entirely out of proportion to city growth and expansion, the loss per alarm in European cities has decreased. This fact can, in a measure, be accounted for by appreciation of values in Canada and the increasing number of fires that involve adjoining properties. Exact figures of the loss due to exposure are not readily obtainable, but the most conservative estimate indicates that at least 14 per cent of the total property loss of Canada is caused by fires extending beyond the building of origin. On the other hand, in European cities, such as Leeds, Sheffield, Bristol, Antwerp, Brussels, Milan, Rouen and Havre, practically every fire is confined to the building in which it starts. In Vienna, Florence, Dresden, Budapest and Moscow, in 1914, every fire was confined to the floor on which it originated. In Hamburg, Germany, the extension of any fire to an adjoining building has been unknown since 1842. In Vienna, there is no case known in which fire has involved two buildings, and, in recent years, in only seven instances has damage been caused to more than one floor of a building.

Such results, contrasted with the Canadian record, of 1,378 fires spreading to 6,786 buildings during the four years 1912–1915, are extraordinary. Moreover, they were obtained with the most inadequate fire protection facilities. In Rome, where practically all fires are confined to the room in which they originate, the means available for extinguishment are thus described by U. S. Consul-General Bourn:

"Buckets and fire extinguishers are chiefly used for extinguishing fires. If these are not sufficient, small hose, perhaps 1¼ inches in diameter, is brought into service. But the force of water in many parts of the city is not great, although the supply is very abundant. If the hydrant pressure is not sufficient, small, portable fire engines are used, and, in cases of great emergency, there is one steamer, but, as it is so seldom required, no proper arrangements exist for bringing it into service. The last time the steamer was called out it was over two hours before it was ready to throw water on the fire."

Except London, Paris and Berlin, European cities have paid little attention to modern fire protective equipment. They have directed their chief energies to fire prevention. Municipal expenditures have been devoted to the control of building construction and maintenance. On the contrary, Canada has developed very elaborate and efficient fire-fighting facilities. As regards appliances, methods and personnel, the fire brigades of large Canadian and American cities are incomparably superior to those of other countries. In this course of action lies one of the essential differences between the respective policies of Canadian municipalities and those of Europe. To prevent rather than extinguish fires has not impressed public bodies in Canada as being a part of their functions. Consequently, the annual maintenance costs of city fire departments average $1.43 per capita, fire losses $2.96 per capita, and insurance rates $1.18 per capita in Canada as compared with 21 cents, 71 cents and 26 cents, respectively, in Europe.

Causes of Excessive Fire Waste in Canada

Three factors enter into the occurrence of all fires. These may be defined as physical hazard, moral hazard and temperamental hazard. Physical hazard is a term applied to characteristics inherent in combustible property and its use, such as poor construction, heating, lighting, power and occupational hazards. Moral hazard may arise from motives of revenge, from insanity or from the desire to secure unlawful gain by the destruction of insured property. Temperamental hazard is the habit of the people, the state of mind which condones carelessness and is indifferent to its effects.

The striking contrasts between the losses, frequency and extent of fires in European countries as compared with Canada are due to differences in the regulation and control of these three prime factors of fire waste. The immediate effects of this control are most clearly shown in

(1) The general character of the buildings
(2) The laws governing the conduct of the people
(3) The viewpoint and civic responsibility of the individual.

(1) Character of Buildings—The chief structural conditions that operate to effect a small fire loss in Europe are the general use of non-combustible materials, the restricted height and area of buildings in cities, and the stringent requirements of building codes. With the exception of Norway, Sweden and Russia, where wood construction is prevalent, practically all European countries prohibit the erection of frame buildings within municipal areas. Very few wooden buildings exist even in rural districts, and whole communities of inflammable structures, such as are common in Canada, are unknown. This condition is primarily due to the relatively high cost of lumber in Europe and the intangible influence of older civilizations, which make for permanence. The authorities have realized the necessity of good construction, so that, on the average, buildings are much less inflammable than in Canada. Anomalous as it may appear, the more fire-resisting all buildings are, the less fire-resisting does any particular building need to be. What is known as modern fire-proof construction is far from common in Europe. Few buildings are comparable with the steel and tile or concrete structures erected in Canada during recent years. They have not been found necessary, because internal fires are few and the external hazard due to exposure is practically negligible. In a city composed of buildings which, although not fire-proof, are comparatively incombustible, the danger of fire is much less than it is in a city having a large amount of inflammable construction and a few scattered fire-proof buildings.

In Canada, the most costly and extensive fires have invariably been caused by the poor average of building construction in the areas affected. It is estimated that only one in every 1,200 buildings in Canada is in any sense fire-resisting and that 69 per cent of the total number are of frame construction. Despite advances in the price of lumber in recent years, 47 per cent of all the buildings erected during 1912–1915 were built of wood. No harsh indictment of the Canadian people is justified by these facts. Timber has always been abundant, more adaptable and less costly than other materials. Pioneer settlements have become villages and villages have become towns in a brief period of time. The demand for new buildings has been urgent and development has taken place with little definite planning or foresight. In all Canadian cities, community problems incidental to industrial growth have, at some time, forced the transition of residential streets into mercantile districts. There has been no guarantee of permanence and no means of anticipating future developments. Consequently it has been to the economic interest of the individual to build cheaply and temporarily, to burn if necessary and build again.

There is no immediately effective remedy applicable to structural conditions in Canada. The worst features will gradually disappear as lumber becomes relatively more expensive and the existing buildings are destroyed or torn down to be replaced by a better type. Municipal building legislation, such as is in force in most Canadian cities, does not adequately deal with the situation. Frame construction is usually prohibited in small congested business areas but, in adjacent districts, the poorest type of buildings is permitted. As the cities expand, these districts, in turn, become congested areas and form an insuperable barrier to any real progress. To effect reform and to approach European standards, in even a measureable degree, the only logical plan appears to be the enactment of legislation in each province to regulate and control all building construction in accordance with known standards of structural safety.

(2) LAWS GOVERNING THE CONDUCT OF THE PEOPLE—While better construction and climatic conditions account largely for the insignificance of the fire losses in Europe as compared with those in Canada, another potent factor is to be found in the laws governing the conduct of the people. European laws punish carelessness, protect the community from its results, rigidly investigate the cause of fires and enforce severe penalties for negligence and criminality. Profit from the burning of property is made practically impossible.

In France, government regulations control all dangerous trades and hazardous occupancies. The non-observance or the infringement of any precautionary measures required by the authorities may have serious consequences to the offenders, inasmuch as it renders them responsible for any loss by fire arising from neglect on their part. A tenant is held responsible for all loss occurring through a fire breaking out in the premises he occupies, unless he can prove that the fire was not occasioned by his neglect or fault. In the case of a fire due to a defect in the building, the landlord is responsible to the tenant and others suffering loss thereby; the landlord, in turn, can sue the architect, builders or others to whom the fault for the defect is traced. They are also liable to the penalties provided for by the laws and regulations which have been violated. The law imposes capital punishment for the crime of setting fire to inhabited houses. In other cases, the penalty for arson may be penal servitude. An inquiry into the cause and circumstances attending each fire is obligatory unless the loss is of a trifling nature. In Paris and other cities this inquiry is made by the Commissioners of Police, with the assistance of the officers of the fire brigades, and deals particularly with the financial position of the person upon whose premises the fire originated. Attention to this point is given even in the case of fires in private apartments. In villages and country districts the duty of inquiring into fires rests with the mayor, police or other representatives of the law. Wherever there is reason to believe the fire is of incendiary origin, or if the circumstances are suspicious, a report of the investigation is sent to the judicial authorities who take criminal proceedings against the offender.

In Germany, rigid control over all building operation is exercised by the different municipalities. The strictest regulations are enforced regarding heating, lighting and the general maintenance of buildings. All theatres must be built of incombustible material, only electric lighting may be used and metallic fire curtains able to resist a very high temperature must be installed. Chimneys in all buildings must be erected according to regulations and must be cleaned and examined periodically by an official chimney inspector. The storage of combustible goods and the conducting of hazardous trades are subject to municipal laws varying in detail in different localities, but everywhere such conditions are subject to supervision. In contracts covering the renting of apartments, the lessee is forbidden to carry an open light into attics or cellars. An imperial law forbids such action and is enforced by the local authorities. In workshops and workrooms, at the conclusion of each day's work, all combustible material, such as paper and shavings, must be removed to a place of safety for the night. Stringent regulations govern the use of inflammable products of petroleum, and petrol and other internal combustion engines are subject to the closest supervision. Piles of firewood are not permitted to be stored in yards for any length of time, and, when brought inside, the wood must be so stacked that, in case of fire, the living rooms will not be endangered. The German civil code makes every individual responsible for the damage caused by his act or negligence to the person or property of others. Liability for intent and negligence is always presumed, and, in the absence of other regulations, the provisions of sections 827 and 828 of the Imperial code are obligatory. Negligence is defined as failure to use due precaution; non-presumption of intent is prohibited. The principal is liable for the infraction of his legal representative and of persons to whom he delegates the discharge of his obligations exactly as for his own act. Where several persons have joined in committing an unlawful deed, each is individually liable for the resulting damage. The same is applicable if it is impossible to determine which of the participants actually caused the damage. Instigators and accessories are considered on a par with participants. The criminal code provides severe punishment, in the form of imprisonment with hard labour, for the crime of incendiarism, varying according to the degree of culpability, not only for the immediate perpetrator but also for accomplices. Even negligence, under given circumstances, is punished with imprisonment, and, should it involve the loss of human life, for a term of not exceeding three years.

These are the customs and laws in France and Germany; the same general policy of regulating public conduct is followed by nearly all European countries. Such restrictions are regarded by the people as entirely natural and proper and in the interests of the individual and the community. They can see no reason why a man should be permitted to destroy property by his carelessness or to endanger the lives and homes of his neighbours. Speaking upon the question of fire waste in the United States, the Insurance Commissioner of Michigan recently stated:

"Other nations have seen the handwriting upon the wall and have realized its import, and it is high time that we should follow their example. These countries have, for years, been pursuing a policy looking to reduction of fire loss by enforcing strict and drastic statutes relative to cleaning up of alleys, basements and garrets and by placing the responsibility of fires upon the shoulders not only of the person who has been guilty of a violation of any of these decrees, but also of the persons who should have known of their origin.

To an American this seems harsh, and perhaps smacks of paternalism, but to those who have made a reasonable study of fire prevention, this question becomes an important one, and the conclusion is unavoidably reached that the necessity calls for more drastic and far-reaching criminal statutes."

Not all European laws are adaptable to Canadian conditions, but the general principle is, *i. e.*, that the legal and criminal responsibility for fires shall be imposed upon and borne by the person responsible. A railway is held liable if sparks from one of its locomotives set fire to a building along its right-of-way. By an extension of the same principle, should not the owner of a building be held responsible for loss caused to his neighbour by sparks from a neglected chimney? An employer is held liable for injury to his employees or to the public through his negligence. Why should this responsibility not extend to injury by fire as well as to that caused by machinery, where lack of reasonable precautions is contributory? Theatres, factories and places of public assemblage are safeguarded in a measure by statutory or other regulations and such protection is held to be in the public interest. It is equally essential to public welfare to legislate for the safety of life from fire in all buildings. Reasonable laws, applying the same principles to fires that are enforced against other violations of the rights of others, would curtail carelessness to a great extent and, undoubtedly, effect a considerable reduction of fire waste in Canada.

(3) Viewpoint and Civic Responsibility of the Individual—In all portions of Europe influenced by the Code Napoleon, the law of *voisinage* prevails and the individual is held to strict accountability for acts of omission as for acts of commission. One of the far-reaching effects of the principle involved is that the individual is made to consider his relationship to his neighbours. This is, perhaps, best illustrated by reference to the insurance practices of Europe. In France, to meet obligations created by the law, the insurance companies have evolved a system whereby a person may protect himself, not only against his own individual loss, but also against any damage that may ensue to others. The system comprises four distinct risks: (1) That to a man's own property; (2) the '*risque locatif*,' covering the tenant's liability to the owner; (3) the '*risque des voisins*,' affecting the risk of setting fire to a neighbouring property, and (4) the '*risque des locataires*,' or the tenant's right of recovery against the landlord for faults of construction and maintenance, or carelessness of workmen.

The assumption by insurance companies of the responsibility of the individual to the community has had a reflex influence upon the relationship of the community to the individual. Regulations safeguard the individual on every hand in order that the investor who improves his property by the erection of permanent structures may not suffer constant hazard through neighbours who are careless of their civic duties. Such stringent legislation is an expression of the national character. Hon. Robert Stone, of the Kansas legislature, has thus defined the difference between the American and European temperament:

"We are a nation of money-makers, Europe is a people of money savers; we are a people of waste, they are a people of thrift. We figure that the most important thing is to make a dollar, and they that it is of equal importance to save one. This is evidenced in our hurried construction of inflammable buildings, and in their slow and solid masonry; in our willingness to pay a high rate of fire insurance with the attendant risk, and their insistence on a low rate and unceasing care; in our elaborate fixtures for the putting out of fires, and their precaution in preventing fires. We regard fire as a misfortune and sympathize with the man who has had one; they regard fire as a crime and investigate and punish the man who is guilty. Our temperament is also shown by the different view we take of an insurance policy. Here, if our property is insured and we have a fire, we do not count it as a loss—simply that we have transferred the loss to other and distant shoulders. There, the insurance is regarded as a tax, which is ultimately borne by every one. Here, we regard insurance as a gamble. There, it is regarded as a means of reducing the loss to a certainty and borne by the whole community. Here, we figure that the insurance company restores the loss; they, that it really indemnifies the owner for a loss which can never be restored. Here, we figure a fire is an exchange of property for the ready money; there, they figure that a fire is an absolute loss of toil and natural resources. We figure a fire is a misfortune, they figure a fire is a crime. We endeavour to extinguish the fire; they labour to prevent it."

The Control of Fire Waste

Consideration of the basic differences between fire waste conditions in Canada and foreign countries leads to the conclusion that, in this generation, we cannot hope to approximate the same standards as Europe. The mass of timber construction, climatic conditions, the restless, mobile character of the population, are three sufficient reasons, apart from incendiarism and carelessness. Nevertheless, the present rate of loss can be greatly reduced by placing proper emphasis upon preventive measures.

Fire prevention in its larger significance aims at control of the three great sources of all fires, physical, occupational and personal.

It seeks to compel a proper construction of buildings and the safeguarding of hazardous features in buildings. It aims to correct personal negligence in regard to fire dangers and to discourage incendiarism by urging rigid investigation into the causes of all fires. While it is improbable that such laws as obtain in Europe in regard to the control of fire will ever become enacted in Canada, there is a pronounced and growing tendency to curb public evils by statutory intervention. In our complex modern life, proper legislation and its effective enforcement have been found essential to produce any real control over the things that should be repressed in the common interest and for the common good.

In the treatment of no other subject affecting public welfare has Canada tarried so long as it has in the field of fire prevention. Canadians have had such a fund of natural wealth and believe so thoroughly in individual freedom that they have not felt the need of economy nor have they been willing to circumscribe personal liberties. The fire waste has become, however, an economic burden that not even the wealthiest country can long afford. Argument, therefore, is unnecessary as to the right and the present advisability of government control of all matters concerning loss by fire. The form of this regulation is without legal or administrative difficulties. Each province, through its sovereign police power, is the logical unit of control. Authority delegated to municipalities has proved to be almost worthless in effecting any diminution of fire waste, even within restricted areas. Local regulations are, unfortunately, subject to local influences that destroy uniformity as between municipality and municipality, and finally reduce general requirements to the minimum. What is needed is widespread legal control of fire waste by the imposition, continuously and universally, of requirements covering every problem involved. More law is not required. Reasonable, modern, intelligent, uniform, and effective legislation should replace the insufficient and inefficient laws now administered by different administrative departments of the provincial and municipal governments.

All fire prevention legislation should be province-wide in its application, empowering cities, towns and villages to increase requirements locally if desired. The advantage of this method of dealing with the question is that it provides an elastic system of government quite unlike the drastic police control of European countries. Moreover, by furnishing definite and unvarying standards in each province it affords a continuous education to property owners that must create public support and render the laws more effective. Ultimately, the real problem in preventing fires is to secure the actual interest and co-operation of the individual property owner.* It is he who largely determines the construction, the nature of the contents, the extent of protection, the state of repair, the management and the hundred details which enter into the fire hazard of any building. The very fact that the aid of the individual must be enlisted indicates that there is no royal road to the control of fire waste in Canada.

"To arouse the people against the fire foe is our greatest task. There is no difference regarding the essentials. The average citizen will admit that our fire waste is in the nature of a national disgrace. The task is to make him do something to remedy conditions. It seems ridiculous that a people so eager to seek out and destroy the mysterious and hidden enemies of mankind should be so slow and sluggish in fighting a foe so plainly in sight and so readily vanquished. We have led the world in seeking out the causes of pestilence and removing them. We are in the vanguard of the battle against tuberculosis, typhoid and other malignant diseases. Still we stand apart and let the older nations lead the fight against an enemy much more easily conquered.

"To relieve the people of the unnecessary burden which they are now carrying, we must teach them the importance and the significance of that burden and show them the necessity for defence against the common enemy. Let the people once realize the exact facts of their own negligence and they will be swift to provide a remedy."—*Hon. Walter L. Fisher, Secretary of the U.S. Dept. of the Interior.*

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* "When you say that $300,000,000 is wasted in fire it does not make an impression. It would impress a Frenchman or Englishman or German. It does not impress us. Go to Chicago or New York and say to a man: 'We waste $300,000,000 a year in fire.' What will he say? He will reply: 'I am busy. I do not care about that.' It is supposed to be a normal condition to waste."—*Hon. Wm. C. Redfield, Secretary of the U.S. Dept. of Commerce.*

CHAPTER III

Statistical Survey of Fire Waste and Fire Protection in Canada

IN the preceding chapter it has been shown in a general way that the extent of fire waste in Canada exceeds that of any other civilized country in the world, and constitutes an irreparable drain upon our national prosperity. It has also been pointed out that the situation is capable of being remedied by a change of attitude involving the employment of entirely new methods of dealing with the conditions that occasion fire. Before any systematic programme of action can be entered upon, however, it is necessary that reliable data should be available, not only of the extent but also in regard to the distribution, nature and specific causes of the fire loss. Such data should also include detailed particulars of all agencies incidental to the occurrence of fires, such as public fire departments, in order that an appraisal may be made of their effectiveness. So far as known, no organized attempt to gather information of this character has ever been made, and the figures generally used in referring to fire waste have been little more than rough estimates. In Manitoba, Saskatchewan and British Columbia fairly complete records of fire losses are compiled by the respective fire marshal departments, but statistics for the whole of Canada have never been available.

Period Covered by Investigation

The tables embodied in this section of the report were compiled from figures supplied by municipal officials and insurance companies, and, as broad statistical summaries, they indicate the great necessity for some measure of reform in the matter of fire waste. As a period of four years is considered the minimum upon which to base conclusions of any value, the record covers that length of time. Owing to fluctuations in the amount of loss from year to year, it is obvious that reliable averages cannot be obtained from the figures for any one year. For a similar reason, figures for the year 1916 are omitted. Two fires, one destroying the Dominion Parliament buildings at Ottawa and the other sweeping northern Ontario, caused an aggregate property loss of approximately $5,000,000, and increased the per capita loss of the Dominion for the year to $3.40, as compared with an average of $2.73 for the four preceding years. Therefore, to include 1916 figures, in any statement designed to show average conditions would be entirely misleading. From 1912 to 1915 no conflagration of extraordinary importance occurred, and it is believed these years fairly represent the present normal fire waste situation in Canada.

Extent of Loss Urban and Rural

The cities, towns and incorporated villages from which reports were received, have a population aggregating 3,982,968, and suffered a total property loss of $53,767,310 in the four years 1912-1915 inclusive. During the same period, townships and rural districts with a population of 3,773,532 experienced a loss of approximately $31,227,367.

The average annual loss in urban districts was $13,441,827, or $3.37 per capita,* and in rural districts $7,806,841, or $2.06 per capita. It may, therefore, be stated with a reasonable degree of accuracy that the fire loss of Canada during the years 1912-1915 amounted to at least $84,994,677, an average annual loss of $21,248,660, or $2.73 per unit of population.

In addition to this great destruction of property values, 789 persons lost their lives and no fewer than 2,103 were severely burned or otherwise injured by fire.

Insurance Indemnity does not Fully Cover Loss

The average annual loss of $21,250,000 by fire represents the squandering of a sum equal to the interest upon a capital investment of $425,000,000. It means a waste of almost $59,000 every day in the year, apart from the vast expenditures rendered necessary for the maintenance of fire departments. The term ' waste ' is used advisedly, because the loss is an absolute and irrecoverable one.

The money paid by insurance companies does not by any means cover the total losses sustained. Upon this point opinions differ, some underwriters maintaining that from 75 to 85 per cent of all property is insured and others that only 50 or 60 per cent of the insurable value is covered. Taking the losses for the year 1914, it is found that insurance companies under Dominion license paid $15,347,284 and provincial licensees $2,273,562 in meeting claims,

*The figure quoted on page 21, $2.96 per capita, refers only to 56 cities and does not include the smaller urban municipalities.

HALIFAX DISASTER, 1917

Overlooking the Intercolonial Railway freight yards, after the explosion and fire that destroyed 1,500 lives and damaged property to the extent of almost $20,000,000

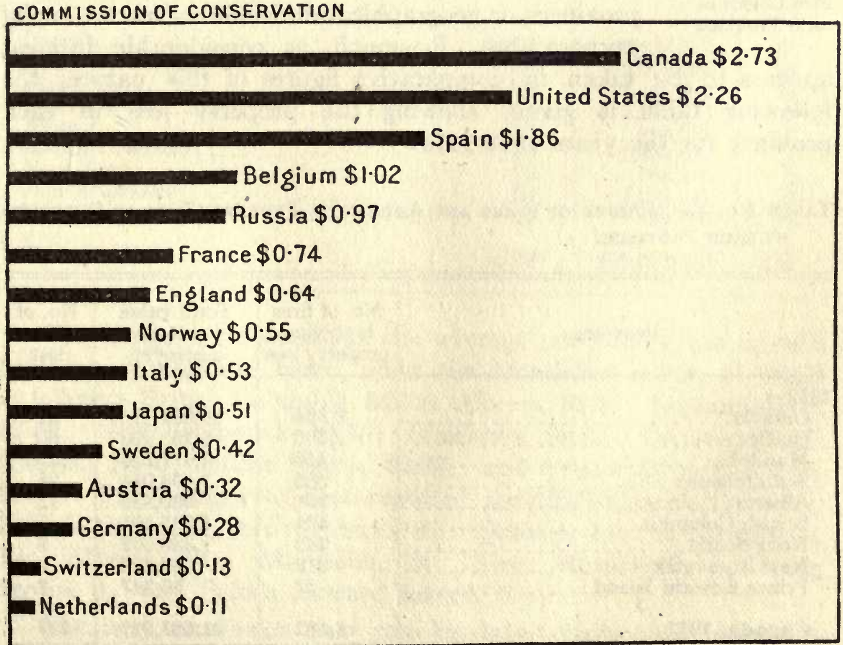
or a total of $17,620,846. Omitting unlicensed insurance, as statistics are not available, it would appear that at least 80 per cent of the total loss was covered by insurance.

This estimate is fully borne out by the returns received from the chiefs of fire departments in Canada who have made a point of collecting such information. According to their records for the year 1914, almost 94 per cent of the loss in cities and towns exceeding 5,000 population was fully insured. Similar figures for the small towns and villages and rural districts could not be obtained in a complete form, but particulars supplied by insurance companies and adjusters prove that fully 60 per cent of the loss was covered by insurance.

Loss in Canada Compared with Other Countries

The true significance of the fire waste in Canada can perhaps be best realized by comparison with the loss in foreign countries. From figures made available by the National Board of Fire Underwriters, it appears that the average per capita loss in Canada exceeds that of every other nation in the world. The actual comparison is graphically shown in the following diagram:

COMMISSION OF CONSERVATION



AVERAGE PER CAPITA FIRE LOSS IN CANADA, ENGLAND AND FOREIGN COUNTRIES, 1912-15

More striking still at the present time is a comparison of the total volume of Canada's loss with that of the United Kingdom. The record for the war period, August, 1914, to December, 1916, is as follows:

	Canada	United Kingdom
August-December, 1914	$ 7,605,090	$ 7,116,250
January-December, 1915	19,022,332	17,457,000
January-December, 1916	25,400,000	16,821,750
	$52,027,422	$41,395,000

Commenting upon the exceedingly small losses in the United Kingdom during the above period, *Fire*, the official newspaper of the National Fire Brigades Union of Great Britain, says:

"The average property waste by fire is appreciably below the pre-war average, notwithstanding the immense new fire risks created by the establishment of new industries, and the employment of untrained labour, unused to the handling of high inflammables. When these facts are considered, it shows conclusively that not only has Britain risen to the military occasion in the fields of warfare, but has also established the most efficient private fire protective system in the world."

Fire Losses in each Province

The classification of fire loss statistics by provinces or geographical divisions serves no useful purpose, but, inasmuch as considerable interest appears to be taken in comparative figures of this nature, the following table is given, showing the property loss in each province for the years 1912-1915:

TABLE NO. 4.—NUMBER OF FIRES AND AMOUNT OF PROPERTY LOSS AS REPORTED BY EACH PROVINCE.

Province	No. of fires involving property loss	Total value of property destroyed	No. of lives lost
1912—			
Ontario	3,694	$8,082,118	87
Quebec	2,565	5,165,920	60
Manitoba	416	1,477,166	19
Saskatchewan	583	1,498,044	28
Alberta	398	960,835	12
British Columbia	524	1,605,394	7
Nova Scotia	242	1,339,602	8
New Brunswick	213	898,493	6
Prince Edward Island	47	56,247	2
Canada, 1912	**8,682**	**21,083,819**	**229**

TABLE NO. 4—*Continued*

Province	No. of fires involving property loss	Total value of property destroyed	No. of lives lost
1913—			
Ontario	3,743	$8,179,626	79
Quebec	2,914	5,254,760	56
Manitoba	457	1,461,422	7
Saskatchewan	629	1,772,675	36
Alberta	437	2,409,520	13
British Columbia	651	1,839,741	21
Nova Scotia	265	1,263,889	15
New Brunswick	249	845,531	6
Prince Edward Island	38	278,244	1
Canada, 1913	**9,383**	**23,305,408**	**234**
1914—			
Ontario	4,196	$7,831,333	68
Quebec	3,007	4,767,321	30
Manitoba	445	1,595,460	14
Saskatchewan	696	1,652,350	43
Alberta	387	1,377,417	11
British Columbia	793	1,732,187	6
Nova Scotia	226	945,531	2
New Brunswick	207	1,586,270	3
Prince Edward Island	53	95,249	3
Canada, 1914	**10,010**	**21,583,118**	**180**
1915—			
Ontario	3,206	$6,884,317	51
Quebec	2,873	3,976,901	35
Manitoba	402	1,403,442	20
Saskatchewan	472	1,973,024	17
Alberta	415	904,677	10
British Columbia	686	1,407,674	7
Nova Scotia	186	986,270	2
New Brunswick	171	1,393,531	3
Prince Edward Island	39	92,496	1
Canada, 1915	**8,550**	**$19,022,332**	**146**

The foregoing table shows the average per capita loss in each province (population based upon the Dominion census of 1911) as follows: British Columbia, $4.19; Alberta, $3.77; Saskatchewan, $3.50; New Brunswick, $3.36; Manitoba, $3.26; Ontario, $3.07; Quebec, $2.39; Nova Scotia, $2.30, and Prince Edward Island, $1.39. The number of fires reported per 10,000 population were: British Columbia, 17; Ontario, 15; Quebec, 14; Saskatchewan, 12; Alberta, 11; Manitoba, 9; New Brunswick, 6; Nova Scotia, 5, and Prince Edward Island, 5.

The only conclusion that can be drawn from these figures is that there is no fixed law governing the location of fires. The amount of loss and the number of fires are altogether independent of latitude. The statement has been frequently made that losses in Western Canada are greater than in Eastern Canada. To some extent this is probably true, because structural conditions are generally poorer and property values higher. Fires are not more frequent, however, in Western than in Eastern Canada, and there is no indication that the people are more negligent or indifferent, as is sometimes claimed.

Effect of Climatic Conditions

Climatic conditions are generally held responsible for a large proportion of the fire waste in Canada. Chart No. 2 shows that this conclusion merits some consideration. The curve A, representing the total amount of loss by monthly periods, develops two peaks in each year and at comparatively regular intervals. These recurrent points of maximum loss prove beyond question that climate has a definite bearing upon the fire waste. The first occurs in January or February and the second in June, July, or later, the exact month usually depending on the length and heat of the summer and lack of precipitation. Records show that during the summer the greatest loss occurs after a prolonged period of dry weather. Exposure fires are frequent in small towns, villages and rural districts, and extensive losses occur in lumber mills and yards. Throughout the winter months artificial heating and lighting systems and devices cause many fires. A sudden spell of extreme cold is generally accompanied by numerous outbreaks of fire, occasioned by the forcing of heating apparatus beyond the point of safety. Fire departments are also greatly hampered in their work by road conditions and frozen hydrants and the difficulty of handling hose streams in winter, with the result that fires frequently get beyond control and cause heavy losses.

Curve B in Chart No. 2 represents the monthly fire loss, exclusive of fires in which the loss exceeded $10,000. While the movements of this curve are practically simultaneous with those of Curve A, the degree of fluctuation is far less pronounced. It is obvious, therefore, that large fires are the cause of the great variation in the total fire loss from month to month. The occurrence of these fires at certain specific periods is undoubtedly due to such causes as hot, dry weather in summer and special occupancy hazards in winter. The record of individual fires proves this by showing that the largest winter losses occur in manufacturing and mercantile establishments

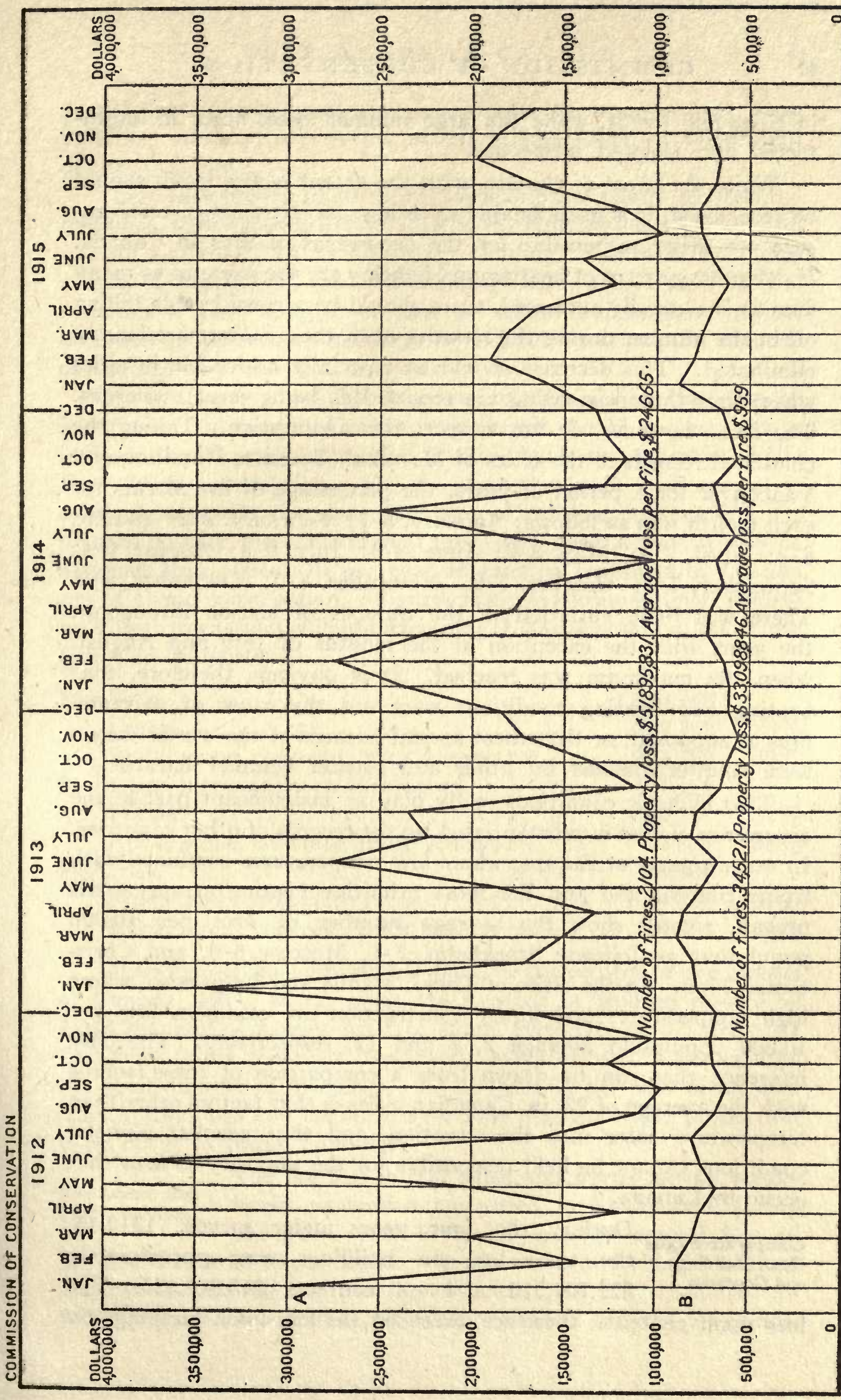


CHART NO. 2—MONTHLY FLUCTUATIONS IN FIRE LOSSES DURING THE YEARS 1912-15, INCLUSIVE.

Curve A indicates the total property loss, and curve B the property loss excluding fires in which the damage exceeded $10,000.

in cities and towns, while the large summer losses occur in unprotected and isolated properties.

While the effect of climate upon the extent of fire losses should be recognized, it is questionable as to how far extremes of temperature are really responsible for the occurrence of fires in Canada. If defective systems of heating and lighting are the cause of as many fires as is generally supposed, there should be a considerable falling off in the number during the months when these factors are largely eliminated. This decrease should be especially noticeable in cities where fires thus originating are reported as being most numerous. The facts, however, do not support this assumption. Taking the combined records of the cities of Montreal, Toronto, Hamilton and Vancouver for a period of years, the percentage of fire alarms for each month was as follows: January, 8·7; February, 8·2; March, 8·2; April, 7·4; May, 8·9; June, 8·0; July, 9·3; August, 9·4; September, 7·4; October, 7·8; November, 8·0; December, 8·8. There was little variation in the number of alarms throughout the year, with the exception of the months of July and August, when the maximum was reached. It is obvious, therefore, that heating and lighting conditions were not the cause of as many fires as supposed, or that these special hazards of the winter season were counterbalanced by other and greater summer hazards.

That climatic conditions really play an insignificant part in the occurrence of fires is substantiated by the records of other countries. In certain parts of Europe, where low temperatures combined with frame construction and the most primitive heating arrangements prevail, records show the average number of fires per 10,000 population as follows: Stockholm, 7·1, Moscow, 6·0, and Christiania, 11·6. In the cities of Tokio, Manila and Valparaiso, where high temperatures and flimsy construction are common, fires per 10,000 population average 2, 7 and 12, respectively. The only inference that can be drawn from a comparison of these records with the average of 29 in Canadian cities is that factors other than temperature enter into the situation, and that peculiar climatic conditions cannot be held responsible for the majority of fires that occur in Canada.

Comparative Loss Upon Buildings and Contents

During the four years under survey, 1912-15, the total loss on buildings was approximately $29,704,916 and on contents $45,876,125. The loss upon contents, therefore, exceeded the loss upon buildings by

54 per cent. Fires numbering 3,107 damaged property other than buildings and contents to the extent of $9,413,636, or 11 per cent of the total loss.

There were fires in 10,791 brick, stone or other solidly constructed buildings, with a loss of $17,537,143 on the buildings and $32,405,836 on the contents. In 22,727 frame buildings there were fires with a loss of $12,167,773 on the buildings and $13,470,289 on the contents. The number of fires in frame buildings, therefore, exceeded those in brick buildings by 112 per cent, but the amount of loss was only one half as great.

In the absence of reliable figures as to the exact number of brick and frame buildings in Canada, this record should not be held to indicate that frame construction is more liable to outbreaks of fire than brick construction. On the contrary, such evidence as is available supports the view that type of building construction has little to do with the occurrence of fire. In a general way, it may be assumed that almost 70 per cent of existing buildings in Canada are of frame construction. Figures compiled from estimates made by cities, towns and villages exceeding 1,000 population, show the following proportions:

Dwellings	1,003,998	
Frame	702,799	70%
Brick, stone, concrete, brick veneer, etc.	301,199	30%
Stores and mercantile establishments	101,472	
Frame	42,101	42%
Brick, stone, concrete, brick veneer, etc.	59,371	58%
Factories	16,996	
Frame and metal clad	5,335	31%
Brick, stone, concrete, brick veneer, etc.	11,661	69%

These figures are supported, in part, by the records of the Census of Canada, 1911, which gives the number of wooden houses as 1,043,284, and of houses built of other materials as 373,027. At that time, frame buildings comprised approximately 74 per cent of the total number of dwellings. As at least 60 per cent of all fires start in dwellings and barns, it is obvious that the larger proportion must occur in frame buildings.

Fire Losses and Fire Protection

The fire loss in 500 cities and towns having waterworks protection amounted to $45,826,884 during the years 1912-1915, an average annual loss of $11,456,721, or $3.29 per capita. In 361 towns and villages without waterworks but having fire departments, the loss amounted to $5,883,860, an average of $1,470,965 per annum, or $4.63 per capita.

The loss in villages and rural districts having no fire protection facilities amounted to $33,333,933, an average of $8,333,483 per annum, or $2.16 per capita.

Fires causing property loss numbered 25,566 in fully protected cities and towns, 1,214 in partly protected towns and villages and 9,845 in unprotected villages and rural districts. The average loss per fire amounted to $1,792 in fully protected cities and towns, and $4,805 in partly protected towns and villages. In unprotected villages and rural districts, the average loss in the fires reported amounted to $3,385, but, as fires causing less than $100 damage are not included, a comparison with protected places cannot be fairly made. Extensive losses might more reasonably be expected in cities and towns where the buildings are filled with millions of dollars worth of goods. These buildings are also subject to additional risk because of congestion. In the smaller towns and villages large values are, as a rule, only found in manufacturing plants. Mercantile buildings contain very little value compared to similar properties in the cities. Yet the average loss per fire in the small towns and villages with partial protection was more than two and one-half times as great as the loss per fire in fully protected cities and towns. While a similar comparison with unprotected places cannot be made, it is suggestive that in small villages and rural districts the loss amounted to 40 per cent of the total loss for Canada, as against 54 per cent in protected cities and towns. The value of adequate fire protection is evident from these figures.

Classification and Analysis of Municipal Returns

Compilation of fire loss statistics under an alphabetical arrangement of names of places is of limited value, although this method is almost universally followed. Other factors, such as fire protection, affect the results in so large a measure that proper classification demands their consideration. Unfortunately, in the absence of uniform standards of fire protection in Canada, the only method that could be adopted in the present enquiry was that of classification into groups based upon population. While this system leaves much to be desired, the question of available fire protection has to some extent received recognition. The main group headings under which all figures have been arranged, are as follows:—

Group A—Cities exceeding 10,000 population having waterworks and fire departments.

Group B—Towns with 5,000 to 10,000 population having waterworks and fire departments.

Group C—Towns and villages with 1,000 to 5,000 population having waterworks and fire departments.

Group D—Towns and villages with 1,000 to 5,000 population without waterworks but having fire departments.

Group E—Villages with less than 1,000 population having waterworks and fire departments.

Group F—Villages with less than 1,000 population without waterworks but having fire departments.

Group G—Villages with less than 1,000 population without waterworks or fire departments.

Group H—Townships and rural districts without protection.

Cost of Fires and Fire Protection

Table No. 5 gives a condensed statement of the value of property destroyed by fire and the cost of fire protection in Canada. The figures, as compiled from official returns, are arranged under self-explanatory column headings.

TABLE NO. 5—ASSESSMENT VALUES, COST OF FIRE PROTECTION AND PROPERTY LOSS BY FIRE IN CANADA, 1912–15.

	Year	Population	Assessed value for taxation	Value of new buildings erected	Water supply systems		Fire departments					Fire loss		
					Total cost of system	Annual maintenance	Value of fire halls	Value of equipment	New appliances purchased	Annual maintenance Total	Annual maintenance Per capita	Total	Per capita	Deaths by fire
Group A No. of cities 56	1912	2,488,841	$2,632,075,800	$208,392,628	....	$2,294,371	....	....	$519,524	$2,705,952	$1·08	$6,842,476	$2·74	86
	1913	2,698,668	2,914,266,400	143,339,587	....	2,686,540	....	....	459,273	3,355,048	1·17	8,697,735	3·22	86
	1914	2,857,987	3,100,487,300	102,807,686	....	3,054,509	....	....	470,146	3,813,146	1·33	9,686,302	3·38	72
	1915	2,786,540	3,207,995,200	34,980,391	89,509,704	3,277,260	4,307,483	$3,802,104	398,725	3,987,515	1·43	6,964,092	2·49	66
Average...		2,708,009	2,963,706,175	122,380,073	....	2,828,170	....	....	461,917	3,465,415	1·27	8,047,651	2·97	78
Group B No. of towns 49	1912	298,172	187,032,450	4,495,679	....	439,085	....	....	47,092	151,237	0·51	1,742,748	5·84	7
	1913	319,210	193,744,000	4,524,435	....	451,764	....	....	69,473	184,062	0·58	1,358,898	4·25	18
	1914	328,495	206,818,000	3,684,220	....	466,734	....	....	52,505	200,764	0·61	1,064,550	3·24	14
	1915	320,285	211,005,200	1,916,400	13,073,190	469,551	557,157	630,346	43,846	206,940	0·64	1,693,365	5·28	11
Average...		316,540	199,649,912	3,655,183	....	456,783	....	....	53,229	185,751	0·58	1,464,890	4·63	13
Group C No. of towns and villages 297	1912	463,947	226,489,500	....	....	627,043	....	....	55,754	80,654	0·17	1,977,060	4·26	12
	1913	488,365	228,756,000	....	....	631,286	....	....	56,713	89,871	0·18	1,644,926	3·36	21
	1914	503,542	232,195,000	....	....	635,395	....	....	47,264	107,248	0·21	1,865,666	3·70	9
	1915	490,965	235,079,000	....	18,879,000	643,270	482,479	634,558	36,853	112,837	0·23	808,283	1·64	7
Average...		486,704	230,629,875	....	....	634,248	....	....	49,146	97,652	0·20	1,573,984	3·23	12
Group D No. of towns and villages 90	1912	120,305	50,046,750	....	....	....	....	....	17,294	13,208	0·10	465,916	3·87	10
	1913	126,636	53,998,500	....	....	....	....	....	23,415	24,600	0·19	533,877	4·21	8
	1914	133,272	55,298,000	....	....	....	....	....	14,182	31,977	0·24	430,116	3·23	10
	1915	130,942	56,875,200	....	....	....	281,506	188,604	9,876	38,425	0·29	399,356	3·05	6
Average...		127,789	54,054,612	....	....	....	....	....	16,192	27,052	0·21	457,316	3·60	9
Group E No. of villages 98	1912	65,973	....	....	....	56,989	....	....	2,430	1,821	0·03	215,821	3·27	9
	1913	67,268	....	....	....	57,346	....	....	2,235	3,190	0·04	595,181	8·84	16
	1914	69,753	....	....	....	59,435	....	....	4,049	3,468	0·05	258,909	3·71	7
	1915	68,010	....	....	1,252,000	60,024	40,238	89,791	1,885	5,141	0·07	410,872	6·04	12
Average...		67,751	....	....	....	58,448	....	....	2,650	3,405	0·05	370,196	5·46	11

TABLE NO. 5—ASSESSMENT VALUES, COST OF FIRE PROTECTION AND PROPERTY LOSS BY FIRE IN CANADA, 1912–15—*Continued*

	Year	Population	Assessed value for taxation	Value of new buildings erected	Water supply systems		Fire departments					Fire loss		
					Total cost of system	Annual maintenance	Value of fire halls	Value of equipment	New appliances purchased	Annual maintenance Total	Annual maintenance Per capita	Total	Per capita	Deaths by fire
Group F No. of villages 271	1912	186,355	....	....	....	....	....	....	19,989	4,814	0·03	792,775	4·25	12
	1913	189,847	....	....	....	....	....	....	12,020	8,664	0·04	1,387,243	7·30	10
	1914	197,733	....	....	....	....	....	....	23,792	9,336	0·05	1,199,944	6·06	7
	1915	192,791	....	....	....	....	147,856	249,105	10,325	10,026	0·05	624,633	3·24	5
Average...		191,681	....	....	....	....	....	....	16,531	8,210	0·04	1,001,149	5·24	9
Group G No. of villages 336	1912	81,300	....	....	....	....	....	....	....	....	....	473,821	5·82	18
	1913	84,652	....	....	....	....	....	....	....	....	....	397,046	4·69	17
	1914	87,096	....	....	....	....	....	....	....	....	....	582,719	6·69	15
	1915	84,921	....	....	....	....	....	....	....	....	....	706,980	8·32	6
Average...		84,492	....	....	....	....	....	....	....	....	....	540,141	6·43	14
Group H	1912	3,763,107	....	....	....	....	....	....	....	....	....	8,573,202	2·28	75
	1913	3,783,354	....	....	....	....	....	....	....	....	....	8,690,502	2·29	58
	1914	3,822,122	....	....	....	....	....	....	....	....	....	6,548,912	1·71	46
	1915	3,725,546	....	....	....	....	....	....	....	....	....	7,414,751	1·99	33
Average...		3,773,532	....	....	....	....	....	....	....	....	....	7,806,842	2·06	53
Canada	1912	7,468,000	3,095,644,500	212,888,307	....	3,417,488	....	....	622,083	2,957,686	0·39	21,083,819	2·82	229
	1913	7,758,000	3,390,764,900	147,864,022	....	3,826,936	....	....	623,129	3,665,435	0·47	23,305,408	3·00	234
	1914	8,000,000	3,594,798,300	106,491,906	....	4,316,073	....	....	611,938	4,165,939	0·52	21,582,118	2·69	180
	*1915	7,800,000	3,710,954,600	36,896,791	$122,713,894	4,450,105	$5,816,719	$5,594,508	501,510	4,360,884	0·56	19,022,332	2·43	146
Average...		7,756,500	$3,447,790,575	$126,035,256	....	$4,002,650	....	....	$589,665	$3,787,486	$0·48	$21,248,669	$2·73	197

*Estimated population.

From this table it appears that fire losses per capita are greater in the smaller and less efficiently protected municipalities. Caution needs to be exercised in drawing conclusions based upon this fact. Per capita comparisons have a certain superficial value when representing large numbers, but they are apt to be misleading in regard to fire waste. This becomes very clear by comparing the records of different cities or even of the same city in various years. For instance, the variation is very pronounced in the statistics of the cities and towns in Canada, which, during the years 1912-15, had a per capita loss exceeding $5.00.

1912

City or Town	*Fire loss per capita*
Chicoutimi, Que	$123.25
Cobalt, Ont	35.13
Galt, Ont	10.98
Moosejaw, Sask	10.51
Owen Sound, Ont	10.31
Kenora, Ont	9.67
Halifax, N.S	7.64
Vancouver, B.C	5.68
Port Arthur, Ont	5.44
Fort William, Ont	5.12

1913

City or Town	*Fire loss per capita*
Charlottetown, P.E.I	$19.94
Calgary, Alta	14.07
Portage la Prairie, Man	13.44
Brantford, Ont	10.79
Springhill, N.S	8.24
Sydney Mines, N.S	7.52
Edmonton, Alta	7.25
North Vancouver, B.C	6.17
Pembroke, Ont	6.17
Vancouver, B.C	5.14
Quebec, Que	5.01

1914

Midland, Ont	$41.54
Galt, Ont	21.65
Moncton, N.B	14.57
Saskatoon, Sask	12.06
Hull, Que	11.04
Kingston, Ont	10.84
Outremont, Que	10.56
Nanaimo, B.C	8.68
New Westminster, B.C	8.53
Lévis, Que	8.34
Fort William, Ont	7.94
Amherst, N.S	6.80
Vancouver, B.C	5.89

1915

St. Jérôme, Que	$55.60
Sorel, Que	11.79
Bracebridge, Ont	10.05
Collingwood, Ont	8.52
Miniota, Man	7.63
Chatham, Ont	6.60
Vancouver, B.C	5.30
Pembroke, Ont	5.08

In each of these cities and towns the loss was increased to an abnormal extent by one fire. In Chicoutimi a conflagration, in Galt a machine shop, in Midland a lumber yard and in Charlottetown a cathedral caused a per capita loss in each municipality that does not in the slightest degree represent actual fire conditions. The effect of population should also be pointed out. A large factory situated in a small town will, if burned, saddle the community with an enormous per capita loss for that particular year and will proportionately affect the average over a period of years. This, it should be stated, is the reason insurance companies have found it impossible to base rates to any large extent upon the experience of individual towns.

Comparison of fire loss with building construction in Canada shows that the amount spent upon the erection of new buildings is not all growth. Despite the fact that the volume of construction is frequently used to indicate the progress of the country, it is evident that a considerable proportion of the expenditure is for the replacement of buildings damaged and destroyed by fire. There are no reliable statistics of new buildings erected from year to year, and such figures as are gathered by the Department of Labour do not afford a continuous or complete record for any save the larger cities. The index numbers computed from this data, however, give the rate of progress from 1904-1912, assuming the year 1904 as 100, are as follows: year 1905, 132·6; year 1906, 167·3; year 1907, 152·2; year 1908, 136·4; year 1909, 202·7; year 1910, 283·2; year 1911, 393·2 and year 1912, 437·4. Since 1912 there has been a gradual falling off in building activity as shown by the summary of returns from municipalities in Table No. 5. For the four years 1912-1915 the value of buildings erected averaged in round figures $126,000,000 per annum. The average annual fire loss upon buildings during the same period was $7,426,229, or over 6 per cent of the value of the new construction.

The true cost of fire waste is not limited to the value of the actual property destroyed. The incidental cost comprises:

(1) The insurance loss; or the difference between the premiums paid to insurance companies and the amount returned to the insured.

(2) The actual expense of the proportion of water supply systems primarily necessary to furnish fire protection in addition to domestic requirements.

(3) The annual expense of municipal fire departments.

(4) The annual expense of private fire protection.

(1) During the years 1912-1915, the premiums collected by licensed fire insurance companies in Canada exceeded the amount of losses paid to the public by $56,204,972, or an average of $14,051,243 per annum.

(2) Water supply systems in Canada providing fire as well as domestic service number 500. These represent an initial invest-

ment of $122,714,000 and annual maintenance charges of $4,003,000, exclusive of interest and sinking funds. The approximate cost of sources of supply, storage and pumping totals $89,226,000 and distribution mains, hydrants, etc., $33,488,000. The proportion of this cost that may legitimately be charged to fire protection is not, of course, easily ascertained. Many municipal engineers hold that at least one-half of all expenditure is necessitated by provision for fire, except in very large cities where a greater proportion should be charged to domestic supply. Messrs. Metcalfe, Kuichling and Hawley, in a recent paper before the American Waterworks Association, stated, in the case of communities having less than 5,000 population, that the portion of the waterworks plant required for fire protection properly constitutes from 60 to 80 per cent of the entire cost of the physical property. This opinion was supported by figures obtained in an enquiry conducted by the United States Geological Survey in 1907, and also by data gathered in the present investigation. Although, in many instances, it was found impossible to do more than make a rough estimate, the general results indicate that the following additional cost has been rendered necessary by provision for fire protection in Canada:

Group A cities	$22,377,425
Group B towns	5,229,280
Group C towns	9,439,500
Group E towns	751,200
	$37,797,405

Or 30 per cent of the total cost.

Incidentally, it may be noted that of the 500 systems 206 have a gravity supply and 294 are direct pressure or intermediate reservoir systems. Pumps are operated by steam power in 98 places, by electric power in 52, by water in 21, by steam and electric in 53, by steam and water in 17, by water and electric in 12, by electric and gas in 10, and by gas, gasolene or oil in 31. The daily domestic consumption in cities and towns depending upon pumped supply amounts to 263,000,000 gallons and the actual available pumping capacity provided is capable of delivering 978,000,000 gallons. Distribution system mains in use have a total length of 7,050 miles, of which 1,435 miles is 4- and 5-inches, 3,786 miles is 6-inches, 1,243 miles is 8-inches and 586 miles is 10 inches or more in diameter. These mains supply for public fire service 37,624 hydrants.

(3) Municipal fire departments in Canada number 861. The capital invested in equipment and the cost of maintenance are given in Table No.6. Fire department up-keep is a direct charge upon every tax-payer in a protected community, but the exact amount is invariably hidden in the general tax rate. Comparison of the columns in Table No. 5, which give fire department cost and assessed value of property, will show the following rate of taxation: In A cities, 23 cents; in B towns, 18 cents; in C towns, 8 cents and in D towns, 1 cent on every hundred dollars of property value.

The per capita cost of fire department maintenance in Canadian cities averages $1.27 as against $0.21 in Europe. The following comparison is of interest, although full allowance must be made for the difference in the scale of salaries paid to Canadian and European firemen:*

Canadian cities	*Cost per capita*	*European cities*	*Cost per capita*
Calgary	$2.56	Cologne	$0.26
Vancouver	2.22	Breslau	0.26
Edmonton	1.93	Stockholm	0.23
Winnipeg	1.67	Petrograd	0.22
St. John	1.53	Paris	0.21
Toronto	1.52	London	0.19
Regina	1.32	Milan	0.17
Montreal	1.06	Budapest	0.06

(4) The estimated cost of private fire protection in Canada, including the capital invested in the construction and equipment of automatic sprinkler installations, etc., aggregates almost $15,500,000. The interest on this sum, depreciation charges and cost of watchmen's services and alarm systems amount to approximately $4,700,000. Fairly complete information was gathered with regard to private protection in the larger manufacturing and mercantile establishments, but particulars of expenditure by small property owners were, of course, unobtainable.

*The Toronto fire department is said to have the lowest scale of salaries of any city of equal size in America. Toronto salaries compare with those paid by the Metropolitan fire brigade of London, England, as follows:

	Toronto	*London, Eng.*
1st grade firemen, per annum	$ 800	$325
2nd " " " "	800	380
3rd " " " "	900	388
4th " " " "	1,000	442
Full " " " "	1,100	455
Captain " "	1,300	572

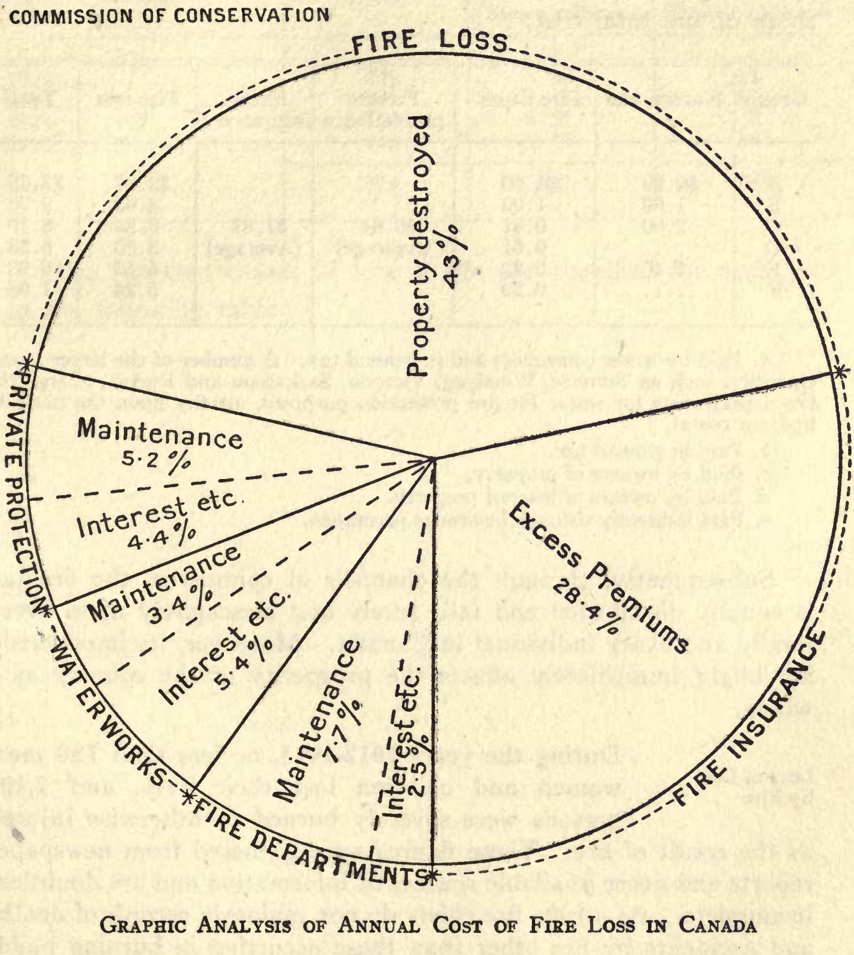
Taking into account the direct and incidental cost of fire waste, viz., property loss, insurance protection, waterworks protection, municipal fire department protection and private fire protection, it appears that the total reaches the enormous sum of $49,400,000 per annum. The contribution of each respective item is given in the following summary:

TABLE No. 6.—WHAT FIRE WASTE COSTS CANADA EVERY YEAR

	Capital investment*	Annual cost†		
		Interest and depreciation	Maintenance	Total
Fire Loss				
Total fire loss	....	....	....	$21,248,669
Fire Insurance				
Premiums in excess of losses paid	....	....	....	14,051,243
Waterworks				
Cost chargeable to fire service:				
Group A	$22,377,425	$1,566,418	$1,131,268	
Group B	5,229,280	352,974	182,713	
Group C	9,439,500	660,755	317,124	
Group E	751,200	52,584	46,758	
Total	37,797,405	2,632,731	1,677,863	4,310,594
Fire Departments				
Cost to protected communities:				
Group A	8,109,587	877,589	3,465,415	
Group B	1,187,521	138,517	185,751	
Group C	1,117,037	133,019	97,652	
Group D	470,110	51,274	27,052	
Group E	130,029	16,439	3,405	
Group F	396,961	48,687	8,210	
Total	11,411,245	1,265,525	3,787,485	5,053,011
Private Fire Protection				
Estimated cost	15,435,000	2,160,900	2,571,750	4,732,650
Grand total	$64,643,650			$49,396,167

*1915.
†Average of 1912-1915.

The accompanying diagram shows in graphic form the main divisions of the foregoing table as percentages of the whole amount.



GRAPHIC ANALYSIS OF ANNUAL COST OF FIRE LOSS IN CANADA

An aggregate expenditure of approximately $49,400,000 per annum is equal to a tax of $6.36 per capita of the entire population in the Dominion, or $30.78 per family unit of 4·84 persons. This tax is not directly nor equally levied, owing to the fact that the cost of municipal fire protection is limited to local areas and, with insurance, primarily affects the property owners. As distributed, various groups of municipalities show the following per capita share of the total cost:

Group	Waterworks *a*	Fire depts. *b*	Private protection *c*	Excess insurance *d*	Fire loss *e*	Total
A	$0.99	$1.60			$2.97	$7.98
B	1.69	1.02			4.63	9.76
C	2.00	0.47	$0.61	$1.81	3.23	8.10
D	....	0.61	(Average)	(Average)	3.60	6.63
E	1.46	0.29			5.46	9.63
F	....	0.29			5.24	7.95

a. Paid by water consumers and in general tax. A number of the larger municipalities, such as Toronto, Winnipeg, Victoria, Saskatoon and Regina, charge the fire departments for water for fire protection purposes, usually upon the basis of hydrant rental.

b. Paid in general tax.

c. Paid by owners of property.

d. Paid by owners of insured property.

e. Paid indirectly through insurance premiums.

Subsequently, through the channels of commerce, the fire tax is equally distributed and falls surely and inescapably upon every family and every individual in Canada. Moreover, its impoverishing blight immediately affects the prosperity of the country as a whole.

Loss of Life by Fire

During the years 1912-1915, no less than 789 men, women and children lost their lives, and 2,103 persons were severely burned or otherwise injured as the result of fire. These figures were gathered from newspaper reports and other available sources of information and are doubtless incomplete. As a rule, fire chiefs do not maintain records of deaths and accidents by fire other than those occurring in burning buildings. It is safe to assume, therefore, that the figures given are considerably below the actual number.

Comparison of the number of deaths by fire with population gives a ratio of 1·01 per 10,000 for the whole of Canada. In group A cities, 310 lives were lost, and in rural districts 212, or 1·1 and 0·6 per 10,000 of population, respectively.

For every passenger killed on steam or electric railways in Canada over 4 persons are burned to death by fire.

TABLE NO. 7.—DEATHS CAUSED BY FIRE AND BY RAILWAYS IN CANADA, 1912-1915.

Year	No. of deaths by fire	Passengers killed	
		Steam railways	Electric railways
1912	229	48	16
1913	234	41	17
1914	180	27	9
1915	146	17	14
Total	789	133	56

The reported causes of loss of life are classified for each year in the following table:

TABLE NO. 8.—ESTIMATED NUMBER OF FATALITIES BY FIRE DURING THE YEARS 1912-1915

Cause of death	1912			1913			1914			1915			Annual totals			
	Men	Women	Children	Men	Women	Children	Men	Women	Children	Men	Women	Children	1912	1913	1914	1915
Burning buildings, brick or stone	5	10	13	16	14	23	8	7	4	5	9	14	28	53	19	28
Burning buildings, frame	18	7	17	24	18	25	15	9	42	19	23	11	42	67	66	53
Burning tents	2	..	..	2	1	..	..	..	..	..	..	..	2	3	..	..
Burning vessels	1	..	..	1	1	4	..	..	..	..	..	..	1	6	..	..
Bush fires	1	..	..	..	..	..	3	..	..	2	..	..	1	..	3	2
Children playing with fire	..	..	6	..	..	3	..	..	5	..	..	9	6	3	5	9
Clothes ignited by bonfires	..	..	1	..	1	1	..	2	2	..	..	2	1	2	4	2
Clothes ignited by coal grates	..	11	1	1	8	4	..	3	2	..	2	2	12	13	5	4
Clothes ignited by coal-oil stoves	1	13	3	..	19	9	..	1	1	1	3	2	17	28	2	6
Clothes ignited by gas jets	..	5	1	..	1	..	..	1	2	..	..	..	6	1	3	..
Clothes ignited by matches	4	5	20	1	3	13	..	4	24	..	2	10	29	17	28	12
Coal-oil lamps overturned	1	12	5	..	4	2	..	3	7	..	2	1	18	6	10	3
Explosion of coal-oil lamps	2	3	1	..	1	5	1	1	3	1	3	..	6	6	5	4
Explosion of coal-oil stoves	..	3	..	..	1	1	1	2	4	..	1	2	3	2	7	3
Explosion of spirit lamps	..	1	..	..	..	..	..	..	1	..	..	..	1	..	1	..
Fireworks	1	..	..	..	..	..	..	..	..	..	..	1	1	..	..	1
Ignition of gasolene	3	12	..	1	7	..	..	6	..	1	4	..	15	8	6	5
Ignition of turpentine and wax	..	1	..	..	..	..	..	..	..	1	..	..	1	..	..	1
Ignition of tar	..	..	..	..	..	..	1	..	..	..	..	..	..	..	1	..
Lighting fires with coal-oil	6	18	..	..	8	2	..	6	..	1	7	1	24	10	6	9
Lighting fires with gasolene	1	3	..	..	2	..	1	4	..	1	..	..	4	2	5	1
Prairie fires	1	1	..	..	..	..	..	..	1	1	1	..	2	..	1	2
Railway fires	5	..	..	1	..	..	1	..	..	..	..	..	5	1	1	..
Smoking in bed	2	..	..	4	1	..	2	..	..	1	..	..	2	5	2	1
Tapers and candles upset	..	2	..	..	1	..	..	..	..	..	..	..	2	1	..	..
Totals, from all causes	54	107	68	51	91	92	33	49	98	34	57	55	229	234	180	146

AT THE REAR OF A TORONTO BLOCK
The main street frontages are graced by imposing mercantile establishments, at the rear of which ugly and dangerous slum conditions exist.

FIRE BREEDING CONDITIONS IN A CANADIAN VILLAGE
Proper building laws should control conditions that are a menace to both health and safety

From the foregoing figures it appears that 78 per cent of the deaths recorded was of women and children. Over 350 lives were lost in burning buildings, and it is significant that almost 75 per cent of these occurred in dwellings. As might be expected, the overwhelming majority of fires was caused by criminal carelessness. This is especially true in regard to the kindling of fires with coal-oil and gasolene and permitting children to play with matches. Such reckless disregard of the safety of human life constitutes a forcible indictment of the entire Canadian attitude towards the dangers of fire.

Structural Conditions in Canada

The tremendous fire loss upon the American continent as compared with other countries has been almost universally ascribed to differences in the construction of buildings and the inadequacy of laws regulating hazardous conditions in properties. Thus, the United States Geological Survey, in *Bulletin 418*, states:

"The great fire waste in the United States is undoubtedly due to the predominance of frame buildings. In most European cities frame buildings are positively prohibited within the limits of municipalities, and few are erected in rural districts, owing to the scarcity and high prices of timber."

There are no statistics showing structural conditions in Canada, and therefore to obtain a clear idea of the situation in regard to existing construction and the laws regulating the erection of buildings, it was necessary to make a general survey of every city and town in the country. The results of this enquiry may be briefly summarized as follows:

	Cities over 10,000 population	Towns 5,000-10,000 population	Towns 1,000-5,000 population	Villages under 1,000 population
In business districts:				
Percentage of brick buildings....	72	53	27	18
Percentage of brick-veneer buildings....	14	8	5	3·4
Percentage of frame buildings...	14	39	68	78·6
Percentage of shingle roofs......	2	57	74	88·7
In residential districts:				
Percentage of brick buildings....	31	20	4·6	3·2
Percentage of brick-veneer buildings....	21	14	16·4	5·6
Percentage of frame buildings...	48	66	79	91·2
Percentage of shingle roofs......	84	93	96	98·4

In rural districts it is estimated that over 99 per cent of the buildings are of frame construction with shingle roofs.

Fire limit by-laws controlling frame construction and ordinances regulating the storage of combustibles and explosives are in force in the following places:

	No. reporting	Number with fire limit by-laws	Number prohibiting shingle roofs	Number regulating combustibles	Number regulating explosives*
Over 10,000 population..........	56	51	44	46	44
5,000-10,000 population..........	49	39	35	26	19
1,000-5,000 population............	387	172	93	51	32
Under 1,000 population..........	703	Practically no regulations			

*Provincial Regulations in Nova Scotia, Manitoba and British Columbia.

In Table No. 9 particulars of structural conditions in the larger cities of Canada are given in considerable detail.

TABLE NO. 9—SHOWING EXISTING STRUCTURAL CONDITIONS AND THE BY-LAWS REGULATING THE ERECTION OF FRAME BUILDINGS AND SHINGLE ROOFS AND THE STORAGE OF COMBUSTIBLES AND EXPLOSIVES.

Group A—Cities exceeding 10,000 Population having Waterworks and Fire Departments.

City or town	Total area of municipality in acres	Existing structural conditions											By-laws and ordinances in force		
		Business section						Residential section							
		Buildings			Roofs			Buildings			Roofs				
		Brick and stone %	Brick-veneer %	Frame %	Shingles %	All other materials %	Highest buildings ft.	Brick and stone %	Brick-veneer %	Frame %	Shingles %	All other materials %	Frame construction	Shingle roofs	Combustibles and explosives.
Amherst, N.S.	5,000	60	..	40	20	80	60	5	5	90	90	10	Frame construction prohibited excepting one storey sheds not to exceed 320 sq. ft. area and additions to existing frame buildings not to exceed 360 sq. ft. area.	Shingle and other combustible roofs prohibited on all classes of buildings.	No provision for regulation of coal-oil, crude oil, benzene or gasolene storage, or of explosives.
Belleville, Ont.	1,800	90	3	7	25	75	50	20	10	70	85	15	Erection of buildings with walls of other than brick, iron, or stone prohibited.	All roofs must be of incombustible materials, which excludes wooden shingles, whether laid in mortar or otherwise.	No regulation of storage of crude oil, benzene and other petroleum products; gunpowder limited to 50 lbs.; dynamite, etc., 10 lbs. except in approved magazine 200 ft. from other building or public street.
Brandon, Man.	5,760	60	10	30	10	90	60	35	15	50	90	2	Frame construction prohibited excepting one storey sheds not to exceed 140 sq. ft. area and detached six or more feet from other buildings.	Shingle roofs prohibited, excepting on one-storey sheds.	Storage of coal-oil limited to 2 bbls., benzene, etc., 1 bbl. unless kept underground; gunpowder limited to 28 lbs. unless in approved magazine.

TABLE NO. 9—*Continued*

City or town	Total area of munici-pality in acres	Existing structural conditions											By-laws and ordinances in force		
		Business section						Residential section							
		Buildings			Roofs			Buildings			Roofs				
		% Brick and stone	% Brick-veneer	% Frame	% Shingles	% All other materials	Highest buildings ft.	% Brick and Stone	% Brick-veneer	% Frame	% Shingles	% All other materials	Frame construction	Shingle roofs	Combustibles and explosives
Brantford, Ont	2,976	97	1	2	5	95	60	95	4	1	97	3	Frame buildings prohibited in limit B. excepting one shed, not to exceed 240 sq. ft. area, on any one premises. In limit A frame dwellings permitted if 25 ft. distant from other buildings, and frame business buildings not exceeding 1,500 sq. ft. area may be erected if over 50 ft. distant from other buildings.	All roofs must be fire-resisting in limit B. Shingles laid on asbestos are permitted in limit A.	Storage of coal-oil limited to 5 bbls., benzene, etc., 10 gals. within limit B. unless in fireproof buildings or Bowser tanks approved by Fire Chief; gunpowder limited to 25 lbs.
Calgary, Alta.	25,900	80	10	10	5	95	70	40	20	40	90	10	Frame construction prohibited in first and second class limits. Buildings over five storeys to be fire-proof or mill construction in first class limits. Frame construction permitted in third class limits.	Combustible roofs prohibited.	Storage of coal-oil limited to 5 bbls., gasolene, etc., 5 gals. if in approved portable tank; larger quantities in approved isolated oil-houses or underground; gunpowder limited to 25 lbs. except in approved magazines.
Chatham, Ont.	1,650	80	..	20	5	95	65	25	..	75	95	5	Frame construction prohibited except by permission of the City Council.	Shingle roofs prohibited.	Storage of coal-oil limited to 5 bbls., gasolene, etc., 1 gal.; gunpowder limited to 25 lbs.
Edmonton, Alta.	28,200	60	4	36	20	80	60	90	..	10	96	4	Frame construction prohibited in first and second class limits but permitted in third class limits.	Shingle roofs permitted in third class limits only.	Storage of gasolene, etc., limited to 5 gals. unless in approved portable tank not exceeding 50 gals. capacity; larger quantities may be stored underground.

Fort William Ont.	9,865	70	20	10	10	90	45	5	45	50	95	5	Frame construction prohibited in limit A excepting one-storey metal-clad sheds not to exceed 200 sq. ft. area. Metal-clad buildings permitted in limit B.	Roofs must be of incombustible material in both limits A and B.	Storage of crude oil, gasolene, etc., limited to 5 gals.; gunpowder limited to 25 lbs.
Galt, Ont.	16,000	75	20	5	8	92	40	40	40	20	95	5	Frame construction prohibited in limits A and B but brick-veneer buildings permitted in limit A.	Shingle roofs permitted if laid in mortar or on asbestos.	Storage of coal-oil limited to 15 gals., crude oil, gasolene, etc., 15 gals. unless in fireproof building. No regulation of gunpowder or other explosives.
Guelph, Ont.	2,800	90	7	3	4	96	60	75	7	18	80	20	Frame construction prohibited in both limits A and B. In limit B brick-veneer is permitted above the first floor.	In limit A shingles on asbestos are permitted on dwellings and out-buildings not over 35 ft. high. In limit B shingles on asbestos allowed on any building.	Storage of coal-oil limited to 5 bbls., benzene, etc., 1 bbl.; gunpowder, limited to 28 lbs., must be kept in boxes of copper, tin or lead; larger quantities may be stored in approved magazines.
Halifax, N.S.	4 400	50	..	50	20	80	70	5	..	95	98	2	Frame construction prohibited.	Shingle roofs prohibited.	Storage of coal-oil limited to 6 bbls., naphtha, etc., to 10 gals.
Hamilton, Ont.	7,143	96	2	2	3	97	110	90	2	8	85	15	Frame construction prohibited in limits A and B. In limit C one frame structure not exceeding 216 sq. ft. area may be erected on any one lot but must not front upon a street line. In limit D frame buildings not exceeding 35 ft. in height are permitted.	Shingle roofs prohibited in limit A but permissible upon dwellings in limit B. and upon any building in limits C and D if laid in mortar or upon asbestos.	Storage of coal-oil limited to 5 bbls.; benzene, etc., to 1 bbl. Unlimited quantities may be stored in detached fireproof buildings or in approved underground tanks. Storage of gunpowder limited to 25 lbs.
Hull, Que.	4,000	4	90	6	10	90	40	..	10	90	82	8	Frame construction prohibited excepting sheds at least 60 ft. from street line. Brick-veneer and metal-clad buildings permitted.	Shingle roofs prohibited on all buildings.	Storage of coal-oil limited to 200 gals. No restriction of gasolene, benzene, etc. Storage of gunpowder limited to 100 lbs.
Kingston, Ont	1,920	86	8	6	5	95	50	50	15	35	95	5	Frame construction prohibited in first and second class limits.	Shingles laid on asbestos permitted.	Storage of coal-oil limited to 5 bbls.

TABLE NO. 9—*Continued.*

City or town	Total area of municipality in acres	Existing structural conditions: Business section: Buildings: % Brick and stone	% Brick-veneer	% Frame	Roofs: % Shingles	% All other materials	Highest buildings ft.	Residential section: Buildings: % Brick and stone	% Brick-veneer	% Frame	Roofs: % Shingles	% All other materials	By-laws and ordinances in force: Frame construction	Shingle roofs	Combustibles and explosives
Kitchener, Ont.	3,182	95	..	5	20	80	64	92	3	5	98	2	Fourth class buildings of frame, brick or stone veneer, rough-cast or stucco prohibited.	Shingle roofs permitted, if laid in mortar.	Storage of coal-oil limited to 2 bbls., crude oil, etc., 1 bbl; gunpowder limited to 25 lbs.
Lachine, Que.	2,850	45	25	30	25	75	50	15	50	35	30	70	Frame construction prohibited in principal sections of city unless 80 ft. from street line and 8 ft. from division line.	Shingle roofs prohibited on all buildings.	No regulations with regard to combustibles or explosives.
Lethbridge, Alta.	6,944	85	5	10	24	76	55	10	5	85	80	20	Frame construction prohibited in first class limits.	Shingle roofs prohibited.	Storage of coal-oil limited to 5 bbls., gasolene, etc., 1 bbl. unless underground or protected in approved manner; gunpowder limited to 25 lbs.
London, Ont.	6,302	95	4	1	5	95	65	40	50	10	70	30	In limit A frame construction prohibited and out-buildings not to exceed 250 sq. ft. area must be brick-veneered. In limit B frame construction not permitted unless encased with brick, metal or stucco. Frame out-buildings must be covered with asbestos or asbestos felt.	Shingle roofs prohibited in limit A but permitted on buildings not exceeding two storeys in limit B. All shingles on 14-lb. asbestos paper.	Storage of coal-oil limited to 5 bbls., benzene, etc., 10 gals., larger quantities may be kept in approved fireproof buildings and underground tanks; gunpowder limited to 35 lbs. in metal boxes and subject to approval of the Police Commissioners.
Maisonneuve, Que.	1,133	40	50	10	10	90	50	35	30	35	85	15	Frame construction prohibited, except one-storey sheds, in the rear of lots, but they must be covered with fire-proof material. Brick or stone veneered buildings must not exceed three storeys.	Shingle roofs prohibited.	Storage of coal-oil, benzene, etc., limited to 5 bbls.; gunpowder and other explosives unrestricted.

Medicine Hat, Alta.	4,000	95	..	5	20	80	75	29	1	79	90	10	Frame construction prohibited in first class limits.	Shingle roofs prohibited in first class limits.	Storage of coal-oil limited to 5 bbls., crude oil, gasolene, etc., 1 bbl., unless in detached fire-proof building or underground and then the total must not exceed 25 bbls.; gunpowder limited to 25 lbs. unless in approved magazine.
Moncton, N.B.	2,092	35	..	65	15	85	50	1	..	99	95	5	Frame construction prohibited.	Shingle roofs prohibited.	
Montreal, Que.	26,618	50	45	5	5	95	130	60	30	10	75	25	Various.	Shingle roofs prohibited.	
Moosejaw, Sask.	9,600	63	3	34	32	68	69	1	2	97	95	5	Frame construction prohibited in first and second class limits.	Shingle roofs prohibited in first class limits.	No gasolene, naphtha or other inflammable liquids to be stored except in approved underground tanks.
New Westminster, B.C	3,840	80	..	20	10	90	85	..	5	95	98	2	Frame construction prohibited excepting sheds not exceeding 140 sq. ft. in area, one storey in height, and 10 clear feet from any other shed.	Shingle and other combustible roofs prohibited.	Storage of gasolene, etc., not to exceed 1 gal. without permit from Fire Chief; coal oil limited to 80 gals. in wood casks and 300 gals. in iron drums if in frame buildings, and 150 gals. in wood casks and 750 gals. in iron drums if in brick buildings; gunpowder limited to 28 lbs.
Niagara Falls, Ont.	1,414	50	10	40	20	80	60	30	10	60	97	3	Frame construction prohibited within fire limits except small frame sheds one storey high.	Shingle roofs prohibited.	Storage of gasolene, etc., limited to 2 gals.; coal oil, 5 bbls.; gunpowder, 25 lbs.
North Bay, Ont.	2,100	50	40	10	35	65	60	20	30	50	95	5	In limit A buildings to be of fireproof construction throughout or of brick, stone or equally substantial and incombustible materials. In limit B brick-veneer and rough-cast buildings are permitted. In limit C frame buildings may be erected if veneered with iron.	Shingle roofs strictly prohibited in limit A, but shingles on asbestos are permitted in limits B and C.	Storage of gasolene, etc., limited to 5 bbls.; coal oil, 5 bbls., gunpowder, 50 lbs.

TABLE NO. 9—*Continued*

City or town	Total area of municipality in acres	Existing structural conditions											By-laws and ordinances in force		
		Business section						Residential section							
		Buildings			Roofs			Buildings			Roofs				
		% Brick and stone	% Brick-veneer	% Frame	% Shingles	% All other materials	Highest buildings ft.	% Brick and stone	% Brick-veneer	% Frame	% Shingles	% All other materials	Frame construction	Shingle roofs	Combustibles and explosives
Ottawa, Ont.	5,295	78	15	7	4	96	120	24	44	32	90	10	Walls of other than brick, iron, stone or concrete prohibited in limit A. Frame structures may be erected in limit B, but outside walls must be veneered with brick or other incombustible materials. Wooden sheds and offices for temporary use permitted in both limits A and B on approval of Inspector.	In limit A roofs of other than incombustible materials prohibited. In limit B. shingle roofs on asbestos are permitted.	Storage of crude oil, benzene, etc., limited to 1 bbl., but must be kept in approved underground fireproof vault or in fireproof detached buildings; coal oil limited to 5 bbls., and subject to inspection; gunpowder, under permit from City Council, limited to 28 lbs.
Outremont, Que.	975	65	34	1	..	100	50	70	29	1	..	100	Frame construction prohibited except sheds in the rear of other buildings, which other buildings must be constructed of stone, brick or brick-veneer.	Shingle roofs prohibited.	
Owen Sound, Ont.	2,909	98	..	2	5	95	60	60	35	5	98	2	Frame construction prohibited in limits 1 and 2. Veneered structures permitted in limit 3. Boat-houses on the river bank may be covered with corrugated galvanized iron.	Combustible roofs prohibited on all buildings in limit 1. In limit 2 dwelling-houses and sheds may be roofed with shingles on asbestos paper.	Storage of coal oil limited to 5 bbls.; crude oil, gasolene, etc., "for personal use on premises," 1 gal.; larger quantities in underground or detached fireproof buildings; gunpowder limited to 50 lbs. unless in approved magazine.
Peterborough, Ont.	2,821	99	..	1	20	80	60	20	75	5	95	5	Frame construction prohibited except that certain store-houses at the western limit near the G.T.R. may be of wood covered with iron.	Shingle roofs laid in mortar permitted.	Storage of gasolene, etc., not restricted; coal oil not restricted; gunpowder limited to 28 lbs.

Port Arthur, Ont.	10,275	20	60	20	25	75	100	2	25	73	90	10	All buildings in limit A to be of brick, iron or stone. In limit B brick-veneered buildings permitted, metal-clad buildings prohibited.	Shingle roofs prohibited in limit A, but permitted in limit B if laid in mortar.	Storage of gasolene, etc., limited to 1 bbl.; coal oil, 5 bbls.; gunpowder limited to 28 lbs.
Prince Albert, Sask.	9,700	75	5	20	5	95	35	15	30	55	97	3	Building by-law in force dividing the city into two sections.	Shingle roofs not permitted.	Storage of coal oil limited to 5 bbls.; gasolene, etc., 1 bbl., in approved building or underground; gunpowder limited to 50 lbs.
Quebec, Que.	4,851	80	5	15	3	97	120	20	60	20	25	75	Frame construction prohibited in St. Peters, St. Louis and Palace wards except sheds lined with brick at least four inches in thickness; also in St. John, Montcalm, St. Roch and Jacques Cartier wards except sheds used for storage of fuel, which sheds must be veneered if bordering on a street. In St. Sauveur, St. Valier, St. Malo, Limoilou and Champlain wards all buildings bordering on a street must be of stone, brick or concrete, or of wood lined with brick, asbestos cement, or rough-cast cement on metallic laths.	Shingle roofs prohibited.	Storage of benzene, etc., and coal oil limited to 5 bbls.; gunpowder limited to 25 lbs. in any one building.
Regina, Sask.	8,640	90	5	5	15	85	125	10	20	70	90	10	Frame construction prohibited.	Combustible roofs prohibited.	Storage of gasolene, etc., limited to 1 bbl., but larger quantities may be stored underground; coal oil limited to 5 bbls.; gunpowder limited to 25 lbs. in any one place except in approved magazine.
St. Boniface, Man.	11,290	40	25	35	25	75	50	5	25	70	97	3			Storage of gasolene limited to 1 bbl., coal oil 5 bbls., and gunpowder 25 lbs.

TABLE No. 9—*Continued*

City or town	Total area of munici-pality in acres	Existing structural conditions											By-laws and ordinances in force		
		Business section						Residential section							
		Buildings			Roofs			Buildings			Roofs				
		Brick and stone %	Brick-veneer %	Frame %	Shingles %	All other materials %	Highest buildings ft.	Brick and stone %	Brick-veneer %	Frame %	Shingles %	All other materials %	Frame construction	Shingle roofs	Combustibles and explosives
St. Catharines, Ont.	2,400	99	..	1	15	85	40	50	2	48	98	2	Erection of buildings with walls of other than brick, stone, brick-veneer or cement plaster, prohibited.	Roofs of combustible materials, including shingles in mortar, prohibited.	Storage of gasolene limited to 2 gals., coal oil 5 bbls., and gunpowder 25 lbs.
St. Hyacinthe, Que.	1,800	50	49	1	10	90	40	20	30	50	20	80	Frame buildings prohibited within city limits except by permission of Council. This by-law does not appear to be strictly enforced.	Shingle roofs prohibited.	Storage of gasolene, etc., limited to 2 gals.; coal oil, 3 bbls., and gunpowder to 5 lbs., unless kept in isolated fireproof building.
St. John, N.B.	10,000	80	5	15	8	92	80	25	10	65	60	40	Frame buildings prohibited within fire limits with various exceptions in districts 2, 3 and 4.	Shingle roofs prohibited.	Storage of gasolene limited to 2 gals. in safe metal container; gunpowder limited to 25 lbs.
St. Thomas, Ont.	2,000	40	50	10	25	75	50	10	70	20	90	10	Within fire limits no building may be erected with outer walls of other than brick or stone.	Roofs of shingles laid in mortar permitted.	Storage of gasolene limited to 2 gals., coal oil 5 bbls., and gunpowder to 25 lbs., but larger quantities may be kept for a period not exceeding 5 hours.
Sarnia, Ont.	2,000	80	12	8	12	88	55	15	10	75	92	8	All buildings within fire limits must be of stone, brick, concrete or iron except isolated residential buildings which may be of brick-veneer or metal-clad frame within certain specified limits.	Shingle roofs prohibited.	Storage of gasolene, etc., limited to 2 bbls.; coal oil, 5 bbls., and gunpowder to 25 lbs.

Saskatoon, Sask.	8,480	85	8	7	8	92	180	10	5	85	95	5	New building by-law under consideration.		Storage of coal oil limited to 5 bbls., and gasolene, etc., 1 bbl. unless underground or in approved building; gunpowder limited to 50 lbs. in any one premises.
Sault Ste. Marie, Ont.	3,100	85	5	15	5	95	33	1	60	39	94	6	Within limit A the erection of any frame building is prohibited. In limit B galvanized iron on studding and brick-veneer is permitted in buildings not over 30 ft. high.	Shingle roofs prohibited in both limits A and B.	Storage of gasolene, etc., limited to 5 gals., coal oil 5 bbls., and gunpowder to 50 lbs.
Sherbrooke, Que.	3,104	50	30	20	15	85	60	10	20	70	95	5	Frame construction strictly prohibited in limit A. Brick-veneer buildings not exceeding two storeys permitted in limits B and C, and frame buildings if more than three feet from line of adjoining lot.	Shingle roofs prohibited in all sections of the city.	Storage of coal oil limited to 5 bbls., gasolene, etc., to 2 gals., unless in building at least 100 ft. from any other building; gunpowder limited to 25 lbs.
Stratford, Ont.	2,835	90	..	10	20	80	65	50	25	25	98	2	Frame construction prohibited in limit A. In limit B metal-clad stables not over 380 sq. ft. area and frame sheds not over 140 sq. ft. area permitted if not less than 6 ft. from other buildings. In limit C frame buildings not over 35 ft. high permitted but must be veneered with brick, plaster or covered with metallic siding	Shingle roofs permitted only on dwelling-houses not over 35 ft. high and out-buildings not over 25 ft. to the highest point of roof. Shingles must be on asbestos.	Storage of gasolene, etc., limited to 1 bbl., in approved underground vault, coal oil to 5 bbls. in approved premises; gunpowder to 28 lbs
Three Rivers, Que.	3,200	75	15	10	10	90	65	..	..	..	..	..	Frame buildings, unless brick-veneered or metal-clad, are prohibited in the principal sections of city.	Shingle roofs strictly prohibited.	Storage of coal oil and gasolene unrestricted; gunpowder limited to 5 lbs.

TABLE NO. 9—*Continued.*

City or town	Total area of munici-pality in acres	Existing structural conditions											By-laws and ordinances in force		
		Business section						Residential section							
		Buildings			Roofs			Buildings			Roofs				
		% Brick and stone	% Brick-veneer	% Frame	% Shingles	% All other materials	ft. Highest buildings	% Brick and stone	% Brick-veneer	% Frame	% Shingles	% All other materials	Frame construction	Shingle roofs	Combustibles and explosives
Toronto, Ont.	25,330	90	9	1	10	90	260	58	24	18	85	15	In limit A frame construction is strictly prohibited. In limit B metal-clad stables not over 384 sq. ft. in area and 25 ft. high permitted and frame sheds not over 140 sq. ft. in area if not less than 6 ft. from any other building. In limit C brick-veneer and metal-clad buildings permitted if not over 35 ft. high. Frame stables not over 384 sq. ft. in area and 16 ft. high are permitted if more than 6 ft. from other frame buildings. In limit D frame buildings permitted if covered with metal. In limit E frame buildings not exceeding 35 ft. high permitted without fire retardent covering.	In limits A, B and D all roofs must be of incombustible material except on buildings not over 35 ft. high and outbuildings in limits A and B, which may be covered with shingles on asbestos paper. Shingle roofs are permissible in limits C and D if on asbestos paper but may be directly on roof boarding of stables not over 16 ft. high.	Storage of coal oil limited to 5 bbls. in premises subject to inspection; gasolene to 1 bbl. in approved underground vault, but larger quantities may be kept in underground steel tanks or detached fireproof buildings; gunpowder limited to 28 lbs. for not exceeding ten hours except in approved storage.
Vancouver, B.C.	10,784	85	..	15	15	85	200	15	..	85	90	10	In first class building district only fireproof and mill construction permitted. In second class district buildings with walls of brick, stone or other incombustible material only permitted.	All roofs must be covered with incombustible materials.	Storage of coal oil limited to 5 bbls. unless in approved buildings; gasolene to 1 bbl. but more may be kept in approved underground tank or fireproof building; gunpowder limited to 28 lbs. for not exceeding ten hours unless in an approved magazine.

Victoria, B.C.	4,637	97	1	2	5	95	120	2	1	97	90	10	In limit No. 1 all buildings must be fireproof except those not over three storeys high which may be mill construction. In limit No. 2 buildings with external walls of brick, stone or cement only are permitted. Brick-veneer, metal-clad and frame buildings permitted in the municipality outside the fire limits.	All roofs within limits 1 and 2 must be covered with incombustible material.	Storage of gasolene and other petroleum products limited to 5 gals. unless kept in approved underground tank; gunpowder limited to 50 lbs.
Westmount, Que.	976	95	2	3	..	100	45	95	4	1	..	100	Frame buildings prohibited within the limits of the municipality.	All roofs must be of metal, slate or gravel.	Storage of coal oil limited to 2 bbls. in iron or steel tanks; gasolene to 1 qt. within buildings or 5 gals. in galvanized iron tanks outside, larger quantities permitted in approved underground tanks; no explosives permitted without permit from Council.
Winnipeg, Man.	15,287	90	5	5	10	90	192	40	20	40	85	15	No frame buildings may be erected within the inner first class limits, but no district is specified where fireproof buildings only may be erected. Within the first class limits, which include not only the congested mercantile districts but also a large proportion of the principal residential districts, buildings must be of brick, iron, stone or concrete, except modern detached frame dwellings. All buildings over 70 ft. high (exclusive of grain elevators), theatres and tenement houses must be fireproof.	All roofs in the first and second class limits must be covered with incombustible materials, but shingles laid on asbestos paper are permitted.	Storage of coal oil is limited to 5 bbls. and gasolene, etc., 1 bbl. except by permission of Council. Gasolene must be kept in metal containers. Storage of gunpowder limited to 25 lbs. unless in approved magazine.
Woodstock, Ont.	1,525	75	20	5	12	88	50	25	25	50	90	10	Frame buildings prohibited in limit A. In limit B brick-veneered building permitted, also frame outbuildings not over 750 sq. ft. in area, provided they are not less than 20 ft. from other buildings. In limit C any class of buildings may be erected.	Shingle roofs permitted if laid in mortar or on asbestos.	Storage of coal oil limited to 5 bbls., gasolene, etc., 1 bbl., but any quantity not exceeding 15 bbls. may be kept in a building 25 ft. from any other building. Storage of gunpowder limited to 10 lbs.

Municipal Fire Protection in Canada

The municipal fire departments of Canada, taken as a whole, are probably as well organized and equipped as any in the world. In the larger cities they are incomparably superior to the public fire brigades of Europe. Personnel, apparatus and management, however, differ greatly in every community, and it is doubtful even whether a fire department adapted to the needs of one place would satisfactorily meet the needs of any other place. There are obviously many grades, both in organization and equipment, from that in the small village, which provides a hand pump and reel of hose in some citizen's barn and depends upon a group of volunteer firemen, to the fully paid and elaborately equipped brigades of cities, such as Toronto, Winnipeg and Montreal. No well-recognized standards of development have been laid down. Each municipality has been a law unto itself and, in many cases, the only impetus given to the growth of departments has been a number of serious fires which have demonstrated the inadequacy of previously existing protection. Improvement has usually taken place without any well-formulated policy and, as a result, volunteer companies have grown into paid departments with insufficient equipment and accommodation, or apparatus has been purchased piece-meal, without regard to its forming a part of the fuller equipment which might naturally be expected to follow in a few years. Fortunately, some guidance is being given in this matter by the fire insurance companies, and consequently in all the larger municipalities rapid improvement is being brought about.

Table No. 10 gives detailed particulars of the organization and equipment of fire departments in all the more important cities and towns in Canada. The smaller municipalities are, in some few instances, suitably protected but, as a general rule, it may be stated that places with less than 5,000 population are sadly in need of direction and advice. Such is especially desirable, in view of the fact that money is more apt to be thrown away than spent wisely without expert guidance as to the form of protection best adapted to meet the peculiar needs of each individual community.

TABLE 10—STATISTICAL SUMMARY OF THE FIRE DEPARTMENTS OF CANADA SHOWING THEIR COMPARATIVE STRENGH IN MEN AND EQUIPMENT

City or town	No. of firemen			No. of fire halls	Steam fire engines		Straight chemical engines	Hose waggons			Ladder trucks		Aerial trucks		Total No. of feet of hose available		No. of salvage covers	No. of playpipes	Automobile apparatus								
																			Pumping and triple combination engines		Comb. chemical and hose waggons		Hose waggons				
	Fully paid	Partly paid	Volunteers		No.	Total pumping capacity in gals. per minute		Combination chemical and hose trucks	Hose trucks and reels	Total hose carrying capacity in feet.	No.	Longest ladder carried (feet)	No.	Maximum extension (feet)	Regular 2½ inch	Chemical			No.	Total pumping capacity in gals. per min.	No.	Hose carrying capacity	No.	Hose carrying capacity	No. of ladder trucks	No. of aerial trucks	No. of auxiliary and chiefs' cars
Group A																											
Amherst, N.S.	1	52		3	2	1,000			3	2,400	1	45			5,700	250	20	15			1	500					1
Belleville, Ont	3	21		2	1				2	1,800	1	65			4,300			8									
Brandon, Man	17			2	1	550	1		1	1,000	1	45	1	65	6,000	300		10			1	1,200	1	1,000			1
Brantford, Ont.	21			2					5	5,250	2	60	1	55	7,500		3	16									
Calgary, Alta	75			10	1	700		1	4	5,000	1	45	1	65	16,000	600	50	36	2	1,400	1		4	4,000	1	1	6
Charlottetown, P.E.I			40	2	1				2	2,400	1				4,500												
Chatham, Ont	8	6		1	1	400		1	3	4,000	1	45			4,300	300	15	12									
Edmonton, Alta.	80			10	1	500	5		6	7,200	3	66			25,000	1,650	4	38	4	2,800	5	6,200			1	1	2
Fort William, Ont.	25			3	1	550		1	3	4,000	2	50			8,450	450	10	20			1	900					1
Galt, Ont.	1	17		1					2	2,400	1	65			4,000			10									
Guelph, Ont	11			1				1	3	3,750	1	50			4,000	200	4	12									
Halifax, N.S.	35	86		8	7	5,250	2	1	7	7,200	2	60	1	75	15,000	1,300	20	30	1								
Hamilton, Ont	88			8	2	1,400		4	4	7,600	3	60			18,100	1,400	28	42			1	1,000			1		1
Hull, P.Q.	26			3	2	1,600		3	7	6,500	2	55			9,000	600	20		1	900							
Kingston, Ont	16			2	2	1,300		1	3	4,650	2	65			4,500	300		22									
Kitchener, Ont.	13			2					2	2,000	1	60			4,350	250	2	12			1	1,250					
Lachine, P.Q.	13	14		1	1	400			4	2,500	2	70			4,750			10	1	1,500							
Lethbridge, Alta	15			2	1	560	2	1	1	1,800	1	66			6,400	400	6	12			1	1,000					1
London, Ont.	42			5	1	700	1	4	2	5,800	2	55	1	75	12,350	1,200	20	34			1	1,000	1	1,000			1
Medicine Hat, Alta.	8		18	1											7,000	200		12	1	750	1	1,200				1	1
Maisonneuve, Que.	52			2	1	500			2	2,000			1	70	12,000		52	22	1	1,000	1	1,200			1		2
Moncton, N.B	5	54		4	2	1,000	2		3	1,800	2	55			5,000	300	21	8	1	800							1
Montreal, Que	762			40	18	16,500		1	34	34,000	27	65	3	85	113,500		801	146	2	2,400	2	2,500	3	600	2	3	17
Moosejaw, Sask	36			3	1	600		1	1	2,500	1	50			7,500	900		19	1	750	2	2,400			1	1	1
New Westminster, B.C.	31			6					3	3,600					11,000	600		18			3	3,600				1	
Niagara Falls, Ont.	1	12	100	4	1	600			3	3,000	2	65			7,500			18									
North Bay, Ont.	8	3		1					1	1,200	1	60			3,200		3	7									
Ottawa, Ont.	104			11	5	4,200		6	2	5,800	5	50			20,850	1,850	50	28	3	3,000	1	750				1	1
Outremont, Que.	16			1					1	1,000	1	54			4,000			6									

TABLE No. 10—*Continued*

City or town	No. of firemen: Fully paid	No. of firemen: Partly paid	No. of firemen: Volunteers	No. of fire halls	Steam fire engines: No.	Steam fire engines: Total pumping capacity in gals. per minute.	Straight chemical engines	Hose waggons: Combination chemical and hose trucks	Hose waggons: Hose trucks and reels	Hose waggons: Total hose carrying capacity, in feet	Ladder trucks: No.	Ladder trucks: Longest ladder carried (feet)	Aerial trucks: No.	Aerial trucks: Maximum extension (feet)	Total No. of feet of hose available: Regular 2½ inch	Total No. of feet of hose available: Chemical	No. of salvage covers	No. of playpipes	Automobile apparatus: Pumping and triple combination engines: No.	Automobile apparatus: Pumping and triple combination engines: Total pumping capacity in gals. per min.	Automobile apparatus: Comb. chemical and hose waggons: No.	Automobile apparatus: Comb. chemical and hose waggons: Hose carrying capacity	Automobile apparatus: Hose waggons: No.	Automobile apparatus: Hose waggons: Hose carrying capacity	No. of ladder trucks	No. of aerial trucks	No. of auxiliary and chiefs' cars
Owen Sound, Ont.	8	9	....	1	1	500	....	....	1	1,300	1	50	....	....	5,000	150	....	16	....	....	....	....	....	....	....	....	....
Peterborough, Ont.	17	1	....	1	1	850	....	....	3	3,500	1	54	....	....	6,000	....	....	10	....	....	....	....	....	....	....	....	....
Port Arthur, Ont.	25	....	....	2	2	900	1	2	....	2,000	1	55	....	....	6,800	1,200	6	15	....	....	1	1,500	....	....	....	....	....
Prince Albert, Sask.	15	....	....	1	....	....	....	....	1	1,200	1	65	....	....	4,000	150	2	11	1	800	....	....	1	1,200	....	....	....
Quebec, Que.	185	....	....	13	3	2,000	3	....	11	7,500	9	65	....	....	23,000	2,500	40	50	....	....	2	2,000	2	2,000	....	3	1
Regina, Sask.	37	....	....	4	1	300	....	2	2	3,000	2	60	....	....	10,000	600	12	16	1	....	2	1,800	....	....	....	1	1
St. Boniface, Man.	20	....	....	2	2	1,200	2	1	1	2,250	1	55	....	....	10,000	450	....	10	....	....	....	....	....	....	....	....	1
St. Catharines, Ont.	15	....	....	3	1	750	....	....	2	2,400	1	54	....	....	4,250	....	3	10	....	....	....	....	....	....	....	....	....
St. Hyacinthe, Que.	10	10	....	1	2	950	....	....	4	3,000	1	65	....	....	6,000	....	1	14	....	....	....	....	....	....	....	....	....
St. John, N.B.	41	....	105	9	7	4,800	1	1	7	5,200	1	55	1	65	22,000	400	88	30	1	800	....	....	....	....	....	....	....
St. Thomas, Ont.	8	8	1	....	....	....	....	....	1	1,200	1	55	....	....	3,000	250	6	12	....	....	1	1,000	....	....	....	....	....
Sarnia, Ont.	1	15	....	1	....	....	....	....	2	2,200	1	45	....	....	3,200	....	....	8	....	....	....	....	....	....	....	....	....
Saskatoon, Sask.	31	....	....	3	1	500	....	1	1	2,000	1	60	1	85	7,450	450	9	15	....	....	2	2,000	....	....	....	....	1
Sault Ste. Marie, Ont.	9	....	30	2	1	600	....	....	2	2,000	1	55	....	....	5,500	150	6	18	....	....	1	1,500	....	....	....	....	....
Sherbrooke, Que.	23	....	....	4	2	950	1	....	4	4,300	3	65	....	....	9,000	....	12	30	....	....	....	....	....	....	....	....	1
Stratford, Ont.	9	7	....	1	2	1,000	....	....	2	2,200	2	60	....	....	5,200	200	5	14	....	....	1	2,000	....	....	....	....	....
Sydney, N.S.	7	26	20	2	1	600	1	....	3	2,100	1	45	....	....	4,050	350	4	10	1	800	....	....	....	....	....	....	....
Three Rivers, Que.	29	6	....	2	1	800	....	....	6	4,800	2	65	....	....	6,600	....	4	17	....	....	....	....	....	....	....	....	1
Toronto, Ont.	360	....	....	28	10	8,750	....	1	20	32,000	10	65	2	85	60,800	9,250	145	90	1	1,400	9	13,500	....	....	1	....	....
Vancouver, B.C.	170	....	....	15	6	5,000	2	1	4	6,000	2	55	....	....	42,200	300	....	69	1	1,400	6	2,000	9	18,000	2	2	2
Verdun, Que.	30	....	....	2	....	....	....	....	....	....	1	65	....	....	4,700	....	6	8	....	....	....	....	....	....	....	....	....
Victoria, B.C.	79	....	....	8	5	3,390	....	4	4	10,900	1	55	2	80	24,750	2,600	50	50	....	....	4	5,400	1	1,500	1	....	2
Westmount, Que.	37	....	....	2	....	....	....	....	2	2,000	2	50	....	....	6,400	250	12	9	1	1,000	1	1,000	....	....	....	....	....
Windsor, Ont.	25	....	....	3	....	....	....	1	2	3,000	1	52	....	75	7,500	600	12	20	1	750	2	2,000	....	....	....	....	1
Winnipeg, Man.	217	....	....	15	7	5,000	6	7	17	34,400	9	60	3	85	52,000	2,000	....	57	....	....	....	....	7	8,200	....	1	4
Woodstock, Ont.	8	1	....	1	....	....	....	....	2	2,800	1	50	....	....	4,000	....	....	11	....	....	....	....	....	....	....	....	....
TOTALS	2919	348	314	273	109	78,150	30	47	218	275,400	127	....	18	....	699,150	34,900	1,567	1,243	26	22,250	55	60,400	29	37,500	11	16	63

Group B																											
Barrie, Ont.			30	2	1	700			2	2,250	1	50			3,300			7									
Brockville, Ont.	6	14		1	1	400		1	2	2,500	1	40			3,800	150	10	8									
Campbellton, N.B.		20		1		600			3	1,800	1	50			3,300			8									
Chatham, N.B.			20	1	2	1,250			3	1,500	1	45			3,600			12									
Chicoutimi, Que.	3		14	1					3	1,500	1	52			4,100			4									
Cobalt, Ont.	4		28	1	1	550			2	2,200	1	60			5,500			14									
Cobourg, Ont.			13						1	1,250	1	60			2,800			9									
Collingwood, Ont.	5	8		1	1	400	1		3	2,400	1				3,300			10									
Cornwall, Ont.	1	15		1	1	400			1	1,000	1	60			3,500			9									
Dartmouth, N.S.		5	67	2	1	400			3	2,000	1	60			2,850			5									
Fernie, B.C.	3	7		1				1	1	2,300					9,000	100		20									
Fraserville, Que.	8		9	2	1	400			2	1,700	2	50			4,200			12									
Fredericton, N.B.	2		34	3					1	1,000	1	35			4,000		8	10									
Granby, Que.			18	1					1	2,000	1	50			2,500			4									
Grand'mére, Que.		5	24	1	1	500			1	900	1	66			2,000			5									
Joliette, Que.	6	20		1	2	1,000			2	1,600	1	45			4,000			9									
Kamloops, B.C.	3		16	1											4,500	250		5			1		1	2,000			
Kenora, Ont.	2	1	18	1		580		1	1	1,500	1	45			3,500	150		9									
Lévis, Que.	11			3	3	800			5	3,750					5,000			11									
Lindsay, Ont.	3	10		1					1	1,200	1	50			3,700			10									
Longueuil, Que.	3	4	4	1					1	1,000	1	42			2,850			4									
Midland, Ont.			20	1	1	300			1	1,000					2,400			8									
Nanaimo, B.C.	3	22		1	1	600					1	45			4,500	400		8			2	2,400					
Nelson, B.C.	5			1					3	3,000		35			5,200	500		10			1	1,200					
New Glasgow, N.S.		47	8	5	1	600	1	1	1	1,500	1	55			7,000	175		12									
North Sydney, N.S.		20	22	1	1	400			4	2,000	1	55			2,000												
North Vancouver, B.C.	14			2					1	1,100	1	55			4,400	250		8			1	1,200	1	1,100			
Orillia, Ont.		3	18	1					1	1,200	1	35			2,400			8									
Oshawa, Ont.			20	1	1	700			2	1,800	1	45			2,400			5									
Pembroke, Ont.		22		1	1	500		1	2	1,700	1	45			3,800	200	2	9									
Portage la Prairie, Man.	4	8		1	1	700	1		1	1,200					2,900	150		6					1	1,200			
Port Hope, Ont.		15		2					1	1,250	1	45			2,800			8									
Prince Rupert, B.C.	6	4		1											4,500	400		5			2	3,600					
St. Johns, Que.	4		14	1	1	600			3	2,700	1	54			3,600			14									
St. Lambert, Que.	4	12		1					2	2,000	1	50			2,500			5									
Smiths Falls, Ont.		25		1	1	300			1	1,250	1	55			2,300			6									
Sorel, Que.	10		18	1	2	1,100			1	1,400	1	60			8,000			14									
Springhill, N.S.			25	1			1		1	1,000	2	30			1,700	150		4									
Steelton, Ont.	3	4	12	1					1	1,200					2,400			7									
Sudbury, Ont.	1		19	1					1	1,000	1	60			4,000			9									
Sydney Mines, N.S.			26	1	1	600			1	1,000	1	35			2,000			7									
Thetford Mines, Que.	5		16	1					1	1,000		35			2,000			10									
Truro, N.S.		5	60	1			1		1	1,000	1	40			4,500	200		14									
Valleyfield, Que.	8			2	2	950			3	1,800	1	45			4,500		4	16									
Walkerville, Ont.	16	8		1											7,500	1,200		22			2	2,500	1	1,000		1	1
Welland, Ont.	1		40	3	1				1	1,000	1	45			2,900			13									
Weyburn, Sask.	2		28	1			1	1		1,200	1	50			2,400	450		8									
Yarmouth, N.S.	3	8	140	3	2	900			4	3,700	1	60			3,800		4	10									
Yorkton, Sask.	1		20	1			1		2	1,600	1	34			2,500	100		4									1
TOTALS	150	312	801	66	32	16,230	7	6	79	73,950	41				182,200	4,825	28	435			9	10,900	4	5,300		1	2

Public Fire Alarm Systems

The extent of any fire in a protected community depends in a large measure upon the promptness with which the fire extinguishing appliances are brought into operation. The fire alarm system of a city or town ought, therefore, to be as nearly perfect as money and skill can make it. A deficient fire alarm system constitutes a general hazard. It may be tolerated when re-construction would involve a heavy outlay, but a community is dealing with the whole question of fire protection from the wrong end when extinguishing apparatus is purchased at the expense of the alarm system. Three minutes after a fire has broken out a pail of water would usually be sufficient to subdue it. With ten minutes' uninterrupted start, a fire may need a quarter of a million dollars worth of apparatus and an army of men before it can be controlled. An obsolete fire alarm system is the crudest form of economy.

In all the larger cities of Canada, where brigades are fully or partly paid, electric telegraph systems with street alarm boxes are in use. In the smaller towns and villages, discovery of fire is usually announced by means of a public bell or whistle. The number of places depending upon each respective system is given herewith:

	No. of places reporting	Electric telegraph system	Bell, whistle, telephones or other means
Cities over 10,000 pop*...............	56	53	3
Towns 5,000 to 10,000 pop*...........	49	37	12
Towns 1,000 to 5,000 "	387	62	325
Villages under 1,000 "	369	..	369

The transmission of alarms of fire over public telephone systems has become so general in Canada that, to some extent, fire alarm telegraph systems are considered of secondary importance by municipal authorities. During the years 1912-1915, out of 52,178 alarms of fire received in group A cities, no less than 32,380, or 62 per cent, were transmitted by telephone. While the public telephone exchange is adapted for this work, it is the consensus of opinion of all fire chiefs that the street box system is vastly less subject to error.

Night patrols and watchmen are of greatest importance to the prompt discovery of fire. Practically all large fires starting in

*See page 76

manufacturing and mercantile establishments from carelessness and bad management occur during the period when employees are absent.

Divided as far as possible into hourly periods, the record in large cities shows that over 40 per cent of the alarms are received between 7 p.m. and 6 a.m.

Day—	A.M.						P.M.						
Hour........	7	8	9	10	11	12	1	2	3	4	5	6	Total
Alarms, p.c...	1·75	2·25	2·25	4·75	5·25	4·25	5·0	5·0	9·5	7·5	7·25	4·75	59·5
Night—	P.M.						A.M.						
Hour........	7	8	9	10	11	12	1	2	3	4	5	6	Total
Alarms, p.c...	4·50	6·75	4·75	6·50	4·25	5·0	3·5	1·25	1·0	0·75	1·25	1·0	40·5

Table No. 11 gives a complete statistical record of fire alarm telegraph systems, telephone systems and night patrols in cities and towns, together with the average number of alarms per 1,000 of population. Comparison of Canadian with European cities and towns as regards the frequency of alarms is of interest. In Canada, no less than 40 places have a three year average of over 5 alarms per 1,000 population, ranging up to 13·5 in the case of St. Boniface, Man. European cities report as follows: Paris, France, 1·3; Milan, Italy, 1·3; Christiana, Norway, 1·3; London, England, 1·3; Birmingham, England, 1·2; Birkenhead, England, 1·2; Madrid, Spain, 1·0; Messina, Italy, 0·9; Cardiff, England, 0·8; Marseilles, France, 0·8; Florence, Italy, 0·8; Stockholm, Sweden, 0·8; Dublin, Ireland, 0·7; Moscow, Russia, 0·6; Belfast, Ireland, 0·6; Lyons, France, 0·5; Bolton, England, 0·4; and York, England, 0·3 per 1,000 population.

TABLE No. 11—SURVEY OF FIRE ALARM SYSTEMS IN USE IN CANADA

City or town	Population	Fire alarm system		No. of subscribers to local telephone system	No. of police on night patrol	No. of firemen sleeping in fire halls	No. of alarms per 1,000 pop. (average 3 years)
		No. of boxes	Boxes per 1,000 pop.				
Group A							
Amherst, N.S.	11,000	33	3.0	1,000	2	1	4·0
Belleville, Ont	12,000	Bell	......	800	2	10	3·3
Brandon, Man.	18,000	37	2·0	....	....	16	6·4
Brantford, Ont	26,454	34	1·3	3,413	7	21	3·5
Calgary, Alta.	84,000	142	1·6	10,500	44	71	5·1
Chatham, Ont.	12,465	29	2·4	1,239	4	12	5·0
Edmonton, Alta	72,516	143	1·9	9,500	56	75	6·5
Fort William, Ont.	24,071	46	1·9	2,700	9	24	6·3
Galt, Ont	12,016	Bell	....	1,200	2	7	2·1
Guelph, Ont.	16,735	Bell	....	1,400	4	11	3·2
Halifax, N.S.	55,000	60	1·0	7,800	27	39	3·6
Hamilton, Ont.	101,808	62	·6	8,100	30	87	4·4
Hull, Que	20,684	54	2·7	535	6	20	6·0
Kingston, Ont.	21,105	45	2·1	1,820	6–9	14	5·4
Kitchener, Ont	19,056	38	2·0	1,660	2	6	2·9
Lachine, Que.	15,000	23	1·5	580	7	7	...
Lethbridge, Alta.	10,070	37	3·7	930	4	15	6·9
London, Ont	55,026	71	1·2	5,100	20	32	3·8
Maisonneuve, Que	34,856	34·	1·0	Montreal	10	10	...
Medicine Hat, Alta	12,500	50	4·1	1,000	3	15	4·2
Moncton, N.B.	15,000	35	2·3	4,800	5	7	4·4
Montreal, Que.	650,000	900	1·3	51,500	630	604	4·8
Moosejaw, Sask	25,000	60	2·4	1,950	9	30	5·8
New Westminster, B.C.	17,000	34	2·0	1,648	7	31	5·7
Niagara Falls, Ont	11,340	49	4·4	1,400	6	14	3·4
North Bay, Ont	10,470	12	1·2	1,080	3	10	6·0
Ottawa, Ont	101,795	183	1.8	11,400	50	95	5·3
Outremont, Que	10,000	21	2·1	Montreal	8	8	4·5
Owen Sound, Ont.	12,385	29	2·4	880	3	16	5·9
Peterborough, Ont	20,653	38	1·9	2,300	7	16	7·4
Port Arthur, Ont	15,657	54	3·6	2,450	5	24	9·1
Prince Albert, Sask	13,000	19	1·4	625	4	15	8·2
Quebec, Que	80,000	183	2·2	3,800	60	124	7·9
Regina, Sask	50,000	47	.9	3,350	15	36	2·9
St. Boniface, Man	12,025	40	3·3	750	8	20	13·5
St. Catharines, Ont	17,296	44	2·5	2,300	5	10	3·4
St. Hyacinthe, Que.	12,228	34	2·8	544	3	10	...
St. John, N.B	50,000	108	2·1	6,200	30	40	4·3
St. Thomas, Ont.	16,794	36	2·2	1,450	4	9	3·5
Sarnia, Ont	12,000	24	2·0	690	2	8	3·9
Saskatoon, Sask	25,000	42	1·6	2,000	10	30	7·0
Sault Ste. Marie, Ont	13,000	22	1·6	1,070	6	14	6·5
Sherbrooke, Que.	19,305	111	5·8	1,927	11	23	7·6
Stratford, Ont.	16,425	43	2·6	1,145	4	8	3·0
Sydney, N.S.	21,000	38	1·8	.....	5	6	...
Three Rivers, Que	18,000	56	3·1	1,020	10	28	4·4
Toronto, Ont.	470,144	460	·9	58,000	310	338	4·1
Vancouver, B.C	174,000	296	1·7	......	120	152	3·4
Victoria, B.C.	55,000	135	2·4	......	20	74	4·5
Westmount, Que.	18,500	47	2·6	Montreal	13	14	3·5
Windsor, Ont.	22,993	87	3·9	3,050	7	25	4·4
Winnipeg, Man.	203,255	355	1·7	34,500	190	213	6·9
Woodstock, Ont	10,265	21	2·1	650	3	8	3·7
TOTALS		4,641	2·2	252,666	1,801	2,553	3·4

TABLE NO. 11—*Continued*

City or town	Population	Fire alarm system: No. of boxes	Fire alarm system: Boxes per 1,000 pop.	No. of subscribers to local telephone system	No. of police on night patrol	No. of firemen sleeping in fire halls	No. of alarms per 1,000 pop. (average 3 years)
Group B							
Barrie, Ont	7,215	9	1·2	650	2	5	2·8
Brockville, Ont	9,240	30	3·3	810	3	10	5·3
Campbellton, N. B	4,500	12	3·0	......	....	....	5·5
Chatham, N.B	5,000	10	2·0	350	2	....	...
Chicoutimi, Que	6,000	None	....	500	1	3	5·8
Cobalt, Ont	6,418	12	2·0	250	1	7	6·4
Cobourg, Ont	5,074	None	....	450	2	....	....
Collingwood, Ont	6,619	13	2·1	460	1	8	5·4
Cornwall, Ont	6,700	10	1·6	460	1	....	4·3
Dartmouth, N.S	5,500	Bell	....	650	1	3	3·0
Fernie, B.C	5,000	14	2·8	......	2	10	3·8
Fraserville, Que	6,957	42	7·0	600	3	8	8·8
Fredericton, N.B	7,770	30	4·2	......	....	2	11·9
Granby, Que	5,033	11	2·2	300	1	....	4·0
Grand Mère, Que	6,500	None	....	243	1	2	...
Joliette, Que	7,925	Bell	....	350	4	8	3·4
Kamloops, B.C	6,000	29	4·8	675	3	8	6·6
Kenora, Ont	6,500	23	3·8	525	1	8	7·0
Levis, Que	7,500	None	....	855	2	7	7·0
Lindsay, Ont	7,672	9	1·2	1,000	1	4	4·4
Longueuil, Que	5,500	13	2·6	244	....	4	...
Midland, Ont	6,253	None	...	400	1	1	...
Nanaimo, B.C	8,500	11	1·3	770	2	6	5·3
Nelson, B.C	7,000	14	2·0	560	2	5	4·1
New Glasgow, N.S	8,500	18	2·2	750	2	2	2·7
North Vancouver, B.C	8,000	None	...	660	3	13	6·2
Orillia, Ont	7,366	10	1·4	612	1	3	...
Oshawa, Ont	8,248	10	1·2	580	1	4	1·3
Pembroke, Ont	7,450	30	4·2	420	2	2	3·6
Portage la Prairie, Man	7,000	24	3·4	750	2	9	6·8
Port Hope, Ont	5,000	None	...	421	1	1	2·8
Prince Rupert, B.C	6,005	29	4·8	700	1	7	7·0
St. Johns, Que	8,000	20	2·5	465	2	3	...
St. Lambert, Que	4,500	14	3·5	376	2	2	5·3
Smiths Falls, Ont	6,551	11	1·8	300	1	....	3·2
Sorel, Que	8,727	None	...	355	3	1	...
Springhill, N.S	5,700	21	4·2	150	1	....	1·7
Steelton, Ont	5,400	12	2·4	200	1	7	7·7
Sudbury, Ont	7,060	23	3·2	906	3	4	9·7
Sydney Mines, N.S	8,450	None	...	170	1	....	2·4
Thetford Mines, Que	7,236	20	2·8	228	....	4	...
Truro, N.S	8,000	20	2·5	......	1	2	9·1
Valleyfield, Que	9,487	24	2·6	250	4	6	3·7
Walkerville, Ont	4,721	35	8·7	......	3	15	6·1
Welland, Ont	7,235	10	1·4	918	2	3	3·2
Weyburn, Sask	5,345	20	4·0	450	1	10	3·6
Yarmouth, N.S	7,000	18	2·5	626	3	....	3·6
Yorkton, Sask	5,200	None	...	230	1	8	...
TOTALS		661	2·9	21,719	79	215	4·6

Frequency of Fires

A classified summary of the frequency of fires in Canada during 1912-1915 is presented in Table No. 12. Column 1 shows alarms received by fire departments and column 2 actual fires that occurred. Fires involving property loss are sub-divided as follows: Column 3, losses above $10,000; column 4, losses of $1,000 to $10,000; column 5, losses of $100 to $1,000 and column 6, losses below $100. Column 7 gives the total number of fires where losses occurred, and column 8 the number where no loss was reported.

TABLE NO. 12.—NUMBER OF ALARMS AND ACTUAL FIRES GROUPED AND SUB-DIVIDED ACCORDING TO THE EXTENT OF DAMAGE INCURRED
(See page 41 for classification of groups)

Year	No. of alarms	No. of actual fires	No. of fires involving property loss					*No loss, number of fires
			Loss above $10,000	Loss $1,000 to $10,000	Loss $100 to $1,000	Loss below $100	Total	
Group A—								
1912........	11,294	7,341	113	522	1,861	2,798	5,294	2,047
1913........	14,243	8,116	158	473	2,506	2,616	5,753	2,363
1914........	14,534	9,140	162	529	1,391	3,270	5,352	3,788
1915........	12,107	7,472	120	388	1,514	2,830	4,852	2,620
Group B—								
1912........	892	561	35	102	186	155	478	83
1913........	1,020	511	21	91	115	167	394	117
1914........	1,359	727	17	136	307	198	658	69
1915........	1,180	647	33	85	157	244	519	128
Group C—								
1912........	605	453	45	77	101	174	397	56
1913........	853	531	42	116	74	192	424	107
1914........	985	704	51	102	141	315	609	95
1915........	721	595	28	83	99	264	474	121
Group D—								
1912........	204	188	12	21	25	92	150	38
1913........	266	217	14	17	46	78	155	62
1914........	293	245	13	26	61	110	210	35
1915........	212	151	12	14	30	83	139	12
Group E—								
1912........	113	94	8	23	63		94	
1913........	117	109	11	14	84	No	109	No
1914........	125	73	10	18	45	record	73	record
1915........	97	86	16	12	58		86	

*Includes fires extinguished before the arrival of fire departments. Loss in such cases was insignificant.

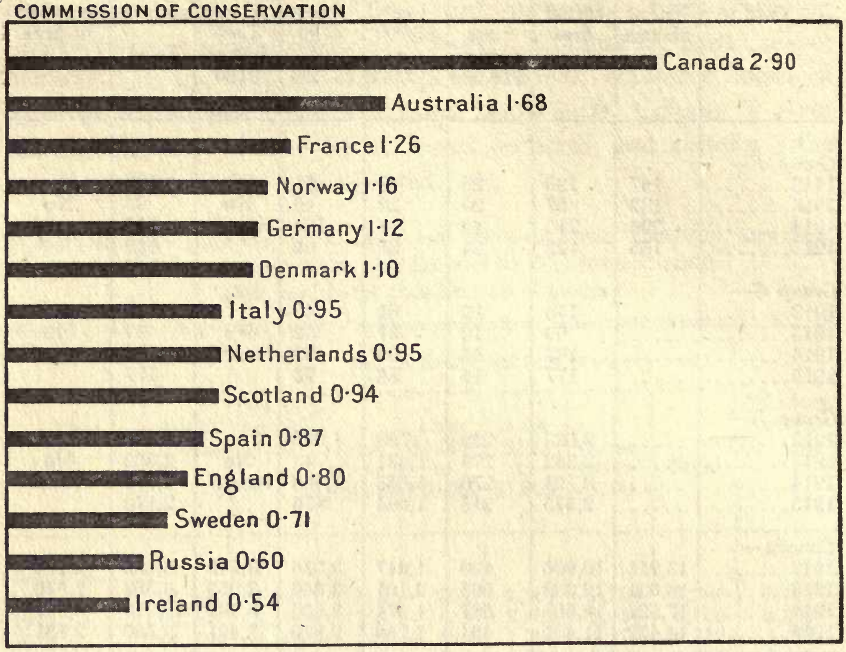
TABLE NO. 12—*Continued.*

Year	No. of alarms	No. of actual fires	No. of fires involving property loss					*No loss, number of fires
			Loss above $10,000	Loss $1,000 to $10,000	Loss $100 to $1,000	Loss below $100	Total	
Group F—								
1912........	147	120	26	43	51		120	
1913........	132	97	29	22	46	No	97	No
1914........	226	215	49	61	105	record	215	record
1915........	155	128	24	35	69		128	
Group G—								
1912........	.....	116	12	61	43		116	
1913........	.....	99	10	37	52	No	99	No
1914........	.....	102	15	49	38	record	102	record
1915........	.....	177	16	88	73		177	
Group H—								
1912........	.....	2,033	239	768	1,026		2,033	
1913........	.....	2,352	278	1,331	743	No	2,352	No
1914........	.....	2,791	270	1,053	1,468	record	2,791	record
1915........	.....	2,175	215	1,084	876		2,175	
Canada—								
1912........	13,255	10,906	490	1,617	3,356	3,219	8,682	2,224
1913........	16,631	12,032	563	2,101	3,666	3,053	9,383	2,649
1914........	17,522	13,997	587	1,974	3,556	3,893	10,010	3,987
1915........	14,472	11,431	464	1,789	2,876	3,421	8,550	2,881

From the foregoing record, it appears that, of 61,880 alarms received during 1912-1915, 13,514 were false and 48,366, or 78·2 per cent, actual fires. In 11,741, or 24·3 per cent, the services of fire departments were not required or the damage was too small to be reported. Fires in which the loss was less than $100 numbered 13,586, or 28·1 per cent; from $100 to $1,000, 13,454, or 27·8 per cent; from $1,000 to $10,000, 7,481, or 15·5 per cent, and over $10,000, 2,104, or 4·3 per cent, of the total number.

For the whole of Canada, the number of actual fires per 1,000 of population averaged 1·05 per annum. Classified by groups the distribution was as follows: A cities, 2·9 per thousand; B towns 1·9; C towns, 1·2; D towns, 1·6; E villages, 1·3; F villages, 0·7; G villages, 1·5, and rural districts, designated H, 0·6 per thousand. The figures for groups E, F, G and H are not, of course, strictly accurate, owing to the impossibility of securing returns for small losses.

A comparison of the number of fires in Canadian and foreign cities, on the basis of population, is shown in the following diagram:



NUMBER OF FIRES PER THOUSAND POPULATION IN CANADA, GREAT BRITAIN AUSTRALIA AND FOREIGN COUNTRIES (CITIES ONLY)

As sub-divided by the extent of loss in each fire, the record emphasizes the value of adequate municipal protection. This point is made clearer by conversion of the figures into percentages of the total number of fires in each group, as follows:

Group	Above $10,000	$1,000 to $10,000	$100 to $1,000	Below $100	No loss	Total
A.	1·7	5·9	22·5	35·9	33·7	100
B.	4·3	16·9	31·2	31·2	16·2	100
C.	7·2	16·5	18·1	41·4	16·5	100
D.	6·3	9·7	20·2	45·3	18·3	100
E.	12·3	18·7	69·0	....	....	100
F.	22·8	28·8	48·4	....	....	100
G.	10·7	47·6	41·7	....	....	100
H.	10·9	45·2	43·9	....	....	100

From the foregoing it will be noted that the percentage of large fires was least in fully protected group A cities, where the greatest number of valuable properties are situated. In combined groups A, B, C and E, which includes all cities, towns and villages provided with waterworks protection, 10·4 per cent of the fires exceeded $1,000; in partly protected groups D and F, the percentage is 16·9, and in unprotected groups G and H, 28·6.

Some of the more important points emphasized by these figures are as follows: In Canada, 95 out of every 100 fire losses are of limited extent. As the extent of any fire depends upon the size of the property endangered or the adequacy of the protection provided, it follows that the majority of fires in Canada occur in small properties or are controlled in their incipiency. Properties in unprotected districts are invariably a total loss. In places without waterworks protection, good work is sometimes done in checking fires before they gain headway; but, in the absence of an adequate water supply, local fire departments are at a tremendous disadvantage. In fully protected cities and towns large fires constitute a very small percentage of the total number, but even these need not and should not occur. The fact that they do occur is evidence of the existence of one or all of the following conditions: (1) Delayed fire alarms; (2) defective building construction; (3) inefficient fire protection.

Causes of Fires in Canada

Knowledge of the causes of fire must necessarily precede the adoption of effective measures for their cessation or prevention. What are termed common hazards, or those conditions which affect all classes of property irrespective of occupancy, are undoubtedly responsible for the largest percentage of fires. Special hazards, or conditions due to the use of buildings for specific purposes, are many and complex because of the multiplication of inventions and industrial processes during recent years. While comparatively few fires originate from special causes, they naturally occur in more valuable property and frequently result in extensive losses.

Table No. 13 enumerates the causes of all fires reported during the years 1912-1915, grouped and arranged in the order of their importance. The number of fires in each group is expressed as a percentage of the total number of fires reported.

TABLE No. 13.—REPORTED ORIGIN OF FIRES DURING THE YEARS 1912-1915, GROUPED AND ARRANGED IN THE ORDER OF THEIR NUMERICAL IMPORTANCE

Specific causes of fires	Number of fires			
	1912	1913	1914	1915
1. ELECTRICAL CAUSES—				
Defective wiring	569	703	681	514
Excessive voltage on interior wiring	17	5	11	21
Defective fuses and switches	53	71	84	47
Unprotected lamps	25	42	16	28
Heating devices	41	56	73	69
Defective motors and dynamos	119	133	167	104
Defective trolley equipment	142	237	108	176
Defective central station generating and transforming equipment	23	16	38	12
Total number of fires in group	989	1,263	1,178	971
Percentage of all fires reported	9·0%	10·4%	8·4%	8·5%
2. CHIMNEYS, FLUES AND SMOKEPIPES—				
Defective chimneys and flues	523	475	958	604
Defective and over-heated stove and furnace pipes	344	428	301	337
Total number of fires in group	867	903	1,259	941
Percentage of all fires reported	7·9%	7·5%	9·0%	8·2%
3. CRIMINAL AND SUSPICIOUS FIRES—				
Reported incendiary	261	394	322	295
Mischievous boys	15	48	33	27
Tramps	53	89	65	40
Reported as suspicious	318	265	574	488
Total number of fires in group	647	796	994	850
Percentage of all fires reported	5·8%	6·6%	7·1%	7·4%
4. MATCHES—				
General carelessness with matches	337	606	572	411
Children playing with matches	212	137	344	184
†Mice and matches	65	34	48	24
Total number of fires in group	614	777	964	617
Percentage of all fires reported	5·6%	6·4%	6·9%	5·5%
5. COAL OIL—				
Ignition of defective lamps	81	53	41	69
Lamp explosions	105	94	136	118
Ignition of defective stoves	57	77	39	42
Stove explosions	34	12	26	30
Overturned lamps and stoves	63	101	92	74
Trimming lighted lamps and stoves	13	12	8	10
Kindling fires with coal oil	117	54	89	44
Total number of fires in group	470	403	431	387
Percentage of all fires reported	4·3%	3·3%	3·0%	3·3%

†It is extremely doubtful whether fires are caused by mice gnawing matches.

TABLE NO. 13.—*Continued*

Specific causes of fires	Number of fires			
	1912	1913	1914	1915
6. COAL STOVES AND RANGES—				
Defective stoves	62	55	142	83
Overheated stoves	198	317	238	206
Drying wood on stoves	19	31	11	12
Sparks from stoves	40	65	32	21
Clothes, paper, etc., ignited by stoves	22	39	101	68
Plasterers' stoves	61	29	43	27
Total number of fires in group	402	536	567	417
Percentage of all fires reported	3·6%	4·4%	4·0%	3·6%
7. INDUSTRIAL AND SPECIAL HAZARDS—				
Defective and overheated boilers	37	48	20	33
Sparks and back-draughts from boilers	46	88	72	34
Defective and overheated dry rooms, kilns and ovens	13	32	20	18
Unprotected cupolas	1	4	3	1
Sparks from forges and furnaces	15	9	10	22
Overheated sand dryer	..	1	..	..
Defective vulcanizer	..	..	1	..
Welding torches	2	..	1	..
Heating glue and wax pots	7	3	1	5
Hot metal	14	24	9	7
Overheated journals and bearings	86	56	42	63
Foreign substances in smutters, pickers, etc	40	59	35	27
Static electricity generated in machinery	2	5	..	1
Ignition of various materials in process	58	31	72	34
Railway collisions	14	9	5	3
Miscellaneous known causes	46	29	52	38
Total number of fires in group	381	398	343	286
Percentage of all fires reported	3·5%	3·3%	2·4%	2·5%
8. SMOKING—				
Cigar stubs, cigarette ashes	234	180	372	219
Smoking in bed	18	39	21	11
Total number of fires in group	252	219	393	230
Percentage of all fires reported	2·3%	1·8%	2·8%	2·0%
9. FURNACES—				
Defective furnaces	83	159	121	98
Overheated furnaces	139	105	228	186
Overheated hot-air ducts	12	23	18	11
Total number of fires in group	234	287	367	295
Percentage of all fires reported	2·1%	2·3%	2·6%	2·5%
10. GASOLENE, BENZINE AND OTHER VOLATILE—				
Defective lamps and lighting systems	22	40	31	32
Defective stoves and heaters	19	36	14	22
Defective engines	30	5	11	8
Ignition and explosion of gasolene (various)	136	91	162	107
Total number of fires in group	207	172	218	169
Percentage of all fires reported	1·9%	1·4%	1·5%	1·4%

TABLE NO. 13—*Continued*

Specific causes of fires	Number of fires			
	1912	1913	1914	1915
11. CANDLES, TORCHES AND FLARES—				
Candles, overturned, etc	33	65	53	28
Plumbers' torches	41	22	37	26
Thawing frozen pipes	106	225	161	98
Total number of fires in group	180	312	251	152
Percentage of all fires reported	1·6%	2·5%	1·8%	1·3%
12. ASHES—				
Hot ashes in contact with wood	177	118	135	99
Percentage of all fires reported	1·6%	0·9%	1·0%	0·8%
13. ILLUMINATING GAS—				
Ignition of curtains by gas jets	33	64	39	37
Portable gas lamps overturned	2	3	3	5
Overheated and defective gas ranges	46	37	51	70
Gas irons	3	1	7	5
Defective flexible tubing	33	29	30	15
Explosions (various)	27	48	29	17
Defective acetylene generators	2	1	3	2
Total number of fires in group	146	183	162	151
Percentage of all fires reported	1·3%	1·5%	1·1%	1·3%
14. SPONTANEOUS COMBUSTION—				
Various	117	83	52	96
Coal and charcoal	24	7	10	14
Total number of fires in group	141	90	62	110
Percentage of all fires reported	1·2%	0·7%	0·4%	0·9%
15. GREASE, OIL, PAINT AND TAR FIRES—				
Ignition of grease and oil on stove	61	22	80	35
Wax and varnish on stove	7	10	4	3
Heating tar	26	24	53	41
Burning sulphur	2	..	5	1
Total number of fires in group	96	56	142	80
Percentage of all fires reported	0·8%	0·4%	1·0%	0·7%
16. OPEN GRATE FIRES—				
Coals and sparks from grates	42	58	96	39
Clothing, etc., ignited by unprotected grates	17	13	24	9
Total number of fires in group	59	71	120	48
Percentage of all fires reported	0·5%	0·5%	0·9%	0·4%
17. BONFIRES AND RUBBISH FIRES—				
Ignition of buildings and fences therefrom	43	58	35	61
Percentage of all fires reported	0·4%	0·4%	0·2%	0·5%

TABLE No. 13—*Continued*

Specific causes of fires	Number of fires			
	1912	1913	1914	1915
18. FIREWORKS	48	27	39	12
Percentage of all fires reported	0·4%	0·2%	0·3%	0·1%
19. STEAM PIPES—				
Steam pipes in contact with combustible materials	29	42	57	18
Percentage of all fires reported	0·3%	0·3%	0·4%	0·1%
20. MOVING PICTURE FILMS	12	7	8	5
Percentage of all fires reported	0·1%	...	...	...
21. MISCELLANEOUS EXPLOSIONS—				
Dust explosions	5	1	4	...
Explosions of gunpowder, etc	2	1	3	9
Total number of fires in group	7	2	7	9
Percentage of all fires reported	...	...	...	...
22. EXPOSURE FIRES—				
Ignition from burning buildings	336	328	390	324
Chimney sparks	364	278	402	329
Sparks from locomotives, steamboats, etc	51	83	69	47
Sparks from refuse burners, kilns and cupolas	34	27	48	22
Total number of fires in group	785	716	909	772
Percentage of all fires reported	7·2%	5·8%	6·5%	6·3%
23. BRUSH, GRASS AND FOREST FIRES—				
Grass and prairie fires	67	103	92	51
Bush and forest fires (excluding fires where damage was confined to standing timber)	97	198	78	60
Total number of fires in group	164	301	170	111
Percentage of all fires reported	1·5%	2·5%	1·2%	0·9%
24. LIGHTNING—	1,160	817	920	627
Percentage of all fires reported	10·6%	6·7%	6·5%	5·4%
25. UNKNOWN CAUSES—	2,796	3,478	4,266	4,063
Percentage of all fires reported	25·6%	28·9%	30·4%	35·5%

A brief summary of the figures in this table shows that fires from easily preventable causes are in the overwhelming majority. Of a total of 48,366 fires, the percentage contributed by each group of causes was as follows: Electrical hazards, 9·1; chimneys, flues, etc., 8·2; lightning, 7·3; incendiarism, 6·7; exposure, sparks, etc., 6·5; matches, 6·1; coal stoves, 3·9; coal oil lamps, etc., 3·5; industrial hazards, 2·9; furnaces, etc., 2·4; smoking, 2·2; candles, etc., 1·8; gasolene and other volatile, 1·6; forest fires, etc., 1·5; illuminating gas, 1·3; hot ashes, 1·1; spontaneous combustion, 0·8; grease, oil, etc., 0·7; grate fires, 0·6; bonfires, 0·4; fireworks, 0·3; steam pipes, 0·3; unknown, 30·1.

Eliminating for the moment fires arising from unknown causes, it is clear that the remainder may be charged as a whole to inexcusable carelessness, ignorance and criminal intent. Lightning losses are easily prevented, exposure dangers can be mitigated, if not entirely removed, and incendiarism may undoubtedly be suppressed. Smoking caused almost the same percentage of fires as the special hazards of all the numerous industries in Canada. Unknown causes constituted a third of the total number. While the difficulty of assigning a specific reason for fires that have destroyed the evidence of their origin is admitted, it is manifest that more searching enquiry should follow every fire. Efforts at fire prevention cannot be prosecuted with success while 30 per cent of all fires occur from unknown causes. In this connection, it should be mentioned that 70 per cent of the fire chiefs in the Dominion stated that, in their opinion, incendiarism was one of the most common causes of fire. Official records failing to support this statement, it is evident that, if such is the case, the majority of fires designated "unknown" are of incendiary origin. Special significance attaches to this point, inasmuch as fires from undiscovered causes are invariably those involving the largest losses.

Fire Losses due to Exposure

In any analysis of fire waste, the fact stands out prominently that a considerable proportion of the loss is occasioned by fires that spread beyond the building in which they originate. Underwriters have estimated that at least one-fifth of the insurance loss during recent years has been caused in this way. Table No. 14 gives a summary of all fires involvtwo or more properties as reported during the present enquiry. By a rough sub-division of the figures, comparison is shown between (1) fires that spread to adjoining or beyond adjoining buildings and (2) fires that originated in brick or in frame buildings. The true exposure loss might properly include losses caused by sparks, grass and bush fires and fires spreading, for instance, from burning lumber piles to other property, but the difficulties confronting the compilation of such statistics are insuperable. Moreover, the results obtained would hardly further the object in view, namely, to discover the extent and causes of fires spreading from building to building.

TABLE NO. 14.—EXPOSURE FIRES: STATEMENT OF PROPERTY LOSS CAUSED BY FIRES EXTENDING BEYOND THE BUILDING OF ORIGIN

Year	Fires extending to adjoining buildings			Fires extending beyond adjoining buildings			Total exposure fires and losses		Percentage of total no. of fires in group	Percentage of total property loss in group
	Started in brick building	Started in frame building	Property loss	Started in brick building	Started in frame building	Property loss	No. of fires	Property loss		
Group A										
1912......	21	37	$520,174	7	15	$204,530	80	$724,704	1·5%	10·6%
1913......	18	45	719,017	11	19	452,367	93	1,171,384	1·6%	13·4%
1914......	27	32	626,611	9	18	276,993	86	903,604	1·6%	9·2%
1915......	10	28	358,825	5	26	295,464	69	654,289	1·4%	8·4%
Group B										
1912......	8	14	89,072	4	11	872,937	37	962,009	7·7%	55·2%
1913......	12	19	76,259	3	7	261,845	41	338,104	10·4%	24·8%
1914......	23	8	93,526	3	15	132,384	49	225,910	7·4%	21·2%
1915......	14	32	208,344	8	12	179,612	66	387,956	12·7%	22·9%
Group C										
1912......	7	31	236,988	5	8	494,721	51	731,709	12·8%	37·0%
1913......	12	28	135,642	2	25	348,096	67	483,738	15·8%	29·4%
1914......	9	14	269,770	7	24	298,463	54	568,233	8·8%	30·4%
1915......	3	16	48,064	4	13	117,399	36	165,463	7·6%	20·5%
Group D										
1912......	5	14	66,740	2	10	104,944	31	171,684	20·6%	36·8%
1913......	7	9	38,921	3	7	147,439	26	186,360	16·7%	34·9%
1914......	2	8	20,313	1	11	199,186	22	219,499	10·5%	51·0%
1915......	6	11	21,809	2	9	86,492	28	108,301	20·8%	27·1%
Group E										
1912......	1	2	13,276	..	2	81,588	5	94,864	5·3%	43·9%
1913......	1	3	23,399	..	4	88,326	8	111,725	7·3%	18·8%
1914......	..	4	43,759	..	2	29,734	6	73,493	8·2%	28·3%
1915......	..	5	18,628	1	1	41,905	7	60,533	8·1%	14·7%
Group F										
1912......	Record not subdivided						13	257,461	10·8%	32·4%
1913......							11	617,987	11·3%	44·5%
1914......							12	403,568	5·5%	33·6%
1915......							9	212,071	7·2%	33·9%
Group G										
1912......	Record not subdivided						13	235,820	11·2%	49·7%
1913......							18	107,061	18·2%	26·9%
1914......							27	398,746	26·4%	75·4%
1915......							11	411,328	6·2%	58·1%
Group H										
1912......	Record not subdivided						106	159,468	5·2%	1·8%
1913......							64	83,550	2·7%	0·9%
1914......							135	261,732	4·8%	3·9%
1915......							98	115,098	4·5%	1·7%
Canada										
1912......	42	98	926,250	18	46	1,758,720	336	3,337,719	3·9%	15·8%
1913......	50	104	993,238	19	62	1,298,073	328	3,099,909	2·5%	13·3%
1914......	61	66	1,053,979	20	70	936,760	391	3,054,785	2·8%	14·1%
1915......	33	92	655,670	20	61	720,872	324	2,115,039	2·7%	11·7%

From this record, the following facts appear: Of the 36,625 fires involving property loss, 1,379, or 3·7 per cent, spread to other than the buildings in which they originated and occasioned damage amounting to $11,607,452, or 13·7 per cent of the total loss.

As classified by groups, the figures show that of every 1,000 fires in which loss occurred, the number that extended beyond the building of origin was as follows: In A cities, 15; in B towns, 95; in C towns 112; in D towns, 171; in E villages, 72; in F villages, 87; in G villages, 155, and in rural districts, 43. The cities, therefore, where congestion of buildings is greatest, and rural districts, where buildings are scattered, experienced the least number of losses from exposure. In cities the freedom from spreading fires was undoubtedly due to better structural conditions and efficient fire departments, and in rural districts to the wide separation of buildings. In small towns and villages where more or less density of poor construction in combination with inadequate protection exists, the proportion of exposure fires was naturally greatest.

The average loss caused to adjacent property by each fire that escaped from the building where it originated was as follows: In A cities, $10,530; in B towns, $9,917; in C towns, $9,370; in D towns, $6,409; in E villages, $13,000; in F villages, $33,135; in G villages, $16,695, and in rural districts, $1,138. These amounts vary considerably, but no special significance can be attached thereto, as, in several instances, one extensive fire contributed the largest proportion of loss in an entire group.

The information obtainable from small towns, villages and rural districts was not sufficiently detailed to permit complete classification of exposure fires, but, as far as practicable, those spreading to adjoining buildings and those spreading beyond adjoining buildings are given separately. It is shown that 63·3 per cent of spreading fires damaged adjoining buildings to the extent of $3,629,137, or 43·5 per cent of the total exposure loss, and 36·7 per cent caused loss to other than adjoining buildings amounting to $4,714,425, or 56·5 per cent of the total loss.

Comparison of brick with frame construction shows that of every 100 spreading fires in A cities, 68 started in frame buildings; in B towns, the number was 61; in C towns, 79; in D towns, 77, and in E towns, 88.

Of every 100 fires starting in frame buildings in A cities, 35 spread to three or more buildings. In B towns, the number was 38; in C towns, 44; in D towns, 46, and in E towns, 39. In other words, frame construction was largely responsible for spreading fires, even in cities provided with the best protection. This is, of course, considered numerically, for it must be borne in mind that, in large cities, the majority of such fires are confined to sheds and outbuildings. The total destruction of a score of frame dwellings and sheds does not usually entail so great a loss as a small warehouse fire in a mercantile district.

The causes of fires spreading from building to building are numerous. Being contributory rather than causative, they do not usually receive much attention in the reports of fires. The following list shows the specific reasons assigned for the spread of the more important fires included in this record:

*Combustible construction in general	218
*Combustible roofs	184
*Unprotected windows	116
†Lack of properly organized fire department	69
*Defective party walls	53
*†Low water pressure	43
*Unprotected doorways	41
*†Lack of public water supply	37
*Openings in party walls	29
†Inadequate fire apparatus	23
*Lack of parapeted walls	22
*†Frozen hydrants	16
*Collapse of external walls	16
†Lack of fire alarm system	14
*Unprotected communications between buildings	9
†Accidents to fire apparatus	8
†Weak fire department	7
*†Broken water mains	6
*†Lack of hydrants	5
†Lack of fire boat	3

Seventy-five per cent of the fires are shown to be the result of poor construction.

Classes of Property Damaged by Fire

One of the essential steps in any attempt at fire prevention is to discover the classes of property in which fires are most frequent. The type of building is immaterial to this consideration, as buildings do not themselves originate fire, although they constitute one of the chief factors in its spread. Eliminating fires started by external agencies, such as sparks and lightning, the use of property is responsible for practically every fire. Underwriters recognize this fact by basing all classifications and schedules upon the specific occupancy of buildings.

Table No. 15 shows the number of properties of various classes damaged by fire during a period of four years. The method of analysis closely follows the latest system adopted by insurance companies. The classes included in the non-hazardous, habita-

*These causes, nine in number, are due to construction.

†These causes, six in number, are due to fire departments.

*†These causes, five in number, are due to public water supplies.

tional and congregational groups contain little inherent hazard and are generally termed 'preferred risks' by insurance men. The mercantile group has all the common hazards and, in certain instances, contains additional hazards due to peculiar commercial uses. Industrial group A includes premises used in the lighter trades, as distinct from industrial group B, which covers all the larger factories and industrial plants. The miscellaneous group comprises classes of property not directly associated with buildings and not included in any of the foregoing groups.

TABLE NO. 15.—SHOWING THE CLASSES OF PROPERTY DAMAGED BY FIRE DURING THE YEARS 1912-1915

Occupancy	1912	1913	1914	1915	Total
Non-Hazardous Group—					
Barns, sheds and out-buildings other than farm property	868	1,196	678	834	3,576
Barns (farm)	1,055	759	1,277	902	3,993
Garages (private)	53	29	37	42	161
Greenhouses	2	4	1	2	9
City and town halls	5	2	6	7	20
Court houses, etc	....	1	....	1	2
Libraries and museums	6	....	2	3	11
Banks	14	9	5	13	41
Office buildings	59	41	35	28	163
Post offices	5	6	2	4	17
Telephone exchanges	1	2	4	2	9
Habitational Group—					
Dwellings (protected)	3,992	4,365	3,348	2,676	14,381
Dwellings (unprotected, other than farms)	1,516	1,242	2,036	1,089	5,883
Dwellings (farm)	748	587	623	845	2,803
Apartment houses	39	47	53	22	161
Barracks	1	....	....	1	2
Boarding houses	14	6	10	7	37
Club houses	6	3	5	10	24
Colleges (residential)	11	3	7	8	29
Convents, etc	4	5	3	4	16
Fire halls	4	1	3	2	10
Hospitals	11	5	16	9	41
Hotels	129	86	91	54	360
Hotels (summer)	27	9	13	22	71
Institutions (various)	3	5	4	2	14
Jails and penitentiaries	2	1	3	1	7
Tenement houses	67	31	73	46	217
Congregational Group—					
Armouries	....	2	1	....	3
Churches and Sunday schools	80	59	101	42	282
Halls (public and lodge)	5	14	16	6	41
Moving picture theatres	8	13	11	14	46
Schools and academies (day)	53	87	41	29	210
Skating rinks	4	7	16	8	35
Theatres and opera houses	10	6	9	7	32

TABLE No. 15—*Continued*

Occupancy	1912	1913	1914	1915	Total
Mercantile Group—					
Barber shops	7	12	5	8	32
Boathouses	38	27	43	15	123
Bowling alleys	4	2	6	1	13
Coal docks and wharves	6	4	2	5	17
Coal and wood yards (retail)	8	11	5	9	33
Fair and exhibition buildings	5	9	5	7	26
Freight sheds	4	4	3	2	13
Garages (public)	43	57	38	29	167
Ice houses	10	14	6	9	39
Livery and hotel stables	24	35	44	27	130
Market halls	2	1	3	1	7
Paint and oil storehouses	15	37	9	16	77
Pool rooms	12	22	18	10	62
Rag and junk storehouses	7	11	4	6	28
Railway stations	12	17	23	8	60
Restaurants	65	48	37	29	179
Retail stores (with dwellings)	982	1,201	1,142	1,068	4,393
Retail stores (with offices)	197	151	134	183	665
Retail stores (multiple occupancy)	147	103	309	226	785
Storehouses (furniture)	5	3	8	2	18
Storehouses (various)	16	29	12	31	88
Warehouses, wholesale (various)	162	124	206	95	587
Warehouses (cold storage)	11	5	3	4	23
Industrial Group A—					
Blacksmith shops	28	15	9	17	69
Carpenter shops	7	18	12	5	42
Engraving shops	2	1	3	1	7
Jewellery factories	....	1	2	....	3
Laundries (hand)	32	26	41	15	114
Mica shops	....	1	....	....	1
Printing offices	21	46	18	12	97
Sheet metal shops	2	....	1	....	3
Slaughter houses	6	1	4	1	12
Spice and coffee mills	3	1	1	....	5
Industrial Group B—					
Abattoirs and packing houses	7	3	2	5	17
Agricultural implement works	5	9	8	4	26
Artificial stone factory	....	1	....	....	1
Asbestos plants	1	....	1	....	2
Bakeries	10	18	7	16	51
Biscuit factories	2	3	5	2	12
Blanket factories	6	2	2	1	11
Boot and shoe factories	24	11	8	13	56
Box factories (wood)	5	3	4	2	14
Box factories (paper)	6	2	2	1	11
Brass works	4	2	2	1	9
Breweries and malt houses	8	6	3	4	21
Brick and tile works	4	3	6	4	17
Butter and cheese factories	5	4	7	9	25
Button factories	1	1	....	....	2
Candy factories	3	9	4	2	18
Car barns	4	1	3	1	9
Carbide factory	....	....	1	....	1
Carpet factories	....	4	2	2	8
Carriage factories	9	3	6	1	19
Car works	7	5	2	3	17

TABLE NO. 15—*Continued*

Occupancy	1912	1913	1914	1915	Total
Industrial Group B—					
Cement works	3	9	4	5	21
Chemical plants	4	4	1	....	9
Cigar factories	8	3	5	2	18
Clothing factories (including furs)	47	13	17	25	102
Cordage and twine factories	3	2	2	1	8
Corundum mills	....	1	1	....	2
Dairies (power)	2	....	4	1	7
Dry kilns (see planing mills)					
Dye works	2	3	6	1	12
Electric power stations	23	16	38	12	89
Evaporators	2	2	1	3	8
Explosives factories	2	....	....	1	3
Fertilizer works	....	1	....	2	3
Film factory	....	....	....	1	1
Fish curing and packing houses	2	6	3	1	12
Flour and grist mills	21	9	33	17	80
Forging works	2	3	1	1	7
Foundries	36	28	13	16	93
Fruit and vegetable canneries	1	5	3	1	10
Furniture factories	7	4	4	2	17
Gas works	1	....	2	....	3
Glass works	8	3	4	1	16
Glove factories	2	2	3	1	8
Glue works	....	....	1	....	1
Grain elevators	39	51	46	35	171
Harness factories	8	3	2	4	17
Hat factories	4	2	6	3	15
Knitting mills	11	7	5	12	35
Laundries (steam)	8	19	6	4	37
Machine shops	65	28	31	46	170
Mattress factories	9	6	8	5	28
Metal works (various)	7	13	5	6	31
Mineral water works	2	3	1	1	7
Paint and varnish factories	4	1	2	1	8
Patent food factories	1	1	....	....	2
Planing mills	12	7	8	15	42
Pulp and paper mills	6	9	4	12	31
Pumping stations	3	1	2	6	12
Reduction plants	....	3	1	2	6
Rolling mills	10	3	7	5	25
Roofing factories	5	1	2	1	9
Roundhouses (railway)	4	2	2	6	14
Rubber goods factories	2	3	1	....	6
Sash and door factories	28	13	15	12	68
Saw mills	71	85	63	37	256
Shingle mills	16	4	9	5	34
Shoddy and waste factories	8	5	7	6	26
Smelters (ore)	1	6	1	3	11
Stave and heading mills	2	1	4	....	7
Steel tool works	....	3	2	3	8
Sugar refineries	2	....	1	3	6
Tanneries	4	12	16	10	42
Tobacco factories	5	1	2	....	8
Vinegar works	1	....	1	....	2
Wire works	2	1	1	....	4
Woodworking factories (various)	14	8	11	6	39
Woollen mills	8	9	3	4	24

TABLE NO. 15—*Continued*

Occupancy	1912	1913	1914	1915	Total
Miscellaneous Group—					
Automobiles	55	86	143	67	351
Boats (gasolene)	47	93	38	26	204
Box cars (railway)	68	39	27	46	180
Bridges	8	14	3	5	30
Buildings under construction	52	19	34	12	117
Contractors' and logging camps	5	11	8	4	28
Hay, corn and flax stacks	8	7	13	6	34
Lumber in yards	35	18	27	15	95
Mining plants	12	23	27	19	81
Oil pumping gear and storage tanks	4	3	2	2	11
Prairie fires (see table, Origin of Fires)					
Pulpwood (corded)	3	1	2	....	6
Railway property (various)	42	28	71	30	171
Stockyards	1	....	1	2	4
Street railway cars	132	84	63	105	384
Threshing outfits	19	23	27	13	82
Vessels (passenger and cargo)	16	12	9	14	51
Vessels (steam tugs and dredges)	14	23	18	11	66
Wharves and docks	5	9	2	6	22

Of the 44,620 properties damaged, the foregoing table shows 32,707, or 73·3 per cent, in the first three groups, 7,565, or 17 per cent, in the mercantile group and 4,348, or 9.7 per cent, in the combined industrial and miscellaneous groups. Fires occurred in 23,067 dwellings and in 7,730 barns, sheds and outbuildings. At first glance, there appears to be a disproportionate frequency of losses in the supposed non-hazardous classes. The explanation is, however, that dwellings outnumber mercantile and factory buildings by over ten to one, so that the numerical ratio of losses to buildings is really lowest of all in residential properties.

The actual monetary loss in the first three groups amounted to $8,963,178, or an average of $274 for each property damaged. In the mercantile group, the total loss was $39,861,153, in industrial groups A and B, $28,858,276, and in the miscellaneous group, $7,492,050, or an average loss per property damaged of $5,269, $11,048 and $3,909, respectively.

From these figures it appears that 82 per cent of the fire loss was caused by 26 per cent of the total number of fires. This loss occurred in mercantile and manufacturing establishments, representing less than 10 per cent of the total number of buildings in Canada. The obvious conclusion is that curtailment of fire waste can be more easily and speedily accomplished by attempting to prevent fires in mercantile and manufacturing establishments than by a general diffusion of activity over the entire field.

Reduction of Fire Loss Easily Accomplished

Whether fire waste can be best attacked along lines of fire prevention or fire protection, or a combination of both, is a matter of opinion. Fire prevention deals with the abstract dangers that may occasion fire, as distinct from fire protection, which definitely establishes certain precautionary measures to reduce losses to the minimum. The object of fire prevention is ideal, but, in attempting to prevent all fires a wide field must be covered, owing to the impossibility of defining just how, when or where a fire may originate. As it is largely of an educational nature also, it must not be forgotten that measurable results can only be accomplished by years of unbroken and untiring effort.

On the other hand, experience has shown that, by the provision of adequate protection in properties, combined with the education of property owners, fire losses can be appreciably reduced. The Factory Mutual Insurance Companies of New England, by specifying approved automatic sprinkler protection in all insured properties, have radically changed some of the most hazardous industries in the United States and Canada into the safest risks. Factories that, at one time, could not obtain insurance at the highest rates are now insured at a few cents per hundred dollars of value.

An indication of the course that might be followed to bring about immediate reduction of fire losses in Canada is given in Table No. 16.

TABLE NO. 16—SUMMARY OF FIRE LOSSES IN EXCESS OF $10,000, ARRANGED BY LOCATION AND CLASSIFIED INTO NON-HAZARDOUS, MERCANTILE AND MANUFACTURING OCCUPANCIES.

	Year	Non-hazardous properties				Mercantile properties				Manufacturing properties				Other than building fires		Total		Percentage of total loss in group
		Brick		Frame		Brick		Frame		Brick		Frame						
		No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	
GROUP A—	1912	4	$ 122,187	2	$ 42,674	45	$2,174,695	9	$ 247,056	32	$1,076,527	17	$ 825,703	4	$ 108,590	113	$ 4,597,432	67%
	1913	13	729,995	5	189,532	69	2,045,914	19	435,171	26	2,245,635	23	643,532	3	47,118	158	6,336,897	72%
	1914	7	431,826	1	11,249	73	3,133,256	22	728,229	27	1,355,798	28	1,035,128	4	112,270	162	6,825,756	70%
	1915	10	358,231	3	60,502	53	1,675,514	12	289,674	22	887,350	15	454,263	5	143,550	120	3,869,084	55%
GROUP B—	1912	2	34,296	2	314,077	9	224,896	12	432 375	6	115,884	3	85,233	1	17,624	35	1,224,385	70%
	1913	..	....	..	....	6	179,613	8	298,404	1	18,050	4	57,810	2	261,300	21	815,177	59%
	1914	2	22,175	..	....	3	68,259	3	47,362	5	198,870	3	71,945	1	191,700	17	603,311	56%
	1915	3	184,154	1	11,367	8	181,593	5	142,501	8	206,880	5	73,116	3	232,600	33	1,032,220	60%
GROUP C—	1912	4	127,600	3	72,853	7	138,529	11	407,842	5	202,953	14	317,290	1	11,200	45	1,278,267	65%
	1913	1	31,962	2	25,064	5	88,962	12	347,678	5	138,641	17	306,155	..	....	42	938,462	57%
	1914	3	44,796	7	92,547	9	168,063	17	312,842	3	81,388	9	280,005	3	41,967	51	1,021,608	54%
	1915	2	29,663	1	14,019	4	104,790	9	172,664	7	85,262	5	69,410	..	....	28	475,808	59%
GROUP D—	1912	..	....	..	....	2	26,540	9	200,437	1	15,737	..	....	..	....	12	242,714	52%
	1913	..	....	..	....	1	14,709	10	117,390	1	26 510	2	49,025	..	....	14	216,634	40%
	1914	..	....	1	10,271	1	11,046	6	103,550	2	28,300	3	58,496	..	....	13	211,663	49%
	1915	1	16,449	..	....	3	56,152	4	126,689	2	37,515	1	13,622	1	14,710	12	265,136	66%
GROUP E—	1912	1	19,763	..	....	3	37,658	4	66,566	..	....	..	....	..	....	8	123,987	57%
	1913	..	....	..	....	1	23,725	6	91,315	..	....	4	243,109	..	....	11	358,149	60%
	1914	1	13,856	1	12,447	2	27,885	3	41,789	1	51,492	2	31,620	..	....	10	179,089	69%
	1915	4	105,196	2	34,614	3	40,337	3	54,495	3	46,042	..	....	1	36,490	16	317,214	77%
GROUP F—	1912	..	....	..	....	8	113,471	14	298,064	..	....	3	34,185	1	14,896	26	460,616	58%
	1913	..	....	2	27,937	2	46,093	17	358,121	1	12,340	7	266,579	..	....	29	711,070	51%
	1914	1	10,238	3	49,820	5	92,225	38	601,834	..	....	2	31,040	..	....	49	785,157	65%
	1915	..	....	1	15,566	2	26,756	19	294,675	..	....	2	75,026	..	....	24	412,023	66%

TABLE NO. 16—SUMMARY OF FIRE LOSSES IN EXCESS OF $10,000, ARRANGED BY LOCATION AND CLASSIFIED INTO NON-HAZARDOUS, MERCANTILE AND MANUFACTURING OCCUPANCIES—*Continued.*

	Year	Non-hazardous properties				Mercantile properties				Manufacturing properties				Other than building fires		Total		Percentage of total loss in group
		Brick		Frame		Brick		Frame		Brick		Frame						
		No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	No. of fires	Loss	
GROUP G—	1912	1	$21,348	2	$28,975	..	....	2	$44,526	2	$75,520	5	$134,270	..	....	12	$304,635	64%
	1913	1	32,109	1	10,213	1	$17,645	3	38,700	1	87,173	2	29,640	1	$ 12,480	10	227,960	57%
	1914	..	....	2	59,131	2	30,477	3	76,255	2	140,900	3	79,681	3	51,145	15	437,589	75%
	1915	1	57,546	3	45,630	2	22,719	5	82,442	1	22,477	2	53,640	2	118,132	16	402,586	57%
GROUP H—	1912	3	123,343	27	308,230	19	238,535	82	1,056,263	27	1,053,429	63	1,122,796	18	393,270	239	4,295,866	50%
	1913	..	....	16	269,116	35	509,706	102	1,592,250	22	258,435	73	1,494,124	30	912,300	278	5,035,931	57%
	1914	1	83,700	17	288,369	23	320,702	11	1,567,712	20	167,635	60	885,990	38	788,026	270	4,102,134	63%
	1915	3	46,488	9	122,605	16	197,104	44	640,922	39	1,090,172	83	1,384,160	21	305,820	215	3,787,271	51%
CANADA— Totals for all groups	1912	15	448,537	36	766,809	93	2,954,324	143	2,753,129	73	2,540,050	105	2,518,847	26	546,030	490	12,527,902	59%
	1913	15	794,066	26	521,862	120	2,926,367	177	3,279,029	57	2,786,784	132	3,089,974	36	1,233,198	563	14,640,280	62%
	1914	15	606,591	32	523,834	122	3,851,913	203	3,479,543	60	2,024,383	110	2,473,905	49	1,188,108	587	14,166,307	65%
	1915	24	797,727	20	304,312	91	2,304,965	101	1,804,062	82	2,375,698	113	2,123,237	33	851,302	464	10,561,342	55%

During the years 1912-1915 loss amounting to $51,895,831 was caused by 2,104 fires each involving damage exceeding $10,000. Fires other than these, numbering 34,512, caused a loss of $33,098,846. There were also 11,741 fires in which no loss occurred. Taking mercantile and manufacturing properties only, 1,782 large fires were responsible for damage amounting to $43,286,210, or over 50 per cent of the total loss in Canada.

Still further analysis shows that fires in buildings in which the loss exceeded $50,000 numbered 297, and that the property destroyed was valued at $26,231,840, or over 30 per cent of the total loss in Canada. Ninety-nine out of every hundred of these losses were preventable, and it is doubtful if the total damage for the whole number would have amounted to more than 5 per cent of that reported if each building had been properly equipped with automatic sprinklers. Based upon the average cost, these properties could have been so protected for about $1,250,000. The indirect saving to the people of Canada would have been over $25,000,000, and the direct saving to each property owner, through the reduction of approximately 80 per cent in insurance premiums, would have paid for the entire installation in the period of four years covered by Table No. 15.

Upon the ground that the bulk of fire loss in Canada occurs in large properties and that such properties are limited in number, the simplest method of bringing about a reduction in the fire loss is obviously to prevent fires in large properties. It is not to be expected that radical improvement can be effected immediately, but concerted action will accomplish much. Once property owners are convinced that fire protection is a paying proposition, the problem of fire waste will be on its way to solution. The point that needs re-emphasizing, therefore, is that over 60 per cent of the total loss in Canada is caused by less than 5 per cent of the total number of fires, and that over 30 per cent of the loss is the result of less than 1 per cent of the fires. Realization of that fact must form the basis of any campaign that is intended to appreciably reduce the fire loss without waste of time or effort.

Compilation of Fire Loss Statistics

In the statistical survey of fire waste conditions contained in this chapter, the widest possible field of enquiry has been covered. Owing to the dearth of reliable figures and the lack of uniformity in such municipal records as are maintained, the difficulty of compiling data of even approximate accuracy is considerable. One suggestion, therefore, is considered as being of importance to any further systematic study of the subject.

It is desirable that each province should make adequate provision for the compilation of information in regard to fire losses and fire protection, either through the existing fire marshal or some other single agency created for that purpose. Each province should authorize this agency to co-operate with like agencies in other provinces and with an organization of the Dominion Government, such as the Commission of Conservation, in

(*a*) Establishing a uniform classification of causes of fires and of properties in which fires occur.

(*b*) Securing complete and uniform data with regard to all fires.

(*c*) Classifying and analyzing such information and determining and publishing the best methods of preventing fires under various conditions and circumstances.

The initial classification might be made from existing available data in the possession of the Commission of Conservation, provincial fire marshals, insurance departments and insurance companies; and the classification should be extended from time to time as necessary. The analysis and study of the data for determining the causes and methods of prevention should be made by the various provincial agencies in co-operation with each other and with the Federal bureau, that uniformity of action may be obtained throughout the whole of Canada.

CHAPTER IV

The Community Fire Hazard

THE North American continent has stood pre-eminent in the number and size of its fires during the last century. Reliable records of conflagrations throughout the world show that, of those involving property damage in excess of $1,000,000, 55 per cent of the number and 69 per cent of the loss is credited to the United States and Canada. The actual figures are:

	No. of fires	Property loss
World record—1815-1915	528	$1,983,335,000
United States and Canada	290	1,365,289.000

Conflagrations large enough to find a place in this statement are counted as overwhelming disasters by almost every country in the world. On this continent, however, their very frequency has led them to be accepted as merely normal and incidental occurrences.

Since 1870, Canada has suffered from 21 major conflagrations, involving destruction of property values in excess of $72,000,000. The total insurance indemnity recovered in these fires amounted to $39,700,000, or over 15 per cent of all the losses paid by insurance companies in Canada during that period.

In addition to what may be properly designated as conflagrations, large fires which swept whole villages and town sections numbered 134, and caused property damage to the extent of $54,000,000. The uncontrolled spread of fires in Canada has, therefore, resulted in losses aggregating $126,000,000, or 36 per cent of the total fire waste during the last half century. In view of this statement the importance of a proper determination of the causes or combination of circumstances responsible for such enormous losses is apparent.

Physical Phases of the Conflagration Hazard

As generally understood, conflagrations are fires extending to and involving several combustible units. Local exposure is the effect that one single unit may have upon adjacent units and can be foreseen and, to some extent, measured and controlled. Conflagration exposure is the effect of a group of units upon another group and is beyond practical measurement. A fire raging in one building endangers only the buildings surrounding it, but, once having spread to a whole block, the conflagration or community hazard has materialized.

There are four general ways in which an individual fire may assume the dimensions of a conflagration: By the communication of flame, by radiated heat, by flying brands, and by wandering volumes of superheated gases of combustion.

(1) *By Communication of Flame*—Flame, in the case of burning buildings, is the visible union of gases roasted out by combustion, and air. Above or beyond the flame, depending upon whether it is ascending or blown horizontally, there is always a non-luminous zone approximating in temperature to the heat of the flame itself and consisting of the unconsumed gases which have been generated by combustion. These gases, under induced draft, form what is known as a 'hot blast,' and immediately ignite wooden cornices, roofs or other inflammable materials with which they may come into contact.

(2) *By Radiated Heat*—Radiated heat is of a different character from flame. It is in the nature of a wave disturbance, that will pass through transparent objects, such as glass, and ignite combustible materials beyond. It is not dependent upon the direction of air currents as is the destructiveness of flame. The principle of radiated heat may be illustrated by the heat wave felt through the closed windows of a railway car as the train passes burning ties beside the track. The temperature of the atmosphere inside the car does not appreciably increase and, as soon as the fire is passed, no heat is felt.

(3) *By Flying Brands*—The communication of fire by burning brands is commonly understood, but, the extent to which it can, and does, occur is not fully realized. The upward rush of heated air from a burning building may carry high into the air flaming brands which may fall miles distant and ignite grass, lumber piles, porches, awnings, roofs, or even pass through windows and skylights to the interior of buildings.

(4) *By Superheated Gases of Combustion*—The action of wandering volumes of unconsumed gases generated by combustion has not been well understood, and many of the peculiar features of conflagrations have been wrongly attributed to hot blasts of flame. These gases always exist where a large mass of materials is burned without sufficient oxygen, a condition common to all fires that have spread over a considerable area. If such gases are carried by wind, or the induced drafts of the fire itself, to a distance, many

interesting phenomena are possible. Fires, for instance, have been observed to break out suddenly in buildings, trees and grass far removed from the original fire. The inflammation has been so instantaneous and general over a large area that no other explanation is possible than that an accumulation of unconsumed gases has been carried forward, localized and ignited in one of several ways. Examination of the ruins of many large conflagrations points to evidences of fire having broken out instantaneously at widely separated points, leaving intervening buildings unconsumed.

The foregoing physical features are, singly or together, present in every conflagration and demand consideration in any attempt to prevent the spread of fire. In the majority of instances on record, all the conditions mentioned have helped to extend the destruction. Burning brands from shingle roofs have been widely scattered, flames and radiated heat have impinged upon every object within reach, and unconsumed gases have been hurled about, to explode with violence as they combined with the air. The last occurrence has undoubtedly been the most terrific in its effects, as it has added the damage wrought by explosion to that of fire.

Temperature of Conflagrations

It is of the greatest practical importance to know exactly what temperatures have been developed in conflagrations, for upon that basis all standards of fire resistance should rest. The flame temperatures of common bodies burning in air are generally held to be as follows: Wood, 800 to 1,140; stearin, 1,135 to 1,670; alcohol, 2,037 to 2,217; charcoal, 2,200; coal, 2,400; sulphur, 3,300; carbon monoxide, 3,600, and hydrogen, 3,700 degrees Fahrenheit. The melting point of cast iron is from 1,900 to 2,228, of various grades of steel from 2,300 to 2,600, and of glass from 1,500 to 2,200 degrees Fahrenheit.

The maximum intensity reached in actual fires has been the subject of searching investigation by authorities following every conflagration and considerable difference of opinion exists upon the point. It is generally agreed, however, that the average temperature ranges from 1,500 to 2,000 degrees. Thus Capt. John Sewell, in his report upon the San Francisco conflagration, states:

"I am inclined to think that temperatures considerably in excess of 2,000 deg. Fahr. were not at all uncommon, although there were, manifestly, in the burned area, places where no such temperature was reached. The department stores, dry-goods stores and other buildings of mercantile occupancy evidently suffered from temperatures at least as high as 2,000 deg. Fahr. In mercantile buildings these temperatures seemed to be the rule and not the exception."

Mr. Richard L. Humphrey in the same report says:

"The heat was so intense that sash weights and glass melted and ran together freely. In some places the edges of broken cast-iron columns softened, the tin coating in piles of tinned plates volatilized, even in the middle of the piles, and nails were softened sufficiently to weld together. The maximum temperature, lasting for a few minutes in each locality, was probably 2,000 to 2,200 deg. Fahr., while the average temperature did not exceed 1,500 deg. Fahr."

Professor Ira Woolson, of Columbia University, maintained that many of the estimates made in regard to the Baltimore fire were grossly exaggerated:

"The temperatures developed have been estimated by numerous writers as from 2,500 to 4,000 deg. Fahr., and the statement has been repeatedly made that different kinds of metals were fused, including cast iron and steel. Now, I will not dispute that such things may have occurred in rare instances, but, as a general proposition, the statements are not founded on fact. Glass melted freely, and hung down from the light fixtures in fantastic forms, but the brass fixtures were everywhere intact. From this evidence I am convinced that the average heat of those buildings was not far from 1,500 to 1,800 degrees."

In a detailed report on the fire in the Quaker Oats Co. factory at Peterborough, Ont., on December 11, 1916, Mr. T. D. Mylrea, engineer in charge of the investigation, states:

"The temperature in the interior of the building must have been very intense, for melted metal parts of machines may be found here and there in the ruins. In the front windows of the second story and in the front and some of the west windows of the third story of the concrete warehouse were found melted sash weights. In some cases they were but slightly fused, in other cases two or more weights had run together, and in several places on the third floor the weights were reduced to shapeless masses of cast iron. On the inside of the walls of all the buildings may be found large patches of fused brickwork. The melted brick ran down the face of the wall and out upon the floor like molasses for a distance of about 18 inches, and over the doorway it trickled across the face of the concrete lintel and dripped from there to the floor. Upon breaking off some of the fused brick from the lintel, it was found that the concrete had been badly calcined beneath the running brickwork. From the fact that cast iron melts at about 2,200 deg. Fahr., and that brickwork reaches the stage of incipient fusion at about the same temperature, it must be concluded that, at many places during the conflagration, temperatures in the neighbourhood of 2,300 deg. Fahr. must have been reached."

It may be generally accepted that the temperatures exhibited in large fires have ranged from 1,500 deg. Fahr. upward; the maximum is reached in the zone of hot blast flames and by the sudden ignition of accumulated bodies of carbon-monoxide and hydrogen gases. Even with the minimum temperature, unprotected iron and steel columns may be deflected to the point of collapse and, as the heat reaches its maximum intensity, few structural materials will remain intact.*

Contributory Causes of Conflagrations

The history of conflagrations shows that they have occurred in cities with the best protection as well as in those without any, and that they have destroyed 'fire-proof' buildings as well as those of poorest construction. Every conflagration develops from an ordinary exposure fire in one of two ways. It starts in the outskirts, or frame districts, of a city and sweeps into the congested district after it has attained a hot blast form, or it starts in the heart of the business section and spreads more rapidly than the firemen can operate. In its first form, such as destroyed St. John in 1877 and Ottawa-Hull in 1900, a conflagration has never been extinguished; it has burned out for lack of fuel. In its second form, such as Baltimore in 1904 and Toronto in 1904, a fire has sometimes been controlled by accident rather than design. A change in the direction of the wind may have turned it back over its course or its heat may have been deflected or absorbed by an indestructible obstacle in its path.

No conflagration has ever been stopped by organized attempts at extinguishment. The most powerful hose streams are ineffective at more than 150 feet, the exact distance depending upon the velocity of the wind. The horizontal reach of flames driven by a gale has, in many instances, exceeded 1,000 feet, and buildings over one-half mile in advance of the fire have been ignited. Under such conditions, a fire department can fight the conflagration neither in advance of the flames nor from the rear, because of the trail of hot and burning debris. Operating on each flank of a sweeping fire, the efforts of a fire department are again of doubtful value, being spread over too large an area to permit effective work. Without attempting to disparage the efforts of firemen in dealing with conflagrations, it should be recognized that their chief value has been

*Wise men no longer talk about fire-proof construction. No material known is absolutely proof against heat. Experts prefer to talk about 'fire resisting' or 'fire retarding' qualities. The distinction is a good one. The most that man can hope for is to put such obstacles in the way of a fire as to delay its progress until the combustible material on which it feeds is consumed. There can be no doubt that if it is gone the right way about, it can be done effectually.—*New York Tribune*, 1911.

in preventing flames from spreading across the wind, and in extinguishing brands that have alighted outside the zone of the fire.

The foregoing facts emphasize the importance of discovering the immediate causes responsible for the development of sweeping fires. In a previous paragraph it has been stated that 36 per cent of the total fire loss in Canada during the last fifty years has been the result of conflagrations. Of greater importance to the present enquiry is the estimate that only 1 in 20,000 fires has ever reached the magnitude of a conflagration. The origin of the incipient fire, whether from defective wiring, rubbish, matches or incendiarism, is of minor consequence. Fires occur in multitudinous ways, in divers places and at various hours, but less than $\frac{5}{1000}$ of one per cent are attended by all the features essential to rapid and uncontrollable extension.

The specific circumstances favourable to conflagration will be more clearly understood by reference to the list of notable fires in Canada included as an appendix to this report.† The incidents of the conflagrations there cited are typical of those surrounding every great fire upon the American continent and show that the contributory conditions are capable of classification as follows:

(1) Contiguity of frame buildings.

(2) Prevalence of combustible roof coverings. The extension of numberless fires has been due to the shingles released from burning buildings being carried by heated air currents to ignite distant buildings.

(3) Individual buildings of large area or excessive height, situated in congested districts, and so constructed that intense internal combustion is rapidly set up. These may be low one-storey buildings of unbroken area, such as the wharf warehouse at New Westminster, or modern six-storey buildings with numerous vertical openings that permit combustible goods on each floor to ignite almost simultaneously.

(4) Lack of firebreaks, such as solid brick walls and window protection. Gases and superheated air cannot be confined within a burning building and, under certain conditions, jets of flame issuing from window openings and doorways may set fire to structures at a considerable distance.

(5) Inadequate or non-existent water supply systems. In many instances this has been due to deficient pumping capacity, broken mains, frozen hydrants, or the carelessness of the authorities in emptying the reservoir for cleaning purposes during a dry season, without providing an alternative available supply.

†Appendix I of this report contains a brief description of all the notable fires that have occurred in the history of Canada. The details therein given were, to a large extent, abstracted from original records placed at the service of the Commission of Conservation by Mr. John B. Laidlaw of Toronto.

THE BREEDING GROUND OF A CONFLAGRATION

Wooden dwellings and shacks stand huddled together on the outskirts of every large Canadian city and form the entire residential areas of the ess mportant towns. Fires starting in such districts during a high wind can seldom be controlled.

(6) Delay in transmitting the first alarms of fire.

(7) Poor organization and equipment of fire departments. Often brigades have been seriously crippled by accidents to apparatus at the commencement of fires or by the weakening of the force in an attempt to cope with two or more fires at the same time.

Conflagration Conditions in Canada

With the elements contributory to the extension of fires defined, an enquiry into existing conditions in Canada shows that no city or town is free from the danger of conflagration. In some the hazard is severe, in others it has been modified by recent construction—in all it is bad. The chief of every city fire department fears the day when he will have to solve for himself the problems that have confronted the organized brigades at Montreal, Toronto, Ottawa and other cities. In a general way it may be said that the larger cities and towns in Canada consist of compact brick and stone business centres, surrounded by districts constructed almost entirely of wood. Frame buildings, to a greater or lesser degree, constitute the mercantile centres of the smaller towns and villages and the whole residential sections.

In the congested business areas of cities, the more recent buildings are of a good type, but are usually too high for efficient protection by the available water supply under conflagration conditions. The older buildings are of a poor class, ranging from frame to ordinary joist construction. Many have large floor areas that would give an unbroken sweep to fire. Intermingled with the good and bad construction are buildings dilapidated beyond repair, forming a constant menace to adjoining structures. In nearly all buildings the floors are pierced with numerous unprotected openings for stairways, elevators and skylights. The windows of one building are permitted to exactly oppose similar windows in adjacent buildings without any provision to minimize the exposure hazard. To the exterior of many of the buildings immense metal-covered wooden cornices, useless domes, mansard roofs and other combustible features have been added, entirely destroying the fire protective value of brick and stone walls.

Outside the business centres of cities and towns, there is, invariably, a zone of cheap construction. Municipal boundaries have been extended from time to time, with the result that the poorest class of buildings has been brought within the limits. These endanger all buildings thereafter erected in proximity to them. This outer zone generally includes the main residential sections, which are, in many instances, closely built up districts of cheap brick veneer and frame buildings. Construction is extremely defective, owing to the speculative features that enter into the ownership of such property.

Beyond the outer area again are hundreds of suburban real estate developments, composed entirely of wooden buildings. Without restrictions, every builder has been a law unto himself. In many cases there is congestion through the efforts of real estate men to sell the maximum number of lots per acre. These sub-divisions are absolutely devoid of fire-retarding features and have little or no protection from public fire departments. They form a problem in themselves and, at the same time, constitute a menace to the cities which they adjoin. A fire, well started in such a locality, with a strong wind blowing, is exceedingly difficult to control. As a matter of fact, such fires seldom are extinguished until they have burned out, or are blocked by some natural barrier, such as a river, park or other open place. In their sweep they annihilate everything combustible and destroy homes which represent the investment of years of toil and saving by those who can least of all afford the loss. The sad experience of scores of small communities justifies and demands legislation that will operate to control all forms of construction outside of municipal fire districts. This is not only of importance to the particular community itself but vitally affects the future extension of the city or town to which it stands adjacent.

While the significance of a general statement, such as the foregoing, is more or less apparent, the actual situation can only be fully appreciated by a survey of existing conditions in Canadian cities and towns.

Typical Cities

To show more clearly the limited effect of building laws upon conditions already established, a brief description of the potential conflagration hazard in three typical large Canadian cities, each having a modern building ordinance, is given herewith. The conditions described are in some instances none too flattering, and the names of the cities have, for obvious reasons, been omitted.

City A has a central business district in which approximately 85 per cent of the construction is brick, the remainder consisting of 2½-storey frame residences. Ninety per cent of the brick buildings is of ordinary joist construction with unprotected window and floor openings and numerous light areas and courts constructed of combustible material. Four- and five-storey heights predominate. Adequate inside fire protection is provided in only 5 per cent of the outer mercantile and manufacturing buildings. The outer business district is composed of approximately 38 per cent brick and 62 per cent frame construction, the buildings ranging from 2½ to 4 storeys in height. Throughout the extensive wharf and manufacturing districts, the majority of buildings are metal clad with patent roofs. Practically all the residences in this district are frame with shingle roofs.

The main residential district, extending over a large area, consists of 2-and 2½-storey, frame, shingle-roof houses, compactly built up, in many cases adjoining each other in long ranges. Numerous apartment houses in this district are from 3 to 7 storeys in height. The entire district has a serious conflagration hazard, the principal danger points being several large lumber yards, frame arenas and railway fuel-oil tanks.

Several *minor residential districts* are situated in close proximity to hazardous lumber mills and yards. These residential districts are all liable to sweeping fires, as they consist entirely of frame, shingle-roof dwellings, compactly built together in ranges of considerable length.

The conflagration hazard of the city in general varies from light to very pronounced in specific localities. It is moderate in the principal business district, pronounced in practically the whole of the wholesale and outer business districts, severe along the water front and in all the manufacturing districts, pronounced in the main residential district, and very serious in the numerous frame dwelling districts, exposed by industrial sections.

In City B, the congested value district covers about 50 blocks and is divided into three sections by two wide streets. The eastern section is composed of retail stores, low-value hotels, wholesale warehouses and a number of office buildings. Most of the construction is joisted brick with a few 'slow-burning' and 'fireproof' buildings. In the northern part of the section, the potential conflagration hazard is severe, owing to poor brick construction and the large number of frame buildings with shingle roofs scattered throughout the entire area. The western section is composed of retail stores, motion picture theatres, low-value hotels, wholesale establishments and office buildings, a great number of the latter being of first-class construction. In the northern portion of the district the potential conflagration hazard is severe, owing to structural weaknesses, lack of window protection and the amount of frame construction. The buildings are mainly small and the probability of fire spreading would not be great but for the frame, shingle-roof buildings scattered throughout the district. In the warehouse portion of this district, the construction is practically all brick and the buildings fairly accessible. Owing to unprotected openings and light party walls, however, a whole block might readily become involved in one fire. The southern section is practically a fireproof office section and the conflagration hazard is negligible.

In the minor mercantile districts, frame construction predominates but the buildings are mainly small and values low. Owing to exposure by frame, shingle-roof dwellings, a large area might be swept by one fire.

Dwellings throughout the whole of the city are largely frame with shingle roofs. In some districts, where they are closely built up, there is every probability of a large fire. Brick apartment houses are scattered throughout the residential districts but, owing to their lack of window protection, these would have little value as fire breaks.

The conflagration hazard of the city in general varies from 'slight' to 'very pronounced' in the principal mercantile district. It is pronounced in some parts, owing to the amount of frame constructon, structural weaknesses and severe exposures. In the residential districts, protection is weak, and, in high winds, there is every probability of large areas being involved in a general fire.

In City C the central mercantile district is composed of retail stores, offices, hotels and wholesale warehouses. The district consists of 29 blocks, 31 per cent of the area being occupied by streets and 84 per cent being built upon. The blocks are small but 45 per cent of the total number is inaccessible from the interior. The streets are narrow, being from 40 to 60 feet in width, and there is little open space surrounding the district. Of the area built upon, 63.6 per cent is covered by joisted brick, 32.7 per cent by frame and 3.7 per cent by fireproof construction. Frame construction exists in 83 per cent of the blocks. While the individual areas are mainly small, one four-storey hotel with a shingle roof covers an area of 12,200 square feet and communicates through unprotected openings to two other sections of joisted brick construction, making a combined fire area of 19,700 square feet. In the event of a fire gaining headway in this district, it could spread rapidly and, during high winds, might easily destroy the entire section.

The warehouse district comprises numerous mercantile occupancies in buildings mainly of three-storey frame construction. A few buildings are of joisted brick. Along the water front, all the construction is frame and, at times, the wharves contain high values in transit. In the rest of the district the buildings are largely of frame construction, one to four storeys in height with shingle roofs and large areas. Lumber and coal storages, fish warehouses, car barns and several industrial plants are situated in the northern end of the warehouse district. The potential hazard is high on account of the frame construction. Lack of sufficient water supply makes the probability of spreading fires high.

The outer mercantile district consists of small stores with dwellings above. The heights are from 2½ to 3 storeys. The buildings have shingle roofs, are closely grouped in ranges, with no barrier to the spread of fire. With high winds, sweeping fires would be probable in this district.

The residential sections are mainly frame with shingle roofs and, though most of the houses are detached, some are in frame rows and there is liability of extensive fires because of shingle roofs.

The conflagration hazard of the city in general is very severe. In the principal mercantile district there is a large amount of frame and structurally deficient joisted brick construction; the streets are narrow, there is little open space in block interiors and, therefore, the probability of conflagration is high. In the wharf and warehouse district, the lack of fire protection and the amount of frame construction makes sweeping fires probable. The minor mercantile district imposes but a small barrier to the spread of fire and serious fires are probable. In the residential sections, the usual hazard of frame dwellings with shingle roofs is present.

Structural Conditions Unsatisfactory

That unsatisfactory structural conditions are common throughout the Dominion, without respect to any particular province or locality, is shown by figures gathered for the purpose of the present investigation. Enquiries were made of the local authorities in each city, town and village in Canada as to the actual number of buildings of each particular type of construction within the municipal boundaries. The replies show that frame buildings and shingle roofs are quite prevalent in the congested districts of the larger cities, predominate in the outer areas of all cities and towns, and are almost universal in the small towns and villages. In tabulated form, the percentages of each type of construction may be classified as follows:

TABLE NO. 16—SUMMARY OF STRUCTURAL CONDITIONS IN CANADA
(Places classified by population)

Type of Construction	Cities over 10,000	Towns 5,000 to 10,000	Towns 1,000 to 5,000	Villages under 1,000
	Per cent	Per cent	Per cent	Per cent
(a) Brick or stone	72	53	27	18
Brick-veneer	14	8	5	3.4
Frame	14	39	68	78.6
Shingle roofs	12	57	74	88.7
(b) Brick or stone	31	20	4.6	3.2
Brick-veneer	21	14	16.4	5.6
Frame	48	66	79	91.2
Shingle roofs	84	93	96	98.4

(a) In congested districts. (b) In residential districts.

The Shingle Roof Hazard

One of the hazards of greatest importance, as affecting conflagration conditions, is emphasized in a remarkable manner by the foregoing table. The figures show that shingles form an overwhelming percentage of the roof coverings in use throughout Canada, despite the fact that they have been long regarded as the most potent cause of spreading fires. In considering this matter, however, it cannot be too strongly urged that caution should be exercised against hasty conclusions that prohibitive measures against the use of wooden shingles are desirable in the Dominion. In view of the many phases of the subject, such action would be uneconomical, and, therefore, might reasonably be regarded as against sane public policy. The reasons for their continued use are their supposed low first cost, ease of application and availability. These advantages are evident in a lumbering country like Canada, but, unfortunately, they are overshadowed by one discrediting feature—the fire hazard. To illustrate this danger in its most formidable aspect, particulars have been gathered regarding a number of recent conflagrations in the United States.

Fortunately, Canada has so far been free from such overwhelming disasters, notwithstanding our widespread use of shingles for roofing.

Authorities state that practically every major fire upon the American continent has been increased in scope by flying embers from wooden roofs. Thus Mr. Frank Lock, United States manager of the Atlas Insurance Company of London, England, asserts:

"If I were asked to name the one condensed evil productive of the greatest fire loss, apart from carelessness, I would name shingle roofs. They are wholly bad and should not be tolerated in any city where they are on buildings within reasonable reach of any other building. The great Galveston fire, the Jacksonville fire, the Chelsea fire, not to go back to the vast proportion of the area destroyed by the great Chicago fire, all owe their spread to the shingle roof, which was directly responsible for each great loss; and the same is true of tens of thousands of other losses where the flames have spread from one building to another."

Shingle Roofs in Recent Conflagrations

In confirmation of this statement a list of conflagrations, compiled by the Fire Prevention Committee of the National Board of Fire Underwriters, shows that thirteen fires in the United States, involving a loss of almost $70,000,000, have been directly caused by shingle roofs since the year 1900.* The fires enumerated and the amount of loss in each instance are as follows:

1901—Jacksonville, Florida	$10,000,000
1904—Yazoo City, Minnesota	2,000,000
1908—Chisholm, Maine	1,700,000
1908—Chelsea, Massachusetts	12,000,000
1909—Fort Worth, Texas	800,000
1910—Wallace, Idaho	1,000,000
1911—Bangor, Maine	3,500,000
1912—Houston, Texas	4,500,000
1913—Hot Springs, Arkansas	2,250,000
1914—Salem, Massachusetts	13,000,000
1916—Paris, Texas	11,000,000
1916—Nashville, Tennessee	2,000,000
1916—Augusta, Georgia	4,500,000

Reference to the official reports upon these conflagrations makes it clear that the special danger of shingle roofs is not mitigated to

* Since the compilation of this list a conflagration at Atlanta, Georgia, on May 21, 1917, completely destroyed the residential section of the city, devastating scores of blocks of the finest homes and hundreds of cheap frame houses. Estimates placed the property loss in the neighbourhood of $3,000,000. The extent and character of the fire was attributed to the prevalence of shingle roofs.

any great extent when buildings are separated by open spaces or barriers in the shape of intervening brick buildings. Shingles appear to have been carried to considerable distances by wind or by the draught of conflagrations, igniting in turn the roofs upon which they alighted. In the report upon the fire at Salem, Mass., June 25, 1914, it is stated:

"The tremendous factor of the wooden shingle was again made wearisomely clear. Had it not been constantly blowing about, the fire should not have crossed Essex street, or, at any rate, the Boston and Maine tracks, in the face of the assembled half of the fire fighting forces of Eastern Massachusetts. Every watcher of the fire from any elevation testifies to houses all over South Salem igniting from these fire brands. The skipper of a tug boat extinguished embers falling on his decks five miles at sea."

In regard to the Nashville conflagration, March 22, 1916, the report of the Tennessee Inspection Bureau states:

"Shortly after the fire started 33 frame dwellings, situated from 100 to 1,000 feet south-east of the planing mill, were on fire; of this number, 18 were covered with shingle roofs. It is here that the hazard of shingle roofs is more forcibly illustrated than ever before. At about 12.20 the firemen succeeded in controlling the fire in the 33 buildings located in the first zone, but, due to the increased velocity of the wind, burning shingles were carried across an 1,800 feet clear space and ignited other shingle roof buildings on Main and Howerton streets, resulting in a second conflagration in the more thickly populated and highly valued residence section of East Nashville. The rapidity with which the fire burned perhaps establishes a record for the destruction of dwelling property by fire, considering the number of buildings consumed in the relatively short space of time. The fire travelled at the rate of 42 feet per minute, and destroyed more than two buildings each minute. The chief lesson taught by this conflagration, that destroyed the best portion of the residence section of East Nashville, is that, if sweeping fires are to be avoided, the hazards which invite them must be eliminated or minimized. Light frame construction and especially shingle roofs, were, undoubtedly, responsible for fire starting in the second zone. If the hazards of quick burning construction are to be minimized in cities and towns, the power lies solely in the hands of those who have legislative control of the common welfare and safety, and public sentiment should stamp with everlasting approval the legal abolition of the shingle roof, and encourage only that type of building construction which resists fire as well as time."

The report upon the Paris, Texas, fire, which occurred on March 21, 1916, especially emphasizes the fact that in frame districts the majority of fires could be controlled, apart from the shingle roof. With shingles and a high wind as factors, a dozen fires may be started over a radius of more than a mile, while the brigade is seeking to extinguish the original fire. The Texas fire marshal thus described the Paris fire:

"The fire burned north-north-east from the place of origin, widening its area as it swept on until it burned itself out on the north and east sides of the city, leaving now and then a scorched structure in its path, in almost every instance supporting a non-combustible roof covering. The entire area of the districts covered by the flames amounts to 264 acres within the corporate boundaries, and many small buildings, stables and outhouses outside the city proper; 1,440 buildings were destroyed, 1,051 of which had combustible roofs, or 73 per cent of the total number of buildings lost; 1,297 of the total number of buildings were of frame or metal-clad construction, or 90 per cent of the total destroyed; 117 brick mercantiles, 522 outbuildings, such as barns, stables, garages, etc., 13 churches and 9 public buildings. The most important lesson to be drawn is the hazard of the shingle roof. Modern history does not contain a more perfect example of the conflagration hazard that is present in every city or town where the shingle roof is prevalent. The burning of the business district of Paris was not due to a lack of fire fighters. It was not due to a lack of water. It was not due to the construction of the business district itself, but was primarily due to the shingle roofs of the residential district of the city. The firemen were not able to hold the blaze to the first building being burned for the reason that the brands carried by the high gale had set on fire buildings four, five, six and even ten buildings away, and, in practically every instance, the fire started on the roof of the building. Those, in turn, would send their burning brands on the wings of the wind to other buildings with shingle roofs, until every dwelling on both the south and east sides of the business sections was a seething, roaring mass of flames, and, notwithstanding the fact that the roofs of the business buildings had not taken fire from the burning embers that had fallen upon them like a rain of hail, when the half circle of fire around the business districts had closed in, the intense heat of the wind-driven flames and the flying brands which were many inches deep in the streets, broke through the windows and doors. When once an entrance was effected, the doom of the business district was sealed. Had the roofs of the dwellings in the path of the fire from its point of origin to the business district been of non-combustible material, it is believed the fire department of Paris alone could have easily held the blaze to at least the block in which it originated."

As this fire was given wide publicity in trade journals, both in the United States and Canada, and the very strongest protests were urged against ordinances prohibiting shingle roofs, it is deemed advisable to make reference to the evidence given before a state commission of enquiry following the fire. The salient facts brought out in the investigation were that the business district, with its incombustible roofs, withstood the flames until surrounded by fire on three sides; that one fire is all that an ordinary fire department can cope with at one time, and that the fire only attained conflagration proportions because of the prevalence of shingle roof coverings.

Advocates of shingle roofs state that they are not only safe when used outside of congested areas but make an excellent fire-break if wet. The National Lumber Manufacturers' Association, in *Engineering Bulletin No. 1*, says:

"The same influences which have created a prejudice against the use of structural timber in commercial structures and frame dwellings have attempted to eliminate the shingle roof. The propaganda is based entirely on the fire hazard, since it is well known that good shingles, properly laid with good nails, will give better service than any other form of roofing material and, in case of fire in adjacent buildings, can be wet down so as to constitute an excellent fire-break. No one denies that a dry shingle roof, particularly an old one, will ignite from brands and large sparks; nor does any sane man, lumberman or otherwise, advocate other than non-combustible roofs in congested districts or wherever there is real danger, but it is equally certain that many other roofing materials are in the same class with shingles as regards inflammability. Where buildings are separated, as in small towns and residential districts, the wooden shingle has qualities of beauty, economy, storm resistance and long life superior to any other roof covering."

Adjacent fires and flying brands from distant fires do not, however, constitute the only reason for the objection to shingles. With the exception of the winter months, hardly a day passes that buildings are not damaged or destroyed by chimney sparks falling upon wooden roofs. Reference to Table No. 13, page 85 shows that, during the years 1912-1915, no fewer than 1,373 fires were recorded as having originated from chimney sparks. In addition, 381 fires were caused by sparks from locomotives, steamboats, refuse burners and cupolas, and it is fair to assume that many of these sparks alighted on shingle roofs.

Upon analysis of the figures this particular danger becomes even more apparent. Of the chimney spark fires 942, or almost 70 per cent, occurred in dwellings; 736, or 78 per cent, of these were situated outside of municipal boundaries, so that the mere fact of isolation does not appear to bear out the claim that shingles are free from fire hazards except within congested areas. Apart from this, however, it should be remembered that, under ordinary circumstances, a roof fire is quickly extinguished by the fire department in protected districts, while in rural districts it frequently involves total loss.

It has been frequently suggested that insurance companies do not regard shingle roofs as an appreciable fire hazard in dwellings and, therefore, no specific charge is made for their use. The National Board of Fire Underwriters, than which there is no better authority, in its 1916 report on dwelling house fires, says:

"Wood shingle roofs, in combination with chimneys, defective or otherwise, have probably been accountable for more dwelling house fires than any other defect in construction or equipment. Records show that they are responsible for over 20 per cent of all fire losses in dwellings. The wood shingle has been justly called a 'conflagration breeder,' for experience has shown that many of our large conflagrations have been spread and rendered uncontrollable by the flying brand hazard of this material. Therefore, the National Board of Fire Underwriters urges that wooden shingle roofs should not be used where a safer covering can be afforded."

While discrimination is rarely made in insurance rates for shingle-roofed dwellings, because of the difficulty of dealing with so great a number individually, the hazard is fully appreciated. Reference to the schedules of any underwriters rating bureau shows that the shingle hazard enters very largely into the computation of all except flat rates.

Of recent years, total prohibition of the shingle as a roof covering has been strongly advocated by fire marshals, fire departments and underwriters. While it is doubtless possible to pass restrictive and severe legislation of this nature, so as to cut the fire loss from this cause to a minimum in any community, its wisdom is questionable if it imposes unnecessary hardship by arbitrary enforcement. A certain amount of legislation is needed in regard to the use of the wooden shingle, but there is an economic problem involved that can not be solved by theory alone. The shingle roof, as well as the frame building, will continue just so long as it appears financially advantageous to build with these materials. During recent years, the awakening of the public to the conflagration hazard has precipitated a great deal of local legislation restricting the use of shingles. Many substitutes have been placed upon the market in the shape of prepared metallic and asbestos compound roofings that are fire-retardent to a high degree, durable and not too heavy for two-by-four or two-by-six-inch roof timbers. The majority of these materials are higher in price than wood shingles but their additional qualities make cost a secondary consideration in all except temporary construction. Thus the only logical argument in favour of the wood shingle roof appears to be its initial cost. As the price of lumber increases and the quality declines this advantage will become less and the problem of the shingle roof will to some extent find its own solution.

Treatment for Wood Shingles

A field for investigation, of tremendous importance to the industries affected, lies in an attempt to discover a satisfactory treatment for wood shingles that will render them measurably fire-retardent. No process can ever make wood 'fire-proof,' for no class of material will resist fire under all conditions. Innumerable experiments have been made to demonstrate the efficacy of various compounds, but conclusions of practical value have never been reached. While tests have proved certain treatments to be suitable for one particular condition, such as retarding fire, the substances used have failed to embody equally valuable qualities of permanence and weather resistance. A good shingle fire-retardent must also have endurance, insolubility, attractiveness and cheapness. With the discovery of a satisfactory method of treatment, there does not appear to be any sufficient reason why shingles should not become a most desirable roof covering for dwellings and other buildings outside congested areas. They have adaptability and beauty superior to most roofings and, up to the present, have entailed the least first cost. Since the temporary nature of many of our buildings, the migratory tendencies of our people, and the rapid development of our cities and towns are factors making the use of wooden construction advisable, to attempt to legislate the shingle or the frame dwelling out of existence is believed to be both uneconomical and impracticable in Canada at the present time.*

In the face of the accumulated evidence, however, regarding the susceptibility of wood shingles to ignition from sparks, and their other fire-spreading characteristics, there can be no question as to the desirability of regulating and restricting their use where they create a potential community hazard. Any but incombustible roofs should be entirely prohibited within the congested districts of all cities and towns. In the outer districts, such as the more openly-built residential areas, wood shingle roofs should be permitted, subject to definite exposure distances, within which they should be treated with an approved fire-retardent. Between these two

*One suggestion that might be made in this connection is that a satisfactory fire-retardent will in all probability be found in discovering a preservative treatment other than the present creosote and pigment stains. A newly shingled roof offers much better protection from fire than an old one, because the shingles lie closely together and present a smooth, hard surface upon which sparks or embers are not likely to lodge permanently but will roll or be blown off. On an old roof, where the shingles are badly weatherworn and have curled and broken edges, the chances of sparks being held and igniting the roof are very greatly increased; therefore, any treatment which will preserve the shingles and prolong their existence as a smooth roof surface will incidentally improve its fire resistance.

districts, there should be a middle zone where shingle roofs should not be permitted at all, unless treated in such a manner as to render them measurably fire-retardent. The chief difficulty likely to arise in thus regulating the use of shingles would undoubtedly be in the delimitation of boundaries in any particular city or town. A systematic enquiry should be instituted to discover, if possible, what conditions of congestion have existed in the case of shingle roof fires. The relative fire danger directly depends upon the exposure curve of the shingle roof. By this is meant that, in considering the record of shingle roof fires communicating from adjacent property, it will be found that a certain number have occurred at an exposure distance of less than 20 feet and that the percentage rapidly decreased with the increase of exposure distance above that point. A careful study of these facts is necessary to determine what degree of congestion is permissible, and before any logical conclusion can be reached, in connection either with the unprotected shingle roof or a roof that has been treated with fire-retardents.

The Control of Spreading Fires

The measures popularly advocated to control the spread of fire are four in number, namely, fire prevention, fire limits, fireproof construction and fire departments. None of these alone can prevent a conflagration, and records show that together they have failed in almost every instance.

Fire Prevention

As referred to in this connection, fire prevention is the attempt to reduce the frequency of fires. The preponderance of disasters from unknown and trivial causes appears to forbid hope of controlling conflagrations by strictly fire prevention methods. It has been previously pointed out that, on the average, only one in 20,000 fires has reached the magnitude of a conflagration. That one fire is the problem demanding solution. If fire prevention successfully reduced the occurrence of fires in Canada to 100 per annum, there is no assurance that the spreading fire would not be one of the hundred. That depends largely upon the location of the outbreak and the character of its environs. When a small frame dwelling in Hull, Que., caught fire, that was the identical place where Hull and Ottawa began to burn. A similar occurrence in an isolated farm dwelling in a country district would have been equally serious so far as the individual building was concerned but it could not have resulted in the partial destruction of two cities. To debar conflagrations, therefore, fire prevention must not only diminish the frequency of fires, but also establish the confines of the occasional outbreaks that occur.

Establishing Fire Limits

A Canadian city or town ordinarily develops out of a nucleus of small wooden buildings. Then comes the realization that this material, so available and cheap that it is inevitably used first for building purposes, is too hazardous. A supposed remedy is prescribed by declaring fire limits that generally comprise a small congested district in the centre of each city or town. In that area, frame buildings and shingle roofs are prohibited and general building regulations indifferently enforced. There are pleasing exceptions to this statement, but, ordinarily, it is true. Outside of the central area, there are few restrictions and the fire limits are an arbitrary dividing line. With the growth of the city or town, the business district invades the poorly built sections surrounding it and the fire limits are extended. To attempt the control of frame construction at such a time amounts to prohibiting the creation of a condition that already exists. Enforcing the erection of brick buildings in frame districts is not of itself much protection against the sweeping fire. While brick is non-inflammable, the final result is that a brick wall remains as useless fragments and a frame wall as ashes.

Fireproof Construction

Very slowly our municipalities are beginning to recognize and make obligatory the essentials of good construction, at least in the congested districts. Many places are at present revising their building regulations or formulating new ones. This is a hopeful sign, for it shows that the fires of recent years have not been wholly unfruitful lessons. A city of good buildings means reduced maintenance cost for the owners, fewer repairs, a longer life to buildings, less expense for its fire department, the minimum of insurance rates and the maximum of safety to life and property. Unfortunately, every city is burdened with an inheritance of structurally defective buildings handed down from its years of unwisdom. These very largely constitute the existing conflagration hazard and the problem cannot be solved by laws enforcing fireproof construction. The old buildings endanger the new buildings, which, in consequence, must be superlatively well-built to withstand adjacent fires. The typical 'fireproof' building, having merely incombustible floors, roofs and walls, cannot control a conflagration any more than can an ordinary brick building with good roof. A conflagration moves laterally and a 'fireproof' building in its path, as evidenced in many of the larger fires, is merely a crate which holds up the fuel contents in position for free burning. The contents in buildings make up the bulk of property loss, and repeated experience shows that no building can withstand the heat due to the burning of a large quantity of merchandise. Before the Baltimore conflagration, it was not at all uncommon for the claim to be made that the contents of modern 'fireproof' buildings were quite secure from fire originating outside of the buildings themselves. Insurance men considered that a number of 'fireproof' buildings in a given district would make that district 'conflagration-proof,' by virtue of the resistance offered to the spread of fire. Baltimore, San Francisco and other cities have demonstrated conclusively that, so far as conflagrations are concerned, these opinions were over-sanguine. The weak link in the chain proved to be the window openings. The current methods of admitting light and air and providing communication are the result of experiments of generations, but even now improvements are possible and much to be desired. To accomplish these ends and also resist the attack of fire without, is practically an unsolved problem. Until some satisfactory method of overcoming the difficulty has been discovered, the 'fireproof' building cannot alone be considered as a means of controlling conflagrations.*

Fire Departments

While fire departments are indispensable in extinguishing and thus retarding the spread of small fires, they have never yet succeeded in controlling a fully developed conflagration. Fire brigades are useless when the radius of a fire is greater than the effective reach of their hose streams. The value of water in extinguishing fire depends entirely upon its blanketing effect upon the seat of the flame. Much criticism is often levelled at fire brigades because particular fires have assumed magnitude after their arrival. Were this not so, the fire departments in Canadian cities would have been unable to record that only 553 fires out of almost 37,000 caused damage exceeding $10,000 during the years 1912-1915. These figures show that the departments arrived while the vast majority of fires were incipient and that they worked with the highest degree of efficiency. Considering differences in construction and moral hazard, the record cannot be surpassed by any country in the world. Where losses have

*The glaring omission of the fireproof barriers for the exterior openings was the direct and sole cause of the damage and destruction of the interiors of nearly all the fireproof buildings. This detail, in the present stage of fireproof construction, is of paramount importance and should receive attention in all future buildings. It is manifestly idle to claim that any building is fireproof so long as the windows and door openings in the outside walls are unprotected by some efficient fire-resisting device.—*Report on San Francisco Conflagration by A. M. Himmelwright, C.E.*

attained large proportions, either the alarm was delayed, or, when the brigade arrived, the fires were inaccessible. Conflagrations are always inaccessible in a fire-extinguishing sense, because water in sufficient volume cannot be thrown upon the heart of the fire where, alone, it is needed. It is, therefore, obvious that fire departments cannot be considered as more than an assisting factor in solving the conflagration problem.

Any engineering plan attempting to debar conflagrations immediately, if intended to cover an entire city inclusive of cheap districts, would be prohibitive in cost. Such a plan must be limited to retarding the spread of fires occurring in high-value districts, and, at the same time, preventing any deep penetration of those districts by sweeping fires that may develop in surrounding low-value sections. Three methods, each complementary of the others, have been devised as a means to this end. Based upon the principle that the size of any fire depends upon the area freely subject to that fire, they may be dealt with under the following heads: (1) unit control; (2) local control; (3) district control.

Unit Control

All fires are the same size at the start. To localize or confine a fire, so that it will not spread beyond the unit of area in which it originates, would effectively debar the possibility of conflagration. To reduce that area to the smallest possible dimensions, by breaking up large undivided floor spaces into efficiently surrounded units, would ensure the fire being always within control of the fire department. The measure and intensity of fire and the rapidity with which it gains headway are all vastly greater in large areas than in small. It is much more difficult for a fire department 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 be found, or, if found, cannot be reached. 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. Mr. John B. Laidlaw, in suggesting a remedy for conflagrations, emphasizes this point in the following manner:

"The first step towards the elimination of conflagrations must be the reduction of the area of any unit freely subject to one fire. If we say, for instance, that there must be no space subject to one fire of more than 15,000 square feet area, and 15 feet in height, that would permit a building 75 x 200 feet or 100 x 150 feet when of one storey only, but if that building is two storeys in height, then the ground floor area must be reduced to 7,500 feet; if of three storeys, to 5,000 feet; if of four storeys to 3,750 feet; if of five storeys to 3,000 feet and if of six storeys, to 2,500 feet.

"If, however, a building is constructed so that the floors are absolutely intact, a larger ground area could be allowed than if it were of ordinary construction, with open stairways and elevators. It will be readily admitted that a five-storey 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. Over and over again it has been proved that when a fire originates in a building of large area, even if it is only one storey high, such a structure becomes a conflagration breeder.

"Attention should be drawn to the great change in the character of the mercantile buildings in our cities. Fifty years ago, buildings were usually small in area and seldom over three storeys high. Elevators were unknown and the upper floors of the buildings were, in nearly every instance, used for residential purposes. Now, a three-storey building is considered low, the average height would be about five storeys, and every flat is used for mercantile purposes. To facilitate the business carried on, open stairways and elevators have been provided; frequently there are chutes to carry small parcels from one flat to another, and often a large well-hole is added. All these factors assist the spread of fire through a building, once it has broken out.

"For years municipal regulations have provided that fire-walls shall be built to separate each building from its neighbours. This is an excellent provision, but it will be admitted that fire will travel upwards more easily than in a horizontal direction. We must apply the party wall by-law to the floors and insist that there be no communication whatever from floor to floor in a mercantile building, so that, for at least half an hour, if fire breaks out it will probably be confined to the floor on which it originates. When that has been accomplished, our firemen will have an infinitely easier task in preventing any fire which breaks out from extending to the dimensions of a conflagration.

"To accomplish this end, existing buildings will have to be altered, but the point of view of the majority of citizens must change before such measures can be brought about. Many municipalities have by-laws governing the erection of new buildings, but, if the conflagration hazard is to be eliminated, the authorities must go further and insist upon the re-modelling of existing structures. No one hesitates to put this principle into practice in connection with the treatment or eradication of diseases A landlord in whose building unsanitary conditions exist is compelled by law to correct the conditions, and the manufacturer who employs a number of people in his building is obliged to provide such means of escape as the Factory Act demands."

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. The possibility of such subdivision of large horizontal areas depends to a considerable extent upon the intended uses of the structure. In retail and wholesale stores, warehouses and factory buildings, large undivided areas are apt to be considered indispensable—in store buildings because the impression, on the customer, of vastness is supposed to be in direct proportion to the unobstructed area— in warehouses and manufacturing buildings because the arrangement of machinery or the handling of goods is considered of more importance than dividing fire walls. The expediency of permitting large areas in department stores, under sprinkler protection, is debatable, although the question is of much less importance when a building is provided with automatic sprinklers. 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. In large, open structures such as car barns, pier sheds, churches, armouries and even theatres, division walls or fire stops to limit the horizontal areas are usually considered impracticable. The result of fire in such structures is, invariably, their complete destruction. The experience of fire departments in buildings of this type shows that, if a fire is not extinguished in its incipient stage, great headway is rapidly acquired and the department cannot prevent the ultimate destruction of all combustible contents and, frequently, the collapse of the structure.

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.

Prof. Ira H. Woolson, consulting engineer of the National Board of Fire Underwriters, in a paper read before the American Society of Mechanical Engineers, 1914, gives the results of an investigation undertaken with a view of obtaining the consensus of opinion regarding limitation of building heights and areas in large cities. He states in part as follows:

"Factory buildings of excessive area have long been recognized by underwriting organizations as a great danger to life and property, owing to the difficulty of controlling fires in them. They have for years urged limitations which have been freely ignored by ambitious architects and factory owners because the suggested restrictions were considered unreasonably drastic. It is logical to assume that the men best fitted to determine safe limits of area are the men who have made a life work of combatting fires under all conditions of weather and hazard. With this idea in mind, all the fire marshals and fire chiefs in America, representing cities of over 20,000 population, were communicated with. A set of eight questions and a letter of explanation were sent to each. Replies were received from 117 representative cities, well distributed as to size and geographical location, and these formed the basis of the conclusions reached. Naturally, local conditions were reflected, such as the efficiency of the fire department, water pressure, combustibility of goods manufactured, sprinkler equipments and the degree of congestion among the buildings. However, all conditions were represented and the summary of so large a number of opinions should indicate fairly well the average opinion throughout the country. Replies have been summarized as follows:

Type of building	Area between fire-walls in sq. feet
Non-fireproof and not sprinklered	6,300
Fireproof, not sprinklered	12,300
Non-fireproof, sprinklered	12,800
Fireproof, sprinklered	27,100

"The most rigid restrictions were suggested by the large cities. As fire-proof construction and sprinkler equipment are common in most large cities, it is reasonable to assume that the fire chiefs of such cities would have had much more experience with these methods of protection and be able to decide what increase should be given in the size of a building when such protection is provided. It is quite proper to believe that their figures are more nearly correct than their less experienced fellow-officers in smaller towns. With these thoughts in view, the table has been changed to represent more correctly the consensus of opinion among the chiefs of the country most qualified to state what should be the proper limit in the largest cities.

Type of building	Area between fire-walls in sq. feet
Brick and joist construction, not sprinklered......	6,000
Fireproof construction, not sprinklered...........	10,000
Brick and joist construction, sprinklered.........	13,000
Fireproof construction, sprinklered...............	20,000

"These figures might be increased under the influence of especially favourable local conditions, but the writer submits that, as they represent the average deliberate judgment of such a large body of men, well qualified to estimate the hazard, they should be given careful consideration and should be increased only with the utmost caution."

Local Exposure

What is known as "local exposure hazard" consists of the probability of fire in any building communicating to an adjoining or adjacent building. Exposure is mutual or interacting, in that every building exposes its neighbour and is, in turn, exposed by it. Moreover, exposure is common or counteracting. A building exposed on one side may transmit the exposure to another building on its opposite side. The measure of the hazard is in the factors or conditions that favour or obstruct the passage of fire. The principal of these are space and construction. There may be separated exposure, as in detached buildings, or adjoining exposure, where there is a common wall between two buildings. Separated exposure decreases the danger of communicating fire in proportion to the intervening clear space, but the factor of distance is modified by construction.

Solid brick walls without openings interpose an obstacle to fire that nullifies the exposure hazard irrespective of distance. The inefficiency of any exterior wall under fire test varies inversely as the number and the size of the openings in such a wall. Blank walls are, however, generally limited to party or side walls abutting adjacent property where windows cannot of necessity be introduced. Modern requirements of a maximum of light and air demand that windows be provided in all exterior walls where possible, and even in party or side walls in the case of a structure built to a greater height than an adjacent building. The exposure hazard of these openings may be modified by protecting them with wired glass, fireproof shutters, water curtains or by the equipment of the building with automatic sprinklers.

In many of the smaller towns and cities in Canada old tenement blocks of buildings are sub-divided into store occupancies by lath and plaster stud partitions and light brick walls with numerous openings. The chances of fire being extinguished by even an efficient fire department in any one of these premises is small. When to structural deficiency are added the hazards due to stocks of combustible merchandise and the characteristic carelessness of transient tenants, these blocks of buildings provide most serious exposure hazards.

Wood Cornices are Dangerous

Hollow wood cornices often serve to connect an entire block of brick-fronted buildings which otherwise appear to be separated from each other. In case of fire in such a block, the cornices conceal the creeping of flames to the roof timbers, and the whole structure of the roof is hopelessly on fire before the fact can be discovered by the firemen in the street below. It may be questioned if wood cornices are not more dangerous than shingle roofs, since the latter do not conceal the fire that ignites them externally. Wood cornices are certainly not ornamental, violate the rules of good taste not less than those of safety, and are heavily penalized by insurance companies in their rates.

The exposure hazard is termed abnormal whenever a building in any group is of great height, excessive area or occupied in such a way as to produce intense fires. Lumber yards, planing mills, oil yards and refineries and livery stables are frequently serious hazards and create a danger zone over a considerable radius. Livery stables in numerous Canadian towns extend behind and expose the rear of an entire brick block, and, through inaccessibility, provide one of the greatest problems with which firemen have to deal.

The exposure of frame buildings is such that when two buildings are within ten feet one of the other they may be considered as forming a single unit. The worst possible frame hazard exists in practically all the small towns and many of the large cities in Canada. In the newer municipalities of the West, entire streets and districts are composed of one- and two-storey frame and shingle buildings crowded promiscuously one against another, while on all sides lie hundreds of miles of open prairie. The mining towns of Northern Ontario are even worse in this respect than the cities of Western Canada, for the structural hazard is aggravated by the danger of forest fires in the surrounding bush country. In the older cities and towns of Eastern Canada, wholly frame sections do not exist to the same extent, but dilapidated wooden buildings alternate with more solid construction and endanger the safety of every building to which they stand adjacent.

The debarring of conflagrations by local control aims at effecting the safety of a number of closely situated buildings by applying to each the principles advocated in unit control. The difference lies in attempting to confine fire to one building of a group instead of to the smallest possible area within one building.

The methods especially designed for this purpose are the protection of all exterior openings and the installation of automatic sprinkler equipment in the most dangerous buildings in congested districts. All large exposure fires show that the chief avenues for the communication of fire are unprotected windows and doors. The report of the National Fire Protection Association on the Baltimore fire states:

"The general absence of protection at exposed wall openings was responsible for the spread of this conflagration more than any other cause. In fact, this condition may be safely stated to have been the cause for the spread of this fire beyond fire department control."

Types of Window Protection

The types of modern window protection may be divided into three classes, namely, water jets or open sprinklers, metallic shutters, and metal or metal-covered frames in combination with wired-glass. Open sprinklers, or 'water-curtains,' have been subjected to no very severe tests, although they are often advocated even to the exclusion of shutters. This dependence does not appear to be justified, as water is diathermanous and permits radiant heat to pass through it readily. A report of the New York Board of Fire Underwriters, upon the question of sprinkler protection over window openings, summarizes its limitations in the following conclusion:

"We are confident that open sprinkler systems, fed by high pressure fire service mains, cannot be relied upon as a conflagration barrier and should not be introduced to the exclusion of the more positive protection to be afforded by standard wired-glass windows and shutters, which latter, we believe, should be required at all street fronts in exposure districts."

The greatest value of open sprinklers lies in the reinforcement they provide for other measures of window protection, such as fire-resistant shutters and wired-glass windows.

Shutters have proved their efficiency in many fires, but they are unsightly. For rear walls of warehouses and factories they may be unobjectionable, but in a building occupied by tenants any systematic method of closing them would be hardly practicable. A further objection is the fact that, if such shutters are closed at night, internal fires may attain serious proportions before discovery. Rolling shutters of the normally open automatic type do not possess these objections, but they are far more costly to instal. Shutters in any form should combine the following requisites: (a) Fire resistance. This is dependent upon the material of which the shutter is made and upon the way in which it is installed. (b) The ability to resist radiation of heat. (c) Capability of being opened from the outside. The latter feature is essential, that firemen may have access to interior fires or that the shutters may be opened to permit the escape of persons caught in the interior of the building.

Where the danger of exposure is not sufficient to necessitate the use of shutters, or if their appearance is objectionable, wired-glass in metal or metal-covered frames forms a more pleasing though less efficient type of protection. Wired-glass windows, however, readily admit radiant heat, and are not to be recommended for severe exposures unless used in combination with shutters or outside sprinklers.

As a rule, with light exposures of first-class construction 75 feet or more distant, open sprinklers should be sufficient, except for a risk particularly dangerous in itself. If the exposure is moderate at 40 or 50 feet and the building is not specially hazardous, wired-glass would be preferable. If the exposure is severe and within 25 to 40 feet, tin-covered shutters should be used where attractive appearance is not essential. If the exposure is less than 25 feet distant, tin-covered shutters in combination with wired glass or open sprinklers may be used. These recommendations are merely suggestive, as every building is a problem in itself, according to its construction, occupancy and exposure. The chief disadvantage of protected windows, other than unsightliness, is that the saving upon insurance premiums is too small an amount to cover the cost of their provision. They are, moreover, valueless as a protection against internal fires.

Value of Automatic Sprinklers

Probably the best safeguard against a fire gaining such headway as to spread to adjoining buildings is the automatic sprinkler. A building properly equipped with sprinklers, and having ample water supply with sufficient pressure, is practically safe from destruction. The contents of a combustible building, sprinklered, are usually regarded as a better risk than those of a fireproof building without sprinkler protection. An illustration of the value of this form of protection in large exposure fires is given by the Kilgour building in the Toronto conflagration. In a report upon this fire, E. V. French states:

"Kilgour Brothers' building, a four-storey brick paper bag and box factory on Wellington street west, a sprinklered risk, stopped the fire at this point. This plant had a 15,000 gallon tank and steady water on the sprinklers. There were also outside sprinklers on the south and west sides from which direction the fire approached. About 40 feet of the roof on the exposed side was of an ornamental design with tower and gables of large boards on joists, and the fire, catching here, obtained a good start. Although the plant was rather badly damaged by the destruction of the roof and windows, the larger part was saved by the protection equipment and further spread of the conflagration in that direction was stopped."

While capable of preventing almost any fire communicating from one building to another, and providing the best possible protection against exposure fires, automatic sprinklers are at present restricted almost entirely to special buildings with high values in the larger towns and cities. As in the case of protected windows, the reduction in insurance charges is not sufficient to make their installation a profitable investment, except in buildings where the total insurable value is not less than about $100,000. Even in such cases the motives of self-interest do not always control. There are, invariably, negligent owners who fail to protect their buildings, preferring to place dependence upon full insurance indemnity in the event of loss.

District Control

The value of protected windows and sprinklered buildings as a deterrent of local exposure fires has been pointed out. If all the buildings in an entire district were protected in this manner, it would not only be impossible for a fire in that district to attain the size of a conflagration, but a large sweeping fire originating in an outside area would be debarred from entering the central portion of a city or town. This means of protecting the high value districts of cities has been urged by many competent authorities. Franklin H. Wentworth, secretary of the National Fire Protection Association, in an address delivered before the Nova Scotia Union of Municipalities, said:

"There is one way to solve the conflagration problem—not absolutely, but at least relatively. In the heart of nearly every city there are streets crossing at right angles, along which for a considerable distance are buildings of brick, stone and concrete. Looked at upon the map this shows a more or less complete Maltese cross of buildings which are not wooden, and which operate to divide the wooden-built district into quarter sections, and which might hold a fire in any one of these sections if they were equipped to do so.

"These brick and stone buildings are ordinarily valueless as fire-stops because their windows are of thin glass and their window frames of wood. At Baltimore and San Francisco the conflagration attacked such buildings easily, breaking out the panes, consuming the frames, and converting every storey of these brick structures into horizontal flues full of combustible contents. Brick and stone buildings are logical and capable fire-stops if the fire can be kept out of them. The small city that will trace out its Maltese cross of such buildings and equip them with metal window frames and wired-glass will immediately possess the equivalent of substantial fire walls crossing at right angles in its centre, dividing it into four sections. By such a simple, inexpensive, but yet strategic procedure, many a city may save itself from the destruction which now awaits only the right kind of a fire on the right kind of a night.

"It is obvious that this form of protection is equally imperative in the brick, stone and concrete districts of all large cities where great values are housed in close proximity. Fires in the large cities entail an enormous waste because of the great values assembled there. We must come eventually to the equipment of all commercial, factory and office buildings with metal window frames and wired-glass. This will mean the abolition of the conflagration hazard in our cities. Fires will then be unit fires, extinguished easily by a competent fire department within the building in which they originate; for the protection of window openings not only prevents fire from entering but prevents fire from issuing from the burning building. We may expect an occasional exceedingly hot fire to break down the defences of an adjoining building, but it is obvious that a conflagration could not get under way among buildings of fire-resistive construction with properly protected window openings.

"With our window openings protected, the conflagration hazard in mercantile districts will be eliminated. There will then remain for consideration our immense residence districts constructed almost wholly of wood surrounding the mercantile centres, like fagots around a funeral pyre."

Debarment of City Conflagrations

Mr. Albert Blauvelt, Manager of the Western Factory Insurance Association, Chicago, has dealt exhaustively with the debarment of city conflagrations, in a paper read before the American Society of Mechanical Engineers. He states:

"Conflagrations may be successfully controlled both by deflection and absorption. Taking up the deflection idea first, all will agree that, if the four walls of every building were left blank with no doors or windows, a spread of fire would be impossible, even without a fire department. From this it follows that, if all doors and windows were protected by wired-glass, shutters or fire curtains, the walls of the buildings would gain as a fire stop. Any experienced fire chief will testify to the enormous fire-stopping effect of an alley having buildings shuttered on both sides, the heat being deflected upward.

"Experience shows, however, that when a fire reaches a building prepared to act as a deflector by suitable protection for its doors and windows, the first result is partial failure. This is owing to the fact that the heat will radiate through the wired-glass, or leak through the shutters, and ignite the contents. Nevertheless, there occurs a retardent effect, and it is obvious that if other buildings located to the right or left have window openings similarly stopped, they must suffer less and the elsewise lateral ramification of the fire decrease. The heat is thus largely deflected upward, partly checked and less able to cross the next street or alley, assuming protected windows throughout.

"Just how many deflected walls and air spaces could be jumped through by a conflagration of given severity is a matter of judgment based on observation, precisely as the extinguishing power of a hose stream is a matter of judgment from experience, not reducible to exact figures. The writer submits that, if all the alley windows were protected and also all the street windows on the second floors and above in the solid three and four-storey parts of a town, a conflagration from without could not then bore a hole or a bay into such a district deeper than through four deflecting walls and across three air spaces, which would mean two blocks and three streets, of which one might be an alley.

"Not that the fire would be put out, nor that brands would not have to be taken care of; but that the fire would be deflected upward so the firemen could make a front stand and the general advance and ramification would subside to a state of normal fire department control.

"There remains but one other known means to control a conflagration, that of absorbing the heat by means of the piped building. Experience has demonstrated that a hot blast can be absorbed by a spray if the spray be deep, as is true of the spray from a sprinkler installation in full action in a building whose windows have been burnt out.

"The most notable demonstration of this was the Brown-Durell building at Boston. Inasmuch as this building became a single large cage of spray, which absorbed the main body of a down-town fire that was wholly beyond control, it is certain that a row of such cages of spray, if placed two or more deep, would always accomplish the same thing, and do so without the aid of protected windows.

"The writer submits that, if a city throughout all of its three and four-storey and higher parts were composed exclusively of suitably piped buildings, and special water supply provided at the border for at least one block wide, a conflagration from a district without could not burn across a street, through a block deep of spray, and across the next street. The fire would not be put out and fire brands would have to be taken care of; but there would be no ramification of fire in the sprinklered territory and there would be a full restoration of normal fire department control."

Hon. Herman L. Ekern, former commissioner of insurance of Wisconsin, in a report to the Governor of the state, advocated general sprinkler installations as the only way to protect congested value districts.

"The danger parts of our cities can be made conflagration proof immediately. A complete sprinkler equipment will do this for an entire city district the same as it now does for a mercantile or manufacturing plant. Milwaukee pays fire premiums exceeding $2,000,000 a year. The larger part comes from the danger district. Some of this is already sprinklered. More undoubtedly will be sprinklered within a few years. It is not a great additional step to sprinkler all the rest. The savings in insurance premiums alone will pay all the cost in a few years."

High Property Value Districts

Mr. Albert Blauvelt, in the paper previously quoted, submits that the compulsory protection of high value districts would be a profitable investment for any city. He states that the burned property values in the Boston and other fires amounted to over $500,000,000 per square mile and that concentrated values are increasing rapidly.

"It seems fair to assume $250,000,000 per square mile as an average burnable value over the central districts of our leading cities. For such a square mile, standard automatic sprinklers (including masonry) would cost about four per cent of the burnable values, or $10,000,000, with fixed charges of about 16 per cent per year.

"Empty sprinklers, or protected windows, would each cost about half as much, or $5,000,000, per square mile for either, and each incur fixed charges (about the same as the buildings) of about 9 per cent.

"The savings per square mile and per $100 of burnable values per year, would be about as follows:

FIXED CHARGES, FIRE COST SAVING AND NET GAIN ON A BASIS OF $250,000,000 PER SQUARE MILE.

On an annual basis	For standard automatic sprinklers with double water supply	For shutters, fire curtains, or wired-glass applied as per preceding text
Investment per square mile	$10,000,000	$5,000,000
Fixed charges as given above	1,600,000	450,000
Saved by eliminating risk of conflagration at 33 cts. per $100	825,000	825,000
Saved by eliminating common exposure fires at 7 cts. per $100	175,000	175,000
Saved by reducing fire cost within buildings in which fire originated	2,000,000	nominal
Difference between charges and savings	1,400,000	550,000
Per cent earned by savings	14	11

"In surveying any actual square mile it would develop that but one method would best suit any one building, and this would be likely to result in a detail plan calling for gross investment of about three per cent of the burnable values."

The view that compulsory measures should be adopted to enforce the protection of property in all cities and towns is held by Hon. Rufus M. Potts, superintendent of insurance of Illinois. In an address before the National Convention of Insurance Commissioners in 1915, he says:

"I am firmly convinced that the time has arrived when the protection of all openings and the installation of sprinkler systems should be compelled by law in the congested districts of all our cities. The saving on account of reduced insurance rates would be so great that it would pay for the expense of installation in a few years, and the saving of life and property and prevention of loss through interruption of business would be far greater than is possible to replace by mere insurance.

"A proper law requiring complete protection of all openings and adequate sprinkler equipments with ample water supply and 'siamese' outside connections would eliminate the conflagration hazard from any district composed of well-constructed buildings."

Delimitation of Conflagration Areas

While compulsion to secure a maximum of protection in certain specified districts of large cities is admittedly necessary to prevent the destruction of high values, if such requirements could be so framed as to enforce graded measures of protection over the entire areas of cities and towns more desirable conditions would be brought about. To produce the best possible results, however, such regulations must also provide for the control of construction and occupancy of buildings in clearly defined districts. In other words, all communities should be divided into districts or zones wherein rules reasonably limiting and regulating the presence, form and use of property may be legally imposed with due regard to future developments in such areas and their relation to the community as a whole.*

The present regulation of construction and fire protection in Canada is almost entirely confined to the larger towns and cities. Control is exercised by means of municipal ordinances which define fire limits, in some cases, with wide boundaries and, in others, including only the main street and its immediate vicinity. Within these limits, whatever their area, frame buildings are usually prohibited and regulations govern the storage of explosives, gasolene, benzene and other dangerous substances. In the larger cities, explicit requirements are often laid down for the erection of new

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*I believe that it is absolutely impossible to frame proper laws governing the erection of buildings in a city without first having determined upon a general plan for its future development based upon the principle of segregation of activities or a scheme of zoning.

In the great area outside of the congested districts we should regulate the erection of buildings according to a scheme of zoning wherein the laws governing each zone should be related to the use and occupancy of that class of buildings desired in a particular zone. This is the only way whereby permanence of values can be maintained and the buildings of the city erected in a permanent manner.—*Statements of Frederick L. Ackerman before the Heights of Buildings Commission, New York city, December, 1913.*

buildings, the alteration of old buildings and, in some cases, limiting the use and occupancy of buildings. The exact provisions with regard to construction vary with different cities, but the fire limits always follow arbitrary lines, and the question of danger zones or specially hazardous areas is given little consideration. It has been previously pointed out that this method of regulation involves many undesirable features and has invariably brought sections within the fire limits that should properly be excluded.

Classification of Built-up Areas

What is required is not merely a division into two districts, one of them inside and the other outside the general fire limits, but a classification of all built-up areas into categories, based upon the fire hazards which exist within them by reason of the compactness of the buildings, their structure and height, the uses to which thay are devoted and the relative congestion of population. This last feature is important, because fire prevention aims to avert the loss of life as well as to prevent the destruction of property.

Dangerous areas from the standpoint of fire prevention may exist in connection with any one of the following conditions:

(1) Large valuation in conjunction with a large population per acre, as in the central business districts and industrial areas of a city.

(2) Moderate valuation with small population, as in high-class residential sections.

(3) Small valuation with large population, as in poor-class dwelling and retail districts.

(4) Small valuation coupled with small population, as found in outlying suburbs and country districts.

Every populous community becomes divided into more or less clearly defined districts. The character of buildings erected in each district depends upon their occupation and use in that particular district. A comparatively high degree of concentration appears to be important for facilitating business in office and mercantile districts. Certain trades and industries require structures of unusual size or shape. The type of dwellings varies with the different tastes and necessities of the people. Advantages of location and differences in land values shape the character of each district in a large measure and these and other economic factors tend towards a natural segregation of buildings according to type. Each community naturally divides itself into building districts and these districts must be recognized in any complete and effective system of fire control.

Building Development Must Be Controlled

It is beginning to be recognized that a setting apart of business, industrial and residential districts, with proper restrictions for each, is essential to well-ordered economic and socially beneficial growth.* Haphazard methods of development have resulted in an aggregation of fire dangers in congested areas and have demanded a maximum expenditure for fire protection by the public generally. In addition, failure to control building development inevitably entails enormous loss due to building obsolescence, which may be defined as lack of adaptation to function. In practically every city and town in Canada this is particularly noticeable in the number of manufacturing industries carried on in neighbourhoods that were entirely residential a few years ago. Even the central districts of the larger cities change with great rapidity. The office building becomes a warehouse and eventually a factory with practically no regulation in regard to its change of function as a building, or control of its influence upon the surrounding neighbourhood. Where dwellings, stores and factories are thrown together indiscriminately the danger of community fires is multiplied accordingly. Dealing with the question of fire prevention, the Wisconsin Insurance Investigating Committee, in 1913, pointed out that the ordinary building code is of little use in controlling the community fire hazard.

"The best of building codes will not fully serve the public interest without some far-sighted scheme of city planning. Our buildings should not only be serviceable and safe; they should be conveniently situated, and arranged to form a beautiful and harmonious plan. A city plan should contemplate both the physical expansion of the city and a growth of civic pride on the part of its people.

"The cities on the Pacific coast have made a great advance along the line of city planning, and both this question and that of building codes have been given thorough study in European cities. Civic clubs and park associations have taken up the work here. This work cannot be begun too soon. It should be done before more of our wooden and temporary construction is replaced by expensive and permanent buildings.

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* We must rely more and more on the right and necessity of the public to regulate private property with due regard to all the interests affected. In its final form, this means the zone system of building districts; that is, the division of the city into areas each devoted primarily to industry, to business, and to residences. Districts should be established in such a way as to help industrial, business and residential interests; that is, effort should be made to provide each district with the best possible facilities for its purposes. In other words, the zoning or districting of a city should help all kinds of buildings by discriminatingly limiting them to those districts in which they naturally belong, and by providing a first rate development in each district, for the various types of buildings. Each district or sub-district will thus have its appropriate restrictions so as to safeguard it. The points of greatest importance will be percentage of lot allowed to be covered, or density per acre, and the height of buildings.—*John Nolan, Fourth National Conference on Housing, Minneapolis, 1915.*

"A comprehensive inquiry involves many points of view, some of which may be merely suggested, for example:

"As to a building code:

Standards of building safety.
Cost of materials.
Modern sanitation.
Fireproof buildings, especially schools and public buildings.
Fire protective devices and apparatus.
Public supervision of building operations.
Effect of improvements on fire losses.
Effect on insurance rates.
Effect on expenses for fire protection.
Effect on municipal prestige.

"As to city planning:

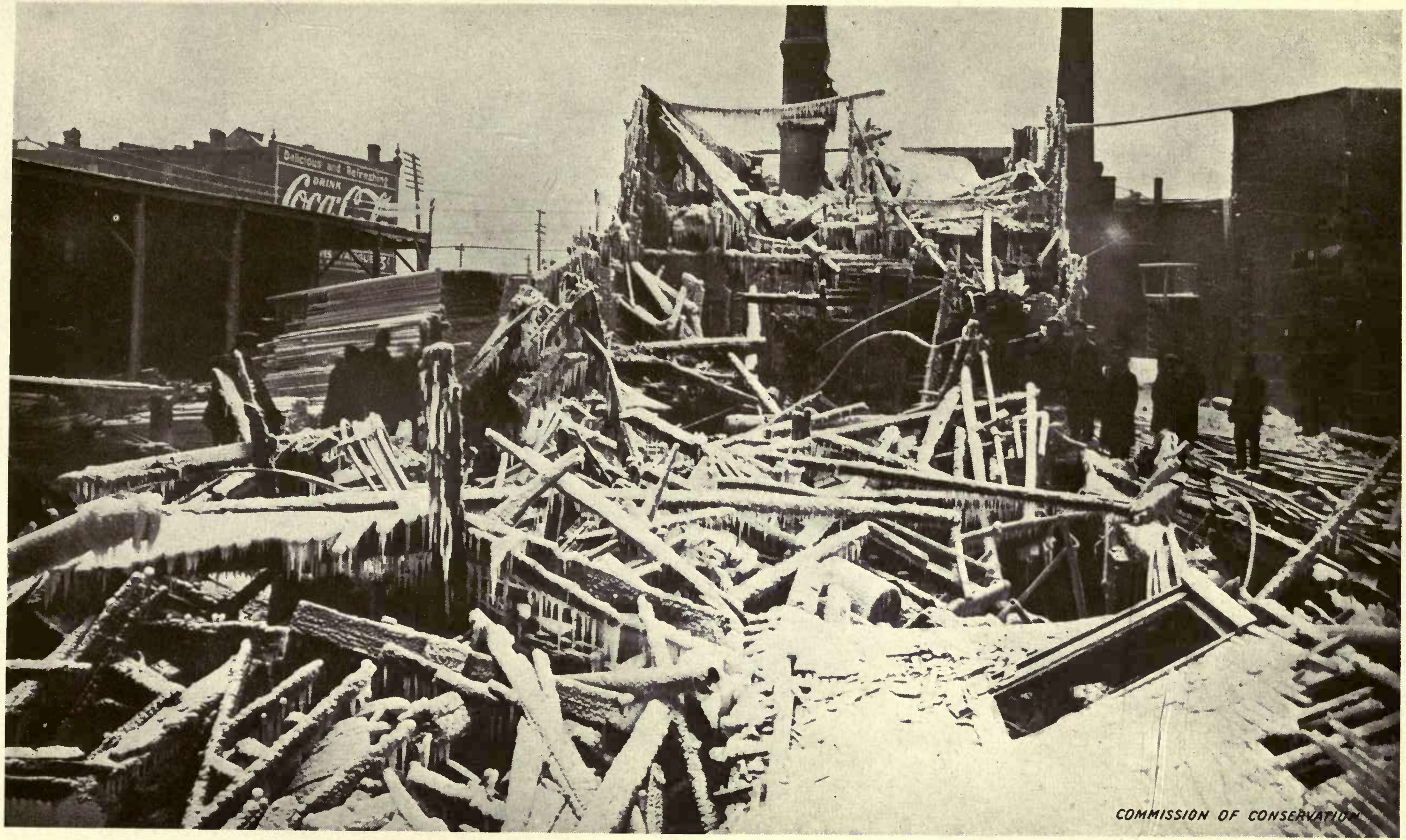
Public utility service—
 Water supply.
 Lighting, heating and power.
 Telegraph and telephone.
 Sewerage.
Dockage and wharfage.
Railways and terminals.
Streets, avenues and driveways.
Parks and playgrounds.
Location of public buildings and schools.
Location of stores, factories and industries.

"The investigation into such city plan and building code should take into consideration the question of high pressure water service for fire use in large cities and, also, the matter of the general use of sprinkler equipment in congested districts in cities, under some plan by which the necessary sources of water supply could be provided by public authority to individual owners.

"These subjects should be dealt with comprehensively. The industrial commission of Wisconsin is engaged in work upon this question and will doubtless render needed service to the state in recommending and assisting in the enactment of legislation which will avoid the errors of the past and, in the future, conserve property as well as the health and lives of the people."

Districting in Europe

The practice of districting, under town-planning schemes, has been very widely developed in Europe. Regulation of height and occupancy is enforced to a considerable extent in England, Sweden, Austria, Germany and France. The general system adopted is that of grouping buildings of different classes and limiting their density in various districts. Buildings are permitted to be higher and cover more of each lot in zones where land values are greatest, and in these districts regulations governing construction are more severe. Various sections are definitely set apart as factory, mercantile and residential areas and are restricted to their designated uses. Factories are not permitted in the residential districts nor are residences allowed where land has been set aside for mercantile purposes. Each class has its own allotted zone. Within each zone there are different building restrictions and often different rules as to taxation. For instance, in a number of European cities twenty-five per cent of all building land must be left vacant in the central or business zone, thirty-five per cent in the next outer zone and fifty per cent in the zone of detached residences. The fundamental restriction upon the height of buildings is based upon the width of the street. This is of paramount importance to the control of fire, in addition to its beneficial effects upon public health, sanitation and street congestion. Zones are not necessarily set in the form of concentric circles and, therefore, the individuality of a community is not destroyed. The best example of a zoned city is Frankfort-on-Main, where the plan has been in operation for many years with advantageous results. Under the provisions of the *Lex Adickes* the authorities have wide powers in the matter of pooling the ownership of land in any area of the city and then re-distributing it among the original owners in re-arranged and more convenient lots with restrictions as to the construction and use of buildings. While so complete a community project would undoubtedly encounter serious obstacles in any other country than Germany and might well merit condemnation, the basic principle of districting is recognized in practically all European countries as being the only method of development that secures permanence of construction and establishes safety of investment. It may seem paradoxical to state that a policy of restricting the use of land tends to its best utilization, but such is the case. Restrictions fix the character of a neighbourhood and a landowner, to secure the maximum returns from his land, must promptly improve it in conformity with the established restrictions. He will not be deterred from building permanently because prospective changes may in a few years make his dwelling site of greater value as a factory site. Nor will he fear depreciation of his investment through changes rendering the location undesirable for a home. The ability to forecast with reasonable certainty the lines of development of a district leads to improvements that otherwise would hardly be justified. The result is that restricted sections are quickly built up with buildings of similar type and use, the dangers of fire are minimized because of the permanence of construction, living and working conditions are improved and real estate values lose their speculative features.



PLANING MILL FIRE, TORONTO

Wood-working factories and lumber yards are indiscriminately scattered through the residential and business districts of Canadian towns and cities and neighbouring property pays increased insurance rates. Specially designated areas should be provided for such industries.

Districting in United States

Some American cities have, during recent years, attempted to adopt a system of districting following the lines of European practice. Los Angeles is perhaps the best example. The entire city, with the exception of two suburbs, is divided into industrial and residential districts. In the former areas, all kinds of business and manufacturing are permitted; in the latter the ordinance forbids the carrying on of any business or industry that would properly be regarded as objectionable in a residential area. A list of such industries is included in the ordinance. The Los Angeles regulations have been in force since 1909 and have applied not only to new industries but are retroactive in their effect upon those already established. They have proved successful in operation, and, more important still, they have been upheld by the highest courts in the United States.*

New York city, under a resolution of the Board of Estimate and Apportionment, adopted, July 25th, 1916, prescribed zones limiting the height and bulk of buildings and restricting the location of trades, industries and buildings for specific uses to certain areas.† Other examples of districting as applied to the heights of buildings are furnished by Boston, Baltimore, Minneapolis and Washington.‡

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*This experiment is fully described, with a summary of the court decisions, by Lawrence Veiller, in a pamphlet entitled *Protecting Residential Districts*, September, 1914.

†In May, 1917, the state of New York enacted a city-planning law, which gives to all cities in the state, with the exception of Rochester, the same power for zoning as that held by New York city. The law, in part, is as follows:

"To regulate and limit the height and bulk of buildings hereafter erected and to regulate and determine the area of yards, courts and other open spaces, and for said purpose to divide the city into districts. Such regulations shall be uniform for each class of buildings throughout any district, but the regulations in one or more districts may differ from those in other districts. Such regulations shall be designed to secure safety from fire and other dangers, and to promote the public health and welfare.

"To regulate and to restrict the location of trades and industries and the location of buildings, designed for specific uses, and for such purposes to divide the city into districts and to prescribe for each such district the trades and industries that shall be excluded or subjected to special regulation and the uses for which buildings may not be erected or altered. Such regulations shall be designed to promote the public health, safety and general welfare and shall be made with reasonable consideration, among other things, to the character of the district, its peculiar suitability for particular uses, the conservation of property values and the direction of building development in accordance with a well-considered plan."

The legislature of the state of California also recently passed a state-wide districting act (Senate Bill 430), giving power to any city to limit the use and height of buildings and segregate various classes of business and industries to specific districts.

‡Boston: *Report of commission, 1904 and 1905, Boston, City Documents Nos. 109, 133.* Adoption of districting systems: Acts of 1904-1905.

Baltimore: Regulates the location of certain industries in addition.

Minneapolis: Has established exclusive residential districts for one-family residences.

Washington: Height of buildings limited by act of Congress, 1899.

Districting in Canada

In some of its various phases the question of districting has already received consideration by the larger Canadian municipalities. In addition to the usual fire limits, a few cities have adopted rules restricting the height of buildings in their central districts. It is not to be inferred from this, however, that municipal authorities have power to lay absolute restriction upon the use to which a building shall be put, provided such use does not constitute a public nuisance. Under the powers granted to municipalities by municipal acts, cities may, in some provinces, prohibit the erection and use of buildings for certain purposes within prescribed areas and may declare any highway or part thereof to be a residential street. Thus the Municipal Act of Ontario (Sec. 409) empowers the council of every city in the province to pass by-laws preventing, regulating and controlling the location, erection and use of the following buildings: Livery, boarding or sales stables; stables in which horses are kept for hire or kept for use with vehicles in conveying passengers, or for express purposes; stables for horses for delivery purposes; laundries; butcher shops, stores, factories, blacksmith shops, forges; dog kennels and hospitals or infirmaries for horses, dogs or other animals. The erection or use of buildings for all or any of these purposes may be prohibited within any defined area or areas or on land abutting any defined highway or part of a highway. By-laws of this character may not be passed except by a vote of two-thirds of all the members of the council. Such by-laws, moreover, may not apply to a building which was on April 26, 1904, erected or used for any of these purposes so long as it is used as it was used on that date.

The powers granted to municipalities under municipal acts, such as the foregoing, have been of very little practical value from the point of view of districting. Local by-laws as a means of controlling construction and use of buildings, streets and districts have proved unsatisfactory in the absence of a proper plan of development embracing the whole municipal area and providing for varied conditions. Under the present system of local government, any council may negative the work of its predecessors. Influence brought to bear in the proper quarter can stretch municipal ordinances to almost any extent, and few local authorities in Canada have been prepared to let a by-law stand in the way of securing a new industry. In addition to this vital defect, there is the objection that highly technical questions are often dealt with by unqualified persons. The buildings laws at present in force in municipalities throughout Canada verify this statement. Framed without a standard model and afterwards modified according to the views of successive councils, they, in many instances, present a mass of unrelated and conflicting provisions.

Town Planning Solves Many Fire Problems

As a means of overcoming the many defects of the present haphazard system of development in Canada, the recently inaugurated town planning movement should receive the very strongest support. Without its adoption, the proper districting of municipal areas can never be accomplished, building construction will continue in an unsatisfactory condition, and the community fire hazard unregulated. The Draft Town Planning Act, 1916, prepared by the Commission of Conservation, contains all the essentials for controlling the construction, protection and use of municipal areas. Town planning acts are already in force in the provinces of Nova Scotia, New Brunswick, Manitoba and Alberta, and are under present consideration in Saskatchewan, Quebec and Ontario.* As provincial measures these acts are largely permissive in character and preserve the power of the local authorities. In the Nova Scotia Act and the Draft Act of the Commission of Conservation it is provided that the preparation of sets of town planning by-laws or partial schemes is mandatory. Part III of the Draft Act provides as follows:

"Except as hereinafter provided, each Local Development Board shall, within three years after the passing of this Act, prepare a partial town planning scheme for adoption in its area, and provision shall be made therein for dealing with the matters set out in schedule A to this Act and such other matters as may be necessary for carrying the schemes into effect, including the suspension of any by-law, rule, regulation or provision which is already in operation in the area.

"The department (provincial department) may prepare general provisions for a model scheme (or separate sets of general provisions adapted for areas of special character) for the purpose of adoption by a local board."

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*The Legislature of Ontario in 1917 passed an act by which cities, towns and villages are given the right to regulate and control the survey and sub-division of land not only within their boundaries, but, in the case of a city, of land within five miles, and, in the case of a town or a village, within three miles of its boundaries. The local council is authorized to prepare a general plan, which must be approved by the Ontario Railway and Municipal Board.

Where a person desires to survey and sub-divide his land into lots, he must first submit his plan to the council. If the council refuses to approve of the plan, the owner has a right of appeal to the Ontario Railway and Municipal Board.

If it is thought desirable, the Council may, instead of exercising the powers under the Act, appoint a town planning commission composed of six persons to hold office for three years.

In regard to the question of districting municipal areas, schedule A, paragraphs 5, 6 and 7, requires local authorities to make provision in their schemes for the following matters:

"Prescribing zones within which to regulate the density of building for the purpose of securing amenity, proper hygienic conditions and protection from fire, and fixing the percentage of the area of the lot on which new buildings may be erected or old buildings re-constructed, so that not more than 75 per cent of any lot situate within the central or commercial zone of a city or town and not more than 50 per cent of any lot situate in any outer zones, shall be covered with buildings, except in regard to corner lots fronting on two intersecting streets, in which case the percentage may be increased to 90 and 60 per cent in the central and outer zones respectively.

"Prescribing certain areas which are likely to be used for building purposes, for use for dwelling houses, apartment houses, factories, warehouses, shops or stores, or other purposes, and the height or general character of buildings to be erected or re-constructed; so far as reasonable for the purpose of securing the amenity of such areas, and proper hygienic conditions and protection from fire in connection with such buildings.

"Prohibiting the carrying on of any noxious trades or manufactures or the erection and use of any buildings with inadequate sanitary arrangements or the erection and use of buildings, bill boards or structures for advertising purposes which are such as to be injurious to the amenity or natural beauty of any area."

While town planning in its entirety is of a far-reaching nature and deals with a very wide field, including land development, public health and matters of general welfare, it at the same time provides the only foundation for effective fire prevention measures. It may not accomplish results rapidly, as it applies more especially to future development, but it constantly tends in the right direction and in time will produce buildings, districts and cities conforming to the best ideals of fire prevention.

Control of New Construction

The main difficulty in Canada is that whatever is done now can simply be to avoid adding fresh fuel to the heritage of combustible construction scattered throughout the country. We cannot tear down and re-model our cities and towns, however desirable such a step might appear from the viewpoint of preventing fire, and it will be many years before our present dangerous districts and buildings are replaced with better construction. The only method left, therefore, is to suitably protect new construction against exposure from old construction. This appears to be feasible under the provisions of the town planning measures now being enacted, and, therefore, the following recommendations are made:

1. That province-wide control of the construction and use of buildings, public water supplies and fire protection in general be exercised through legislation substantially following the Draft Town Planning Act of the Commission of Conservation, in which provision is made for the approval of local by-laws and schemes by a provincial town planning board or department of municipal affairs.

2. That model standard by-laws governing the construction and use of buildings, public water supplies and fire protection in general, be prepared by each provincial authority for the guidance of local councils and boards, such by-laws to contain minimum requirements uniformly enforceable throughout the entire province.

3. That all standard by-laws recognize at least three building districts or zones based upon density of buildings in prescribed areas.

The following suggestions are made with a view to showing approximately what minimum requirements should be provided for each of three districts.

First Class Districts—These should include all municipalities or sections of municipalities in which the land is covered with buildings in excess of 75 per cent of the superficial area, excluding streets and passage-ways.

All new construction should be of standard fire-resisting, semi-fire-resisting or slow-burning type, according to height, area and intended occupancy. Allowable heights of buildings should be based upon the type of construction and street width, subject to a maximum restriction of 120 feet. Allowable undivided areas should be based upon street frontages modified by the amount of protection to be provided in any particular building. All roofs should be of incombustible material.

All existing buildings should be required to conform to the standards for new construction in regard to allowable undivided areas, fireproof and smokeproof stairways and elevator shafts and wired-glass windows or shutters. The fire department should have authority to require the installation of fire alarms, automatic sprinklers, standpipes or other fire extinguishing systems in such existing buildings as it deems necessary.

Public protection should be equal to standard first class requirements in respect to water supplies and fire department organization and equipment. No water mains should be of less than ten inches in diameter unless the district is provided with an independent high pressure system. Hydrants should not be over 250 feet apart. No building should be more than 400 feet from a street alarm box.

The personnel of the fire department should be at least 50 per cent stronger than in third class districts.

SECOND CLASS DISTRICTS—These should include all municipalities or sections of municipalities in which the land is built upon to the extent of between 50 and 75 per cent of the superficial area, excluding streets and passageways.

All new construction should have outer walls of brick, masonry, concrete or other incombustible materials. Heights and areas should be subject to the same provisions as in first class districts. All roofs should be of incombustible material.

All existing buildings should be required to conform to the standards for new construction in regard to allowable undivided areas, fireproof and smokeproof stairways and elevator shafts, and wired-glass windows or shutters. The fire department should have authority to require the installation of fire alarms, automatic sprinklers, standpipes or other fire extinguishing systems in such buildings as it deems necessary.

Public protection should be equal to standard second class requirements in respect to water supplies and fire department organization and equipment. No water mains should be less than eight inches in diameter. Hydrants should not be over 300 feet apart. No building should be more than 500 feet from a street alarm box, The personnel of the fire department should be at least 25 per cent stronger than in third class districts.

THIRD CLASS DISTRICTS—These should include all districts with less than 50 per cent of the superficial area built upon.

In these districts any type of building should be permitted, subject to certain provisions, such as distance from other buildings, height, area and intended use. Combustible roofs should be prohibited on all buildings with the exception of dwellings, unless 50 feet or more distant from other buildings.

The fire department should have authority to require the installation of such protection in existing buildings as it deems necessary.

Public fire protection should be equal to standard third class (waterworks) or fourth class (no waterworks) requirements. The fire brigade should consist of at least one paid man for every 1,000 population or part thereof.

Scattered communities and rural districts should be subject to third-class requirements as regards building construction and, in the absence of a local fire department, the provincial authority should be empowered to require the installation of such protection in buildings as it deems necessary.

The actual manner in which the system outlined might be expected to operate would be as follows: the chief mandatory feature is included in the Town Planning Act, whereby every local authority must, within three years, prescribe zones or districts covering its territory. Within such districts, roughly defined as manufacturing, business and residential, building construction and fire protection would be subject to minimum requirements based upon density of buildings. If the plan definitely restricted buildings in a prescribed district to 50 per cent of the land area, such buildings would be subject to third-class requirements. If it was found desirable at any time to change the character of the district so as to permit greater density, more stringent regulations would automatically go into effect. In other words, the requirements for any given area would conform to the actual fire hazard in that area instead of being, as at present, the same for the whole community.

The establishment of this method of districting to be followed by all cities and towns leaves the principle of local option operative. Each local authority may adopt one of two general schemes of control, may administer the law through a department of its own and may add special regulations or increase the stringency of the provincial minimum requirements in its own territory. In no other way does it appear possible to uniformly classify cities and towns and provide districts within which there will be complete control of building construction. In the larger cities conditions are fixed, inelastic and unyielding, and building regulations can do little more than relieve and ameliorate the mistakes of the past. With small towns and villages, however, the case is different. Comprehensive planning will provide against the unnecessary repetition of poor structural conditions in places which are to become the important cities of the future.

CHAPTER V

Building Construction and Fire Prevention

EFFICIENT building construction constitutes the foundation of successful fire prevention. The extensive and indiscriminate use of wood for structural purposes is regarded by many competent authorities as the largest single factor contributing to the excessive fire waste in Canada. Of approximately 2,000,000 buildings throughout the Dominion, less than one-tenth of one per cent has been built with proper consideration of fire safety. In the cities and towns from which statistics are available, almost 70 per cent of the construction is frame, the majority of brick buildings are structurally defective or inadequately protected, and only one in every 1200 is even nominally fireproof. With such conditions prevailing it must be recognised that the enforcement of measures regulating future construction cannot immediately effect any substantial reduction in the volume of fire waste. There are sufficient combustible buildings in Canada to maintain the present rate of loss for many years. Upon the average, fire occurs every year in one out of every 80 buildings in cities and towns. Fire prevention is concerned, therefore, not only with the erection of new buildings, but with what is of equal or even greater importance—correction of the worst faults in existing buildings.

Building Construction as Affecting Fire Losses

Buildings, in relation to fire loss, are contributory rather than causative. Comparatively few fires other than those originating from defective chimneys and shingle roofs, are primarily occasioned by poor structural conditions. The assertion that fires are more numerous in Canada than in Europe because of the greater prevalence of wooden buildings is not strictly in accordance with the facts. Were the frequency of fires thus affected by construction, their numerical ratio to population in Canadian cities should have decreased of recent years. Since 1890, practically all the more important cities have enacted measures prohibiting frame buildings and shingle roofs within at least a portion of their areas. Despite the progressive structural betterment thereby effected, the number of fires in these places has shown no appreciable decline.

While buildings are seldom the original cause of fires, their physical characteristics largely determine the extent and destructiveness of every fire. The value of brick construction in confining fires to the buildings immediately involved is demonstrated by the record of exposure losses in Canada.* Of 1,379 fires spreading to two or more buildings, approximately 80 per cent originated in frame buildings. Analysis shows, further, that losses due to exposure were proportionately least in the places where better construction prevails. As between cities, towns, villages and rural districts the distribution was as follows:

TABLE NO. 17—ORIGIN OF EXPOSURE FIRES

	Started in brick buildings	Started in frame buildings	Total communicating fires	Percentage of fires in group
Cities over 10,000 population..........	108	220	328	1.5
Towns with 5,000 to 10,000, fully protected..........................	75	118	193	9.5
Towns with 1,000 to 5,000, fully protected	49	159	208	11.2
Towns with 1,000 to 5,000, partly protected..........................	28	79	107	19.3
Villages under 1,000, fully protected ...	3	23	26	7.2
Villages under 1,000, partly protected..	Not sub-divided but practically all in frame buildings		45	8.7
Villages under 1,000, unprotected......			69	15.5
Townships and rural districts..........			403	4.3

While brick is undoubtedly superior to frame construction in preventing the external spread of fire, brick buildings do not appear, upon the whole, to safeguard their contents to an appreciably greater extent than frame buildings. Their comparative value in this respect is shown by the record of fires for the years 1912-1915. In the larger cities of Canada, the average impairment of sound values by fire was as follows: brick buildings, 11 per cent; frame buildings, 29 per cent; contents in brick buildings 32 per cent, and contents in frame buildings, 49 per cent. Under first-class protection, therefore, the damageability of brick buildings was one-third that of frame buildings and the damageability of contents in brick buildings two-thirds that of contents in frame buildings. In small towns and country districts, these differences are less apparent, brick buildings usually retaining a greater measure of structural integrity than frame buildings, but the destruction of the contents of both is, in most instances, equally complete.

*See Table No. 14, page 87.

Brick walls merely form a non-inflammable shell which is powerless to retard the internal spread of fire. Wooden joists, floors and partitions, unprotected wall and floor openings and hidden spaces between joists and studding are invariably the same in both brick and frame buildings. Little effort is usually made to prevent or minimize possible damage by fire. Even in first-class buildings a fire may rage from floor to floor, partitions and interior fittings may be consumed and the contents utterly destroyed owing to neglect of simple features that vitiate the entire construction. From statements made by fire chiefs and insurance officials, it is evident that physical defects and the omission of proper safeguards are responsible for the spread of practically all fires throughout buildings. Within the past four years, eight 'mill' buildings* have been gutted, with a loss of over $400,000, through the 'saving' of a few hundred dollars by leaving vertical openings improperly protected. In one new semi-fireproof building, damage exceeding $70,000 occurred as the direct result of reducing the expenditure upon partitions by $1,400. Such instances are by no means uncommon. Like a chain, a building is only as strong as its weakest link, and, in the event of fire, this invariably proves to be the particular point where unwise economy has been attempted.

Structural Conditions in Foreign Countries

Comparison of fire losses and of structural conditions in Canada and Europe leads to the conclusion that a radical change in building methods is fundamental to the curtailment of Canada's fire loss. Serious fires in Europe are exceptional occurrences and conflagrations are almost unknown. The fire departments in the principal European cities are certainly no better than ours and, in the smaller places, comparison would be ludicrous. Their greater immunity from destructive fires is, undoubtedly, due in large measure to superior construction. Frame

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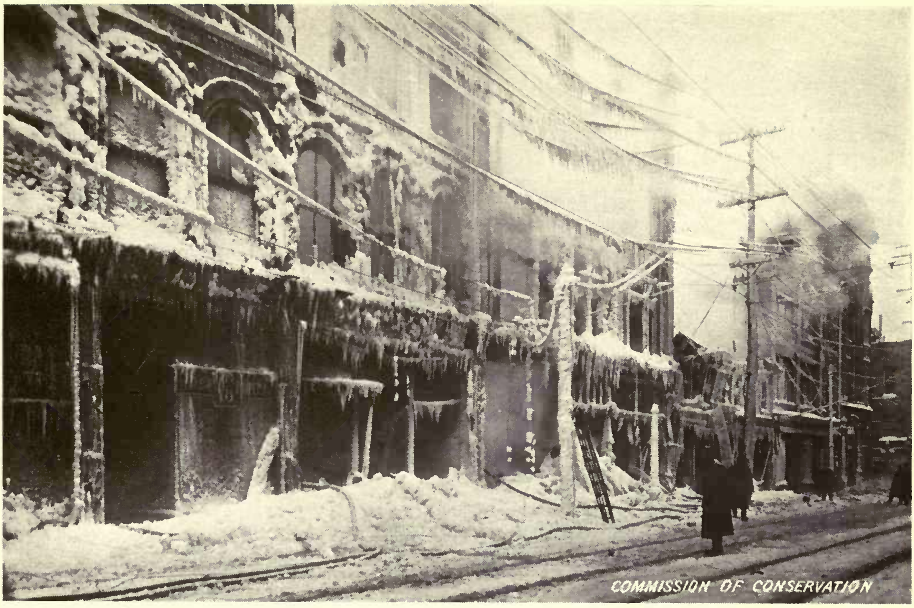
*The term 'mill construction' as commonly used is the name given to that type of building construction in which the interior framing and floors are of timber arranged in heavy solid masses and smooth flat surfaces so as to avoid concealed spaces which can not be reached readily in case of fire.

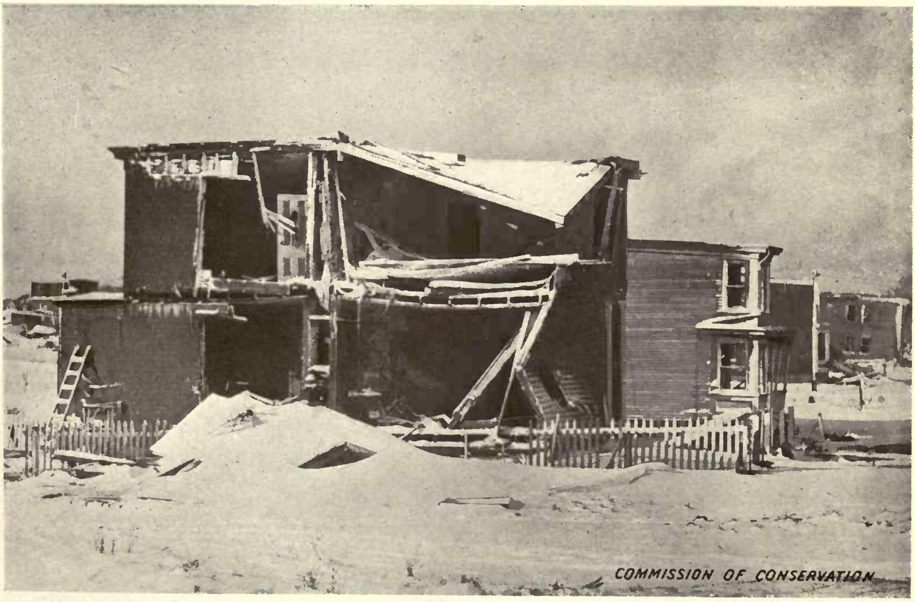
A broader interpretation of the term adds the specification that the building shall be so constructed that fire shall pass as slowly as possible from one part of the structure to another. This implies that each floor must be separated from all others by incombustible walls or partitions, and by doors or hatchways which will close automatically in case of fire. Stairways, and elevator shafts must be enclosed, or, preferably, constructed in fireproof towers. Openings in floors are to be either avoided or fully protected against passage of fire or water.

With the advance in the prices of building materials, the difference in cost between mill and reinforced concrete construction has changed slightly in favour of concrete.



FIRE IN RETAIL STORES, OTTAWA, DECEMBER, 1917

Stoves, paper-board partitions and a watchman *in absentia* were jointly responsible for a loss of over $200,000. Every fire that destroys mercantile stocks at this time is reducing the man power of Canada.



THE FLIMSY HOMES OF CANADA

This building, damaged in the Halifax disaster, represents a common type of dwelling construction in Canada. Though 2½ miles from the scene of the explosion, the walls were ripped apart like paper.

buildings are practically non-existent in the larger cities as shown by the following particulars abstracted from official reports:*

Vienna, Austria	No frame buildings
Antwerp, Belgium	Few frame sheds only
Brussels "	6 per cent frame buildings
Liège "	No frame buildings
Copenhagen, Denmark	Few frame sheds only
Bristol, England	No frame buildings
Huddersfield, England	" " "
London "	" " "
Newcastle "	" " "
Sheffield "	" " "
Calais, France	Mainly brick
Marseilles, France	" stone
Nantes "	" "
Paris "	No frame buildings
Roubaix "	Few frame sheds only
Bremen, Germany	No frame buildings
Dresden "	" " "
Hamburg "	" " "
Stettin "	" " "
Belfast, Ireland	Frame sheds only
Dublin "	" " "
Florence, Italy	No frame buildings
Leghorn "	" " "
Messina "	Mainly frame
Milan "	No frame buildings
Rome "	" " "
Turin "	" " "
Christiania, Norway	30 per cent frame buildings
Moscow, Russia	70 " " " "
Odessa "	No frame buildings
Petrograd "	Frame sheds only
Edinburgh, Scotland	No frame buildings
Glasgow "	" " "
Barcelona, Spain	" " "
Carthagena "	" " "
Malaga "	" " "
Madeira "	" " "
Gothenburg, Sweden	6 per cent frame buildings
Stockholm "	30 " " " "
Berne, Switzerland	Frame sheds only

*General statements to the effect that frame construction is unknown in Europe are somewhat misleading. Outside of the cities and large towns, structural conditions vary. Few wooden buildings are to be found in England, France, Belgium or North Germany, but Norway, Sweden, South Germany and Russia are large users of wood for structural purposes. In Russia, for instance, where climatic conditions are somewhat similar to Canada, all the village settlements of the Northeast, Central provinces, Southeast and White Russia consist entirely of wooden buildings, often densely crowded together and without fire protection of any kind. In Little Russia and South Russia clay and stone are the chief structural materials but, strange to say, these two districts suffer most severely from fire. According to the records of the Russian Government, this is chiefly due to arson and vindictive incendiarism during periods of political unrest.

From the foregoing, it will be noted that, with the exception of Moscow, Christiania, Stockholm and Messina, wooden buildings are either confined to small sheds and out-buildings or entirely prohibited. Comparison of such conditions with those obtaining in Canada is striking. Estimated conservatively, frame and veneer construction in the business districts of Canadian cities amounts to 28 per cent, and in residential districts, to 69 per cent of the whole. See Table No. 9, page 59. This preponderance of wooden buildings may perhaps be better realized by reference to existing conditions in specific towns and cities. For instance, in the city of Ottawa, according to municipal assessment returns, there are 1,795 brick, stone and concrete buildings, 7,734 frame buildings veneered with brick, metal or rough-cast and 4,927 entirely frame buildings. In other words, only 12 per cent of the buildings in Canada's capital city is of solid construction.

The prevalence of frame construction does not, however, constitute the only difference between structural conditions in Europe and in Canada. Approximately 66 per cent of the fire loss in this country occurs in brick and stone buildings which are manifestly incapable of withstanding fire. On the other hand, brick and stone buildings in Europe are of reasonably fire-resisting construction and are so designed and built that the average fire is invariably extinguished with minimum loss to both building and contents. It must not be inferred from this that fireproof construction as known in the United States and Canada is common in Europe. There are few buildings in the whole of Europe equal to the modern type of fireproof building erected in Canada. Conversely, there are few buildings in the whole of Canada equal to the general average of buildings in Europe. This vital difference was emphasized by the Hon. William C. Redfield, Secretary of the United States Department of Commerce, in addressing the last Annual Meeting of the National Fire Prevention Association, Washington, D.C. He said:

"If we built as France builds, as Germany builds, as England builds, there would be very little need of fire prevention bodies. We say, do we not, in the most casual way, as if it involved no element of self-depreciation, that such and such a theatre will burn some day? I went into a building in this city not long ago and went upstairs. I found a wooden staircase surrounding four sides of the stair well with a large space between in which they had put the elevator. The only thing enclosing the elevator was the open staircase. The elevator ran upon oil-soaked wooden uprights, and at every floor was entirely open all round; the floor was all wood and the trim was all wood; the building was joisted construction. You and I know perfectly well that that was an invitation to loss and death. You know, speaking very moderately, that if a fire starts in that building, the people in the upper storeys are going to be burned, and that to maintain such conditions is to invite disaster. As you know, such a building would not be permitted in any capital on the other side of the water. There is not a single European city that would tolerate its existence for forty-eight hours. Yet that building is only one of thousands here."

While Mr. Redfield's remarks had particular reference to the United States, they apply with equal force to conditions in Canada. Structural defects of the most serious character exist in the majority of our buildings and even in the larger cities local ordinances appear powerless to effect any wide-spread improvement. A general survey of structural conditions, for instance, in one of the leading cities of Eastern Canada, shows the central business section, including approximately 29 blocks, to consist of 186 frame, 223 joisted brick and 9 fireproof buildings. The majority of the fireproof buildings, which are from three to seven storeys in height have interior wood trim and finish, they lack protection of vertical openings and only one building is equipped with inside standpipe and hose. In the joisted brick buildings, which are from three to six storeys in height, unprotected communications forming large areas are common, vertical openings in 38 only out of 223 buildings are protected and window protection against exposure is entirely absent. Less than 12 per cent of the buildings which should be so equipped are provided with fire escapes and these are all of the inefficient ladder type. Seven buildings are equipped with automatic sprinklers and two have water curtains, but only 9 have standpipes and these are of small capacity with hose in questionable condition. Eighteen buildings only are provided with chemical extinguishers and water pails. Wooden buildings constitute 44 per cent of the total number, exclusive of sheds, and cover 33 per cent of the entire central area. Height varies from two to five storeys, 96 of the buildings being three storeys while 37 are four storeys and over. Eighteen per cent of the buildings have shingle roofs. Some have excessively large areas with hotel, storage and mercantile occupancies. Outside of the central business district, 97 per cent of the construction, mainly dwellings, is frame.

Inefficient Building Methods

A candid enquiry into present-day building methods in Canada leads to the conclusion that we are decidedly lacking in that thoroughness which might properly be expected, especially in buildings involving considerable cost. Our unwarranted haste and consequent carelessness, our neglect of proper supervision and our system of contracting whereby the date of completion of a building is made the factor of greatest importance, all militate against efficient and permanent work. Unquestionably the majority of buildings in cities are constructed with thoroughness as regards structural safety, but there is ample testimony that few are capable of withstanding a sudden attack of fire. The responsibility for these conditions may be equally divided between the owners, architects, contractors and public authorities. Speculation and the desire for large returns by investors have been the cause of much poor construction in Canada. Efficient building construction requires time. The modern 'rush' contract deliberately invites slighted work on the part of the builder, and scant supervision on the part of the architect. Under pressure of time, the architect is sometimes obliged to pass mediocre work rather than delay completion, and this knowledge is too often taken advantage of by the contractor. Following recent fires, buildings, hitherto assumed to be of first-class construction, have been found with hollow masonry walls filled with broken bricks, floor arches chopped away for the purpose of applying ceiling finish, curtain walls laid with insufficient mortar and tile column coverings fractured for the admission of pipes and wires.

Regarding these things the average building owner is not only ignorant but indifferent.* Dependence is placed upon insurance to take care of any fire loss that may result, and in this manner the burden is shifted upon the community. Every year Canadians pay millions of dollars for the maintenance of fire departments, and other millions to insurance companies to be used in indemnifying losses which are to a large extent unnecessary. If only one-half of the money so expended during the last quarter of a century had been used in the proper structural development of our cities and towns, the fire loss in Canada would be merely a fraction of what it is to-day.

Buildings as Investments

One of the most important phases involved in the question of building construction is that of cost. The first consideration should be security, the second, earning capacity and the third, continuity of earnings. By

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*When the owner, as is generally the case, has no practical knowledge of building construction, and is incapable of judging of the merits of different methods and materials, he invariably accepts the lowest price offered or instructs his representatives to do so. One of the incomprehensible things is the fact that the average owner thinks he is fulfilling every moral and business obligation by so awarding the work. As long as a cheap building complies with the building laws of the city in which the building is to be located and fulfils the requirements for strength, the average owner is satisfied and is unwilling to appropriate additional money for superior methods or materials. It is the same old story of 'just as good' substitution.—A. L. A. Himmelwright, M. Am. Soc. C.E., in *Trans. Am. Soc. C.E.* Vol. LIX, p. 309.

disregarding these underlying principles, investment in buildings is purely speculative. Before purchasing land upon which a building is to be erected, months are spent in investigating titles and values but double the expenditure is often made upon the structure without enquiry save as to its arrangement, convenience and appearance. Security is entirely ignored in dealing with the one factor subject to possible destruction by fire and to certain deterioration by age.

From the standpoint of the individual owner, there can be little doubt that a first-class structure affords a superior investment. The capital expenditure may be greater but, after a number of years, the building will represent practically as valuable an asset as when it was erected. On the other hand, a smaller initial investment in a poor building demands constant and increasing outlays for repairs that add nothing to the actual value of the property.

Solid vs. Frame Construction

Objection has been frequently made to the passage of ordinances requiring brick construction on the ground that it would prove a hardship to builders by compelling a larger initial expenditure. After careful examination of the merits of this argument, it has been found that the additional cost in Canada of solid construction is so small that the prohibition of frame buildings, at least in cities and towns, would involve no real hardship. In a general way, it may be said that the cost of solid brick is not more than 10 or 15 per cent greater than that of ordinary frame construction. Some years ago, Mr. J. Parker B. Fiske investigated the cost of building in America for the Boston Chamber of Commerce Committee on Fire Prevention, and while the enquiry was confined to dwellings, the figures obtained and the conclusions reached are of value. In his report, Mr. Fiske states:

"The public is gradually realizing the enormous loss by fire, the excessive repairs, rapid depreciation and discomfort in both summer and winter of frame cosntruction. How is it then that we have continued so long to build of wood, while the older countries of Europe abandoned this type of construction many generations ago? The answer is that the first cost of a brick building has been prohibitive. However true this may have been a generation ago, it no longer holds good. Conditions have changed. Wood is no longer cheap and frame construction costs almost as much as brick. With its upkeep it costs more. A great majority of the people, however, are still denying themselves the advantages of a superior material for the construction of buildings because of a mistaken idea as to the relative cost. It is time, therefore, that present day facts be made public in a clear and logical manner that all may know the truth.

"In order to prepare an accurate statement regarding the relative costs of different styles of construction, a careful investigation was instituted in which all variable quantities were eliminated and a *bona fide* bid obtained for the construction, in a given locality, of a series of houses each exactly like the others in every particular except the outer walls, which were constructed of the materials which it was designed to compare. In making the investigation, a modern eight-room house, similar to thousands of homes which are being erected at the present time, was chosen. The architects prepared the plans and specifications necessary for obtaining prices for these houses when built with the following types of exterior wall construction, all other details being common:

Type 1—Frame, finished with clapboards over building paper; inside surface furred, lathed and plastered.

Type 2—Frame, finished with shingles over building paper; inside surface furred, lathed and plastered.

Type 3—Ten-inch brick wall, i.e., two 4-inch walls tied together with metal ties and separated by a 2-inch air space; inside surface plastered directly on the brick work.

Type 4—Twelve-inch solid brick wall; inside surface furred, lathed and plastered.

Type 5—Eight-inch hollow terra cotta blocks, stuccoed on the outside and plastered directly on the inside.

Type 6—Six-inch hollow terra cotta blocks, finished with 4-inch brick veneer on the outside and plastered directly on the inside.

Type 7—Frame furred and covered with stucco on wire cloth over building paper; inside surface furred, lathed and plastered.

Type 8—Frame covered with 4-inch brick veneer on the outside; inside surface furred, lathed and plastered.

Type 9—Frame finished on the outside with 4-inch brick veneer tied directly to the studding; inside surface furred, lathed and plastered.

"Five contractors were asked to submit bids for the erection of each type of house and the comparative prices given were as follows:

TABLE No. 18—RELATIVE COST OF DIFFERENT TYPES OF CONSTRUCTION

	Clapboard	Shingle	10-inch brick wall, hollow	12-inch brick wall, solid	Stucco on hollow block	Brick veneer on hollow block	Stucco on frame	Brick veneer on boarding	Brick veneer on studding
1	$6,732	.....	$7,572	.....	$7,416	$7,777	$6,857	$7,130	$7,080
2	6,235	$6,370	6,736	$7,105	6,491	6,762	6,410	6,746	6,664
3	6,692	6,786	7,118	7,418	7,179	7,238	6,847	6,970	6,895
4	6,690	.....	7,496	7,801	7,202	7,648	7,000	7,496	7,420
5	7,450	7,450	7,940	8,240	7,650	7,990	7,650	7,790	7,710
Average of bids	$6,759	$6,868	$7,372	$7,641	$7,187	$7,483	$6,952	$7,226	$7,153

PERCENTAGE EXCESS COST OF EACH TYPE OVER CLAPBOARDS

	Clap-board	Shingle	10-inch brick wall, hollow	12-inch brick wall, solid	Stucco on hollow block	Brick veneer on hollow block	Stucco on frame	Brick veneer on board-ing	Brick veneer on stud-ding
1	.0	...	12.5	...	10.2	15.5	1.9	5.9	5.2
2	.0	2.1	8.0	13.9	4.1	8.4	2.8	8.2	6.9
3	.0	1.4	6.4	10.8	7.3	8.2	2.3	4.2	3.0
4	.0	...	12.0	16.6	7.7	14.3	4.6	12.0	10.9
5	.0	.0	6.6	10.6	2.7	7.2	2.7	4.6	3.5
Average excess	.0	1.6	9.1	13.0	6.3	10.7	2.9	6.9	5.8

Careful investigation by other well-known authorities substantiate the figures compiled by Mr. Fiske. Arthur W. Joslin of Messrs. MacDonald and Joslin, Boston, in *Comparative Costs of Common Types of Wall Construction*, gives the following estimated increase of cost for ten types of buildings:

Type of building	Excess over clapboard building: For walls only	Excess over clapboard building: For whole building (dwelling)
Frame shingled	3.2 per cent	.3 per cent
Frame stuccoed	40.0 " "	4.0 " "
Frame brick veneered	58.6 " "	4.9 " "
8-in. 'sand struck' brick	40.3 " "	4.0 " "
8-in. 'water struck' brick	76.9 " "	7.7 " "
8-in. face brick	81.0 " "	8.1 " "
12-in. 'sand struck' brick	87.9 " "	8.8 " "
12-in. 'water struck' brick exterior	130.0 " "	13.0 " "
12-in. face brick	130.8 " "	13.1 " "
8-in. hollow, terra cotta blocks	52.4 " "	5.2 " "

These figures were based upon prices of materials in 1914 and clearly show that, so far as dwellings are concerned, the cost of incombustible construction need not exceed that of combustible by more than 15 per cent. Mr. Joslin in drawing conclusions from his enquiry, says:

"When the increased architectural effect and the decreased cost of maintenance and fire insurance are taken into account, it is an open question how much longer we can afford to go on building highly inflammable buildings which are so common everywhere to-day."

That actual practice supports this contention is shown by the testimony of a large firm of speculative builders:

"Taking the saving in insurance, heating and painting, we have found that there is really no difference in the cost at the end of a few years and we now build of brick altogether. When we come to sell a house, we can always get about $1,000 more for the brick than frame on account of its beauty, durability and economy. The brick house looks more substantial than the frame house, is much cooler in summer and we have tested the heating in winter and have found that it takes $33^1/_3$ per cent more fuel for a frame house than it does for one of brick."

Comparative costs of classes of buildings other than dwellings are not readily available. Differences in situation, design and specifications as to materials and labour render comparison difficult, but, speaking in a general way, a thoroughly fireproof building rarely exceeds by more than 10 or 15 per cent the cost of a non-fireproof building. In stores and warehouses, this difference may be reduced below 10 per cent. Recent tenders for the erection of four reinforced concrete and 'mill' buildings show little additional cost per cubic foot for fireproof construction.* Professor C. E. Young, of Toronto University, has stated that under average conditions fireproof buildings can be built for from 10 to 15 per cent more than mill buildings except in the city of Toronto, where stringent building requirements increase the cost to from 15 to 20 per cent.†

Mr. Walter F. Ballinger states that, as a rule, concrete construction costs 10 to 15 cents per square foot of floor surface more than mill construction. The cost would be about equal if the form work in concrete construction could be eliminated. If the location is convenient and the materials easily available, fireproof may be as cheap as mill construction. "Between concrete construction and steel frame with terra-cotta the cost is usually 25 per cent less for reinforced concrete. The difference is represented principally by the saving in steel, there being approximately one-third the tonnage of steel used in reinforced concrete."‡

Mr. J. P. H. Perry gives fourteen examples of comparative costs between mill construction and fireproof factories. The mean excess cost of reinforced concrete over mill construction was 6.7 per cent.

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*It must not be forgotten that in estimating upon large buildings there is room for very wide variation. In the case of buildings costing upwards of $100,000, there will frequently be as much as $30,000 difference between the highest and lowest tenders.

†*Canadian Engineer*, February 26th, 1914.

‡Mr. Walter F. Ballinger in *Proceedings of National Fire Protection Association*, 1909.

In fifteen comparisons quoted by Mr. Perry of actual bids submitted for both types the excess cost of steel and hollow tile buildings over reinforced concrete was 6.4 per cent.*

Cost of Maintenance

Apart from the question of first cost, the annual charge-off and repairs are far greater in the case of frame than brick buildings. The following examples clearly show the advantages of the more substantial construction:

1. Frame building, 2½ storeys and basement. Cost $10,000. Estimated efficient life, 20 years.

Annual charge-off with interest at 4 per cent	$736.00
Repairs, painting, etc.	$250.00
Total, per annum	$986.00

2. Cost of house of same dimensions but of brick construction, $11,500. Estimated efficient life, 40 years.

Annual charge-off with interest at 4 per cent	$580.75
Repairs, painting, etc.	$100.00
Total per annum	$680.75

On the above basis, the annual cost is $305.25 or 45 per cent more for a frame than a brick building. Such figures can, of course, only be suggestive owing to the impossibility of establishing an exact ratio of cost and maintenance, length of available life or amount of depreciation. These factors depend altogether on the nature of the construction modified by the character of the occupancy. In ordinary brick joist buildings, the average depreciation amounts to 1½ or 2 per cent per annum, apart from maintenance costs. The rate in brick dwellings is higher, amounting, in some instances, to 2½ or 3 per cent. On the other hand, the average depreciation of a standard mill building is rarely more than 1½ per cent and, of a fireproof building, ¼ of 1 per cent.† These figures justify the contention of experts that, taking everything into consideration, a first-class building costs less than frame or cheap brick construction.

**Comparative Cost and Maintenance of Various Types of Building Construction* in Proceedings of National Association of Cement Users, 1911.

†Tiffany's *Estimates of Depreciation* as used by the United States Government, gives the following rates of depreciation in value:

Brick, occupied by owner	1 to 1¼ per cent per annum
Brick, occupied by tenant	1¼ " 1½ " " " "
Frame, occupied by owner	2 " 2½ " " " "
Frame, occupied by tenant	2½ " 3 " " " "

Matheson's *Depreciation on Factories* contains figures based upon a comprehensive study of mill buildings, showing the rate of depreciation to be 1.2 per cent annually.

F. W. Fitzpatrick, Executive Officer, International Society of State and Municipal Building Commissioners, states that the depreciation upon a fireproof structure is about one-ninth of one per cent per annum.

The continued erection of such buildings is certainly a mistake when regarded as an investment.

Safety for Human Life

The relation of construction to the safety of the lives of those who occupy buildings is self-evident. The danger to human life is influenced by (1) the materials used in construction; (2) the design; (3) the facilities for escape, and (4) the physical and mental condition of the occupants.

It is clear that the materials used should be incombustible and be employed in such manner as to overcome any inherent defects or weaknesses. Unfortunately, a building, even when constructed of fire-resistant material, and equipped with every safety feature and device, may be filled with inflammable and combustible contents, capable of generating gases, smoke, and heat sufficient to destroy the lives of the occupants. Well-designed and constructed fire-resistant buildings will, however, confine a fire to the space in which it originates.

The safety of a building is largely influenced by its design. The maximum separation of the exits, the safe enclosure of the stairways, the proper introduction of fire walls and the character and degree of the fire protection, are all important details. In order to secure economy of design, it is necessary that the purposes and uses of the building should be definitely known. Thus, the correct amount of fire protection may be provided against the exterior fire hazard, and, by dividing walls or partitions, fire doors, and fire-extinguishing apparatus and equipment, protection may be provided internally.

Means of Exit

The usual means of exit or escape are (1) elevators, (2) outside fire escapes, (3) stairways, and (4) the fire wall. Experience in fires has demonstrated that, except under certain specific conditions, the elevator service cannot be depended upon as a safe and sure means of exit in a burning building.

Outside iron fire escapes have been installed as means of escape for many years, although they have vital weaknesses and defects that are now well known. Their presence on the outside of a building is evidence of the lack of safe egress facilities on the inside. Except in small warehouses and other exceptional cases, they should be prohibited by law. Fire escapes of the chute type, steel tubes with a smooth helix instead of steps, if the only entrance is from one level, have considerable capacity but they soon rust, and become useless.

The smoke-proof tower has of recent years been advocated as the most efficient form of fire escape. It is simply an enclosed stairway that cannot be entered except from external balconies, whilst smoke and flames cannot gain entrance. It has, however, no more capacity than any other stairway of the same width, and, as its approach is often open to the weather and its interior is always more or less dark, it is seldom used in ordinary service and becomes neglected. The whole space devoted to fire towers is, therefore, almost a total loss to the owner.

The capacity of a stairway, if time is not a factor, is only limited by its cross-sectional area. In a multi-storey building, with crowds of people on each floor trying to get into the one stairway through exits at each floor level in a limited time, the conditions are very different. If more people try to get into the stairway from each floor than the portion of the stairway between that floor and the floor below will hold, a blockade will occur so that the flow downward will be delayed and, in many cases, cease altogether. The capacity of an average stairway with exits opening into it at each storey is limited to about 12 persons per storey for each 22 inches of width.

Safe Exits

There are only two kinds of safe exits; the enclosed fireproof stairway and the fire wall; but the former has serious limitations and is not suited for crowded buildings. Safety by stairways can only be assured in buildings of 8 storeys or less in height, and where there are only a few people per floor. It has been demonstrated by the operation of fire drills that physical exhaustion occurs when employees are taken down more than 7 storeys or up 3 or 4 storeys. When persons become excited, they are very liable to stumble and slip; or, if they become fatigued, they are apt to fall, causing others to tumble over their prostrate bodies and obstruct the stairway. There are numerous instances where jams have occurred so as to completely fill stairways and the bodies have been packed so tightly that it has required a considerable time for policemen and firemen to disentangle them. In at least two instances, this has occurred when there was a false alarm of fire and there was no real cause for the panic. In buildings exceeding 8 storeys in height, safety for the occupants must be found by some other means than by stairways.

The only real and practical solution of the problem of safety in buildings is a bisectional fire wall. It is, moreover, the least expensive solution of the problem if properly and economically applied. There is, unfortunately, a widespread prejudice against the fire wall, but this is largely due to the lack of knowledge of the manner of its application to the life hazard.

Its merits and advantages as a safeguard and protection to property have long been recognized by underwriters. Where it is introduced, the conditions in buildings are so changed that large economies can often be made in the cost of additional exit facilities. In most cases, this saving more than offsets the entire cost of the fire wall and materially reduces the total cost of the building. There should be at least one stairway and one elevator on each side of the fire wall and the wall should have at least two openings in it at as great a distance from each other as practicable, and both should be closed by standard fire doors.

It is improbable that a fire will occur on both sides of the fire wall simultaneously. Should it occur on one side, the people on that side would pass through the doorways in the fire wall, close the doors after them and be perfectly safe. The half of the building in which the fire occurs can usually be emptied in less than a minute if there are not more than 300 people on each floor, and an average of 150 have to pass through the doorways. If the principle of the horizontal escape presented by the fire wall is correctly applied in the design of new buildings, a most satisfactory method of securing safety at comparatively small expense will be obtained.

School Buildings

School buildings are just as susceptible to serious damage by fire as other structures, and should be as well built and protected as other buildings. The record of fires in such buildings used in Canada shows that a fire has occurred each week during the last four years in a public school or residential college. The direct financial loss resulting from these fires amounts to over one and a quarter million dollars. A careful study of conditions shows that less than one per cent of our schools are in any sense fire-resisting and that over sixty per cent are built of wood.

The safety from fire of the 28,000 public schools of Canada in which over 1,500,000 children spend the greater portion of their time, has received little attention outside of cities and towns where building ordinances govern the methods of construction.

The people, as a whole, favour efficient fire protection in schools, but, when it comes to the question of a single building, the local public almost invariably votes for the cheapest type of construction. Up to the present, loss of life in the schools of Canada has not been such as to arouse a strong public sentiment in favour of improved construction.

Provincial Regulations

This lack of interest by the people most concerned is reflected in the very unsatisfactory regulations in force in the different provinces. These may be briefly summarized as follows:

NOVA SCOTIA—There is no definite regulation of school construction, but generally the plans must be approved by the school inspector. Plans for county academies must receive the sanction of the Superintendent of Education in addition to the approval of the inspector.

Every church, schoolhouse, theatre or hall is required by law to have all the doors opening outward under a penalty not exceeding $50, but the Superintendent of Education states that in all the rural districts and in many of the larger towns and cities, these laws are more honoured in the breach than in the observance. Rural school buildings in the province are all one-storey buildings of frame construction.

New Brunswick—No regulations in respect to the construction of school buildings are in force, but there are regulations under the School Act, which provide for the comfort of the children and specify the minimum requirements for space, light and ventilation. Plans for the smaller school buildings are supplied by the Department of Education and all plans must be approved by the inspector.

Prince Edward Island—There is no act in force dealing with the construction of school buildings, and existing regulations make provision only for comfort and ventilation. Except in the cities of Charlottetown and Summerside, practically all the schools are frame buildings. In these two towns, the buildings are of brick and come under municipal regulations.

Quebec—All school buildings in the province must be constructed in accordance with plans approved by the Superintendent of Public Instruction. The buildings after completion must also be approved by a school inspector. The law provides for safety devices and exits in public buildings and requires that instruction in fire safety and fire drills be given in schools and colleges.

Ontario—The regulations of the Department of Education provide for the construction, lighting and ventilation of school buildings. In respect to safety from fire, these regulations provide as follows:

"The school should be built throughout of substantial and, as far as practicable, fireproof material. The partitions shall be of solid brick extending from basement floor to roof.

"The basement ceiling should be of sheet iron or other durable and fireproof material.

"All floors should be double, the upper tier of flooring being of the best quality of hardwood. In schools of more than one storey the upper floors shall be thoroughly sound-proofed with mortar, felt, or other suitable material.

"In buildings of more than one storey, iron fire-escapes and perfectly safe and convenient means of egress in case of fire, should be provided for all pupils, and should be constantly held ready for instant use. All stairways and fire-escapes for the use of pupils shall be of ample width and with treads safe and suitable for pupils of all ages using them. All the material of the stairways should be fireproof."

Model plans and specifications are furnished by the Department of Education for both brick and frame buildings. All plans must be approved by the school inspectors.

MANITOBA—There is no definite regulation of building construction in respect of schools but the Advisory Board of the Department of Education has authority to make such regulations. All plans for school buildings must be submitted to the Department of Education for approval, but this is done in order that the Department may be assured of proper provision being made for lighting and ventilation.

SASKATCHEWAN—No definite regulations are in force in respect to the construction of school buildings, but the Department of Education has the power under the School Act of requiring suitable buildings. Rural schools are generally of frame construction, but city schools are of brick and are built in accordance with municipal requirements.

ALBERTA—There is no definite regulation of the class of building which may be erected for school purposes, but it is provided in the statutes that, when money is borrowed for the purpose of erecting a school building, the debentures shall be issued only for ten years in case of a frame building, and for twenty years in case of a brick or stone building. Under the law, no district may borrow any money upon the security of debentures without first obtaining the consent of the Department of Education, and this power has been generally used by the Department to enforce the erection of proper school houses.

Standard plans and specifications have been prepared for rural schools and the Department insists upon these being followed. A standard plan for two-roomed village schools is also recommended by the Department to village districts. With these exceptions, plans and specifications may be prepared by any architect but must be approved by the provincial architect.

BRITISH COLUMBIA—There is no act in force regulating the construction of school buildings although, when a provincial grant is made in city school districts, the Department of Education reserves the right to first examine the school plans and modify them if necessary. In city school districts, the boards of school trustees eomply their own architects. In rural school districts, the first school house is erected by the Government free of cost to the people of the district. Plans and specifications for these schools are prepared by the provincial architect.

Types of School Buildings

The general types of school buildings fall into three classes—frame, brick and joist, and fire-resisting construction.

(a) Wooden school buildings should be strictly confined to country districts, and should never exceed one storey in height. In localities where such construction is used, land values are not high enough to warrant assuming the dangers of building to a height of more than one storey. If stoves are used for heating, they should be placed in plain sight. Heaters and boilers should invariably be placed in a basement or separate compartment having fire-retardant walls and ceilings with openings properly protected.

(b) Schools with masonry walls and wood joist construction should be confined to small towns or sparsely settled suburbs, and should be limited to two storeys in height. Planning should especially consider stairs, corridors and exits. Even when a building is but two storeys in height, these features of design are of the first importance.

All stairways and corridors should be built of fire-resisting materials, and the boiler room, if not the whole basement, should be absolutely cut off from the remainder of the building. The principal dangers to school buildings are to be found in heating apparatus, storage rooms, or closets not often used. These features are almost invariably relegated to the basement; hence, the isolation of that portion of the building is of greatest importance.

(c) Few towns and villages have the money to erect the more costly fire-resisting buildings, nor are they called upon by increasing demand for educational facilities to put up many new buildings, thereby offering the chance of providing better structures. For these and other reasons, it is to be expected that ordinary frame and brick buildings will continue in the majority, and it is for such buildings that recommendations are most needed. The plan of the building and the protection of vertical openings are more important than the type of structure or the choice of materials, as these two factors affect the safety of the lives of the occupants.

Moving Picture Theatres

During the last five years, the moving picture theatre has become one of the leading sources of amusement. It is estimated that more than 500,000 people attend such theatres every day, and it is important, therefore, that every possible precaution be taken to ensure their safety. As a general rule, women and children largely predominate in the audiences, and, in the event of panic, the danger is, therefore, at a maximum.

Investigation shows that over 29 per cent of the existing moving picture theatres in Canada are of frame construction. In 92 cases, families are living above theatres with stairways as the only means of escape in the event of fire. The actual figures as given by local authorities are as follows:

TABLE No. 19—MOVING PICTURE THEATRES IN CANADA

Cities and towns	Brick theatres	Frame theatres	Dwellings over theatres
Exceeding 10,000 population	338	27	26
5,000 to 10,000 population	59	31	15
1,000 to 5,000 population	115	109	27
Under 1,000 population	28	57	24
Total	540	224	92

When the hazards connected with moving picture theatres are considered, the existence of so large a percentage of frame buildings is startling; but the fact is capable of simple explanation. While the moving picture business was still in the experimental stage, promoters were uncertain as to the profits that might be expected, and hence, they were unwilling to risk large sums of money in sound construction. Many theatres were erected hastily and cheaply, or existing buildings were fitted up and, in some cases, with little consideration for the question of safety. At the present time, statutes regulating the construction of theatres and providing for the safety of the patrons are in effect in all the provinces in Canada,* and these are supplemented by municipal ordinances.

*ALBERTA.—The Theatres Act, chap. 25, 1911-12. Amended by chap. 2, 1915.

BRITISH COLUMBIA.—Moving Pictures Act, chap. 75, 1914. Amended by chap. 62, 1915 and chap. 31, 1916.

MANITOBA.—The Moving Pictures Act, R.S., chap. 132, 1913. Amended by chap. 42, 1915.

NEW BRUNSWICK.—Theatres and Cinematographs Act, chap. 13, 1912. Amended by chap. 38, 1916.

NOVA SCOTIA.—The Theatres and Cinematographs Act, chap. 9, 1915. Amended by chap. 31, 1916.

ONTARIO.—The Theatres and Cinematographs Act, R.S., chap. 236, 1914. Amended by chap. 20, 1915.

QUEBEC.—An Act respecting Public Safety in Public Buildings. R.S., Art. 3749-3783. Amended by chap. 34, 1911, chap. 40, 1914 and chap. 58, 1915.

SASKATCHEWAN.—The Theatres and Cinematographs Act, chap. 28, 1913.

Factory Buildings

In the majority of modern factory buildings in Canada, ample provision is made for the safety of employees in case of fire, and, under the provisions of the various provincial factory inspection acts, much has been done to improve the older buildings. The chief existing danger appears to be in respect to buildings designed for one purpose but which are now occupied for an entirely different purpose. Many buildings erected as offices and for limited tenantry have, through changing conditions, become warehouses and, ultimately, factories. In these, it is frequently impossible to arrange exits that will guarantee the safety of the occupants. Mr. H. J. F. Porter of New York, who has made a special study of the safety requirements of factory buildings, urges that all buildings be licensed for specific occupancies and that a satisfactory rapid egress test be required of all buildings before their use. He states:

"Factory buildings are sources of great danger to their occupants, both on account of their construction and because of the obstructions to rapid egress due to haphazard placing of machinery, furniture and apparatus, and the small number, size and character of the exit facilities. Of late, there has been advocated the unrestricted use of fireproof construction and the development of a form of exit drill of the occupants of each building to determine if, in the case of danger, they could escape readily from the building. By 'readily' is meant within three minutes, for it is found that people do not want nor would it be safe to remain in a burning building longer than that time. In order to ensure the safety of the occupants of a building in case of emergency, one of two things has to be done: (a) there should be two stairways so that if one be cut off by flames or smoke, the other can be used and the number of occupants reduced on each floor to meet the limited capacity of the portion of the stairway between floors; or (b) the number of stairways should be increased so as to have two separate and independent stairways from each floor to the ground, with its own exit from the building. Persons can then enter whichever one is not cut off by fire and continue down and out at the bottom without colliding with those from any other floor. Fire drills installed under either of these conditions work more or less satisfactorily. Such changes in old buildings are expensive for two stairways have to be installed from each floor to the ground so that if one is cut off by a fire the other can be used. In addition, fire drills are expensive to operate, for they involve not only the loss of time of operatives and a break in the continuity of the process of manufacture, but the actual going down stairs and returning of people reduces the efficiency of the working force for a very appreciable time. A fire-wall bisecting the building eliminates the necessity for external fire escapes, the duplication of stairways and the fire drill. This principle of the horizontal escape presents a satisfactory method of securing the safety of occupants with small expense. It should be developed in old buildings and the vertical escapes prohibited. Legislation should require (a) that architects and builders be prohibited from designing buildings which cannot be emptied within three minutes after a given signal; (b) that the municipal authorities be required to institute an exit test in each building to determine if it can be emptied of its occupants in three minutes. If it cannot pass this test, it should be altered until it can. Afterwards the proper authorities should be required to repeat the exit test from time to time to see that the safe conditions originally established be maintained."

Public Institutions

In institutions established for the care of human lives, it is an anomalous condition that safety from the dangers of fire is so often disregarded. While many of the more recently erected hospitals and asylums in Canada are of fire-resisting construction, there is room for improvement in many of these as well as in the older buildings. It appears to have been largely overlooked in the design of institutional buildings that, while the structure itself may be incombustible, the furnishings and other contents of an inflammable nature are sufficient to make a serious fire. In the older buildings, structural defects, such as unprotected stairways and elevator shafts, open corridors and narrow doorways, are common. External fire escapes are installed on all buildings under provincial government supervision, but, in many institutions, these are of limited value. If helpless patients are unassisted, rapid exit down external fire escapes is obviously impossible. In some institutions, such as those in which patients are being treated for mental trouble, it is necessary to keep all exits locked, especially those leading to fire escapes. To overcome these vital defects in existing conditions, it is suggested that every hospital, asylum and public institution introduce a fire-resisting wall cutting the entire building into two parts. In the case of fire breaking out on one side of a wall, automatic alarm signals would notify everyone on that side and they could pass through the doorways of the wall into the safe section of the building without the danger attending vertical travel.

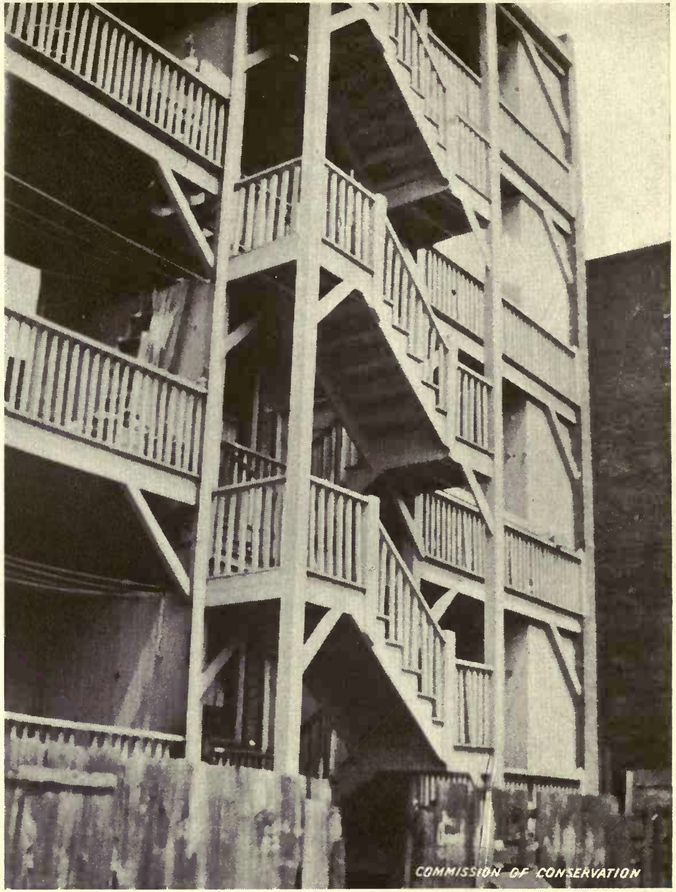
Influence of Architects

Architects and contractors can exert a tremendous influence towards the elimination of fire waste. In the past, it has sometimes been deplored that the building profession has given little encouragement to fire-prevention movements. *Safety Engineering*, June, 1917, points out the responsibility of architects in this respect as follows:

"The architect's duty lies in specifying, advocating and insisting upon fire-resistive construction. The enormous proportions of fire waste in America is a distinct reflection upon American architects. It indicts them as creators of dangerous conditions. Some 9,000 lives are sacrificed each year to fire. What have the architects to

REAR OF FIRE-TRAP HOTEL IN CANADIAN CITY

Provincial statutes and municipal ordinances notwithstanding, light paper partitions, unprotected corridors and inadequate exits cost four guests their lives. Laws that are not enforced are valueless.



TENEMENT HOUSE CONSTRUCTION UNDER THE LAW

In the event of fire, sixteen families must depend upon tinder-like wooden stairways and balconies as the only means of escape.

say to this? The architect's advice is sought in planning a building. He should, under all circumstances, insist upon construction which will not add to the ash heap and appalling loss of life. If the architects would see their duty aright as creators of buildings, it is to them above all that we must look for a reduction of our annual fire waste. The architectural profession, if it will, can render great service to the country and remove from the profession the accusing finger of being a primary cause of the tremendous fire waste."

Unfortunately, architects have been too prone to regard buildings solely from the viewpoint of æsthetic design, convenience and cost, and the essential features of fire resistance have been treated as of secondary importance. On the other hand, some advocates of fire-prevention measures have gone to the extreme in considering a building simply as a fire-retardent and its value proportioned directly to its effectiveness in fulfilling that requirement. Architects and builders have striven for large and imposing areas, ornamental staircases and decorative finish, while these have been heavily charged for in insurance rates as being amongst the factors most conducive to fire loss. Instances could be multiplied of the failure of builders to eliminate hazards which insurance men could have pointed out as readily before the erection of a building as they penalized after its completion. The first contact, therefore, between architects ard fire-prevention interests is one of discord. These relations are rapidly changing and the cause of the change is not far to seek. The wholesale destruction of property by fire has become so serious as to make the cost of insurance an important item in the construction of buildings and is an item that the architect is compelled to take cognizance of on behalf of his client.

Licensing Architects

There is an obvious need for the more general employment of technically competent persons in the planning and erection of buildings in Canada. Pseudo-architects and speculative builders are a menace to life and credit yet flourish without restraint. Very few employers of architects can judge of their technical qualifications by an interview. These can only be revealed empirically and too often the employer pays dearly for the demonstration. In the United States and in Canada, the question of licensing architects has been frequently raised but with indifferent success both in the United States and Canada. In some states, Illinois for instance, registration and licensing by the legislature, after an examination by a technical board, is compulsory.*

*An Act to Provide for the Licensing of Architects and Regulating the Practice of Architecture as a Profession in the State of Illinois. Enacted by the General Assembly, June 3rd, 1897 and amended 1899, 1905 and 1911.

Municipal Taxation of Buildings

One means of bringing about improved construction in Canada is by reform in the manner of municipal taxation. At the present time, no consideration is given to the fact that the assessment value of property is in many cases, increased 20 to 30 per cent by the erection of first-class instead of cheap buildings. Proper construction and improvements to existing property receive favourable treatment through the reduction of insurance rates, and it is perfectly logical that some preference should be given in the imposition of tax rates.* Since municipalities have to provide costly fire protection chiefly on account of defective buildings, in justice to the community, the tax for such service should be equitably levied. *Engineering and Contracting*, April 25, 1917, deals with this point as follows:

"Fire protection is so commonly regarded as being inevitably a municipal function that few business men have ever asked themselves this question: What would be the economic effect of turning over all fire-fighting apparatus and the management of city fire departments to fire insurance companies? What would be the further effect of authorizing the fire insurance companies to collect the cost of fire protection as a part of the premiums charged on fire insurance policies?

"If this were done, it is evident that it would not long remain profitable to erect 'fire traps' in cities. At present the fireproof building is actually taxed to protect the 'fire trap.' This anomalous condition arises from the fact that city fire departments are supported by general taxation of all city property. A fireproof building being more costly than one that is not fireproof, therefore pays a larger part of the fire department expense. Thus, we have the economic absurdity of a fire department supported mostly by taxes on property that least needs its services.

"Were conditions reversed, as they should be and as they would be were fire protection furnished by fire insurance companies, the increased expense of protecting inflammable buildings would lead to their rapid elimination."

The size of fire departments and the extra cost of water supply demanded by insurance companies is not based upon a possible fire in a first-class building, but upon maximum requirements to cope with a widespread conflagration, such as underwriters believe possible in almost every city in Canada. A reform in the method of taxation would place the burden of paying for the maintenance of this protection upon those who make it necessary, and would relieve

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*Scores of improvements would be carried out were it not for the senseless method of taxation, by which improvements are made to bear the burden and consequently, the desirable citizen, and not the undesirable, is discriminated against. *Toronto Saturday Night*, May 12, 1917.

those who are public-spirited and businesslike enough to build so as not to require the service.*

Legislative Control Necessary

Proper legislative control of building construction is the only real and lasting remedy for such conditions as exist in Canada. Much has been accomplished by means of municipal ordinances in the larger cities, but much remains to be done before any real progress can be made. Local measures are only as effective as local sentiment will permit. The statement is often made that building restrictions are for the benefit of architects and builders or for some especial interest. As a matter of fact, not only are good laws combated, but owners of buildings are often aided by their architects, who of all men should be the strongest in their support of protective regulations. Every means is used to secure variations from the letter of the law. Thinner walls are prescribed, greater height is planned, wall openings and vertical shafts are left unprotected and many ill-advised ways of reducing the cost of buildings are attempted. Architects and owners influence individual members of municipal councils, and aldermen have little compunction in attempting to override the building department and grant 'special permits' for any particular building that may not be in accordance with the regulations. Hundreds of buildings in Canadian cities have been erected by 'special permit' and are standing testimony to the futility of local ordinances.

Recently an attempt was made by the Council and the Property Committee of the city of Toronto to go over the City Architect's head in granting a permit to a moving picture theatre in contravention of the city by-law, which provides that a theatre with a seating capacity of 500 or over must be of fireproof construction. In this case, the City Solicitor, the Fire Chief and the Toronto Chapter of Architects supported the City Architect in his fight to uphold the provisions of the by-law. Notable examples of the contravention of ordinances restricting the height of buildings are to be found in practically every large city. There are also many instances of by-laws being amended at secret sessions of municipal councils in order to favour influential interests. A city architect or building inspector may be, and usually is, competent to administer a building law, but, under the circumstances, should he exercise even ordinary courage in the performance of his duties, he soon finds himself in conflict with an alderman whose authority has been gained by the accident of a few votes.

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*The city of Cologne allows a rebate in taxes to the man who erects a better type of building than he is compelled by law to do.

CHAPTER VI

Standardization and Testing of Structural Materials and Devices

A CAREFUL analysis of the items entering into the fire damage to buildings in Canada discloses the fact that, apart from frame construction, approximately 25 to 30 per cent of the loss is upon walls and roofs, and 70 to 75 per cent upon interior work, wooden doors, windows and frames, combustible floors and partitions, faulty column protection and inferior wall plasters. In what are termed 'fireproof' buildings, serious losses sometimes occur, and, although the main fabric may withstand severe damage, the interior trim and surfacing are almost invariably destroyed. The foregoing demonstrates the necessity of acquiring exact knowledge of the action of heat on building materials as a basis for judging of the manner in which losses by fire may be averted or minimized.

Definition of Fire Resistance

That no material in present commercial use is 'fireproof,' or capable of resisting fire beyond certain fixed limits, has been repeatedly borne out by laboratory tests and emphasized in all the important conflagrations of recent years. In the report of a special committee of the American Society of Civil Engineers on 'Fire and Earthquake Damage to Buildings,' it is stated that "Unless one has been an eyewitness, it is difficult to realize how all materials that men make into the shape of buildings can be so utterly destroyed in a general conflagration."*

The word 'fireproof,' though convenient as a figure of speech, describes an ideal to be achieved rather than a condition already attained. In view of the popular misconception attached to the term and the way in which many inferior materials have been made to appear immune against fire, the word is being generally discarded for the more rational description 'fire-resisting.' This term implies varying degrees of resistance to fire, and does not

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* *Transactions of the American Society of Civil Engineers*, vol. LIX, p. 237.

qualify any material as being proof against all fire damage. For this reason, the International Fire Prevention Congress, at London in 1903, in addition to approving this distinction, adopted the following resolutions:

"Re standards of fire-resistance, the congress confirms the British Fire Prevention Committee's proposed standards of fire-resistance, and hereby resolves that the universal standards of fire-resistance shall, in future, be—

1. Temporary protection
2. Partial protection
3. Full protection

in accordance with the committee's schedule as follows:

1.—Standard Table for Fire-Resisting Floors and Ceilings

Classification	Sub-class	Duration of test at least	Minimum temperature	Load per superficial foot distributed	Minimum superficial area under test	Minimum time for application of water under pressure
Temporary protective class..	A B	45 mins. 60 mins.	1,500 F. 1,500 F.	Optional Optional	100 sq. ft. 200 sq. ft.	2 mins. 2 mins.
Partial protective class.....	A B	90 mins. 120 mins.	1,800 F. 1,800 F.	1 cwt. 1½ cwt.	100 sq. ft. 200 sq. ft.	2 mins. 2 mins.
Full protective class.........	A B	150 mins. 240 mins.	1,800 F. 1,800 F.	2 cwt. 2½ cwt.	100 sq. ft. 200 sq. ft.	2 mins. 5 mins.

2.—Standard Table for Fire-Resisting Partitions

Classification	Sub-class	Duration of test at least	Mm mum te per- a ure	Thickness of material	Minimum superficial area under test	Minimum time for application of water under pressure
Temporary protective class..	A B	45 mins. 60 mins.	1,500 F. 1,500 F.	2 in. and under Optional	80 sq. ft. 80 sq. ft.	2 mins. 2 mins.
Partial protective class.....	A B	90 mins. 120 mins.	1,800 F. 1,800 F.	2½in. and under Optional	80 sq. ft. 80 sq. ft.	2 mins. 2 mins.
Full protective class.........	A B	150 mins. 240 mins.	1,800 F. 1,800 F.	2½in. and under Optional	80 sq. ft. 80 sq. ft.	2 mins. 5 mins.

3.—STANDARD TABLE FOR FIRE-RESISTING SINGLE DOORS, WITH OR WITHOUT FRAMES

Classification	Sub-class	Duration of test at least	Minimum temperture	Thickness of Material	Minimum superficial area under test	Minimum time for application of water under pressure
Temporary protective class..	A	45 mins.	1,500 F.	2 in. and under	20 sq. ft.	2 mins.
	B	60 mins.	1,500 F.	Optional	20 sq. ft.	2 mins.
Partial protective class.....	A	90 mins.	1,800 F.	2 in. and under	20 sq. ft.	2 mins.
	B	120 mins.	1,800 F.	Optional	20 sq. ft.	2 mins.
Full protective class.........	A	150 mins.	1,800 F.	2 in. and under	25 sq. ft.	2 mins.
	B	240 mins.	1,800 F.	Optional	25 sq. ft.	5 mins.

The general principle enunciated was that all classes of materials and types of construction should be divided into three broad groups according to the degree in which they withstood damage by fire. The standards laid down by the congress have since been adopted by practically all European countries.

In the United States, a joint committee of the American Society for Testing Materials, the Bureau of Standards, the National Board of Fire Underwriters, the American Society of Civil Engineers, the Canadian Society of Civil Engineers, the American Society of Mechanical Engineers and the American Concrete Institute has been engaged for some time in formulating an American standard for grading the fire resistance of materials. A plan of classification has been adopted in which the terms 'four-hour protection,' 'two-hour protection' and 'one-hour protection' take the place of 'full,' 'partial' and 'temporary' protection, as recommended by the International Fire Prevention Congress.* All materials will be graded upon their degree of resistance in fire tests conducted in accordance with a standard time and temperature curve.

In Canada, no attempt has so far been made to formulate standard requirements in regard to fire resistance and there appears to be little appreciation of the fact that the word 'fireproof' is without real significance in the absence of definite standards of measurement.

* American standard adopted 1917.

Increasing Use of Fire-Resisting Materials

Rapid improvement in the construction of important buildings in Canada has been brought about during recent years by the substitution of brick, structural terra cotta, iron, steel, gypsum and cement products for wood. The following table shows that since 1901 the consumption of cement alone in this country has increased over 700 per cent.

CEMENT USED IN CANADA, 1901-1915

	Barrels produced in Canada	Barrels imported (Portland)	Total consumption (Portland)
1901	317,066	555,900	872,963
1902	594,594	544,954	1,139,548
1903	627,741	773,678	1,401,419
1904	910,358	784,630	1,694,988
1905	1,346,548	918,701	2,265,249
1906	2,119,764	665,845	2,785,609
1907	2,436,093	672,630	3,108,723
1908	2,665,289	469,049	3,134,338
1909*	4,067,709	142,194	4,209,903
1910	4,753,975	349,310	5,103,285
1911	5,692,915	661,916	6,354,831
1912	7,132,732	1,434,413	8,567,145
1913	8,658,805	254,093	8,912,898
1914	7,172,480	98,022	7,270,502
1915	5,681,032	28,190	5,709,222

* Since 1909 no natural rock cement has been produced.

According to figures published by the Mines Branch of the Department of Mines, almost as great progress has been made in the production of other fire-resisting materials, although a considerable falling off in building construction has taken place during the last three years.

VALUE OF BRICK USED IN CANADA, 1910–1915

	Canadian production		Imports	
	Common brick	Pressed brick	Building brick	Building blocks
1910	$5,105,354	$ 807,294	$274,482	†
1911	5,420,890	1,094,582	475,865	†
1912	7,010,375	1,609,854	763,470	†
1913	5,917,373	1,458,733	575,269	$356,366
1914	3,653,861	1,115,556	353,353	276,817
1915	1,755,187	492,774	114,958	181,145

† No figures available.

Terra-cotta and Sand-lime Brick; Production in Canada

	Production of fireproofing and architectural terra-cotta	Production of sand-lime brick
1910	$176,979	$ 371,857
1911	409,585	442,427
1912	448,853	1,020,386
1913	461,387	909,665
1914	405,543	609,515
1915	253,401	141,742

Value of Asbestos Produced in Canada, 1910–1915

	Raw material shipped from mines	Raw material exported
1910	$2,555,974	$2,108,632
1911	2,922,062	2,067,259
1912	3,117,572	2,349,353
1913	3,830,909	2,848,057
1914	2,892,266	2,298,646
1915	3,553,166	2,734,695

Value of Gypsum Produced in Canada, 1910–1915

	Canadian production	Gypsum exported
1910	$ 934,446	$416,725
1911	993,394	425,161
1912	1,324,620	423,208
1913	1,447,739	504,383
1914	1,156,207	404,234
1915	854,929	336,380

In the past, the utilization of these materials in Canada has been restricted by competition with wood. Advances in the price of lumber and the preference shown by insurance companies for improved construction has, however, created a demand that is rapidly diminishing the difference in cost. Wholesale prices of building materials, as gathered by the Department of Labour, show an increase of almost 60 per cent in the cost of lumber in 1915 as compared with 1900. During the same period, brick has increased in price almost 48 per cent, but cement has declined 46 per cent.

Importance of Impartial Tests

Careful enquiry respecting the strength, durability and other structural qualities of fire resistive materials, the more suitable forms for their application and the dissemination of information relative to their comparative costs and permanence, would doubtless enlarge their use. Although there is a vast amount of this information scattered throughout the country, it has not, unfortunately, been collated with the care and accuracy which the importance of the subject warrants. Most of the data in available form have been procured by individuals commercially interested in proprietary materials and, therefore, not fitted to present the facts in their proper relation nor to draw sound conclusions from them. On this point F. W. Fitzpatrick, Executive Officer of the International Association of Building Commissioners, states:

"I have had portions of each of two blocks of a material manufactured by two competing makers tested by experts in their respective laboratories, and, in each case, it was conclusively proven that that maker's material was perfect and the other of absolutely no account. In fire tests, an expert can obtain exactly the results he wants to get. An expert employed by a company naturally has a prejudice towards the interests of that company and his opinions are more or less unconsciously coloured in its behalf. In spite of the splendid laboratories attached to so many great manufacturing plants, I cannot help feeling amused when I read in advertisements that exhaustive tests prove their materials to have advantages over all else in the same line. For money, you can get nearly any kind of a test you want."

The frequently exaggerated claims of the advocates of structural tile, expanded metal, stucco and reinforced concrete in their numerous forms are not only unreasonable, but have resulted in contradictory interpretations of laws regulating building construction. There are types of buildings for which reinforced concrete is best adapted and there are buildings in which terra-cotta offers the greatest advantages. It is also true that there is a large class of buildings for which neither is so well adapted as brick or some form of expanded metal with plaster super-imposed. What is true of the various types of buildings is equally true of the forms in which materials are to be applied. There are many kinds of concrete slabs and of tile, each lending itself best to some peculiar situation. There are also numberless systems of expanded metal utilizing differently constituted plasters, each doubtless having greater merit for a particular purpose than any others. These things can only be determined and brought into proper relation by experiment and investigation. If it be a reasonable contention that compulsory laws are needed to control the construction of buildings, they should be based upon accurate data formulated after the actual testing of materials and devices, according to uniform and unvarying standards.

Inconsistent Municipal Ordinances

The present lack of authoritative data with respect to building materials and modes of construction is clearly evident in the inconsistencies and contradictions incorporated in many municipal building ordinances in Canada. The city of Toronto building by-law, 1913, for example, specifies the following safe loads per square foot for brick masonry:

Kiln-run bricks laid in lime mortar, 4 tons.
Ordinary bricks laid in Portland cement mortar, 6 tons.
Hard bricks laid in lime mortar, 7 tons.

In comparison, the permissible loads per square foot on soils is as follows:

Gravel and coarse sand well cemented, 8 tons.
Dry hard clay, 4 tons.
Sand, compact and well cemented, 4 tons.

According to these requirements, well compacted gravel or coarse sand is considered capable of sustaining a greater load than any grade of brickwork, and twice as much as kiln-run bricks laid in lime mortar.

The provisions of the by-law respecting strengths of girders are such as to require much heavier construction than is considered ordinary good practice. For instance, a girder following the specifications of any Canadian railway or the Canadian Society of Civil Engineers would not be approved for use in a building in Toronto; neither would a bridge girder built by the Works department of the city be regarded as safe by the city architect's department.

Equally inconsistent are the requirements in regard to wood beams and columns. A long-leaf yellow pine column, 12 x 12 inches and 15 feet long, would not be permitted to carry more than 52 tons by the building by-law, but would be considered entirely safe under a load of 65 tons in a structure erected by the city Works department. A column of the same dimensions would be permitted to carry 68 tons by the Dominion or Ontario governments, 61 tons in Boston or Buffalo, 64 tons in Chicago and 70 tons in Baltimore.

The by-law also provides that the steel columns in external walls have, on the outside faces, 10 inches of protective covering, namely 9 inches of brickwork plus one inch of cement, and only 4½ inches of brickwork plus one inch of cement, inside, despite the fact that the heat from a fire is much greater inside than it is outside. Again, 4½ inches is specified as sufficient covering for girders carrying the external walls except that only 2 inches is specified as minimum covering for the outer edges of heir flanges. The buckling of these girders would remove the lateral support of the wall columns and cause collapse of the entire wall. If 5½ inches covering is required for the protection of the columns, 4½ inches is obviously insufficient to protect the girders.

On the other hand, Prof. C. R. Young* points out that San Francisco, after receiving a report of a special committee of the American Society of Civil Engineers, requires only 2¾ inches of brick set in cement mortar for fire-proofing all around such columns. Chicago requires 4 inches of brickwork all around external columns and St. Louis only 3 inches.

Economic Effects

These obvious inconsistencies in the Toronto by-law are mentioned merely to illustrate the need in Canada for uniform standards of building practice. Equal, if not greater, absurdities occur in the building by-laws of other cities and give rise to many grievances, besides occasioning the needless expenditure of large sums of money. Broadly speaking, the day of sound construction in Canada is being deferred through lack of data upon which to base reasonable requirements. There is a difference of almost four hundred per cent between the highest and lowest requirements for the same load in the formula stated by various authorities and used by architects in the calculation of steel reinforcement in flat slab concrete construction. If the minimum figures are correct, there is a tremendous waste of steel when the maximum figures are used, and, on the other hand, if the maximum figures are necessary to structural safety, all buildings not in accordance with them should be condemned. Dr. S. W. Stratton, Director of the United States Bureau of Standards, emphasizes this point in regard to the fire-proofing of steel columns as follows:

"Many millions of dollars are annually spent on buildings the integrity of which depends upon the stability of the supporting steel columns. Little engineering data are available from which to draw conclusions as to the protection required to render these columns safe under various conditions of fire hazard. The requirements of building codes on these questions are so different that it is evident that some codes are either requiring an unnecessarily thick fire-proof covering with undue increase in construction qualities or else other codes are requiring too thin covering with undue increase of danger to the stability of the structure under existing fire hazards."

Many requirements, while admirable in theory, are unworkable in practice, owing to cost. Laws that impose too rigid a standard

* The Structural Requirements of the Toronto Building By-law of 1913. *The Canadian Engineer*, vol. XXVI, pp. 383-387.

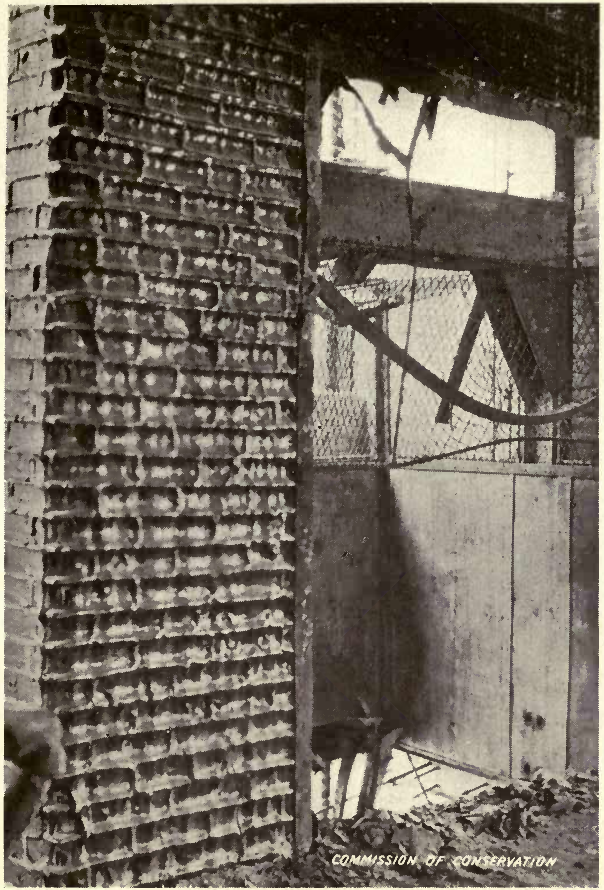
may be condemned equally with those that are too lax in that they tend to atrophy all efforts at improvement. Prof. C. R. Young, in discussing the requirements of the Toronto building by-law, makes the following statement:

"One obvious result of the exactions of the present by-law is the high cost of building. In steel construction, experience has shown that the total cost of buildings is from 3 to 10 per cent more than it should be. Reinforced concrete buildings cost at least from 5 to 15 per cent more than they would if designed to a reasonable and at the same time perfectly safe specification. The waste involved in mill construction buildings is from 5 to 10 per cent of the total cost. Taking all classes of buildings into consideration, it is on the side of safety to say that there is an annual waste in the construction of buildings in Toronto of at least $750,000."

The effect of such severity in building requirements is to limit the extent of first-class construction. Mr. E. H. Darling, speaking before the last annual conference of the Canadian Clay Products Association said: "Conditions imposed in some cases are made so arduous as to be prohibitive, and actually put a premium upon the poorer type of construction. Any legislation that requires an extravagant use of any article or material so adds to the cost of a building that, instead of increasing the demand for it, it actually has a tendency to restrict its use." This is especially true in laying down requirements respecting the fire resistance of materials and modes of construction; for, to the average person, these matters are merely incidental to the more important questions of convenience and appearance in a building. This is one of the main reasons why model regulations, such as those formulated by underwriters, are not universally adopted.

Existing Standards

Such formulæ and general requirements as are at present recognized in building practice in Canada, have been promulgated from time to time by the American Society for Testing Materials, American Society of Civil Engineers, American Society of Mechanical Engineers, Canadian Society of Civil Engineers, Columbia University, New York Building Department, National Board of Fire Underwriters, Associated Mutual Insurance Laboratories, National Fire Protection Association and Canadian Fire Underwriters' Association. As the specifications published by these bodies are, for the most part, based upon experimentation in the United States, it is questionable whether they always provide the best possible guidance for Canadian practice. Moreover, being in the nature of advisory standards, they are obviously powerless to regulate effectively and uniformly the use



NO BUILDINGS ARE FIREPROOF

The most fire-resisting structural materials are not proof against a fierce fire. In the fire illustrated, fused bricks ran like molasses and calcined concrete columns crumbled into dust.

of building materials and methods of construction. Their adoption is naturally influenced by the local cost and availability of materials and, when incorporated into building laws, they are not infrequently manipulated to favour a particular product or impose unnecessary restriction upon the use of some other.

'Underwriters' Requirements,' as promulgated by the National Board of Fire Underwriters, New York, and adopted by virtually every insurance organization in the United States and Canada, cover a wide field, embracing all materials, devices and equipment considered as measurably affecting the fire hazard.* Published in the form of 'Rules and Requirements' for insurance organizations, their general adoption is officially recommended by the National Fire Protection Association. As compliance with them by the public is essential to the securing of concessions in insurance rates, they have become fairly well established as

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* The following standards published by the National Board of Fire Underwriters have been adopted by practically all insurance organizations in the United States and Canada:

Acetylene gas machines and storage of calcium carbide.
Coal gas producers.
Electrical wiring and apparatus (National Electrical code).
Fire department equipment and organization (private).
Fire doors and shutters.
Fire extinguishers (chemical).
Fire hose (for fire departments).
Fire hose (for private installations).
Fire pumps (separate standard for each type).
Fire resisting construction.
Gas and gasolene engines.
Gasolene vapour lighting machines, lamps and systems.
Gasolene vapour stoves for cooking and heating.
Grain dryers.
Gravity tanks.
Hose couplings and hydrant fittings.
Hose houses for mill yards.
Incubators and brooders.
Kerosene oil pressure systems.
Lightning protection equipment.
Municipal fire alarm systems.
Nitro-cellulose films.
Oil storage (fuel).
Oxy-acetylene heating and welding apparatus.
Railway car house construction and protection.
Signalling systems.
Sky-lights.
Sprinkler equipments.
Steam pump governors and auxiliary pumps.

Uniform requirements regarding mill construction, inferior construction general hazards, oil rooms, general protection, stair-way and elevator enclosures, watchmen, thermostats, etc.

Valves, indicator boxes and private hydrants.

Waste cans, ash cans, fire pails and safety cans for benzene and gasolene.

Wire glass and metal window frame construction, etc.

NOTE: Other standards are pending in committees.

standards of practice. From the viewpoint of fire protection, their excellence is beyond dispute, and the only criticism possible is that they invariably represent ideal requirements and not reasonable limits of perfection. Good grounds for this stringency are to be found in the common carelessness and indifference to details which has characterized American and Canadian workmanship in the past. The highest requirements are, however, undesirable for incorporation in general legislation. Such standards, while sufficiently high to justify adoption, should not impose unreasonable expense upon the public.

Need of Testing Facilities

Equally important as the setting of definite structural standards in Canada is the provision of adequate facilities for obtaining unbiassed conclusions as to the qualities of materials. Under existing conditions, architects, builders and municipal officials have necessarily to accept the bare statements of the manufacturers as to the relative value of the majority of new materials and devices. When formulating municipal building laws, those in charge of the work are persistently besieged by representatives of various products, each with convincing testimony that his particular material should be given preference, or, at least, recognition. In the confusion caused by a multiplicity of conflicting data, requirements are more often framed and interpreted to favour good salesmanship than in accordance with experience.

Owing to the difficulty of conducting adequate tests of materials in Canada, it is rarely possible to include requirements respecting quality in building specifications. To mention a particular brand of cement or plaster, for instance, might exclude the best on the market and to simply specify 'plaster' might admit the poorest. Often an effort is made to duplicate material once found satisfactory by prescribing a specific brand and adding the words 'or equal'—a recourse which is absurd, since, without definite standards or adequate testing facilities, comparison is impracticable.

The disadvantage under which architects, engineers, builders and municipal authorities labour, in the absence of a central authoritative testing laboratory or bureau, has been emphasized by many of the leading architects in Canada.

Mr. W. W. Pearse, City Architect and Superintendent of Buildings, Toronto, states:

"This department is at the present time at work on the revision of the city building by-law and we have found great difficulty in getting accurate data with reference to Canadian products which might be used in buildings in order to protect them from fire. If

I might suggest it, I think it would be an excellent thing if some central bureau could be maintained whereby the different municipalities could get full information with reference to the fire-resisting qualities and also the strength of the different materials used in buildings. In a great many cases, this department is forced to get its information either from the fire underwriters or from different cities located in the United States. This it appears to me to be a very poor policy to have to pursue. At the present time we are making use of the testing laboratories of the University of Toronto, but, unfortunately, this is closed to us during the time the school is in session."

The laboratories of the larger universities, such as McGill, Toronto and Queen's, and the testing laboratory of the Dominion Mines Branch, carry on excellent research work along many lines and are suitably equipped (not perhaps fully) for the examination and testing of structural materials and fire protective devices.* Architects and engineers frequently consult and submit materials to these laboratories, but, outside of the more important cities, there appears to be little advantage taken of the facilities they afford.

Underwriters' Laboratories Inc.

The standards formulated by the National Board of Fire Underwriters, New York, to which reference has already been made, specify that all materials, fire protection appliances and electrical equipment must be submitted for testing and approval to the Underwriters' Laboratories, Inc., of Chicago.† Under these standards, as adopted by underwriting organizations in Canada, it is essential that all materials and devices covered by the specifications should be approved at Chicago before recognition is given them by insurance companies.

* The Geology and Mines Act, 1907, assigns to the Mines Branch the function of carrying out chemical, mechanical and metallurgical investigations. At the outset, the scope of the work undertaken was limited by the capacity and equipment of the laboratories. Since 1910, the testing facilities have been largely increased. The fuel testing station for the analysis of natural and other combustible gases, etc., was opened in 1910 and this was followed in 1911 by a metallurgical laboratory. In 1912, chemical laboratories were installed and, in 1915, these were enlarged. A ceramic laboratory was also erected in 1915, with facilities for experimental work upon clays, structural materials in general, cement, concrete, building stones and sands for concrete making, foundry purposes and glass manufacturing. In a report upon the work of the laboratories the Director, Dr. Eugene Haanel, states that it is proposed to extend the scope of the technical investigations carried on and to provide suitable appliances and equipment for other lines of work which come under the statutory jurisdiction of the Mines Branch.

†Lists of approved materials, devices and equipment are issued semi-annually as follows:

(1) Electrical Wires and Fittings (in accordance with requirements of National Electrical code).

(2)) Mechanical Appliances—including structural materials and devices and gas, oil and chemical appliances.

Copies of these lists are procurable from the Underwriters' Laboratories, Inc., Chicago; National Board of Fire Underwriters, New York; and National Fire Protection Association, Boston.

In the absence of any other recognized authority, many municipalities also require similar approval, so that the Underwriters' Laboratories, Inc., decides, in a large measure, what materials and devices shall be used in Canada.

To appreciate rightly the work of the Underwriters' Laboratories, Inc., and the scope and character of its interests, it is necessary to review the methods it employs. The following statement by the manager, Mr. W. H. Merrill, outlines the objects and general procedure of the Laboratories:

"Underwriters' Laboratories, Inc., a corporation chartered in 1901, by the State of Illinois, is authorized to establish and maintain laboratories for the examination and testing of appliances and devices, and to enter into contracts with the owners and manufacturers of such appliances and devices, respecting the recommendation thereof to insurance organizations.

Its chief financial support has been received from the National Board of Fire Underwriters, under whose general direction the work is carried on.

The principal offices and testing stations are situated at 207 East Ohio Street, Chicago. The New York office is equipped for the conduct of examinations and tests of all electrical devices under the same conditions as those afforded at the principal office and testing station in Chicago.

Summaries of the Laboratories' reports are promulgated on printed cards filed according to classifications, and cabinets containing these cards are maintained at the offices of the principal Boards of Underwriters and Inspection Bureaus, at many of the general offices of insurance companies, by some insurance firms, and at the local offices of the Laboratories in larger cities.

The aims of the founders of Underwriters' Laboratories, Inc., were to secure the best and fairest opinion regarding the merits or demerits of every device, system, machine or material, in respect to life and fire hazards, and accident prevention, and to have the work so conducted and reviewed as to secure accuracy and uniformity in its findings. This object has been accomplished to such an extent that the majority of the underwriters in the United States and Canada, many state and municipal authorities, plant operators, and a large number of architects, building owners and users either accept or require a report from these Laboratories incident to their recognition of systems and materials having a bearing upon fire hazards or accident prevention.

As, manifestly, the regular subscribers to the Laboratories cannot be called upon to cover the expenses of tests made at the request of others, a system has been established whereby a manufacturer or owner desirous of securing an examination and report by the Laboratories on any particular device, system or material, is enabled to do so by first depositing a preliminary fee as evidence of good faith, and, on completion of the work, paying the balance of its cost. As a warrant that an applicant will not incur costs beyond his expectations, a limit of expense is fixed in each case beyond which charges are not made. By this means, an opportunity is afforded anyone at a comparatively low cost to secure the opinion of recognized authorities covering any device, system or material in its relation to fire hazards or accident prevention. The amounts of the fees are in proportion to the nature and extent of the work required in examinations and tests. The cost of experimental work is practically the same in each class of device, whether samples show superior or inferior qualities. The applicant's obligation to pay the charges is not, therefore, contingent upon the nature of the opinion rendered—whether favourable or otherwise.

The schedule of charges found necessary in the different branches of the work is arranged by groups, as follows:

	Amount of Preliminary Fee	*Total Cost to Applicant Not to Exceed*
Group A............	$100.00	$250.00
Group B............	50.00	100.00
Group C............	25.00	75.00
Group D............	10.00	50.00
Group E............	5.00	25.00

Group F—Under this group is classified experimental work and researches covering subjects or appliances for which standard requirements are not adopted. The amount of the preliminary fee is $100 and statements are rendered monthly as the work proceeds.

Whenever approval of appliances or materials is ready to issue, the favourable opinion, promulgated as above described, is followed up by one of the following three forms of supervision over goods marketed under the approval.

The oldest of these three forms is the Re-examination Service, in which the maker agrees, during the continuance of the approval, to pay certain fees annually (ranging usually from $5.00 to $30.00), with which the Laboratories defray the cost of obtaining samples in the open market or from the manufacturer and of making examinations and tests of the appliance one or more times yearly. Unsatisfactory features, if any are found as a result of the re-examination, are corrected by the maker on subsequent products.

The second form of supervision is the Inspection Service, which is regarded by the Laboratories' management as superior to the Re-examination Service and is applied, so far as possible, wherever the Label Service, later described, is not considered practicable. The Inspection Service includes regular and frequent examinations and tests of products at factories by Laboratories' engineers and the correction by the manufacturer of features found not in compliance with the standards of efficiency shown by the samples originally approved, together with supplementary examinations at the Laboratories of samples purchased in the open market or received from inspectors and users, thus affording counter-checks on the factory inspection work and determinations of the service value of the product.

The cost of the Inspection Service is billed monthly in each case to manufacturers.

The third form of supervision by the Laboratories is the Label Service. This is regarded by the Laboratories' management as the most efficient and satisfactory of the three methods and is being utilized to a greater extent each year. The Label Service consists of inspections of devices and materials at the factories by Laboratories' engineers, and the labelling of standard goods by stamps, transfers or labels, whereby they may be recognized wherever found; and, in addition, of systematic supplementary examinations and tests at the Laboratories of samples of labelled goods purchased in the open market or received from inspectors and users, thus serving to counter-check the efficiency of the factory inspection work and to determine the service value of the product.

For a number of industries this service now includes inspection of the product at factories, check tests on materials purchased in the open market, service value determinations by re-tests of samples which have been in practical use, and schedule estimates, showing comparative demerits noted on products. These elaborations are working to the decided advantage of all concerned, and are at all possible only under the labelling system.

The cost of this service is defrayed by charges made for the labels which vary according to the nature and extent of the inspection needed. In no case is the cost of the service sufficient to become a factor of importance in determining the selling price of the article labelled.

The activities of the Laboratories in Canada are mainly conducted by the Canadian Fire Underwriters' Association, with offices in Toronto and Montreal. Our London, Eng., office was established three years ago in response to recommendations contained in a report of the British Trade Commissioner in Canada rendered the Admiralty Office. We, at present, have application pending before the Secretary of State at Ottawa for organization of Underwriters' Laboratories, Inc., of Canada."

Criticism of Underwriters' Laboratories, Inc.

While the tests of the Underwriters' Laboratories, Inc., are conducted by able technicians and its findings recognized as authoritative, considerable criticism of the constitution, control and methods of the Laboratories has been made from time to time. Such criticism has been chiefly directed along the following lines:

(1) By means of the Underwriters' Laboratories, Inc., insurance organizations practically dictate what structural materials, electrical devices and fire protection equipment shall be used over the whole American continent.

(2) Manufacturers of any materials or apparatus not approved according to the highest standards of the Underwriters' Laboratories are unable to find a ready sale for their products.

(3) Manufacturers in Canada are forced to submit their products to a private corporation in the United States for approval

before placing them upon the Canadian market. British manufacturers are under an even greater disability in attempting to sell goods in Canada, for the absolute control vested in the Chicago Laboratories *may* be used as a means of discrimination against materials and devices not of United States manufacture.*

Mr. Powell Evans, organizer of the First American Fire Prevention Convention, Philadelphia, 1913, member of the National Fire Protection Association, and representative of United States manufacturing interests, in referring to the operations of the Underwriters' Laboratories, states:

"Suppose a manufacturer of electrical appliances wants to market a new switch to control electric light current. He finds no profitable market for such device unless it is 'approved' by the insurance underwriters having jurisdiction all over the country. When the manufacturer begins to investigate what he should do to get this insurance approval he is directed to send his device to the Underwriters' Laboratories, Inc., of Chicago. In the Laboratories they submit such appliances to analysis and test based on their experience and judgment. If the engineers and managers of the laboratory decide on a satisfactory report, they then submit it, with a sample of the device to their Council, made up of men, who, with one or two exceptions are all primarily occupied in the fire insurance field.† Unless the manufacturer can get this approval he cannot in practice make much of a success of his business.

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* Amongst the many thousands of manufacturers of approved materials and devices (lists of April, 1917 and July, 1917), 47 Canadian firms only are listed as manufacturing labelled goods and 11 of these are branches of United States concerns. The number of Canadian companies manufacturing approved materials are as follows: sprinkler-heads, 1; chemical extinguishers, 3; fire hose, 4; fire doors, shutters, window frames and hardware, 20; time clocks, 1; acetylene generators, 1; gasolene storage tanks, 1; electrical wires, fixtures and appliances, 16.

† The Underwriters Laboratories, Inc., Council consists of: F. E. Cabot, Secretary, Boston Board of Fire Underwriters, Boston; Gorham Dana, Manager, Underwriters Bureau of New England, Boston; †Col. B. W. Dunn, Chief Inspector, Bureau of Explosives, New York City; C. M. Goddard, Secretary, New England Insurance Exchange, Boston; H. H. Glidden, Board of Underwriters of Chicago; A. W. Hadrill, Canadian Fire Underwriters Assn., Montreal; E. B. Hatch, The Union, Chicago; H. C. Henley, St. Louis Fire Prevention Bureau, St. Louis; C. A. Hexamer, Secretary, Philadelphia Fire Underwriters Assn., Philadelphia; W. E. Mallalieu, Manager, National Board of Fire Underwriters, New York; W. H. Merrill, Manager, Underwriters Laboratories Inc., Chicago; E. F. Mohrhardt, Secretary, Board of Fire Underwriters of the Pacific, San Francisco; E. A. Northey, Manager, New England Bureau of United Inspection, Boston; H. L. Phillips, Manager, Factory Insurance Association, Hartford; R. G. Potter, Secretary, Underwriters Association of the State of New York, Syracuse; W. O. Robb, New York Fire Ins. Exchange; W. C. Robinson, Chief Engineer, Underwriters Laboratories Inc., Chicago; T. B. Sellers, Manager, Ohio Inspection Bureau, Columbus; W. A. Stoney, Manager, Underwriters Bureau of the Middle and Southern States, New York; F. J. T. Stewart, New York Board of Fire Underwriters, New York City; †Dr. S. W. Stratton, Director, Bureau of Standards, Washington; Louis Wiederhold, Secretary, Underwriters Assn. of the Middle Department, Philadelphia.
Persons whose names are marked with dagger (†) are not connected with the fire insurance business.

"This control does not stop at the test of the physical unit. It is extended to requiring an applicant to materially expose his business, financial and commercial, to them; and conduct it in accord with their policy as regards the production of approved devices. The Underwriters' Laboratories, Inc., also widely control the continuous factory production of all 'approved' devices and products by the application of the 'label' service applied to all units of production under agreement, which is intended to be a public notification that everything so labelled has been inspected and found up to the standard of its original approved prototype. Any disagreement arising with manufacturers in the conduct of the 'label' service is submitted to arbitration. . . . .

"'Underwriters' Standard' is required by the majority of all underwriters, stock and mutual, as a basis for favourable rates; and non-standard appliances and practices are altogether rejected or penalized in the rate. There is virtually complete insurance concert of purpose and action in this control, otherwise it would prove abortive. The system is highly practical and effective; has been the only competent, critical agent in the matter, and has proved to be a powerful factor in advancing the cause of fire prevention and protection. Like every other human agency, however, it has developed some correctable abuses because of the intensely expert and little understood nature of the business, and the fact that all laboratory authority is lodged in a limited and intimate circle of men owing primary allegiance to some insurance interest. To date it has been a purely commercial despotism—benevolent in the main but despotism still—which is also measurably one-sided. This control lies at the heart of the insurance engineering system; is faithfully and continuously applied by the entire underwriting activity; and virtually covers and materially affects all created property of buildings and contents throughout the United States and Canada—without the owners of property really understanding the fact and without government regulation of any kind to date—National, State or local."

The disabilities of Canadian and British manufacturers in being obliged to submit their products to a United States tribunal before marketing in Canada was the subject of a report to the British Board of Trade in 1913 by C. Hamilton Wickes, British Trade Commissioner in Canada. After investigation, the conclusions reached were, in part, as follows:

"The experimental work carried out by the Laboratories, their method of reports and labelling approved articles, is no doubt advantageous not only to the fire insurance companies but also to the American manufacturer carrying on business in the United States. I would also be prepared to concede that the Laboratories are desirous of not placing difficulties in the way of the foreign manufacturer utilizing the facilities offered by them. It is, nevertheless, an intolerable state of affairs that British manufacturers as well as Canadian, should be compelled to send samples and particulars of their goods to a foreign corporation to be approved or rejected before they are able or permitted to do business in a portion of the British Empire, namely, the Dominion of Canada.

The Laboratories are officered by consulting and other engineers, expert in regard to various lines, and it may be conceded that they exercise a wise and discriminating care in the carrying out of their duties in regard to American manufacturers, but, when it comes to experimenting and testing articles of British or European manufacturers, devised on different lines and manufactured to standards other than the rules and requirements laid down by the National Fire Protection Association, under which the Laboratories carry out their work, the technical staff without any experience in regard to the reliability of the articles submitted not infrequently find themselves obliged to withhold their authorization. To this, the British manufacturer very properly objects and he feels the more indignant when he is aware that his manufactures in every way meet the more stringent requirements in other parts of the world. I think he should be supported in this objection unless, indeed, we are prepared to concede that the United States engineer is the repository of all the wisdom in the world in regard to every class of article, appliance, system or device dealing with fire hazard which has been or is to be invented in the world."

As a result of the foregoing enquiry and report, the Underwriters' Laboratories established a branch office in London, England, to deal with goods of British manufacture. More recently, owing to considerable dissatisfaction on the part of United States manufacturers as to the propriety of a private corporation formulating standards which are, in many cases, enforced by public officials, and arbitrarily approving or condemning materials and devices of general utility, arrangements were made by which the United States Bureau of Standards becomes a reviewing authority upon any findings in dispute. The Bureau is also represented on the Underwriters' Council, which directs the policies of the Laboratories. Dr. S. W. Stratton, Director of the Bureau of Standards, thus defines how such appeals are dealt with:

"Our method of handling such appeals is to appoint a committee of three or five from our scientific and engineering staff. This committee holds public hearings if necessary, collects independent testimony and arranges for, or itself carries out, special experimental work where that is deemed necessary or advisable.

The arrangement for this co-operation is in no sense a legal one, but is purely voluntary. We are hopeful, however, that it will solve many causes for complaint by making available an appeal from the decisions of a private laboratory, where such decisions often have a very important public bearing, or may seriously affect manufacturers' interests."

Despite certain unfavourable features connected with the control and operation of the Underwriters' Laboratories, great credit is undoubtedly due to insurance companies for their initiation and support of the work. Little or no attempt has been made by other bodies, public or private, to provide facilities for determining the qualities of materials and devices or to set up and apply standards of safety from fire. Underwriters' requirements constitute the only potent influence in the United States and Canada directly aimed at the control of fire waste through improved construction, equipment and protection of buildings. The excellence of the work thus accomplished by private enterprise is worthy of emulation in order that its scope and its public benefits may be enlarged. This view appears to be the one taken by Canadian insurance interests as expressed by Mr. W. B. Meikle, General Manager of the Western and British America Assurance companies: "The fire insurance companies are really only doing—and at their own expense—what we conceive it is the duty of the government or other public body to do, and when a public body will do the work the insurance companies will be glad to stand aside."

The desirability of government action in regard to the testing of structural materials and the formulation of basic standards appears to be widely recognized in Canada. Architects, engineers and municipal authorities state that absolutely unbiassed and reliable conclusions will never be available until they are derived from experiments conducted by an independent and thoroughly equipped organization such as the government alone can maintain. The Canadian Society of Civil Engineers has repeatedly urged upon the Dominion Government the necessity for establishing a national laboratory, but, so far, without success. A special committee of the Society reported in 1914 as follows:

"As the establishment of a government testing laboratory is in the hands of the Government there is little that we have been able to do, except to urge its necessity both for the Government and the public. The Minister of Public Works has been asked to place an appropriation in the estimates for testing laboratories. It was pointed out that the definite information acquired through testing laboratories for the use of all the Government departments interested in Canadian structural materials would be of great practical as well as scientific value, and that, should the Government follow the example of other countries in this respect, it could not fail to ultimately add to Canadian prestige in keeping abreast of the times. In reply, the Minister of Public Works stated, "I will be glad to do whatever I can in the matter to which you refer." The Deputy Minister of Public Works also expressed himself in sympathy with our recommendations. Our Committee recommends that, as the establishment of a government testing laboratory is a matter depending solely on the action the Government may see fit to take, the Council should keep the matter before the Government by writing frequently to the Minister of Public Works, drawing attention to the importance to the country, as well as the Government, of a laboratory such as they alone would be in a position to equip and maintain, and, when definite action is taken by the Government, that a Committee be again appointed to assist the Government in any way desirable, should they wish the co-operation of our national Society."

U.S. Bureau of Standards

In the United States, all matters pertaining to physical standards come within the jurisdiction of the Bureau of Standards, Department of Commerce. Testing of all classes of materials is undertaken and the Bureau is regarded as the final authority in questions concerning which there may be dispute. The scope of the work conducted by the Bureau is thus described by Dr. E. B. Rosa, Chief Physicist:

"The United States Bureau of Standards is the largest national standardizing institution in the world, and its equipment and the scope of its work are, in many respects, unique. Official tests for the Federal and State Governments and institutions are made without charge, but stated fees are levied for private investigations. The extent of this private work is limited to such as cannot be satisfactorily conducted by private agencies. Competition with consulting engineers and other laboratories is, therefore, obviated as far as possible. On the contrary, by publishing the methods and results of investigations, an attempt is made to assist engineers in private practice. The Bureau tests all instruments used by the Federal Government, building materials for the supervising architect's office, articles of commerce for the customs service, supplies for the government printing office and post office and electrical equipment for all departments of the government. It establishes the official standards of weight, length, volume, mass, electrical quantities, magnetism, heat, light and other magnitudes, furnishes standard samples of ores, metals and alloys to individual chemists and calibrates thermometers, pyrometers, calorimeters and other heat-registering instruments for scientists, manufacturers and engineers. Practical investigations are conducted in connection with the use of structural materials, steel rails and car equipment, bridge members, thermo-insulation for cold storage, fire resistance of materials, hazards of electrical devices and equipment, electrolytic action on water and gas distribution services, general engineering questions involved in regulation of public utilities and numerous other problems of a scientific character. In co-operation with municipalities and public service commissions, work of the greatest importance and magnitude is undertaken."

In Canada, the Dominion Government, as one of the largest consumers of materials, and, as being vitally interested in the permanent values of the country, should be in a position to conduct reliable tests in order to establish the physical qualities of materials and their adaptability for various specific uses. The engineering data resulting from such investigation would definitely answer many important questions about which there are differences of opinion, and would furnish a basis for the proper regulation of building construction in Canada. It is not suggested that the Dominion Government should seek to impose its findings on local authorities, but it is obvious that the investigations made and standards promulgated by so competent an authority would ensure their widespread adoption. To obviate any difficulties in this connection, however, investigations might be undertaken for the ostensible purpose of determining standards for government work following the lines upon which the United States Bureau of Standards was first established. These findings could then be voluntarily adopted, legalized and enforced by local or provincial governments.

CHAPTER VII

Private Fire Protection

IN any plan designed to control fire waste, consideration must be given to the protection of buildings and their contents by means of fire-extinguishing equipment. Constructional features, while providing the fundamental elements of safety, do not guarantee immunity from fire. Moreover, the most stringent requirements in regard to building construction are powerless to effect any radical or immediate change in present structural conditions. Whatever their faults, it is essential that existing buildings should be adequately protected as they stand. The greater their defects and consequent hazard, the more urgent such protection becomes. Even where a building has been especially designed with a view to fire resistance, active means for the detection and extinction of fire should supplement and make effective the more passive structural qualities. It should not be forgotten, also, that almost two-thirds of the total fire waste in Canada is caused by the destruction of the contents of buildings, and that an incombustible structure does not impart fire-resistance to its contents.

If all fires were detected in their early stages and promptly extinguished, it is obvious that the fire waste problem would not exist. Lack of proper facilities for controlling small fires, or neglect to use them when provided, is responsible for the majority of large and costly fires.* During the years 1912–1915, over 30 per cent of the total fire loss in Canada was occasioned by 297 fires. Not a week passes without the newspapers publishing an account similar to the following:

"NEW GLASGOW, N.S., Sept. 19, 1917.—Shortly after seven o'clock this morning, when the large plant of the Eastern Steel Company at Trenton was filled with a host of workers, fire

*Fires in costly buildings often reveal that complete reliance has been placed on the protection afforded by municipal fire department service and no attempt made to provide local facilities for first aid. There are few instances where it is impracticable to provide these means of auxiliary protection. There are still fewer, if any, where such protection would not prove its value in the case of fire. —*Engineering News*, May, 1907.

suddenly broke out in the machine shop. Resin, gasolene, oil and waste instantly burst into flame. In a short time the shop, which was filled with the finest machines for finishing shells, was a mass of ruins. The building, a steel and concrete structure, was totally destroyed. The fire departments of New Glasgow and Trenton did good work to keep the fire confined to the one building. The loss is estimated at $125,000, almost covered by insurance."

The occurrence of such fires may or may not be preventable, but for their extent there is no excuse. If modern fire-extinguishing appliances are available, as large a loss as $100,000 should not occur.

Limited Efficiency of Fire Departments

The necessity for providing adequate fire-extinguishing equipment in all large buildings is shown by the inability of fire departments to handle many fires with which they are called upon to cope. In the best protected cities in Canada, over 60 per cent of the average fire loss results from a few extensive fires in business premises. Unquestioned efficiency when dealing with fires in small buildings is often partial, if not complete, impotence where large properties are concerned. Since the advent of high buildings and large floor areas for mercantile and manufacturing purposes, it has become plain to those actively engaged in fighting fires that even the best equipped brigade is tremendously handicapped in its work.*

Modern fire department apparatus is of limited value for fire-extinguishing purposes at a greater height than 70 or 80 feet, while in dangerous risks or buildings of large area its efficiency is even less. The New York City fire department, which is rated as one of the best in America, has many times found it impossible to combat fire successfully above the eighth storey of a burning building. At the enquiry into the Asch Building disaster in 1911, Chief Croker testified that the firemen were helpless in attempting to deal with fires over 85 feet above the ground. Giving evidence before the

*The fire in the Equitable building, like those in the Parker building, Triangle Shirtwaist factory and Alwyn Court apartment house, calls attention to the inability of any fire department to effectively fight a fire which has gained headway in the upper storeys of a building lacking such essential fire appliances as an adequate standpipe equipment in conjunction with smoke proof towers. The height of buildings should be limited in proportion to the effectiveness of their fire protection, if life and property are to be preserved.—*Report on Fire in Equitable Building, New York, 1912*, by New York Board of Fire Underwriters.

New York City Heights of Buildings Commission, 1913, Chief Kenlon stated:

"Fire protection cannot be afforded buildings from the street level to a greater height than about 100 feet. A higher nozzle pressure than that required to force water to this level is impracticable. Buildings higher than 85 feet should all have standpipes and automatic sprinklers."

Early Discovery Necessary

The extent of any fire is largely a matter of the time that elapses between its discovery and the first attempt at extinguishment.* Upon the average, paid fire departments in Canadian cities are on the spot ready for work three and a half minutes after the receipt of an alarm; but even this is often too late. In the year 1915, of 4,874 fires attended by municipal fire brigades, 49 per cent was extinguished by small chemical extinguishers and pails of water in the hands of firemen, 31 per cent by chemical apparatus, 12 per cent by the use of one hydrant stream and only 8 per cent required two or more hydrant or engine streams. These figures clearly indicate the small part played by hose streams in the work of extinguishing fires and that the individual must rely more and more on self-protection.

Types of Protective Equipment

Even the best building construction and the most efficient public protection should be reinforced by auxiliary appliances. In villages and rural districts lacking any organized form of public fire protection, it is obviously essential that all buildings should be reasonably equipped with some means of dealing with fire. The installation of such safeguards as automatic sprinklers, interior standpipes, chemical extinguishers and automatic fire alarms ensures maximum security by (a) detecting fire immediately it occurs; (b) providing means whereby the occupants of buildings may cope with incipient fires; (c) assisting fire departments under circumstances where their effective operations may otherwise be limited, and (d) preventing panic and possible loss of life in crowded buildings.

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*Since minutes are as hours where the spread of fire is concerned, are the occupants of a structure working orderly and effectively to quench the fire by means of appliances provided for such an emergency, or is the fire left in indisputable sway, because, forsooth, the fire department will soon arrive and be all sufficient?—J. K. Freitag in *Fire Prevention and Fire Protection.*

Enumerated in the order of their relative importance and value, the principal protective devices are as follows:

1. Automatic sprinklers which both detect and extinguish fire.
2. Automatic fire alarms which discover but do not extinguish fire.
3. Watchmen.
4. Standpipes, chemical extinguishers, private hydrants, fire pails and auxiliary fire alarms, all of which are dependent upon manual operation.
5. Private fire departments.

Automatic Sprinkler Protection

Statistics show that the majority of fires are discovered by the occupants of buildings and passers-by. During the night, when business and industrial premises are vacated and passers-by infrequent, these agencies are obviously unreliable. Hence, the importance of some device which, independent of human assistance, will promptly discover and control a fire at its point of origin. Of all the devices designed for fire protection, the automatic sprinkler alone meets these fundamental requirements. It operates automatically in the precise location of a fire, distributes the least possible amount of water to control it and simultaneously gives notice of the occurrence at any desired point. "It is on duty twenty-four hours a day and 365 days a year. It works as well in smoke and out-of-the-way places as in the open, reaches fire where men with hose could not live and pours water into sections out of the range of fire streams. The automatic sprinkler has revolutionized the science of fire-fighting and has been the main factor in bringing about the control of fire hazard."*

Records show that sprinklered properties in Canada number about 1,800 and that systems are being installed at the rate of about two hundred a year.† The General Fire Extinguisher Company states that in North America more than 35,000,000 sprinklers safeguard 2,000,000 lives and $6,000,000,000 of insurable values from fire. It is estimated that, during the last thirty years, sprinklers

*E. V. French, Vice-President, Arkwright Mutual Fire Insurance Company.

†The installation of sprinklers has increased most markedly in large mill and manufacturing centres, especially where the New England Factory Mutual Insurance companies are operating. For this reason, the eastern states have been a prolific field. In Canada, the province of Ontario is greatly in advance of the rest of the Dominion in the number of sprinklered properties.

DELAY IS FATAL IN FIGHTING FIRES

Firemen are frequently hampered by wooden shanties that prevent ready access to the sides and rear of large buildings in congested districts. In this fire, a few minutes delay was responsible for a loss of $200,000. Automatic sprinklers would have controlled the fire with little or no damage.

have checked and conquered over 35,000 fires, saved more than $700,000,000 worth of property from destruction, rendered possible insurance savings of $800,000,000 and have also saved many lives.

Principle of Operation

An automatic sprinkler system may be described as an arrangement of pipes regularly spaced throughout a building for the purpose of distributing water by means of valves, technically termed 'heads', so adjusted as to open when undue rise of temperature occurs. The water supply is constantly maintained under pressure from elevated tanks, pressure tanks, pumps or city mains. The valves or heads on the distributing pipes are spaced to protect every 80 or 100 square feet of floor space and are normally closed by means of a fusible metal attachment designed to open at temperatures varying from 165 to 360 deg. Fahr. according to the character of the building protected. A single sprinkler head at 30 pounds pressure per square inch will discharge as fine spray about 30 gallons of water per minute and, in the majority of cases, will completely and immediately extinguish an incipient fire.

The various types of sprinkler equipment in use comprise: (a) automatic wet pipe systems, in which the water is constantly maintained under pressure and (b) automatic dry pipe systems, in which the water is held back from the distributing pipes by air pressure. This system is designed for use in situations where the wet pipe arrangement is inadvisable.*

General Requirements

While it is not considered necessary to enter upon a detailed description of automatic sprinkler equipment and its installation, it may be of value to enumerate a few of the more general requirements. The efficiency of such installations depends upon: (1) The design of the building; (2) spacing of the sprinklers; (3) suitability of the sprinkler heads for the building in which they are installed; (4) capacity of the distribution pipes; (5) adequacy of water supply both as regards volume and pressure; (6) proper equipment of system with valves; and (7) maintenance of the system under competent supervision.

Under these heads, the particular features demanding consideration are briefly as follows:

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*The latest rules with regard to standard sprinkler systems may be obtained from the National Board of Fire Underwriters, New York, or the Underwriters' Associations having jurisdiction in Canada.

Types of Buildings

1. The type of building protected does not materially affect the efficiency of sprinkler equipment and its introduction into second-class buildings renders them as satisfactory from a fire standpoint as first-class buildings.* To obtain the best results, however, it is essential that buildings should be constructed without hollow walls and floors or concealed spaces, and have vertical openings enclosed.

Spacing of Sprinkler Heads

2. A fundamental requirement of sprinkler protection is that the sprinkler heads be distributed to properly cover the entire premises. If a sprinkler head is not near the point of origin, a fire may quickly develop an intensity beyond the power of many sprinkler heads to control. Experience teaches that sprinklers are often necessary where seemingly least needed. They should be placed inside enclosures and under platforms and benches, and stock should be so piled that the distribution of water may not be obstructed. Standard spacing is designed to give one automatic sprinkler head to every 80 to 100 square feet of ceiling surface, so that there must be one overhead within approximately 5 feet of any place where fire could occur.

Fusibility of Sprinkler Heads

3. An automatic sprinkler head of the ordinary type melts at from 155 to 165 degrees Fahr. For situations where this temperature is liable to be exceeded, such as engine rooms or near steam pipes, heads fusing at 212 to 360 degrees are employed.

Size of Piping

4. The size of piping employed in sprinkler systems follows a uniform standard schedule in use throughout the United States and Canada. The number of sprinkler heads permissible on various sizes of pipes are as follows:

Size of pipe	*Sprinklers permitted*
¾ inch	1
1 "	2
1¼ inches	3
1½ "	5
2 "	10
2½ "	20
3 "	36
3½ "	55
4 "	80
5 "	140
6 "	200

*It has frequently been objected that sprinkler protection has had a deterrent effect upon improved construction. Under present insurance practice, ordinary buildings sprinklered are granted a much lower rate than fireproof buildings unsprinklered. This is, of course, due to the fact that construction is of minor importance if fires can be extinguished in their first stages. Sprinklers also protect contents while fireproof buildings do not.

The size of the riser—a vertical pipe feeding the distribution pipes—must be capable of supplying all the sprinkler heads on any one floor. Where the number of sprinklers on one floor exceeds the maximum provided for in the schedule, two or more 6-inch risers must be provided.

Water Supply

5. The water supplies for sprinkler service may be furnished by (a) public water works; (b) private reservoir; (c) gravity tank; (d) pressure tank; (e) pumps. For a standard installation, two independent sources of supply are considered essential in order that one may be always immediately available. At least one of these supplies must be automatic and be capable of furnishing water under heavy pressure. The primary supply in cities and towns is invariably provided by the public water mains and the secondary supply usually consists of an elevated gravity tank. For isolated buildings in country districts where public water supplies are not available, a desirable combination is a pressure tank or gravity tank and steam pump.

The supply of water to sprinkler systems from public water works should be sufficient to give a static pressure of at least 25 pounds at the highest line of sprinklers. Water meters or pressure-regulating valves should never be used upon sprinkler systems as all such devices introduce friction and decrease the flow of water.

Gravity tanks should be placed so that the bottom of the tank is not less than 20 feet above the highest line of sprinklers in a building. Underwriters regard 10,000 gallons as the minimum capacity for gravity tanks but urge 20,000 gallons for all except small buildings. On the assumption of 20 gallons flow per minute, this would feed 40 sprinklers for 25 minutes. For buildings of very combustible construction, hazardous occupancy or where city water supply is not available, a capacity of 25,000 to 100,000 gallons is often desirable.

Air pressure tanks should have a minimum capacity of 4,500 gallons. When two-thirds full of water, an air pressure should be maintained sufficient to ensure a water pressure of not less than 15 pounds at the highest line of sprinklers.

Steam fire pumps, if properly designed and installed, form one of the most reliable supplies for automatic sprinklers. The standard steam fire pump is a duplex, double-acting, plunger pump of 500 to 1,500 gallons capacity, especially designed for quick operation. Rotary pumps are used to some extent in factories in country districts where water-power is available, but, being unreliable, they cannot be recommended. The recent development and utilization of electric power throughout Canada has created a large demand for electric pumps for fire protection purposes. Those in common use are of the rotary cam or centrifugal multi-stage types and they have generally proved satisfactory, although they are, of course, only as reliable as the supply of power by which they are operated. For all types of fire pumps a minimum supply of at least 100,000 gallons of water should be provided for every 1,000 gallons pumping capacity.

In cities and towns protected by municipal fire departments, all sprinkler systems, whatever the source of water supply, should be provided with outside connections, permitting the direct attachment of fire engines. Automatic sprinklers are far superior to hose streams in applying water directly to the seat of a fire, especially in buildings difficult of entry by firemen.

Records comparing the reliability of various forms of water supply show that the greatest number of fires satisfactorily controlled by sprinklers have occurred in buildings supplied from public service mains.

Valve Equipment

As numerous extensive losses have been occasioned through the impossibility of reaching inside valves which were closed for repairs at the time of the fire, outside main valves are regarded by many authorities as preferable. In buildings where the contents are susceptible to water damage, such as department stores, gate valves are invariably provided to control each floor.

Automatic alarm valves to give immediate notification that the sprinkler system is operating are rendered necessary by two important considerations: (1) sprinklers cannot, in all cases, furnish complete protection, and other agencies are necessary to finish the work of extinguishing a fire; (2) sprinkler heads open automatically but cannot be automatically shut off, and consequently water continues to flow until the supply is exhausted or the controlling valves are closed by hand.*

The dry pipe system of sprinklers is usually installed in buildings where a wet pipe system would freeze. In the dry pipe system, the distributing pipes are filled with air under pressure sufficient to operate a valve situated at the main riser. This valve holds the water back until the air pressure is reduced by the opening of a sprinkler head, when, the valve being released, the water enters

*'Sprinkler leakage' insurance or insurance against accidental flow of water from sprinkler heads is written in connection with practically all sprinklered buildings, but the insurance companies absolutely require the provision of approved alarm valves.

the distribution pipes and finds outlet at the open head in the same manner as in the wet pipe system. Dry pipe systems are not recommended, except under circumstances or in situations where the wet pipe system is impracticable. The air valve has proved difficult of adjustment, and in cold weather demands special precautions to prevent freezing. The air in the distribution pipes, unless perfectly dry, is subject to condensation, especially in cold storage plants, and this gives rise to numerous troubles. In addition, the time that elapses between the opening of a sprinkler head until water is available—under average conditions, one to two minutes—is the vital time in which a fire is making rapid headway.

Importance of Supervision

7. The value of sprinkler protection is entirely dependent upon effective maintenance. Statistics of fires in sprinklered buildings show conclusively that the greatest losses have been due to the system being inoperative at the critical moment, through causes remediable by intelligent supervision. The following table, compiled from the records of the National Fire Protection Association, gives an analysis of all unsatisfactory sprinkler fires in the United States and Canada during the period 1897-1917.

Analysis of Unsatisfactory Sprinkler Fires in Canada and United States, 1897-1917

	No. of fires	Per cent
Water shut off sprinklers	230	27.0
Unsprinklered portions and defective heads	195	22.9
Defective water supply or supplies	84	9.9
Sprinkler system crippled due to freezing	18	2.1
Slow operation of dry system or defective valve	18	2.1
Slow or defective operation of high test heads	15	1.8
Faulty building construction, concealed spaces, vertical openings, etc.	39	4.6
Obstruction to distribution	53	6.2
Hazard of occupancy too severe for average sprinkler equipment	39	4.6
Explosion crippled sprinkler system	35	4.1
Exposure or conflagration	63	7.4
Miscellaneous	34	4.0
Not classified	31	3.3

The points requiring particular attention in maintaining the efficiency of sprinkler equipment are as follows:

(a). Sprinkler gate valves must be kept open. This is axiomatic because a sprinklered building with the water cut off is obviously an unprotected building. Yet more than 27 per cent of "sprinkler failures" recorded has been due to closed valves, sheer negligence being the contributory cause in the majority of instances, as shown by the following table:

Causes of Closed Sprinkler Valves, 1897-1917

	No. of fires
Unknown reason, negligence or carelessness	92
Shut off before fire was out	38
Accidents and repairs	37
To prevent freezing	39
Probably incendiary	11
Leak in dry system	3
Defective gate valve	8
Miscellaneous	2

(b). Frozen water pipes are a prolific source of trouble. It is a fundamental requirement that all buildings equipped with wet pipe sprinkler systems shall be adequately heated. Dry pipe systems should be carefully drained so that no water may collect in the pipes.

(c). Without ample water supply, sprinkler heads are useless, and conversely, the best water supply is valueless if the automatic heads fail to operate in the event of fire. Prevention of corrosion and accumulation of dirt and dust upon sprinkler heads is of vital importance. In situations where the system is exposed to corrosive vapours, special heads should be installed.

(d). Repairs to sprinkler systems should be carried out by competent mechanics under proper supervision. "Of the many valves found closed by inspectors, probably most of them are due to repairs, whoever did the work having forgotten to open them. Frequently weeks elapse before the omission is discovered."*

(e). Regular inspection of all the vital parts of sprinkler installations, preferably at weekly intervals, should be carried out by property owners or responsible employees under their direction.

Supervisory Service

Contingencies adversely affecting the proper operation of sprinkler systems, such as closed valves, low water levels, frozen pipes and inadequate water pressures, may be guarded against, in all the larger cities, by central station supervision. Electrical devices attached to every vital part of an installation transmit signals to a central station operated by a private company and immediate investigation is made whenever

*Henry A. Fiske.

abnormal conditions are indicated. These companies, as part of their service, regularly inspect installations and conduct working tests of all parts liable to get out of order. The operation of central station signal systems is dealt with more fully in a subsequent paragraph.

Efficiency of Sprinkler Protection

The general reliability and efficiency of sprinkler systems is shown by the record of fires in sprinklered buildings. The most complete statistics available are those compiled by the National Fire Protection Association which include practically every fire that has occured in the United States and Canada during the last twenty years. From 1897 to 1917, the record shows that of 18,795 fires, 12,194 or 64.8 per cent were extinguished and 5,750 or 30.6 per cent satisfactorily controlled by sprinklers. Only 851, or 4.5 per cent of the total number, could be termed unsatisfactory and these were largely due to human interference.* In other words, sprinkler protection shows an average efficiency of over 95 per cent under all conditions of service.

The number of sprinkler heads opening in each fire recorded is given in the following table:

No. of sprinkler heads opening	*No. of fires, 1897–1917*	*Per cent of fires extinguished*
1	5,772	31.5
2	3,005	16.4
3	1,879	10.3
4	1,348	7.4
5	871	4.8
6	735	4.0
7	463	2.5
8	477	2.6
9	313	1.7
10	273	1.5
11 to 15	978	5.4
16 to 25	813	4.4
26 to 50	635	3.4
51 to 100	333	1.7
Over 100	426	2.3

From these figures, it appears that 84 per cent of the fires was extinguished by the opening of less than ten sprinkler heads, or with approximately less water than is discharged by a single fire department standard hose stream.

The Boston Manufacturers Mutual Fire Insurance Company states that, between 1897 and 1912, its loss upon over $3,300,000,000 of sprinklered property insured was only $1,200,000 or 3½ cents per hundred dollars. During the same period, the average annual cost of insurance to the property owner was approximately 6½

*See table, Unsatisfactory Sprinkler Fires, page 197.

cents per hundred dollars. The company furthermore presents the following tabulation showing its experience for sixty-one years:

Years	Amount of insurance written	Losses incurred	Loss per $100 insured
1850–1875	$ 406,284,000	$1,027,536	$0.25
1876–1895	1,551,259,000	2,809,203	0.18
1896–1911	3,416,225,000	1,241,062	0.03
	$5,373,768,000	$5,077,801	0.09

The years 1850 to 1875 represent the period during which plants were unsprinklered; 1876 to 1895 the period in which plants were being equipped, and 1896 to 1911 the period when all risks were fully protected. The manner in which the gradual improvement affected the cost of insurance to property owners is shown in the following statement arranged by ten-year periods:

Years	*Average rate per $100*
1850–1860	$0.43
1861–1870	0.27
1871–1880	0.25
1881–1890	0.22
1891–1900	0.14
1901–1910	0.06

This record, it must be remembered, is confined to manufacturing properties consisting largely of textile mills and boot factories, which are considered especially hazardous risks. A more general experience is covered by figures dealing with 14,454 fires in sprinklered buildings, compiled by the General Fire Extinguisher Company. In 8,553 of these fires, no insurance claim was made. In the remaining 5,901, the average loss per fire was $272, as compared with an average of $7,361 in unsprinklered factory risks insured by mutual companies.

Protection of Life

The automatic sprinkler has proved equally as efficient in the saving of life as in the protection of property. According to statistics covering the last twenty years, less than one hundred lives have been lost through fires in sprinklered buildings in the United States and Canada.* Addressing a recent convention of the National Association of Cotton Manufacturers, L. H. Kunhardt, Vice-President of the

*In 1910, a gravity tank on the roof of the Herald Building, Montreal, collapsed, killing 35 employees, the building being subsequently destroyed by fire.

On December 11, 1916, eighteen lives were lost in an explosion and fire that destroyed the plant of the Quaker Oats Company, Peterborough. These fatalities, although they occurred in sprinklered buildings, were not actually caused by fire.

Boston Manufacturers' Mutual Fire Insurance Company, emphasized this aspect of automatic sprinkler protection as follows:

"The records of the Boston Manufacturers' Mutual Fire Insurance Company show that since the beginning of the factory mutual system in 1835, there have been but 35 lives lost in our factory fires, 23 of these being in an unsprinklered mill in 1874, before the automatic sprinkler was available for protection. Of the remaining 12 (all occurring since 1874), 3 were killed by going back into a building to save personal effects at a fire in 1907, and 4 were men of public fire departments killed in the performance of their duty. This leaves only 5 who were not able to save themselves, in a period of 39 years to date."

The record of the automatic sprinkler as an agency for the safeguarding of human life is not, however, confined to factory buildings. Fire Commissioner Adamson testifies that no life has ever been lost in New York city in a sprinklered building of any class, and Ex-Chief Croker, of the New York fire department, states that "Sprinklers have proved their worth over and over again and the modern office building, factory, warehouse, store, school, institution, theatre or hotel that is without them lacks one of the most practical checks upon fire which has been devised."

Fire prevention engineers unanimously agree that holocausts like the Binghampton fire, with its 31 fatalities, the Triangle Shirtwaist Factory fire, with its toll of 135 dead, the Iroquois Theatre fire, where 786 perished, and the Collinwood school fire, in which 176 children lost their lives, need not have occurred and should never be permitted to recur. "There is one way to safeguard human life from fire that is absolutely certain—the automatic sprinkler system. The only objection that can be raised to it is one of expense, but is human life so cheap that society will longer allow it to be balanced against dollars and cents? The time has come when the Government should compel automatic sprinkler installations the same as it does fire escapes in factories and automatic couplers on railways. It is a question of public policy and the Government should not longer ignore its duty."*

With such substantial evidence of the efficiency of automatic sprinklers in protecting life, it is perfectly justifiable to maintain that all buildings in which large numbers of people gather for work and recreation, and all institutions in which the sick, blind, aged, criminal and insane are confined, should be so equipped. In countless emergencies, external fire escapes and other legally prescribed

*Arthur E. Larter, Vice-President American Fire Insurance Company, Newark, N.J.

means of exit have proved useless. Safety by rapid exit from a building depends entirely upon the self-possession of the occupants and the time at their disposal. These factors do not, however, affect the situation where automatic sprinkler protection is provided. By operating independently of human assistance, and checking even where they cannot immediately extinguish fire, automatic sprinklers guarantee the greatest possible security against loss of life.

Saving Effected on Insurance

That there is a cash return for practically all expenditure upon fire protective apparatus through reduced cost of insurance cannot be questioned. Reference to underwriters' schedules shows the following specific allowances in rate per hundred dollars insured, for provision of the more common auxiliary appliances:

Chemical fire extinguishers, casks of water and fire pails		5 cents
Standpipe, with auxiliary tank supply		10 "
" without tank		5 "
" (external with fire department connections)		5 "
Basement sprinklers (perforated pipe)		5 "
" " (automatic)		10 "
Auxiliary fire pump		10 "
Watchman, with portable clock	(maximum)	10 "
" with electric detector	(maximum)	15 "
Central station alarm system	(maximum)	25 "
Thermostat alarm system..	(maximum)	25 "

Since rates upon sprinklered properties in Canada are not determined by schedule, the reduction secured by the installation of sprinkler systems cannot be specifically stated. In general, rates run from 50 per cent to 80 per cent less upon properties after their equipment with sprinklers and, where the insurance carried exceeds $100,000, this reduction will give a good return upon the investment. In one particular instance, the saving paid for the entire installation in two years. The average experience is that from four to six years are required for the reduced insurance premiums to cover maintenance costs and cancel the original investment with accrued interest.*

*The following statement of sprinkler cost and insurance savings illustrates in concrete manner the average experience and shows that an installation may reasonably be expected to pay for itself in at least five years:

Amount of Insurance Carried:

$60,000 at $0.39 per $100	$ 234.00
30,000 " 0.37 " "	111.00
30,000 " 1.29 " "	387.00
315,000 " 1.02 " "	3,213.00
	$3,945.00
Cost of insurance at sprinkled rate, $435,000 at $0.25 per $100	1,087.50
Insurance saving	$2,857.50

(*Continued on next page*)

The cost of installing sprinkler systems in Canada averages from $5 to $7 per sprinkler head. Thus, a four-storey building having an aggregate floor area of 80,000 sq. ft. and requiring about 900 heads

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INVESTMENT RESULT:

		Dr.	Cr.
First year—			
Cost of sprinkler system	$10,000.00		
Cost of contractor's work	670.00		
Cost of supervisory system (rental)	312.00		
	$10,981.00		
Less immediate insurance saving	2,857.50		
	$ 8,124.50		
Interest cost, one year 6%	487.47		
		$8,611.97	
Second year—			
Investment cost	$ 8,611.97		
Supervisory rental	312.00		
	$ 8,923.97		
Insurance saving	2,857.50		
	$ 6,066.47		
Interest cost, one year 6%	363.99		
		$6,430.46	
Third year—			
Investment cost	$ 6,430.46		
Supervisory rental	312.00		
	$ 6,742.46		
Insurance saving	2,857.50		
	$ 3,884.96		
Interest cost, one year 6%	233.10		
		$4,118.06	
Fourth year—			
Investment cost	$ 4,118.06		
Supervisory rental	312.00		
	$ 4,430.06		
Insurance saving	2,857.50		
	$ 1,572.56		
Interest cost, one year 6%	94.35		
		$1,666.91	
Fifth year—			
Investment cost	$ 1,666.91		
Supervisory rental	312.00		
	$ 1,978.91		
Insurance saving	2,857.50		
	$ 878.59		
Interest earned, one year 6%	52.72		
		Profit	$931.31

Net earnings of $931 for the five-year period, plus a sprinkler system worth $10,000, is a return of 109 per cent on the investment, not to mention the additional $90,000 of insurance carried and most reliable fire protection for five years.

would cost from $4,500 to $6,300 to equip.* Cost, of course, varies with the construction and situation of the building. Some buildings are so poorly designed and constructed as to need extensive alterations and a preliminary strengthening of the walls to support a tank. Again, the availability of a proper water supply may make the service far less expensive in one building than in another. Because of these varying factors, it frequently costs as much to instal a sprinkler system in a building worth $50,000 as it does in one valued at $200,000. Obviously in such cases any reduction in insurance rates will not give an equally remunerative return upon the capital invested. As illustrating the variation in cost of sprinkler protection and insurance savings, particulars of a number of factory installations, each in a different city in Ontario, are shown in the following table:

Occupancy of buildings	System	Cost of equipment	Average insurance carried	Blanket insurance rate		Annual return on investment	
				Unsprinklered	Sprinklered	Net	Including use and occupancy insurance
						%	%
Wool storage......	Two supply	$ 2,700	$214,500	$1.22	$0.33	70	..
Paper warehouse . .	"	2,300	235,000	0.87	0.39	49	..
Printing office.....	"	7,000	217,350	1.80	0.40	43	..
Piano factory......	"	7,000	100,000	2.65	0.40	32	..
Pat. roofing works.	Single supply	4,300	105,000	1.20	0.40	28.8	..
Engineering works .	Two supply..	13,150	385,000	0.75	0.10	19	..
Woollen mill.......	"	6,700	208,000	0.76	0.15	19	38
Dairy..............	"	8,500	153,500	0.65	0.12	9½	19

Automatic Alarm Systems

The necessity for providing some means of discovering fire that would eliminate the human element, led to the introduction of automatic alarm systems. These systems consist of thermostatic devices—usually placed upon the ceilings of the buildings to be protected—which indicate dangerously high temperatures by operating an electric circuit connected with an alarm gong at a central station or fire hall. The thermostats in general use are (1) the solder release type operating on the same principle as the automatic sprinkler; (2) the expansion type, actuated by the expansion of metals and liquids under heat, and (3) the pneumatic type, in which increased pressure of air in a tube caused by a sudden rise of tem-

*The large and certain saving in insurance premiums from automatic sprinkler protection has brought into existence a number of construction companies who install automatic sprinklers free of cost and take their compensation from the reduced insurance premiums. This plan enables the sprinkler system to finance itself and at the end of four or five years the property owner, without investment, is given a system of protection that guarantees not only the safety of his property, but that is, in effect, a life annuity.

perature is transmitted to open or close an electric circuit. Expansion type thermostats may be set to operate at any desired temperature, and are far more sensitive than the solder type, but have one disadvantage in their greater liability to give false alarms under ordinary variations in temperature. The operation of the pneumatic or compensating type depends upon the rapidity with which the temperature increases, rather than the degree of heat reached, and this largely eliminates false alarms. Thermostat systems are all controlled under patents, but some of those installed in Canada at the present time are so distinctly inferior as to be practically valueless. Automatic fire alarm systems are largely confined to city buildings, where they are connected with central stations operated by independent companies. These central stations receive the alarm and, in turn, transmit them to fire departments.

Thermostatic journal alarms are used to a limited extent in hazardous properties, such as grain elevators and flour mills, where fast running machinery and accumulations of dust around bearings increase the danger of fire. They are invariably of the solder release type adapted for use on the journals of shafting, and are set to operate at about 150 degrees Fahrenheit. The alarm is registered upon local annunciators, by means of which overheated bearings can be instantly located.

Watchmen

Watchmen as a means of protection against fire and burglary are recognized as indispensable in all large factories and mercantile establishments. Ordinary prudence forbids the leaving of buildings and their contents without supervision during nights, Sundays and holidays. An intelligent watchman is undoubtedly of value in the protection of buildings, but, unfortunately, the class of men usually employed are not of the highest intelligence and are frequently negligent The hourly patrol of every part of a building or plant should discover the majority of fires in their incipiency. Experience shows, however, that watchmen often fail to discover fires. Even when they do, they frequently do the wrong thing by attempting to extinguish them before turning in an alarm. In many instances, they have themselves caused fires by smoking and the careless use of matches.

Assuming a watchman to be intelligent, the inherent weakness of the system is that he cannot be everywhere at once. If careless, he may neglect his duties and fail to regularly patrol the building. To overcome these defects, in part, three systems for keeping track of watchmen are commonly in use: (1) the portable watch-clock system; (2) the stationary system, and (3) the central station alarm system. The portable watch-clock and the stationary systems merely make available upon the morrow the record of a watchman's visits at various points in a building, thus indicating his wakefulness and regularity. The central station system has the advantage of immediately following up the failure of a watchman to make his rounds. By this system, the building is equipped at certain points with boxes similar to fire alarm boxes, which, upon being operated, register a signal at a central office. The watchman is scheduled to visit each box at a specified time, and if he fails to do so, a messenger is despatched from the central office to ascertain the cause. If he should prove delinquent or be physically disabled, the central office furnishes a reserve man to take his place.

The following figures compiled from one year's records by a signal company in the city of Toronto indicate the numerous causes of failure of watchmen: Asleep, 150; forgot, 780; left premises, 163; busy at other work, 707; illness, 77; clock wrong, 202; refused to give reason, 134; miscellaneous excuses, 430; total failures 2,686. In one instance, the watchman was found unconscious and overcome by gas. In another, he had fallen down into a pit and broken a leg. There were two cases of death, one from heart failure and the other through falling down an elevator shaft. While the advantages of central station supervision are undeniable, it is expensive to maintain and its use is, of course, confined to the larger cities and towns. In small establishments and plants situated in country districts, the portable clock and stationary systems are invariably used.

Private Hydrant Systems

All large plants situated at a distance from public protection or where there is none at all, should be provided with a private hydrant system. An ample water supply from fire pumps or some other reliable source should be immediately available and a liberal quantity of fire hose should be stored in a hose house at each hydrant. In lumber yards, hydrants should be so spaced throughout the piling grounds that effective streams may be directed upon any pile in which a fire occurs. As a rule, hydrants are not provided in sufficient numbers in private systems, dependence being placed upon long lengths of hose. From the standpoint of cost as well as efficiency, this is false economy. With 600 gallons of water flowing through a 6-inch pipe, a pressure of 110 pounds at the pumps will give a pressure of 75 pounds at hydrants 1,000 feet distant and 60 pounds at the nozzles of two

50-foot lines of hose. The same pressure at the pumps will deliver only 190 gallons of water through 1,000 feet of hose, while the pressure at the nozzle will be reduced to 25 pounds. One thousand feet of cast-iron pipe, one two-way hydrant and two 50-foot lengths of hose would cost approximately $1,200 installed. Two 1,000-foot lengths of 2½-inch hose with the necessary couplings would cost approximately $1,650 and be practically useless so far as the delivery of effective fire streams is concerned.

Outside Protection

Monitor protection is intended for outdoor properties where fairly heavy values are concentrated, as in lumber yards, freight terminals and car storage yards. The chief trouble in fighting fires in these classes of property is the almost insurmountable difficulty of dragging heavy hose around blazing lumber piles, cars and other obstructions. Often, yard hydrants of the ordinary pattern cannot be reached, owing to their proximity to the fire. These difficulties are obviated by the monitor system which consists of elevated platforms, twenty-five or thirty feet high, each equipped with a monitor nozzle on a swivel joint, capable of throwing a heavy stream in any direction. The simplicity of the arrangement is such that an employee can, by opening a valve at the foot of the monitor and ascending to the platform, direct a stream on the fire, fix the nozzle, and then put other monitors into service if occasion demands. A switch button on the platform starts an automatic fire pump if greater water pressure is required. Monitors in lumber yards are usually spaced 90 feet apart.

The advantages of this form of protection are briefly as follows: (1) monitors are always in place and ready for immediate use; (2) the equipment is practically indestructible and, therefore, there is no depreciation or maintenance cost as in the case of yard hydrants and hose; (3) as one man can handle a dozen monitors, a large number of employees to drag hose lines, chemical carts and other apparatus to the seat of the fire is not required; (4) by operating independently of human assistance when once set, they are capable of continuous service even in the heart of a conflagration.

Standpipe and Hose Equipment

A well-designed and properly maintained standpipe system affords a ready means for the control of fires by the occupants of a building. It should, in addition, be capable of providing a fire department with heavy calibre streams at elevations and in situations where the laying of hose would be fraught with difficulty.

Unfortunately, standpipe systems, as generally installed, have only been intended for one class of service. Various requirements relative to their installation and use have been adopted by municipal and insurance authorities throughout the country, but little attention has been given to their design, arrangement and maintenance. In fact, standpipe and hose equipments have fallen into such disrepute with officials and property owners in some districts that they are only installed to fulfil the requirements of a loosely worded ordinance, or as a means of obtaining concessions in insurance rates. Standpipes are often installed at remote points in a building, and rendered useless by obstructions. Frequently, not the slightest attempt is made to maintain the system in a serviceable condition or to instruct those who may be called upon to use it. It is not surprising, therefore, that fire departments in some of the larger cities either disregard standpipe systems entirely or make a practice of disconnecting the attached hose and replacing it with their own.

Details of Installation

No elaborate preparation is necessary for the installation of standpipe and hose systems under ordinary conditions. The fixed part of the system can usually be conveniently located, and, by reason of the flexibility provided by the hose, without seriously affecting the protection furnished.

Closets or cabinets are often desirable, to render the hose equipment less conspicuous, and these should be so designed as not to interfere with the handling of the hose, and should be provided with signs calling attention to the fact that they contain the fire hose. Fire extinguishers, extra equipment, watchmen's stations, and fire alarm boxes may be located to advantage in such closets or cabinets.

The size of standpipes and connections is governed by the number of effective fire streams it is necessary to provide economically at any point or number of points in a building simultaneously. In well-designed buildings where fire cannot readily communicate from storey to storey, and where exterior streams are unnecessary, one standard 1⅛ inch hose stream on each floor will ordinarily be all the heavy hose service required. Where a building is so designed that fire can readily spread from storey to storey and where roof hydrants and exterior streams are necessary, the size of standpipes should be increased to supply the maximum number of streams which conditions indicate may be necessary.

The number of standpipes for proper protection is governed by the area and design of a building, the obstructions affecting accessibility, the exterior exposures, the length of hose which can be effectively handled, the facilities for fire extinguishment otherwise provided, and, in some measure, by the occupancy and the character of the construction of the building. There should be one or more standpipes in each building or section of a building divided by fire walls. All portions of each storey should be within the reach of at least one small first-aid fire stream supplied through hose not exceeding 50 feet in length, and also within the reach of at least one standard 1⅛ inch stream supplied through hose not exceeding 100 feet in length. Proper allowance should be made for all obstructions interfering with laying the hose or the application of the streams.

Location of Standpipes

Questions relating to the design of the building, the accessibility of all portions of the interior, the safety of those on whom dependence must be placed for the operation of the system, and the exterior exposures, are the most important factors influencing the location of standpipes. For mercantile and manufacturing buildings, and buildings which are not divided by numerous partitions, the side wall location may be found most suitable. For hotels, office buildings, and buildings which are divided by numerous partitions, the equipment should be placed in passages and corridors, and so spaced that fire in any room can be quickly reached by at least one stream. Standpipes are commonly installed within enclosures containing the stairs and elevators, and where such shafts are designed to exclude fire and smoke, they undoubtedly provide the most desirable situation.

Quality of Hose

Generally speaking, all fire hose stored inside buildings should be unlined linen hose because of its greater durability, under such conditions. Linen hose also has the advantage of being lower in cost than hose containing rubber. Its chief disadvantages consist of a relatively high friction loss due to the rough interior, its greater tendency to kink when handled, and the fact that it is not water-tight when water is first turned on. These disadvantages are more than offset by its lightness, the ease with which it can be handled and the fact that it can be stored in small compass. Cotton, rubber-lined hose is sometimes advisable where moist atmospheric conditions prevail and at roof hydrants and outside stations forming part of the standpipe system. Pure rubber hose should only be used in buildings where cotton fabrics are subject to the action of chemicals.

Water Supply

The size of the water supply required for standpipe and hose systems is dependent on the number of fire streams likely to be brought into action at any one fire. This is largely influenced by the conditions existing in the building to be equipped.

Available sources of water supply may be divided into two classes: those within the building or plant, provided and controlled by the owner; and those outside the property, owned and controlled by municipalities or private companies. The inside sources include the gravity tank, the pressure tank and the fire pump. City fire engines and city mains and high pressure systems constitute the outside sources. Large and important properties should be provided with water supplies of sufficient capacity to furnish all the fire streams necessary for full protection. Where exposures are not severe, such supplies should be also large enough to provide adequate streams for fighting fire in nearby buildings.

The water pressures should be such as to afford good, effective fire streams at any point in the system under the maximum conditions of service. The height of buildings, the volume of water required and friction losses in piping and hose are the most important factors influencing pressures. Flowing pressures of approximately 63 and 80 pounds at the inlet to the hose are necessary for standard 1⅛ inch streams supplied through 50 and 100 feet of 2½ inch linen hose, respectively. For the smaller first-aid streams an inlet pressure of at least 35 pounds is desirable where 50 feet of hose is used.

Requirements for Efficiency

The efficiency of standpipe and hose systems, like that of other fire protection equipment, depends upon the strength of its weakest link. These systems are normally inert and, unlike other apparatus and machinery, the use of buildings or the operation of plants, is not subject to their being maintained in a satisfactory condition. Consequently cheap and unsuitable equipment is installed, and systems are frequently neglected and allowed to become defective or useless. The hose is probably the most perishable part of the system, but if the best grade of linen hose is employed and given proper care, its lasting qualities often exceed twenty years. Water should never be turned into linen hose, unless it is necessary to use it in case of fire, after which it should be thoroughly dried out before it is re-racked. Hose subject to dripping or excessive moisture should be protected by waterproof coverings. It is unlike cotton, rubber-lined hose, in that running water through it reduces its lasting qualities.

Periodical inspection of all portions of standpipe systems is essential, and employees to whom this duty is entrusted should be held strictly responsible.

The standpipe and hose system necessarily lacks the essential qualification responsible for the success of the automatic sprinkler system, namely, the automatic application of water to the seat of fire, regardless of the point at which it may start. At the same time, it furnishes the closest possible approximation to the standard of efficiency in fire extinguishment set by the automatic sprinkler. Its use is essential to complete fire protection and its general application to buildings in congested city districts greatly increases the fire department facilities and very materially decreases the hazards of conflagration.

Minor Auxiliary Appliances

Simple protective devices, such as pails of water or sand, are frequently of the utmost value in extinguishing incipient fires. To be of service, however, it is essential that pails be so distributed throughout a building in permanent locations as to be immediately available in case of need. They must, moreover, be kept full. Covered water casks and patent closed bucket tanks have many advantages in that they are not likely to be used for other purposes, are more sightly and preserve their contents from evaporation. One of the greatest difficulties encountered in connection with such forms of protection is in preventing freezing during cold weather. Common salt or calcium chloride is frequently added to the water in sufficient quantities to reduce the freezing point to about 10 or 15 deg. Fahr. Salt is objectionable owing to its propensity to 'creep' or crystallize over the receptacle and also because it rusts metals.

Chemical Extinguishers

Many emergency appliances of a more handy form than pails of water are upon the market but few of these have proved satisfactory in use. The ordinary type of 2½-gallon chemical extinguisher, however, has been perfected to an extent which makes it a valuable auxiliary for general installation. It is capable of throwing a small but effective stream of water and carbonic acid gas for a distance of from thirty to forty feet and this stream can, of course, be directed into places where it would be impracticable to throw a pail of water. When purchasing chemical extinguishers, approved makes, tested and labelled by the Underwriter's Laboratories, should always be specified. After installation, care should be taken to have them inspected and recharged at least twice a year. Insurance companies have formulated standard requirements for fire pail and chemical extinguisher equipments and grant a liberal reduction in rates when these requirements are carried out. Unfortunately, the effect of this has been the very general installation of such appliances in order to obtain lower insurance rates but little effort has been made to maintain them in serviceable shape. Inspection frequently shows fire pails and tanks quite empty or else filled with rubbish, and chemical extinguishers that would be worthless in an emergency.

Dry Sand

For dealing with fires in volatile liquids, oils, chemicals and about electrical machinery and wires carrying high voltages, water is not only useless but may be extremely dangerous. In such cases, dry sand is by far the most efficient extinguishing agent. Pails of sand and scoops should be provided in all buildings occupied for the following purposes: automobile garages, dry-cleaning establishments, car barns, electric light and power stations, paint and varnish works, oil mills, rubber works, soap works, rendering establishments, telephone and telegraph stations, and all premises in which calcium carbide, sodium peroxide, lime, paints, oils, lacquers and volatile fluids are either used or stored.

Sawdust

Fires in thick liquids such as lacquer, paint, varnish and japan can often be extinguished by spreading sawdust over the surface of the burning material. The sawdust floats and excludes the air whereas sand sinks almost immediately. Exhaustive tests show that 10 pounds of bicarbonate of soda mixed with one bushel of sawdust forms one of the most efficient extinguishers of fires in dipping tanks of moderate size.

Fires in open tanks of liquid petroleum, benzine, etc., can be quickly controlled by the application of any substance which will cut off the burning vapour from the body of the liquid. Special forms of extinguishers are manufactured which, by mixing acid and alkaline solutions, produce a thick foam that will float over the surface of burning liquids and instantaneously extinguish the flames.

Dry-Powder Extinguishers

Although dry-powder fire extinguishers are sold to a gullible public in increasing numbers, they are all, without exception, practically worthless. Tubes costing $3 each contain materials having an average value of eleven cents. Chemical analysis of thirty-one tubes of various makes shows the contents to consist of approximately 60 per cent common baking soda, 26 per cent fine sand, 8 per cent pulverized chalk and 4 per cent colouring matter, chiefly iron oxide. The inefficiency of dry powder extinguishers was made the subject of searching investigation by a special committee appointed by the British Home Office in March, 1916. The report which was issued as a White Paper contained the following statement: "The use of dry powder fire extinguishers is to be deprecated as not only giving a misleading sense of security but being practically useless for extinguishing or controlling fires."

Of an entirely different character are the small one-quart chemical extinguishers sold under different proprietary names but all containing carbon tetrachloride as the extinguishing fluid. These have the great advantage of being easily handled by women and children. When subjected to heat, carbon tetrachloride generates a heavy, non-inflammable gas that will extinguish fires under circumstances where water would be useless. The efficiency of all auxiliary fire equipment is, however, dependent upon several contingencies such as, accessibility for prompt use, presence of mind of the operator and the proper working order of the appliances. In the majority of cases, it is extremely doubtful whether the untrained occupants of buildings have sufficient self-possession at the time of a fire to make the best use of such appliances even when they are immediately available.

Private Fire Brigades

To obtain satisfactory results from any form of fire protection equipment depending upon manual operation, some preparatory training in its use is absolutely essential. Industrial plants and mercantile establishments with large property values and numerous employees, frequently find it advisable to maintain a completely organized fire brigade. For extensive works situated on the outskirts of cities and towns and in country districts, where public fire protection is remote or non-existent, the necessity for self-protection is manifest. Even in localities where a first-class public fire department is available, emergencies frequently arise that prevent its prompt response to alarm, and in such cases, a private brigade may prove of the greatest value. Experience shows that the unorganized efforts of employees to control a fire are usually futile. On the other hand, a small but properly trained private brigade, knowing every inch of the property, is often better able to handle an incipient fire than a more elaborately equipped fire department.

So far in Canada the advantages of complete and properly organized private fire protection do not appear to have been generally appreciated. Numerous large industrial plants and some railway and mining properties are very thoroughly protected, but, apart from these, fire protection has meant largely the installation and subsequent neglect of appliances provided to satisfy insurance requirements. Simple business economy would seem to require that the means whereby costly equipment can alone be made effective should be properly organized and maintained. Viewed from any angle, it is undeniable that a body of employees regularly drilled in the use of fire protective devices must exert a powerful influence towards greater carefulness amongst their fellows. Employees, instead of looking upon fire protection solely as a means of safeguarding private property which is insured in any case, come to regard it also as a means of protecting employment and wages, which are not insured.

General suggestions as to the formation and equipment of private fire brigades are of limited value, as every establishment has its own particular needs. In buildings occupied as department stores, theatres and large mercantile establishments, the work of a private brigade will be limited to the use of light equipment upon incipient fires, pending the arrival of the public fire department. In large industrial plants, lumber yards and railway terminal yards, operations will usually be of a more extended character, involving the use of large hose streams, ladders and heavy equipment.

Legal Requirements

In Canada, legislation respecting the provision of auxiliary fire protection appliances in buildings is confined to local ordinances in the larger cities. These, with few exceptions, deal only with theatres and places of amusement of a specified seating capacity. For instance, standpipes and hose, sprinklers over the stage section and auxiliary fire alarm boxes are required in 6 cities, standpipes and sprinklers only in 5 cities and standpipes only in 9 cities. The following is typical of existing ordinances in respect to theatre protection:

"Every theatre, music hall, opera house or other public building or place of amusement with a seating capacity exceeding 250 shall be provided with a standpipe and hose and hose attachments subject to the approval of the chief of the fire department. Where fixtures or movable stage scenery are employed, a separate and distinct system of sprinklers shall be provided around the proscenium opening and on the ceiling or roof over the stage. Sprinklers shall also be placed wherever practicable under the stage and in carpenters' shops, paint rooms, store rooms and property rooms. All theatres with movable scenery shall, in addition, be provided with a fire alarm telegraph apparatus connected with the head quarters of the city fire alarm telegraph or such other place as the chief of the fire department may select."

Ten cities specify, in addition to theatre requirements, certain measures of protection for other classes of buildings. For instance, Victoria, B.C., requires standpipes and hose in all business buildings over two storeys in height, and water-distributing pipes in basements used for the storage of merchandise. Calgary requires automatic sprinkler systems in all business buildings over two storeys in height with the exception of fireproof and 'mill' buildings. Winnipeg requires that all buildings over 120 feet in height be equipped with fire-extinguishing appliances subject to the approval of the building inspector. Toronto requires standpipes in all buildings exceeding three storeys in height, excepting dwellings, and in all apartment houses over two storeys in height. Perforated pipes must be provided in the basement of all business buildings over three storeys in height. Buildings of hazardous occupancy in congested districts may be required to instal sprinkler protection by the chief of the fire department. Six other cities have somewhat similar by-laws, each, however, differing from the others in regard to its specific requirements.

Apart from 21 of the more important cities, Canada is without laws in the matter of private fire protection. Any type of building may be erected and its protection by a public fire department is undertaken at the expense of the community. The property owner is under no legal obligation to safeguard his own buildings or his neighbours' from destruction by fire.

CHAPTER VIII

Municipal Fire Protection

EVERY community has a responsibility toward its citizens in the matter of protection against fire. Recognition of this responsibility may be legally enforceable, as in European countries, or purely voluntary, as in the United States and Canada.* In all civilized communities, however, without exception, what has been termed 'the civic conscience' assents to the enforcement of laws directed toward the prevention of fire-breeding conditions, and to the allocation of public funds to maintain organizations for the extinguishment of fires that cannot be prevented. According to the adequacy of these measures of prevention and protection, the fire record of a community is usually creditable or otherwise.

The present chapter is intended to outline briefly the more general requirements of municipal fire protection with a view to pointing out the need for improvement in existing conditions in Canada. For this purpose an exhaustive *résumé* of the facilities at present available in each city and town is not considered essential.† There are some long-established and well-governed communities with whose protection little fault can be found, and there are many others decidedly lacking in respect to the most vital requirements. None has yet reached such a stage of perfection that it can be presented as a model to others, and it is even doubtful whether the form of protection best adapted to one community would satisfactorily meet the needs of any other.

In spite of the progress that may be made in fire prevention, whether by structural improvement or by the education of the

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*In the United States and Canada, municipalities are not liable to citizens for neglect to establish or maintain adequate fire protection. First, because there is no contractual relationship between the property owner and the municipality, and, second, because, as one judicial authority expresses it, "no recovery can be had where the neglect of a municipal corporation consists in failing to perform a legislative or discretionary duty. A recovery can only be had where it negligently performs, or fails to perform, a duty imposed upon it by law."

In England, the Public Health Act, 1875, Section 66, provides that "every urban authority shall cause fire-plugs and all necessary works and machinery and assistance for securing an efficient supply of water in case of fire to be provided and maintained." Numerous actions for injuries sustained through fire losses resulting from the failure of water supplies have been upheld by the courts and damages awarded in accordance therewith.

†A complete survey of municipal waterworks is contained in a report on *Waterworks and Sewerage Systems of Canada*, Commission of Conservation, 1916.

people in more careful habits, fires will doubtless continue to occur from innumerable causes and to demand the maintenance of facilities for their control. This involves two distinct yet complementary provisions, namely: (1) municipal fire departments to extinguish fires by the prompt and effective application of water; and, (2) adequate water supplies, without which the most completely equipped brigade is manifestly valueless. In dealing with these two phases of the one problem, the question of water supply, being of fundamental importance, is given first consideration.

Waterworks Systems

The supply of water to organized communities by public service corporations and municipal authorities, while a long-established custom in Europe, is of comparatively recent development upon the American continent.* In 1850, there were only 83 public water-supply systems in the United States and Canada; in 1880, the number had increased to about 600, and in 1915 had reached almost 6,000. Over 98 per cent of all existing water works has been constructed within the last half century. At the present time, it is rare to find a place of more than 2,000 population without some form of public water supply, and, even in the smaller towns and villages, the construction of such work is being rapidly undertaken.†

Apart from the importance of a public water supply from domestic, sanitary and industrial standpoints, its economic value in furnishing a ready means of controlling fires is unquestionable. This is directly shown in the reduction of fire losses and insurance rates following its introduction or improvement. Under ordinary conditions, a per capita expenditure of from $30 to $40 is necessary to develop an adequate waterworks system. Climatic and topographic conditions cause considerable variation in cost and, in localities where expensive water rights have to be acquired, or where a wide range in elevation exists, the first cost may be doubled. The average cost in cities and towns in Canada is shown by Table No. 5, page 46, to be as follows: In 56 cities with populations exceeding 10,000, $33 per capita; in 49 towns with populations from 5,000 to 10,000, $41 per capita; in 297 towns and villages with populations from 1,000 to 5,000, $39 per capita. In addition to

*Brief descriptions of early water supply systems are contained in *Public Water Supplies*, by F. E. Turneaure and H. L. Russell. (2nd ed., New York, 1913); *The Ruins and Excavations of Ancient Rome*, by Rodolpho Lanciani, (Boston, 1897) and *London Water Supply, Old and New*, by W. J. Fisher in *Westminster Review*, January, 1905.

†See *Waterworks and Sewerage Systems of Canada*, Commission of Conservation, 1916.

domestic convenience, such a moderate contribution towards the provision of permanent fire protection, is assuredly more economic than the distribution through insurance of heavy fire losses among the people of a community.

At this point, mention should be made of the fact that one of the greatest obstacles to the extension and improvement of waterworks systems is the difficulty of obtaining funds to carry out work in advance of actual requirements. Owing to lack of appreciation of its importance and to obstructive tactics in municipal councils, a large proportion of the cities and towns in Canada outgrow their supplies long before the necessary additions are made. Since 1913, no less than eighty-three reports of competent engineers upon waterworks systems in various cities and towns have called attention to their inadequacy.* Up to the present time, only sixteen of these have seriously attempted to carry out the improvements advised. It should be hardly necessary to emphasize the fact that money is rarely saved by postponing waterworks development, for in nearly every case, the delay necessitates temporary construction which is comparatively useless in the regular development of the works. In addition, the citizens are often subjected to considerable inconvenience and the entire community exposed to the dangers of epidemic and conflagration.

Municipal Ownership Advisable

During the early stages of water supply development in Canada, the task of providing the service was entrusted to private companies, usually under very favourable franchises. Of recent years, however, municipal ownership has made considerable headway, and 396, or over 79 per cent, of the present systems are publicly owned and controlled. From every point of view, it is advisable that a municipality should control its waterworks system *ab initio*, that it may, from the very outset, determine its design, regulate its development and secure the service for its citizens at the lowest possible cost. Theoretically, an honest corporation can supply water under a contract which contemplates purchase of the system by the municipality at a future date, but in practice, such contracts have proved a mistake. The credit of the town is frequently used by the corporation as a guarantee for its stocks and bonds and over-capitalization generally results. A municipality can better afford to trade upon its own credit and float its own bonds from the start than become the security, the dividend payer and, eventually, the purchaser at an

*A large conflagration during a period of drought would, in several cases, necessitate the utilization of water from polluted sources which have been condemned by public health authorities.

enhanced price of the bonds of a private corporation. In addition, there is the temptation to instal cheap pipe and to neglect repairs as the period approaches for the lapse of the franchise. These considerations, amongst others, point to the advisability of municipal ownership of waterworks systems in all cases.

Management

Under our somewhat clumsy system of municipal administration, the waterworks of a city or town is usually managed by a special committee of the council, composed, in most instances, of tradesmen with little knowledge of the essential requirements of a waterworks system. Efficient management is rare unless a competent engineer is permanently employed. As the committee is elected annually under the ward system, its membership is constantly changing, and frequently the position is sought in order to obtain special advantages for particular neighbourhoods. There are so many objections to the committee system as applied to the waterworks department, that, in all the larger cities, the tendency is to get away from it by the appointment of commissioners. There is everything to be said in favour of the commissioner plan, since not only is the work in the highest degree technical, but in a department which so intimately concerns the health and safety of the people, bi-partisanship and the interplay of local politics should have no place. In the smaller cities and towns, where the cost of employing a commissioner is out of the question, a permanent unpaid board has a very great advantage over the committee plan.

Waterworks Design

There are, in Canada, 105 waterworks systems supplying cities and towns of over 5,000 population and 395, or almost four times as many, supplying towns and villages of less than 5,000 population. Of the 105 larger systems, 80 per cent was constructed in part before the population of the places they supply had reached 5,000, and their present capacity has been attained by piece-meal enlargement of the original systems. As the majority of waterworks problems arise through lack of foresight, it is obvious that their solution can be effected most economically while a system is small.

All waterworks systems should be designed for the future and should provide for gradual enlargement along definitely planned lines. As little immediate construction as possible should be carried out, except where the cost of future extensions would exceed the cost of doing the whole work in the beginning. To build works far in advance of requirements, upon the mere assumption that certain growth will take place, is the height of folly; it is impossible to foretell the character or needs of a community ten years hence. To plan works to meet prospective development, however, costs little and may obviate a multitude of future difficulties.

Sources of Water Supply

The problem of an adequate public water supply is chiefly one of geography. Nature has provided some places with excellent sources within easy reach, while others encounter tremendous difficulties owing to their unfavorable situation. As utilized for municipal service, the sources of supply may be roughly classified as follows:

(a) Surface Waters
1. Rivers
2. Natural lakes
3. Water collected in impounding reservoirs.

(b) Ground waters
1. Springs
2. Shallow wells
3. Deep and artesian wells.

At the present time, 299 cities, towns and villages in Canada obtain their supplies from surface-water sources and 201 from ground-water sources.* With the exception of Winnipeg, London and Regina, practically all the larger cities depend upon lakes and rivers. The rapid increase of urban population in Canada during recent years has created water-supply problems in many municipalities that are almost impossible of solution without the expenditure of large sums of money and the exercise of much engineering skill. The places most favourably situated to keep pace with rapidly increasing demands have been those bordering the Great lakes and near large rivers, where an additional supply could be easily obtained by enlarging the pumping capacity. Even here, however, difficulties have been encountered. Increased pollution, consequent upon growth of population, has necessitated the installation of costly filtration plants. It is estimated that untreated sewage contaminates at least 67 per cent of the lakes and rivers used for public water supplies in Canada.

*The sources of public water supplies in each province in Canada are as follows:

	Surface	*Ground*
Nova Scotia	24	7
New Brunswick	8	9
Prince Edward Island	..	3
Quebec	91	74
Ontario	93	64
Manitoba	7	6
Saskatchewan	9	21
Alberta	24	9
British Columbia	43	8

During recent years, ground-water supplies have been extensively developed by the smaller cities and towns. Sometimes there has been no alternative source, but in many cases they have been found advisable in order to supplement other supplies or to escape the use of polluted river water. While deep wells invariably afford a supply that is bacteriologically pure, it is recognized that they are rarely adapted to progressive development to meet the needs of a growing community. Continued and increased draught invariably lower the static levels, and the quantity of water available is always a matter of doubt. Wells will, however, continue to be a valuable asset to many of the smaller cities and towns situated in districts favourable to the development of such source.

Adequacy of Water Supply

From the standpoint of efficient fire protection, the value of a water supply depends upon (1) the maximum amount of water available; (2) the mechanical means provided for its distribution; and (3) the reliability of the two foregoing requisites. In determining the adequacy of the protection provided in any particular city or town, the main question involved is whether the maximum services available and dependable are equal to any possible emergency demand.

In cities and towns situated where an unlimited supply, such as from large lakes or rivers, is available, the only question that arises is that of distribution. In others, the chief problem involved is that of adequate storage. If the supply is derived from wells, they should be developed to a point where they are able to take care of the maximum daily demands and the extra requirements for fire protection should be stored in reservoirs delivering directly into the distribution system. If the supply is obtained by means of impounding reservoirs from a large catchment area, the storage should be ample to meet the demands of long periods of drought.

The quantity of water required in any particular city or town depends upon the population to be supplied, the amount used for manufacturing purposes and the care taken to prevent waste. It is exceedingly difficult to evaluate these factors, since it is impossible accurately to forecast the industrial development or retrogession of the average community. The population to be served depends primarily upon the growth of industry. Statistics of public water systems show that, in small cities and towns, the average daily per capita consumption is from 75 to 95 gallons and that, in the larger places, it is rarely less than 120 gallons. Great diversity in this respect exists even among cities of equal size and situated in the same geographical area.*

The quantity of water used for the extinguishment of fire is proportionately very small, being approximately one-tenth of one gallon per capita per day or about one-thousandth part of the total average consumption. For short periods of time, however, the rate is very high. One good effective fire stream will use water at as great a rate as the average town of 5,000 inhabitants will require for domestic purposes during the hours of maximum draught.†

*The high per capita rates of water consumption in this country are difficult to reconcile with the low per capita consumption abroad. The explanation is to be found mainly in leakage and in waste by the consumer. This unnecessary consumption has an important bearing upon the question of cost, for it has to be dealt with by the development of larger supplies and the installation of additional pumping equipment and distributing mains of increased carrying capacity, if domestic and fire flow requirements are to be met. Unfortunately, in many instances, fire flow is only partially provided for during periods of maximum domestic demands. An interesting comparison of average per capita consumption in Canadian and English cities is given in the following table:

Canada	*Gallons per head daily*	*England*	*Gallons per head daily*
Halifax, N.S.	170	Liverpool	35
St. John, N.B.	208	Cardiff	31
Montreal, Que	131	Manchester	42
Quebec, Que	156	Bristol	30
Sherbrooke, Que	135	Exeter	36
Lachine, Que	203	Accrington	26
Toronto, Ont	100	Birmingham	29
Ottawa, Ont	174	Oxford	33
Hamilton, Ont	128	Leeds	24
Brockville, Ont	266	Chester	47
Niagara Falls, Ont	256	Leicester	23
Sarnia, Ont	292	Northampton	19
Windsor, Ont	278	Coventry	23
Winnipeg, Man	48	Rotherham	23
Brandon, Man	72	Wigan	26
Regina, Sask	40	Burnley	27
Saskatoon, Sask	62	Carlisle	37
Calgary, Alta	160	Croydon	33
Edmonton, Alta	79	Blackburn	25
Vancouver, B.C	103	Plymouth	34
Victoria, B.C	73	Ipswich	26

†The approximate amount of water used in fighting a number of recent fires is shown in the following table compiled from reports of fire departments. The property was in each case almost totally destroyed.

	Duration of fire (hours)	*Maximum number of streams used*	*Gallons of water used (approximate)*
4-storey brick woollen mill	3½	12	630,000
5-storey tenant factory (mill)	3	10	450,000
3-storey brick furniture warehouse	2½	14	525,000
Frame skating rink	2	9	270,000
5-storey brick warehouse	1¼	13	243,750
Metal-clad car barn	4¼	16	1,020,000
4-storey brick paper warehouse	5	12	900,000
4-storey brick clothing factory	2	10	300,000
5-storey warehouse and offices	1½	8	180,000
Contractors' sheds and lumber piles	3¼	10	487,500
3-storey picture frame factory	2¼	6	202,500
3½-storey brick retail store	2	8	240,000

The standard fire stream is considered to be that thrown by a 1⅛ inch smooth nozzle discharging 250 gallons per minute. There are, of course, many situations where streams throwing 150 to 200 gallons would furnish reasonable protection. In the outlying districts of small towns, any fire which cannot be controlled by two streams of 150 gallons each is not likely to leave much of value if it is extinguished by using a larger number of streams of standard size.

The number of fire streams required simultaneously in any city or town depends upon the structural conditions prevailing, such as areas, heights, exposures, occupancies, types of buildings and the probable maximum amount of water that would be necessary to combat a spreading fire. In cities of average character, estimates based on actual practice show the following number of streams as desirable.*

Population not exceeding	*Number of streams (250 gal.)*
1,800	2
3,000	3
4,000	4
6,000	5
7,500	6
10,000	8
15,000	10
20,000	12
30,000	14
40,000	16
50,000	18
60,000	20
75,000	22
100,000	25

Although the probability of a large fire occurring during the hours of maximum consumption is somewhat remote, it is customary to determine the adequacy of the water supply upon the basis of the required fire rate added to the maximum domestic rate. As every community should have its supply considerably greater than its present requirements in order to care for future growth, this method is not so unreasonable as at first appears.

Types of Supply Systems

At present there are 206 municipalities in Canada supplied by gravity waterworks systems and 294 by means of direct pressure or pumping systems. It is recognized that the gravity system of waterworks, or one delivering the supply directly from its source without the inter-

*The National Board of Fire Underwriters requires a minimum approximately 60 per cent greater than these figures.

vention of pumps, is best adapted to provide reliable fire protection. A well-designed, direct pressure system, however, so nearly approaches the gravity system in adequacy and reliability that not much difference exists in the relative efficiency of the two types. In some cases where water is derived from lakes and more generally where it is obtained from storage reservoirs, there is sufficient elevation to deliver the supply by gravity. In a few instances, the topography of the country is such that the sources of supply are in close proximity to the distribution system, but in by far the greater number they are at a distance. When the water is brought from a distant source, storage reservoirs near the area of distribution are often found to be economic, as they permit the use of much smaller supply mains. So far as possible, all such mains should be in duplicate, that failure from any cause may not completely deprive the municipality of water. In some places, the elevation of the reservoir, or other source, is so small that the gravity head is insufficient to provide fire service. Such a system is usually reinforced by pumps, that, in case of fire, direct pressure may be substituted for the ordinary gravity supply.

Where the water is obtained from wells in which the water does not rise to the surface, deep well pumps of the piston type or compressed air are frequently used. The air lift is not highly efficient, but its reliability and durability largely offset this objection. Electrically-driven centrifugal pumps have been recently installed in several places and have proved remarkably efficient in operation. Their chief drawback is, of course, lack of reliability through being dependent upon a remote and often single source of power.

Systems which are supplied by pumping may be broadly divided into three classes: first, those which distribute from storage reservoirs, second, from intermediate or equalizing reservoirs, third, directly into the distribution mains. As it is only in very small towns that a standpipe can furnish any reasonable proportion of the demand, the third class includes those which are provided with an elevated tank or standpipe.

Where a reservoir supplied by pumps is in continuous service, it should, if practicable, be of sufficient capacity to supply both domestic and fire requirements for a period of 24 hours. Where only in use during fires, it is generally held that the capacity of such reservoirs may be limited to domestic and fire requirements for 10 hours. The pumping capacity available in each case should be ample to fill the reservoirs under conditions of maximum draught and be sufficiently in duplicate to maintain constant service. This capacity may appear greater than is necessary to deal with the average large fire which lasts not more than two or three hours, but provision should be made to meet any emergency, and experience proves that, in conflagrations and spreading fires, the quantity of water used has been far in excess of reasonable expectations. In the Salem, Mass., fire, for instance, the consumption was nearly 18,000 gallons per minute, or more than three times the amount called for by underwriters' requirements. This quantity was only made available by emergency connections with adjoining municipalities.

In pumping systems which deliver directly into the distribution pipes, the capacity of the pumps should be sufficient to supply the maximum domestic consumption and fire draught combined, and be in duplicate to such an extent that this capacity will not be diminished in the event of the breakdown of any one pump. If steam is used, the boiler capacity should be sufficient to enable the pumping of the maximum draught by the most uneconomical units in the station, with one boiler out of service for repairs or cleaning. These requirements of reserve capacity are frequently questioned by municipalities, the foremost objection being the large amount of money invested for machinery which may never be called into use. In a paper recently read before the New England Waterworks Association, Clarence W. Goldsmith, Engineer of the National Board of Fire Underwriters, dealt with this objection as follows:

"If a city were situated in close proximity to a hill of sufficient elevation to furnish the desired pressure, the advisability of building a reservoir of sufficient capacity to secure a supply would not be questioned. Such a reservoir would cost, in round figures, about $5,000 per 1,000,000 gallons, which corresponds closely with the cost of high-duty pump machinery of equal capacity. Low-duty or centrifugal pumps can be purchased at a much lower figure. Viewed from the cost standpoint, therefore, no argument can be adduced against installing pumps to perform the same function as the reservoir."

No system can, of course, be considered reliable unless it can maintain a constant service under all conditions. In the smaller Canadian cities and towns, there has been an unfortunate tendency to regard cost and economy of operation the paramount consideration. This has resulted in the installation of large pumping units to meet ordinary demands and little provision of reserve capacity for emergencies. To illustrate the extent of existing deficiencies in this respect, the following table is given, showing the present capacities of a number of the larger waterworks systems in Ontario as compared with underwriters' requirements. It should be pointed out that these shortcomings are general throughout the whole Dominion and, as a rule, are greatest in the smaller municipalities.

TABLE No. 20.—WATERWORKS SYSTEMS IN CITIES AND LARGE TOWNS IN ONTARIO

City or town	Type of supply system†	Present pumping capacity—per 24 hours	Underwriters' standard requirements for single system, per 24 hours‡	Percentage short of standard duplicate requirements	Present maximum storage reservoir capacity and visible supplies for pumps—Imp. Gals.	Storage capacity required by underwriters' standard—Imp. Gals.	Percentage short of standard requirements
		Imp. gals.	*Imp. gals.*	*Per cent*	*Imp. gals.*	*Imp. gals.*	*Per cent*
Barrie	4	2,000,000	2,550,000	60.8	Inexhaustible		
Belleville	4	4,680,000	4,500,000	33	*360,000		
Brantford	5	17,000,000	7,200,000	Stan.	Inexhaustible		
Brockville	5	9,000,000	3,400,000	Stan.	Inexhaustible		
Chatham	4	4,379,000	4,500,000	36	*200,000		
Cobalt	4	3,306,000	2,100,000	13	Inexhaustible		
Cobourg	5	5,360,000	2,100,000	Stan.	Inexhaustible		
Collingwood	5	2,000,000	2,550,000	61	Inexhaustible		
Cornwall	4	6,297,600	2,550,000	Stan.	Inexhaustible		
Fort William	1	....	....	....	Inexhaustible		
Galt	4	4,804,000	4,500,000	45	180,000	2,750,000	
Guelph	4	6,019,680	5,050,000	36.5	1,148,437	3,000,000	62
Hamilton	5	42,017,600	18,000,000	30	Inexhaustible		
Ingersoll	4	2,500,000	2,100,000	40	165,000		
Kenora	5	3,816,000	2,550,000	21	Inexhaustible		
Kingston	4	6,313,700	7,400,000	53	Inexhaustible		
Kitchener	4	5,744,000	6,000,000	47.5	1,500,000	4,000,000	62
Lindsay	4	3,000,000	3,400,000	65	Inexhaustible		
London	5	19,000,000	12,000,000	50	7,094,000	8,500,000	Stan.
Midland	4	2,364,000	2,550,000	66	1,200,000	and Creek	Stan.
Niagara Falls	3	9,500,000	4,500,000	22	1,500,000	10,000,000	
North Bay	2	4,320,000	3,400,000	49	1,180,000	5,000,000	
Orillia	4	3,456,000	3,400,000	50	Inexhaustible		
Oshawa	4	4,140,000	3,400,000	56	Inexhaustible		
Ottawa	5	41,000,000	18,000,000	Stan.	Inexhaustible		
Owen Sound	1	....	....	....	6,500,000	7,500,000	Stan.
Pembroke	4	3,900,000	3,400,000	38	Inexhaustible		
Peterborough	5	16,500,000	6,000,000	Stan.	Inexhaustible		
Port Arthur	4	10,000,000	5,600,000	Stan.	Inexhaustible		
Port Hope	4	2,367,400	2,100,000	54	1,066,900	1,225,000	Stan.
St. Catharines	1	....	....	....	Inexhaustible		
St. Thomas	4	9,000,000	5,600,000	20	25,000,000	3,500,000	Stan.
Sarnia	5	New system	being installed				
Sault Ste. Marie	5	New system	being installed				
Smiths Falls	4	5,700,000	2,550,000	Stan.	Inexhaustible		
Steelton	5	1,440,000	2,100,000	100.0	659,000	1,225,000	50
Stratford	4	6,540,000	5,600,000	45	Inexhaustible		
Sudbury	4	4,608,000	3,400,000	Stan.	Inexhaustible		
Toronto	3	196,000,000	....	Stan.	Inexhaustible		
H. pressure	5	10,000,000	....	Stan.			
Walkerville	5	12,000,000	2,100,000	Stan.	Inexhaustible		
Welland	5	8,495,200	2,550,000	Stan.	Inexhaustible		
Windsor	5	20,800,000	7,200,000	Stan.	Inexhaustible		
Woodstock	3	7,660,800	4,500,000	42.0	*937,500		

†1. Gravity system
2. Gravity from reservoir supplied by pumps
3. Direct pumping system in connection with reservoir
4. Direct pumping system in connection with standpipe
5. Direct pumping system.

‡Capacity to be in duplicate.

*Standpipes and small reservoirs for domestic supply.

Equipment of Pumping Systems

At the present time, pumping equipment to supply fire pressure is operated by steam power in 141 places, by electricity in 101, by gas, gasolene or oil in 31 and by water in 21. In the larger plants, for continuous high-duty operation, the triple expansion reciprocating steam engine and, for smaller capacities, the horizontal cross-compound condensing type hold an undisputed field. For peak loads and extra fire pressure, reserve steam or electric-driven centrifugal units have, in many cases, been installed. Recent improvements in steam turbine centrifugal pumps have so increased their efficiency that their future general use for both ordinary and fire service is assured. Their first cost is materially less than that of reciprocating pumps and, properly installed, their efficiency may be indefinitely maintained.* On the other hand, tests of a large number of reciprocating pumps in present use show a slip varying from 5 to 15 per cent. The usual demand of pumping engines, that they deliver normal domestic consumption against about 50 pounds pressure and, in case of fire, be capable of furnishing a greater output at 125 pounds pressure, means operation at 40 per cent of the rated capacity for 95 per cent of the time or at more than 100 per cent overload in an emergency. Two centrifugal pumps, operated singly for domestic service and in series for fire pressure, will meet these requirements admirably.

In small towns and villages, where the domestic supply is from a reservoir or elevated tank and a pump is needed only at intervals, motor-driven centrifugal or triplex plunger pumps are the most desirable. If electric power is not available, triplex pumps operated by internal combustion engines have a great advantage, as they can deliver their full output at once instead of requiring the length of time necessary to raise steam in a boiler. The development of the gasolene engine has done much to make waterworks systems for small places financially possible. The first cost is considerably less than steam and, as there is no consumption of fuel and no attendance necessary except while work is being done, the cost of operation is reduced to a minimum.

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*Although steam turbine centrifugal pumps for water-supply systems were only introduced in the United States and Canada in 1913, they are being generally installed in both large and small plants. Their efficiency is shown by the record of a De Laval unit at the Montreal low-level pumping station. This pump, with a rated capacity of 30 millions Imp. gals. per 24 hours against 210 ft. head, has delivered over 31.4 million gals. and given a duty of 134.6 million ft. lbs. per million b.t.u. In Toronto, steam turbine centrifugal units with a total capacity of over 100 million gals. per day have shown equal efficiency.

Electricity has recently become an important factor in connection with pumping plants, especially in districts where hydro-electric power is available. The chief disadvantage of a pumping plant operated by electrical power transmitted from a single source is that it cannot be considered absolutely reliable from a fire protection standpoint. At the present time, steam-driven stand-by units are in general use in the majority of plants equipped with electrical pumps. In most cases, a producer gas unit or Diesel oil engine* would be a reliable and less costly alternative. The gas engine would require a sufficient quantity of stored gas for immediate operation and the oil engine would require adequate oil storage capacity and compressed air for starting, but constant attendance, as in the case of a steam auxiliary, would be unnecessary.

Hydraulic turbines and water-wheels are used in a number of places to furnish motive power for pumps and are recognized as satisfactory where the supply of water is assured throughout the year. It is, of course, essential in such installations to take account of, and provide against, disturbances due to drought, floods, forest

*Diesel oil engines cost from $45 to $65 per h.p. installed, run equally well upon any grade of fuel oil, yield full speed one minute from starting, and require little attention. Under ordinary conditions of continuous service, fuel consumption is about as follows: full load, .5 pound per b.h.p.; half load, .6 pound per b.h.p. hour; quarter load, .8 pound per b.h.p. hour. The greater economy of an oil engine over a steam plant, for stand-by service, is clearly shown by the following comparison of fuel consumption in connection with two 1.5 million gallon pumps:

		Steam unit *Coal used* (*lbs.*)	*Diesel oil unit* *Crude oil used* (*lbs.*)
Mon.	Fires banked, 48 lbs. steam...........	980	Nil
Tues.	" " "	790	"
Wed.	Pumps run 1 hour 10 min............	1,075	84
Thurs.	Fires banked, 50 lbs. steam...........	850	Nil
Fri.	" " "	935	"
Sat.	Pumps run 45 minutes...............	1,235	81
Sun.	Fires banked, 50 lbs. steam...........	795	Nil
	Total for week..................	6,660	165

Producer gas plants will, as a rule, operate on one-third to one-sixth the amount of fuel required by a steam plant, depending largely upon the size of the unit. Their relative economy in this respect is shown by the following instances: One town pumping 450,000 gallons of water daily to a small reservoir used 4,250 lbs. of coal per day in a steam boiler. Since installing a producer gas plant, an average of 719 lbs. of coal per day has been consumed and the saving to the municipality, on this item alone, amounts to $3,200 a year. In another case, where a small multi-stage centrifugal pump operating against 105 lbs. pressure is driven by producer gas, a duty of from 110 to 120 million ft.-lbs. is obtained, and the record covering several months shows a brake horsepower hour developed for every 0.85 pound of coal consumed. A steam plant adapted to similar conditions would require from eight to ten times the amount of coal.

fires, ice-formations, silting up and shifting of water channels and many other contingencies that do not affect steam plants. Emergency units of sufficient capacity to meet full requirements and driven by some other power should always be held in reserve.

Distribution Systems

An efficient water distribution system must be capable of two forms of service. In the first place, it must supply the ordinary domestic consumption which is relatively uniform over the entire area served and is constant for many hours of the day. In the second place, it must amply provide for fire demands in which the rate of flow is extremely high for very short periods of time and is usually confined to a small area. From the figures already given showing the number of fire streams that should be provided in the average city or town, it is evident that the character and capacity of a distribution system is largely determined by fire requirements.*

The opportunity to design a waterworks system in entirety is rarely presented. Most systems are the growth of years and embody the ideas of many individuals. Consequently, the major problems which arise are with reference to the extension, reinforcement and rehabilitation of faulty and outgrown systems. Towns and villages, when first installing distribution mains, have invariably adopted the short-sighted policy of laying small pipes on all but the more important streets. With growth and accession of population, these streets have been built up and have become more or less permanently residential, mercantile or manufacturing in character. No law has restricted the location of business or industrial establishments to suitably protected districts, nor prescribed the measure of protection that should be provided such establishments by the municipality. To-day hundreds of large factories in Canada are depending for fire protection upon mains that were originally installed for residential property and that are incapable of supplying more than an infinitesimal proportion of the water that would be needed in case of a large fire.

It is estimated that, of the total length of public water supply mains in the Dominion, more than 20 per cent is less than 6 inches in diameter. That this condition is not confined to the smaller municipalities is indicated by the following table showing the percentage of mains in the more important cities and towns of Ontario, which are 6 inches in diameter and under, and are therefore almost useless for fire protection:

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*See page 223.

TABLE NO. 21.—DISTRIBUTION MAINS IN CITIES AND TOWNS IN ONTARIO

City or town	Total length of mains	Percentage less than 6 inches diameter	Percentage 6 inches diameter	Percentage over 6 inches diameter
	Miles	*Per cent*	*Per cent*	*Per cent*
Belleville	23.9	15.0	56.7	28.3
Brantford	56.5	31.7	46.6	21.7
Brockville	19.2	47.3	33.7	19.0
Chatham	22.3	43.5	26.2	30.3
Cobalt	3.4	28.4	48.0	23.6
Cobourg	8.0	13.6	67.6	18.8
Collingwood	11.2	31.3	54.4	14.3
Cornwall	13.6	15.4	46.0	38.6
Fort William	50.9	20.8	38.3	40.9
Galt	34.5	48.3	21.6	30.1
Guelph	31.1	33.2	47.2	19.6
Hamilton	169.0	0.7	77.8	21.5
Kenora	6.7	16.6	58.3	25.1
Kingston	31.6	15.2	64.1	20.7
Kitchener	31.2	38.3	42.0	19.7
Lindsay	14.6	29.0	52.7	18.3
London	110.5	46.9	30.2	22.9
Midland	13.7	41.4	46.9	11.7
Niagara Falls	25.3	19.6	58.1	22.3
North Bay	19.6	20.8	37.6	41.6
Orillia	13.8	37.7	26.1	36.2
Oshawa	13.0	43.7	37.9	18.4
Ottawa	195.0	43.7	23.3	33.0
Owen Sound	23.3	10.5	56.7	32.8
Pembroke	9.2	19.9	58.5	21.6
Peterborough	40.8	63.1	11.5	25.4
Port Arthur	43.3	15.2	66.4	18.4
Port Hope	9.0	32.0	47.4	20.6
St. Catharines	57.5	29.2	41.0	29.8
St. Thomas	27.0	35.0	41.2	23.8
Sault Ste. Marie	22.3	27.6	29.7	42.7
Smiths Falls	12.3	32.2	55.4	12.4
Steelton	10.9	47.5	23.5	29.0
Stratford	33.4	17.4	63.1	19.5
Sudbury	14.6	28.6	45.5	25.9
Walkerville	20.0	26.4	45.8	27.8
Welland	11.6	28.0	51.1	20.9
Woodstock	23.3	44.5	39.2	16.3

In the majority of places included in the foregoing list, small mains are more or less confined to residential and minor mercantile districts. This is not true, however, of some of the larger cities where 4-inch pipe, originally laid on unimportant streets, now comprises part of the supply system in the central business sections. These old lengths of pipe constitute a problem that is costing many municipalities dearly in extra pumping capacity and in their efforts to gradually replace them or parallel them with mains of more ample capacity.

As a general rule, no pipe smaller than 6 inches in diameter should be used for public hydrant supply. A 6-inch pipe will carry the same quantity of water as three 4-inch pipes, and an 8-inch pipe will carry the same as six 4-inch pipes. If two fire streams are taken from a hydrant on a 4-inch main, the drop in pressure will be approximately 66 pounds for every 1,000 feet of main, as compared with 9 pounds with 6-inch and 2.3 pounds with 8-inch. The cost of installing 8-inch pipe is approximately 50 cents per foot more than 4-inch, or ten cents per foot for each time the discharging capacity of a 4-inch pipe is added.* Underwriters regard all mains of less than 6 inches diameter as practically valueless fo fire protection purposes. The National Board of Fire Underwriters specify 8-inch for residential districts and 12-inch for important mercantile and manufacturing districts, and usually include in their recommendations for improvement in any city the proviso "that all 4-inch mains used for hydrant supply be replaced within five years."

It is generally conceded by engineers that a waterworks distribution system should be designed to furnish fire protection upon the following scale: (a) in outlying residential districts not likely to change in character, 1,500 gallons per minute, (b) in closely built, but not excessively hazardous, mercantile districts, 2,000 to 5,000 gallons per minute, (c) in manufacturing, warehouse and congested value districts, 5,000 to 20,000 gallons per minute, depending upon structural conditions.† That these quantities may be available, the following minimum sizes of pipe should be used for hydrant supply: for residential districts, 6-inch mains to form a good gridiron; where dead-ends are necessary 8-inch pipe should be installed and also in blocks more than 600 feet in length; for mercantile and manufacturing districts 8-inch, 10-inch and 12-inch mains, the first mentioned only in sections where they complete a good gridiron.

*From data gathered in connection with the extension and reconstruction of over 200 waterworks systems, the average cost of laying cast iron pipe lines before war-prices prevailed was approximately as follows:

Size of pipe	*Weight per lineal foot*	*Cost per foot*
24-inch	233.3 lbs.	$4.20
20 "	175.0 "	3.20
18 "	150.0 "	2.70
16 "	125.0 "	2.30
12 "	82.0 "	1.50
10 "	63.8 "	1.25
8 "	47.5 "	0.95
6 "	33.3 "	0.65
4 "	21.7 "	0.45

†These quantities are in addition to domestic requirements.

To accomplish any improvement of a permanent character in existing systems, a careful study should be made of present requirements and probable future growth, following which a plan should be adopted and rigidly adhered to in all extensions. This plan should include main arteries of ample carrying capacity for at least fifty years, secondary feeders of suitable size not more than 3,000 feet apart and dead-end lines extending to outlying districts without reduction in size. The smaller inter-connecting lines running between the secondary feeders should not be more than 600 feet apart and should be of sufficient capacity to supply maximum requirements under all conditions with a minimum friction loss. Broadly speaking, the more connections there are in a gridiron, to the feed mains, the more certain is a constant volume of water at uniform pressure at any point within it. This simple fact is generally overlooked by cities and towns in Canada. Extensions are made, often in the most haphazard manner, without reference to the system as a whole. Owing to defective circulation, water pressures at hydrants within a block of each other frequently show a difference of 20 to 30 pounds.

Tar-coated cast iron pipe is undoubtedly the best material to instal in a distribution system. In some places steel pipe is extensively used and has given satisfaction. Recently a 16-inch steel main in the city of Vancouver was found in excellent condition after 22 years' service. In the case of steel pipe, however, it is essential that all impurities be eliminated from the metal and that an effective and durable coating be provided to prevent corrosion of the pipe when in service. Kalamein, wood-stave and banded wooden pipes are installed in a number of Western cities and towns for the larger sized mains, but their use in general distribution systems is not favoured. Wood-stave pipe manufactured from carefully selected fir should, under constant service, have a life equal to steel pipe.

Electrolysis from stray electric currents is unquestionably the cause of many troubles affecting water distribution systems. Where single trolley street-railway systems are in operation and defective rail bonding is common, the entire elimination of current leakage to the water mains is impossible. It can be greatly reduced, however, by installing insulated return feeders to drain the rails at radially disposed points. In Europe such return circuits are made necessary by regulations limiting the allowable drop of voltage in the rails. Railway companies object to this method on the ground of expense, but it has been adopted in several cities in the United States as the result of court injunctions restraining electric railway companies from injuring waterworks systems by permitting an escape of current.

To operate a distribution system with facility and to provide against disruption of the service in case of accident, breakage or repairs to the mains, gate valves should be installed at not more than 500 feet apart in business districts and 800 feet apart in residential districts. These valves should be inspected regularly and systematically. In one city where inspection was supposed to be carried out every year, an examination of 7,000 valves showed: 49 fully closed and 300 partially closed; 12 inoperative; 100 marked on the plans but not installed; 2 completely filled with crushed stone; 1 division gate to high service open; and 1,952 clogged with sediment and difficult of operation. In another city, a large fire swept an entire block as the result of shortage of water due to closed valves in one of the large distributing mains.

While hydrants are often regarded as unimportant items, they constitute the connecting link between a waterworks system and the fire department and affect, in large measure, the quality of the protection provided. The distribution of hydrants should be such that ample quantities of water can be delivered to a large fire at an average distance therefrom of nor more than 250 feet. The customary method of requiring hydrant spacing on a linear basis is valueless as an index of the protection afforded unless the size and shape of the blocks in a city or town are known. For instance the placing of hydrants at linear distances of 200 feet in a city where blocks are 200 feet square, would give one hydrant to each 10,000 square feet of area served, whereas the same distribution, where the blocks were 800 feet square, would only give one hydrant to each 40,000 square feet of area served. It is clear, therefore, that to determine the adequacy of hydrant distribution, the only proper unit to adopt is that of the area served. Where it is necessary to concentrate protection, as in high-value mercantile and manufacturing districts, there should be one hydrant for each 40,000 square feet of area. In minor mercantile districts, there should be one hydrant for every 60,000 to 80,000 square feet, the distance between hydrants increasing with decreasing congestion up to a maximum of 120,000 square feet in outlying residential districts. In the case of mercantile districts, this spacing roughly corresponds to a linear separation of 150 feet. In the larger cities in Canada as good distribution as this is usual, but, in the smaller places, no rule appears to be followed and hydrants are placed at street intersections only.

The volume of water available at any point for fire department use depends not only upon the emplacement of hydrants but also upon their capacity. In many cities, the congested-value districts are served by hydrants which may have been adequate in size when installed, but have outlived their usefulness by decades. For the provision of two streams, or for supplying one engine, hydrants with not less than 6-inch barrels should be used. In central business districts, 8-inch hydrants with three 2½-inch hose and 4-inch steamer connections are preferable. Hydrants should be so designed as to entail friction losses of not more than 3 pounds in the 6-inch pattern under maximum draught. There are hydrants in service in some cities, which show a loss of over 35 pounds between the street main and the hose outlet when 500 gallons of water, or two hose streams, are being drawn, whereas there are others which deliver the same quantity of water with a loss of less than 2 pounds.* When purchasing hydrants, neglect of this seemingly trivial item may cost a municipality thousands of dollars every year in extra insurance premiums for deficient water pressure. Maintenance of hydrants in good order is made difficult in many places by the general practice of street cleaning and sewer departments using them to obtain water for flushing purposes. This often results in worn operating nuts, battered threads and leaking foot valves. Leaking foot valves are responsible for the majority of frozen hydrants. No hydrant should be allowed to freeze up. Neglect of this has resulted in many large fires getting beyond the control of the fire departments before water could be obtained. All hydrants should be covered to a minimum depth of five feet and, where very cold winters are experienced, to a depth of six or seven feet. Proper drainage should be provided either to the sewers or by means of broken stone. Frequent inspection should be made to assure their efficient operation. In residential districts they should be packed, lubricated and blown out, at least, once a year. During cold weather, those in high-value districts should be inspected daily.

Water Pressure for Fire Service

From the standpoint of fire protection, water pressure is of

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*One test of hydrants of the same pattern for loss of head gave the following results:

No.	*Diameter of barrel*	*Diameter of branch*	*Approximate flow (gals. per min.)*	*Loss of pressure (lbs. per sq. in.)*
1	6	6	500	10.06
2	5	6	500	2.12
3	5	6	500	9.4
4	6	6	500	3.1
5	6	6	500	14.8
6	6	6	500	1.6

paramount importance. Whether effective fire streams can be obtained directly from the system or whether the use of fire engines is essential, depends entirely upon the pressure available at the hydrants. This, in turn, determines the character and equipment of the fire department. In all smaller cities and towns, it is of the greatest economic advantage to secure fire streams without the use of fire engines, which are costly to maintain and inefficient at best. In large cities, the question is not perhaps of equal moment, as fully organized and equipped fire departments are considered necessary under all circumstances.

Hose Streams

As already stated, over 60 per cent of all fires in cities is extinguished by chemical and other small apparatus. The remaining fires demand the use of hose streams. To be effective, streams must have not only volume but also sufficient force to reach the seat of a fire without being broken up by air resistance. The horizontal and vertical reaches of a stream are mainly dependent upon the pressure with which it emerges from the nozzle. Fairly good fire streams are obtainable with nozzle pressures of from 35 pounds to 50 pounds, very good fire streams with pressures of from 50 pounds to 65 pounds, and heavy streams with pressures above 65 pounds. The requisite hydrant pressures to provide such streams under different conditions of service are shown in the following table:

TABLE No. 22.—HYDRANT PRESSURES FOR STANDARD FIRE STREAMS

	Pressure at nozzle	Vertical distance of fire stream*	Horizontal distance of fire stream†	Pressure in pounds required at hydrant to maintain pressure at nozzle (1⅛ inch) through various lengths of 2½-inch smooth rubber hose.‡								
				50 feet	100 feet	200 feet	300 feet	400 feet	500 feet	600 feet	800 feet	1,000 feet
Good Fire Streams	35	59	54	43	49	60	71	82	94	105	127	149
	40	65	59	50	56	69	81	94	107	120	145	171
	45	70	63	56	63	77	92	106	120	135	163	192
	50	75	66	62	70	86	102	118	134	150	181	213
	55	80	69	68	77	95	112	130	147	165	200	235
	60	85	72	74	84	103	122	141	160	180	218	256
	65	86	75	81	91	112	132	153	174	195	236	...
Heavy Fire Streams	70	88	77	87	98	120	143	165	187	209	254	.....
	75	90	79	93	105	129	153	177	201	224	....	.....
	80	92	81	99	112	138	163	188	214	239	....	.....
	85	94	83	106	119	146	173	200	227	254	....	.....
	90	96	85	112	126	155	183	212	241	....	....	.....
	95	98	87	118	133	163	194	224	254	....	....	.....
	100	99	89	124	140	172	204	236	....	....	....	.....

*Maximum limit reached by water 10 per cent higher.
†Maximum limit reached by water 12 per cent farther.
‡Pressures exceeding 250 lbs. at the hydrant are not practicable, except in special high-pressure systems.

From the foregoing figures, it is apparent that, above a certain point, the nozzle pressure increased by a given increment produces a smaller increment to the reach of a stream. Thus, while an increase of pressure from 40 pounds to 50 pounds increases the vertical reach by 10 feet, an increase of pressure from 90 pounds to 100 pounds only increases it by 3 feet. From the practical standpoint, a stream delivered with a nozzle pressure of 50 pounds, or 55 pounds, will be one of maximum efficiency. The pressure required at the pumping station need be only as much in excess of this pressure as is required to overcome the friction losses between the two points. From the hydrant to the nozzle, the loss of pressure depends upon the size and length of hose in use. From the hydrant to the pumps, the amount of loss is largely affected by the efficiency of the distribution system. In a well-designed plant, this should not perhaps exceed more than 20 per cent or 25 per cent in the closely built-up districts of a city or town. In the majority of the cities and towns in Canada, however, friction losses due to poor distribution are more than double this amount. The following table shows the drop in pressure between pumps and hydrant outlets in a number of the cities and larger towns of Ontario. The tests cover all the principal points of the distribution system in each place.

TABLE NO. 23.—TEST OF HYDRANT PRESSURES IN THE PRINCIPAL CITIES AND TOWNS OF ONTARIO

City or town	No. of hydrants tested	Average normal pressure	Average running pressure	Pressure at pumps during test
		lbs.	*lbs.*	*lbs.*
Barrie	20	104	64	120
Belleville	32	94	71	113
Brantford	55	83	59	120
Brockville	27	82	63	110
Chatham	34	109	82	120
Cobalt	8	138	81	150
Cobourg	16	96	60	105
Collingwood	22	108	64	115
Cornwall	16	90	65	100
Fort William	51	113	87	Gravity
Galt	28	68	52	100
Goderich	18	103	52	160
Guelph	39	99	52	120
Hamilton	68	75	60	100
Ingersoll	16	76	41	100

TABLE NO. 23—*Continued*

City or Town	No. of hydrants tested	Average normal pressure	Average running pressure	Pressure at pumps during test
		lbs.	*lbs.*	*lbs.*
Kenora	15	109	92	113
Kingston	42	55	47	78
Kitchener	14	77	52	110
Lindsay	19	71	53	100
London	73	84	69	110
Midland	18	100	70	127
Niagara Falls	31	84	33	133
North Bay	27	88	63	Gravity
Orillia	19	83	57	130
Oshawa	9	88	58	135
Owen Sound	13	76	56	Gravity
Pembroke	21	108	78	130
Peterborough	43	99	82	120
Port Arthur	48	120	90	156
Port Hope	14	81	54	110
St. Catharines	44	79	68	Gravity
St. Thomas	32	102	75	120
Sarnia	22	80	54	95
Sault Ste. Marie	34	93	78	110
Smiths Falls	20	66	42	100
Steelton	17	100	58	110
Stratford	30	96	44	110
Sudbury	26	100	55	130
Walkerville	24	103	87	110
Welland	23	99	75	120
Windsor	42	57	39	90
Woodstock	29	103	76	120

Higher Pressures Advisable

In practically all waterworks systems at present undergoing improvement and reconstruction, consideration is being given to the question of increasing normal service pressures. Many eminent engineers advocate the maintenance of a minimum pressure of 100 pounds in important cities and towns. While some existing systems would probably be incapable of bearing this strain without considerable changes and replacement, high pressure service would, from the viewpoint of economy, have numerous advantages. Fire engines could be entirely dispensed with in many places and their number reduced in others. As the maintenance of an engine company costs approximately $2,500 to $3,500 a year more than the maintenance of a hose company, a material saving would be thus effected. In addition to reduction of fire department cost, other economies more directly affecting the individual property owner would be possible. At the present time, it is necessary, in all the larger cities, to instal private pumping equipment to supply water in high buildings. This could, of course, be far more cheaply done at a central pumping station. Sprinkler equipment, also would gain in efficiency and reliability with a high-pressure water service. In fact, if automatic sprinklers supplied by a single source are to be generally installed, as is advocated, much higher pressures will have to be provided in public water supply systems. That an increase of pressure, even up to 100 lbs., does not necessarily increase the use or waste of water is shown by a comparison of the per capita consumption in cities with high and low pressures. Neither is the cost of supply in places furnishing water at high pressure materially greater than in places where low pressure is maintained.

Separate High-Pressure Systems

The increasing concentration of values in the central business districts of large cities and the excessive heights to which buildings are now erected, have made imperative the provision of a more effective form of fire protection than the ordinary water supply. What are designated 'high-pressure systems' have, within the past fifteen years, been installed in more than twenty of the more important cities in the United States and Canada. The object of these systems is to provide an absolutely reliable supply of water at maximum pressure, subject exclusively to fire department direction and control. In all of them, it is possible to secure water at 300 or more pounds pressure, but in practice, a pressure of 150 pounds is most frequently used. These pressures are immediately available at call and are, of course, unaffected by other than fire department demands.

In Canada, separate high-pressure water systems have been installed in the cities of Toronto, Winnipeg and Victoria. All are supplied with water from inexhaustible sources, but each differs from the others in its method of pumping, electricity, gas and steam respectively, being employed. As the Winnipeg system is unique in many respects, a brief description of its main features is given herewith.

Winnipeg High-Pressure System

The Winnipeg high-pressure system was built in 1908 and was considerably enlarged in 1913. The distribution system covers the congested-value district and a part of the minor manufacturing and residential districts. The water supply is taken from the Red river through a 36-inch, continuous, wood stave pipe, 450 feet long, terminating at the pumping station in two branches leading to concrete suction wells 45 feet deep. These wells are used as settling basins for the river silt with which the water is heavily charged. On one occasion only has the intake been seriously blocked with frazil ice.

The pumping plant consists of four 1,800-gallon triplex double-acting pumps with friction clutch connections to four 520 b.h.p. Crossley gas engines, two 900-gallon pumps of similar type geared to two 260 b.h.p. gas engines and two 1,800-gallon two-stage turbine pumps operating in series driven by two 320 k.w. induction motors. The gas engines are of 4-cycle pattern, with two tandem cylinders and are supplied with gas from four Crossley gas producers. Compressed air at 200 lbs. pressure is used for starting and the entire plant can be in full operation four minutes after the receipt of an alarm. One engine is kept running all the time to supply water to the Canadian Pacific Railway shops through an independent pipe line which may be shut off if the pump is required for fire purposes. The only other service connection to the high-pressure system is one automatic sprinkler installation with a valve normally closed.

A pressure of 60 lbs. to 110 lbs. is constantly maintained in the distribution pipes. On the receipt of a fire alarm, this is increased to 200 lbs and, if required, to 300 lbs.

There are 15.6 miles of pipe, 127 gate valves, exclusive of hydrant branch valves, and 157 hydrants in connection with the high-pressure system. The hydrant spacing varies from 110 feet up to 525 feet, the avarage area served by each hydrant in the congested district being approximately 70,000 square feet.

The use of the high pressure system in large fires has been entirely satisfactory and, since its establishment, no fire has progressed beyond the building in which it originated.

The chief advantages claimed for separate high-pressure systems may be briefly summarized as follows:

1. They are able to supply water in sufficient quantities to control spreading fires and at an adequate pressure to deal with fires in high buildings.

2. They provide pressure directly from the hydrants without the necessity of transporting cumbersome, inefficient and complicated pumping apparatus through the streets.

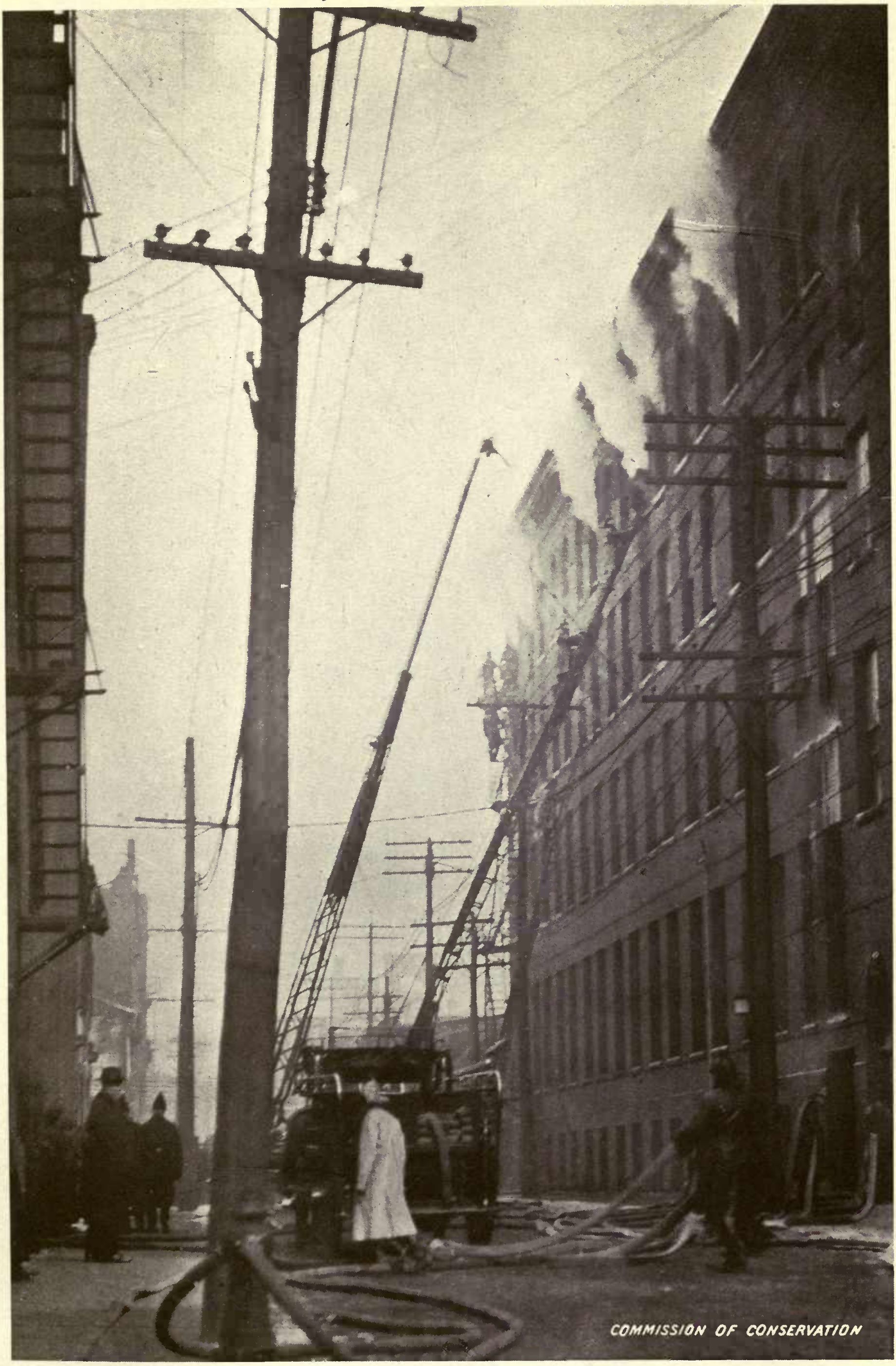
3. By dispensing with the use of fire engines, the cost of fire departments is considerably reduced.

4. There are many minor advantages, such as the elimination of noise and confusion at fires and of the danger to citizens from the rapid passage of heavy apparatus through the streets.

From an economic standpoint, high-pressure systems are only desirable in the very largest cities where the conflagration hazard is high and the domestic water supply weak. In the average city with less than 150,000 population, more satisfactory protection can be furnished by strengthening the domestic distribution system, by installing additional pumping capacity and by maintaining an average normal pressure of about 100 pounds. Improvements to the domestic distribution system benefit the entire municipal area, whereas high-pressure service is confined to a small central district.

Public Fire Departments

At the present time, the organization, equipment and maintenance of public fire departments is universally regarded as a function of municipal government. Originally, the work of extinguishing fires was a purely voluntary undertaking. In England, following the great fire of London in 1666, the then newly formed insurance companies established and supported bodies of men whose duty it was to protect the property insured by their employers. In course of time, these insurance brigades were consolidated and, in 1865, they were taken over by the municipal authorities and maintained as public organizations. In the cities of continental Europe, fire brigades have always been, partly if not entirely, under state control and discipline. The *régiment de sapeurs pompiers* of Paris, for example, is an integral part of the regular army, directed by the prefect of police, who is appointed by the national government. In Russia, professional fire brigades are maintained by the local authorities in each district but are commanded by military officials. In the United States and Canada, the work of fire extinguishment has, from the beginning, been regarded as a public undertaking. Until 1850, or thereabouts, all fire brigades were composed of volunteers organized through the co-operative enterprise of the citizens of a town. In due course, these voluntary organizations gave way to partly-paid or retained brigades and these, in turn, were replaced in all the larger cities by permanent fully-paid departments. These changes were brought about by increasing exigencies of the service consequent upon urban growth and by the introduction of highly specialized fire apparatus which demanded skilled operation.



OVERHEAD WIRING HANDICAPS FIRE DEPARTMENTS

In the central districts of cities and large towns, electric light, power, telegraph and telephone service wires should be placed underground.

In Canada, the form of organization and the measure of equipment of fire departments are largely determined by the size and importance of the communities protected. As a rule, the fire-fighting facilities of any city or town are a better index of its liberality in appropriations than of its actual needs. In all except the cities and larger towns, voluntary brigades are in the majority. These are obviously of many grades of efficiency and range from the small bucket brigade in a country village to the well-equipped and properly trained department of a large town. In the smaller cities, brigades are usually composed of a combination of volunteers, partly-paid men and fully-paid men. The personnel of the various forms of brigades in Canada may be summarized as follows:

Form of Brigade	*Number*	*Members*
Fully paid	41	2,707
Part fully paid and part volunteer	89	964
Chief only fully paid	39	371
All partly paid	97	603
All municipal employees with other duties	18	214
Chief with other municipal duties, remainder volunteers	61	446
All volunteers	516	3,425
Total	861	8,730

The number of firemen attached to fully-paid brigades in Canada varies with the structural density, property values and financial condition of each particular municipality. The average for cities of the first class is approximately 10.6 per 10,000 population but, taking each place individually, the figures range from 7.5 to 20 per 10,000. These men are, as a rule, organized into companies having 7 to 12 members and completely equipped for hose, ladder or engine service.

Comparison with Europe

An interesting comparison in this connection is the strength of fire departments in Europe. The City of London fire brigade numbers 1,365 or 2.8 per 10,000 population, the firemen being organized into 82 companies with an average of 16 men per company. Similar figures for Berlin show a total of 1,040 firemen, or 4.9 per 10,000 population, organized into 20 companies, having an average of 52 men per company. In Milan, the brigade numbers 221 or 3.8 per 10,000 population, organized into 6 companies with 37 men per company. The numerical superiority of Canadian as compared with English fire departments in cities of approximately the same size is shown in the following table:

TABLE No. 24.—COMPARISON OF THE STRENGTH OF MUNICIPAL FIRE DEPARTMENTS OF CANADA AND GREAT BRITAIN

Canada	Great Britain	Population	Area in acres	No. of firemen	Firemen to square mile	Population to each fireman
Montreal		650,000	26,618	762	18	853
	Manchester	714,000	21,645	130	3.8	5,492
	Glasgow	784,000	....	195	....	4,020
Toronto		470,000	25,330	360	9	1,307
	Birmingham	525,960	13,478	194	9.2	2,710
	Sheffield	478,000	23,662	53	1.4	9,019
Winnipeg		203,255	15,287	217	9	936
	Belfast	385,000	....	75	....	5,133
	Leicester	248,370	8,586	28	2.1	8,870
Vancouver		115,000	10,784	170	10	676
	Blackburn	136,000	7,431	36*	3	3,777
	Swansea	116,400	6,229	21*	2.3	5,523
Hamilton		101,808	7,143	88	8	1,156
	Wolverhampton	106,573	3,525	23*	4.6	4,633
	Middlesboro	104,818	2,823	16	4	6,551
Ottawa		101,795	5,295	104	13	978
	Gateshead	133,676	3,138	25*	5	5,347
	Huddersfield	102,000	12,154	20	1	5,100
Calgary		84,000	25,900	75	1.9	1,120
	Walsall	86,430	7,358	13*	1.2	6,648
	Blackpool	83,000	4,244	18	2.6	4,611
Quebec		80,000	4,851	185	26	427
	Davenport	84,695	3,176	21†	4.2	4,033
	Merthyr Tydvil	81,085	17,759	13*	0.5	6,237
Edmonton		72,516	28,200	80	1.8	906
	Barrow-in-Furness	71,500	21,009	28†	0.9	2,553
London		55,026	6,302	42	4.1	1,300
	Stockton	51,478	3,030	20	4	2,573
	Exeter	54,329	3,158	29	5.8	1,873
Victoria		55,000	4,637	79	11.3	696
	Wimbledon	58,000	3,221	25	5	2,320
	Swindon	56,900	4,246	16†	2.3	3,556
Halifax		55,000	4,400	35‡	5	1,599
	Burton	54,977	4,207	18	2.6	3,054
	Lincoln	56,400	3,891	17	2.8	3,317
Fort William		24,071	9,865	25	1.7	962
	Dartford	25,600	4,251	14	2	1,828
	Loughboro	24,300	3,045	15	3	1,620
Total:	Canada	2,067,471	174,712	2,222	8.1	930
	Great Britain	4,211,481	151,151	1,063	4.5	3,962

*Police Brigades.
†Volunteer Brigades.
‡Reserve of 86 volunteers in addition.

CHAPTER IX

Fire Insurance as Affecting Fire Waste

FIRE INSURANCE as an institution owes its existence to fire waste. From the viewpoint of economic theory, the fundamental principle of insurance is the pro rata distribution of fire losses over all insured property. Eventually, through the channels of commerce, these losses enter into the cost of every purchasable commodity, affect every individual and become of nation-wide interest and importance. The problem of fire waste is therefore inextricably bound up with the business of insurance, and a study of one is incomplete without a proper appreciation of the other.

Economic Importance of Fire Insurance

To obtain a clear idea of the relationship of fire insurance to fire waste, it is essential that insurance be briefly considered from the following standpoints: (1) as individual protection; (2) as commercial security and (3) as a national tax.

1. INDIVIDUAL PROTECTION—Fire insurance in its simplest form is a means of relieving individual misfortune by contributions from a combined group of individuals and is a purely mutual undertaking. In its commercial aspect, it is an accumulation of funds to meet future eventualities by applying the law of averages to losses by fire. Damage to any given building, in any given location, within any given space of time, is a matter of uncertainty. With the combination of a number of separate buildings into a group, the element of probability is introduced. It is in the application of this principle that a distinct gain to society is apparent in the institution of insurance. Experience may show that of 10,000 dwellings having an aggregate value of $50,000,000, 50 are damaged by fire every year and a loss of $250,000 entailed. Experience does not indicate, however, which 50 of the 10,000 will be burned next year nor the proportion of damage that will be done in any one. Consequently, where there is no system of insurance, each individual owner is, at all times, risking the total loss of his investment. But, assuming that these 10,000 property owners combine into one group, it is clear that they substitute for individual uncertainty a definite knowledge. Upon the basis of past experience, the annual loss upon the whole group will amount to, say, $250,000.

It, therefore, follows that an assessment of $\frac{1}{2}$ of 1 per cent upon the valuation of each individual's property will provide sufficient funds to reimburse the loss of the entire group. The element of probability, when distributed over a group, becomes a certainty, and the larger the group the greater the certainty.

2. COMMERCIAL SECURITY—The stability resulting from insurance ensures the safety of capital applied to enterprise. Fire insurance has therefore become fundamental in the modern credit system, and its importance in this respect is apparent when we reflect that less than 5 per cent of the world's business is conducted on a cash basis.*

Fire insurance supplies the collateral security without which the wholesale dealer could not extend credit to the retail merchant. With the goods insured, however, credit is often granted to the extent of five or six times the purchaser's available capital. In the same way, the wholesale house operating upon borrowed capital secures favourable rates from banks and manufacturers. As mercantile insurance usually covers all stock coming into a warehouse or store during the term of the policy, $100,000 of insurance may, in the course of a year, cover several million dollars worth of property, thus distributing the actual cost over a large value.†

The enormous importance of insurance as the foundation of modern commercial enterprise has been emphasized by every official enquiry into the affairs of insurance companies. Thus, the Joint Committee of the Senate and Assembly of the State of New York, in its Report upon Insurance Companies, says:

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*Numerous illustrations might be cited to show the far-reaching influence of fire insurance upon the modern credit system. A cargo of grain is shipped from Montreal to Liverpool and is paid for by a cargo of manufactures shipped from London to Halifax. Here is a transaction that is based on credit and consummated without cash. Commodities pay for commodities and the exchange banker who undertakes the financial settlement of the two shipments does so because the safety of the goods is guaranteed by a fire and marine insurance policy in each case. The insurance of these cargoes in reliable companies reduces the element of risk, for, if the property involved were destroyed by fire or upon the sea, the creditors would, nevertheless, be fully protected.

†In still another way fire insurance enables the transaction of business upon limited capital. Grain held in elevators, say at Port Arthur, represents an inactive investment. It also represents security upon which the owner can obtain reasonable monetary advances. Consequently, a grain dealer is not limited in his purchases by his actual available cash. By means of warehouse receipts and insurance policies, he is enabled to make additional purchases, which may, in turn, be used as collateral for further loans. Likewise, the exporter of goods from Canada may, by means of insurance policies and bills of lading, command money with which to buy goods for subsequent shipments and to repeat the operation until his working capital amounts to four or five times his original cash investment.

"The importance of insurance has gone far beyond the point of being simply a system of distributing loss; it is quite as important because of its potential indemnity, that is, because of the state of security which it produces. It is readily recognized that to-day the financial operations of the world are on a basis of credit. Insurance is the foundation of the modern credit system, and by just so much as the welfare of society is founded on the free operation of credit by so much is the institution of insurance of importance to the public, quite aside from its value in actually distributing loss."*

3. A NATIONAL TAX—Fire insurance, being essential to the transaction of business and affecting the selling price of every article of commerce, is invariably referred to by economists as a national tax.† Thus Judge Rufus M. Potts, in a report to the Governor of Illinois upon *Fire Insurance Conditions and Rates in Illinois*, points out that, "under modern commercial conditions, fire insurance is practically compulsory. The insurance business is therefore of personal interest to every citizen. The fire insurance tax falls not only on property owners but also on everyone who sleeps in a house or purchases goods in a store, for owners add the fire tax to the rental of their buildings and include it in the price of goods sold."

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*The absolute necessity for fire insurance in modern industry was thus emphasized in the annual report of the Insurance Committee of the Canadian Manufacturers' Association, 1917:

"Under modern methods of business, insurance is not a luxury, it is a necessity. Credit is so large a factor in business nowadays that the great majority of firms, especially corporate companies, have no option but to keep themselves adequately insured at all times. Were it known that they were not doing so, they would probably be forced to purchase on the basis of cash with the order, and banking accommodation would be denied them. A corporation possessing very large assets, well distributed geographically, may sometimes be justified in not taking out insurance. But these are rare exceptions, for it is probably no exaggeration to say that 90 per cent. or more of the manufacturers carrying on business in Canada have to purchase insurance. To all intents, it is as much a necessity to them as coal or power, as unavoidable an expense as taxes."

†"Fire premiums are a tax which the fire insurance companies are authorized to levy by virtue of the licenses issued by the several states. This tax is paid by all property owners who carry insurance."—*Business of Insurance*, Dunham, vol. 1, p. 60.

In a recent decision the United States Supreme Court has expressed concurrence with the view that insurance is a tax, as follows: "The effect of insurance is to distribute losses over as wide an area as possible. In assimilation of insurance to a tax, the companies are the mere machinery by which the losses are distributed, so as to fall as lightly as possible on the public at large, the body of the insured, not the companies, paying the tax."—*German Alliance Insurance Co. vs. Superintendent of Insurance, State of Kansas.*

Unfortunately, the real nature of insurance is at the present time little understood and this explains much of the public apathy towards all matters concerning the prevention of fire. Franklin H. Wentworth, Secretary of the National Fire Prevention Association, in an address before the ninth annual meeting of the Texas Fire Prevention Association, stated:

"It is a singular commentary upon our mental acuteness that we do not yet discern that fire insurance is a tax, shifted through the buying and selling processes upon the entire community; that every fire hazard tends to increase this tax and that every element of fire prevention tends to lessen it. Insurance is merely a reservoir from which flows immediate relief for the victims of fire, who, because of this reservoir, need not wait to recoup misfortune; but this reservoir must be refilled, and kept full, if sure relief is to flow to succeeding sufferers."

With the fact clearly understood that the fire waste of the country, as distributed through insurance channels, inescapably falls upon every person in the country, it is almost superfluous to draw the corollary that insurance which benefits the individual, at the same time, impoverishes society as a whole. The state suffers an economic loss every time a fire occurs. If the property is insured, the loss is confined to the destruction of created values. If insured, there is not only the loss of actual property, but also the loss incurred in indemnifying the individual owner. For example, in 1916, the destruction of property in Canada insured with Dominion licensed insurance companies amounted to $15,114,000. To reimburse the individual property owners for this loss, the people of Canada were taxed $27,784,000 or $12,670,000 in excess of the indemnity afforded. In other words, for every dollar distributed by the insurance companies, one dollar and eighty-three cents was collected from the public. It is apparent that this tremendously costly method of relieving misfortune does not restore the property that has been destroyed. That can only be made good by the slow processes of re-creation. Neither does insurance in any sense reduce the probability of damage to property. On the contrary, it undoubtedly tends to encourage carelessness on the part of the assured. If each individual property owner could be made to bear directly the loss resulting from his own action or inaction, questions of fire loss and fire protection would soon receive attention. As stated in the report of the Wisconsin Insurance Investigation Commission, 1913, p. 66:

"The individual, ordinarily, can not well get along without fire insurance. Yet the security offered by insurance is undoubtedly one of the greatest causes of indifference to the cause of fire prevention. If people could be made to realize that insurance is merely the distribution upon themselves of an unnecessary tax at an enormous private toll for the distribution, they would soon awaken to the need of fire prevention. The insurance imposes upon the state as a whole an economic loss in expense equal to the losses. This means that if all fire insurance were done away with there would be an immediate saving to the people of Wisconsin of over $5,000,000 per year, assuming the losses continued the same. But losses would also drop owing to the greater care the people would use to avoid fire where they would suffer all the loss. It is a common remark among men familiar with insurance or fire preventive work, that if all insurance could be wiped out, the loss ratio would take a sudden drop. With the lessening of losses would come a reduction in the public tax for fire departments which would have less to do."

To the further disadvantage of insurance, there is a form of loss of more serious character which is inherent in the system. While compensation for misfortune should never be a source of profit, it is frequently obtained in excess of the value of the property insured, and, as a consequence, there is much wilful destruction of property.* Without doubt, over-insurance incites to fraud, full insurance engenders carelessness and even partial insurance leads to a diminution of watchfulness. In estimating the economic value of insurance to society at large, therefore, due regard must be given to the burden it imposes upon the many as well as to the burden of which it relieves the few.†

Insurance as a Commercial Enterprise

Fire insurance being in the nature of a tax, the question next arises as to the agency through which this tax is collected and disbursed. All other forms of taxation are apportioned by governmental authority, federal,

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*The law frowns upon over-insurance. "A policy of insurance is a contract of indemnity against loss, and not to produce gain. The law does not sanction any insurance which would directly and immediately make the assured party a gainer by the destruction of the thing destroyed, because, if otherwise, there would be at once a temptation to destroy the thing insured and thereby get the money."—*Ionides v. London and Provincial.*

†"While I think it is undoubtedly true that the community would be better off if there was no fire insurance, the individual would find himself liable to be impoverished through no fault of his own and business would be hampered if there were no means of providing against the wiping out of property values. Therefore, I would make fire insurance compulsory but regulate it intelligently."—T. L. Morrissey, Manager of the Union Assurance Society, Montreal.

provincial or municipal.* Insurance funds, on the contrary, are accumulated and administered by private institutions, mainly for profit. As a commercial enterprise, fire insurance consists of selling promises or guarantees against loss. These guarantees are traded in precisely as other forms of merchandise. There is a seller and a buyer, a value received for the buyer and a profit on the transaction for the seller.†

This fact must not, however, be permitted to obscure the fundamental mutuality of insurance. Behind the contractual obligations of the insurer is the mass of the insured held together by economic forces that make insurance a quasi-public business.‡

It is generally conceded that fire insurance first took commercial form in England toward the close of the seventeenth century. Dispensation of aid to sufferers from fire was previously a matter of voluntary contribution or general assessment.¶ Following the Great Fire of 1666, Nicholas Barbon proposed to personally insure buildings by somewhat similar methods to those at present in vogue. Numerous clubs, societies and mutual schemes were started and

*The fact must not be lost sight of that insurance is only a tax because, under present commercial conditions, it is practically compulsory. Losses might be provided for by latent or self-insurance on the part of each property-owner. (See *Noveau Dictionnaire d'Economie Politique, vol. 1, p. 101*). A property might also be so built and equipped as to minimize probability of loss and thus render insurance superfluous. The adoption of either of these methods depends upon their relative cost. Statistics show that, during the past half century, increasing reliance has been placed upon insurance and less upon individual carefulness. There is a point beyond which fire prevention and protection becomes unprofitable and irksome to the individual. In the majority of cases, it appears more advantageous to the property owner to transfer his losses to society at large than to avoid losses by a large expenditure upon self-protection. Here the interest of the individual is at variance with the public interest. An awakened public conscience would compel every property owner to reasonably insure his own safety and thus relieve society of the burden imposed upon it by the present methods of insurance.

†Certain essential differences exist between insurance and articles of commerce. Merchandise, when disposed of, is of no further interest to the merchant; insurance policies are of paramount importance to an insurance company throughout their entire currency. The financial stability of a trader is of no concern to the purchaser of his goods; the reliability of an insurer is vital to every policy-holder. The purchaser of ordinary commodities receives immediate and tangible value; the purchaser of insurance receives a promise of contingent benefit only.

‡In countless legal decisions the view has been upheld that insurance is a public business and a proper subject for regulation in the public interest. "The business of fire insurance is essentially of a public nature. The fund from which, in the aggregate, losses and expenses are paid must be raised from premiums."—*Report of Wisconsin Insurance Investigating Committee*, 1913.

¶In Assyria, more than 2,500 years ago, judges were appointed in every community to administer funds maintained for the assistance of sufferers by fire and flood. Du Chaillu in *The Viking Age* mentions village or clan organizations formed among the Northern tribes to assist those whose property was burned. In England, during the Middle Ages, the Anglo-Saxon guilds provided fire insurance in the form of emergency relief funds. In Continental Europe, communal funds—*branden guilden*—were early established and still survive in many countries as municipal insurance. As primitive conditions gave way to a more complex civilization and neighbour-knowledge became less protection against fraud, these forms of mutual assistance were gradually superseded by contractual compensation.

proved so successful as to invite emulation from those who saw a means of diverting profits from participating policy holders to shareholders. In 1710, the first proprietary company was chartered and this was immediately followed by numberless others. At the present time, joint stock companies control over eighty per cent of the world's fire insurance business. With an aggregate capitalization of approximately $320,000,000, their premium income exceeds $800,000,000 per annum and their accumulated assets, exclusive of capital, amount to $1,970,000,000.

This brief reference to the early history of fire insurance is necessary in order that its purely altruistic origin may be clearly recognized. Commercialism only stepped in during the eighteenth century and the transition was a more significant one than is generally realized. Instead of a direct contribution through a common fund toward the relief of misfortune, the premium became a source of profit for a third party who guaranteed the payment of all losses from accumulated funds. For a system in which every individual was vitally interested in preventing loss was substituted a system in which loss is regarded with complete indifference. The public came to erroneously believe that, after the payment of the premium, the companies alone are concerned with losses, while, on the other hand, the companies having the power to fix the rate of premium are not altogether averse to the occurrence of fires.*

Establishment of Fire Insurance in Canada

Fire insurance practices in Canada and the United States have been almost exclusively derived from England. The growth and development of the business in Canada has kept pace with the expansion of the country in other directions. So far as can be ascertained from the scanty materials available, the first insurance company to enter Canada was the Phœnix of London, England, which established an agency at Montreal in 1804. The Alliance and the Globe companies of London, England, entered Canada soon after the Phœnix and these were followed by two American companies, the Aetna in 1821, and the Hartford in 1836. Prior to 1840, there were at least six purely Canadian companies established—the Halifax, Globe, British America, Central of Fredericton, Home District Mutual and Gore District Mutual. From that date to 1868, no fewer than 26 British and 29 American companies were writing business in Canada.

*Theoretically, insurance companies have nothing to do with the prevention of fires. In practice, however, they have done much to improve conditions as regarding fire hazard, even when such was in apparent conflict with their own interests. The reasons for this course of action are given consideration elsewhere in this chapter.

In 1868, an act was passed by the Dominion Government making it unlawful for an insurance company to transact business without first obtaining a license from the Minister of Finance, and calling for a deposit before the issue of such license. This caused the withdrawal of a number of British and American offices, and, as a consequence, the entire Canadian business was thrown into the hands of 12 British, 4 American and 5 Canadian companies. A list of these, with the names of their chief executive officers appears in the first statement issued by the Dominion Government under the Act of 1868.

Early Difficulties

Some mention of the numerous attempts to carry on fire insurance by domestic companies is of interest in reviewing the early history of the business in Canada, as showing the difficulty of establishing companies in a restricted field and with insufficient capital. The pioneer insurance company of Canada was established in 1809 under the name of the Fire Insurance Association of Halifax, and, in 1819, was incorporated as the Halifax Fire Insurance Company. In 1859, it suffered heavy losses by the disastrous fire which destroyed many of the more important buildings in Halifax. After this reverse, the company was re-organized, but has confined its operations to the province of Nova Scotia. The Quebec Insurance Company was organized in 1818. It has had to meet many severe losses such as the Quebec City fires of 1845, 1862, 1865, 1866, 1870, 1876 and 1881. The British America Fire and Life Assurance Company, the oldest Upper Canadian company, was incorporated in 1833. In 1842, it was authorized by the legislature to extend its operations to inland marine insurance, and in 1851, its powers were further extended to include ocean marine insurance. In 1836, the Central Fire Insurance Company of Fredericton, N.B., was incorporated, and in 1837, the Home District Mutual, a purely mutual company, was established at Toronto. The Gore District Mutual was formed in 1839, the Montreal Assurance Company, the Wellington Mutual of Guelph and the Niagara District Mutual in 1840, the St. John Mutual of St. John, N.B., in 1846, and the King's County Mutual of New Brunswick in 1847. The Kingston Fire and Marine Insurance Company, the Ontario Marine and Fire Insurance Company of Hamilton and the Canada Western Farmers' Mutual and Stock Insurance Company, also of Hamilton, were organized in the 'forties.' The Provincial Insurance Company of Canada was incorporated in 1849, as a combined premium and assessment company. The mutual branch insured only farm property and detached buildings; the proprietary branch wrote fire business generally. The Western Assurance Company of Toronto was incorporated in 1851 and was empowered to carry on fire, marine, inland navigation and life insurance.

During the next quarter of a century, 21 Canadian companies were established, their names in the order of their incorporation being as follows:

St. John Fire Insurance Company, St. John, N.B.....1854
Agricultural Mutual (afterwards the London Mutual).1859
Acadia of Halifax............................1862
Perth Mutual..................................1863
Waterloo Mutual..............................1863
Citizens' Insurance Company.....................1864
Toronto Mutual................................1867
Beaver Mutual.................................1868
Economical Mutual of Berlin.....................1871
Isolated Risk (afterwards the Sovereign)............1871
Queen City....................................1871
Canadian Agricultural...........................1872
Royal Canadian................................1873
Hand in Hand.................................1873
Stadacona of Quebec............................1873
Ottawa Agricultural.............................1874
Mercantile of Waterloo..........................1874
National of Montreal...........................1875
Maritime Mutual, St. John, N.B...................1875
Canadian Fire of Hamilton........................1875
Dominion Fire of Hamilton.......................1878

High Mortality Rate

Numerous mutual companies were formed during this period and, with those subsequently established, have proved of considerable benefit to the districts in which they operate. So far as general fire insurance is concerned, however, it is instructive to note that, of the 37 joint stock companies enumerated, only 13 continue in business at the present time. Without enlarging upon the cause or causes of the large number of failures, it is only fair to state that weak companies have met with a similar experience in all countries and in much the same proportion.* The history of fire insurance is a tale of the survival of the fittest. Despite the fact that the profits of the older companies appear large in proportion to their invested capital, an almost hopeless task confronts any attempt by a new or small company to enter the business. Competition with established concerns,

*Failure to make a profit is largely due, in the case of small companies, to a volume of business insufficiently large and well-distributed to give average results, and to adverse selection. The better class business always gravitates to the large companies in consideration of their ability to take poor business of which they have sufficient to assure an average experience. Small companies are, therefore, always at a great disadvantage until their territory has been developed to a point where they can compete on more nearly equal terms.

whose accumulated assets provide sufficient income to pay large dividends irrespective of current underwriting experience, invariably ends in failure.

Present Status of Canadian Insurance

At the present time, fire insurance in Canada is transacted by 87 companies operating under Dominion license, and 46 joint stock and 223 mutual organizations operating under provincial license. The nationality of the companies under Dominion license is as follows: Canadian 25, British 27, United States 31 and French 4. Under provincial license, there are 9 Canadian joint stock companies, 8 British, 27 United States, 1 New Zealand and 1 Swedish. The numerous mutual companies, including cash, county, municipal, parish, ecclesiastical, and farmers' mutuals, are all domestic institutions.* In addition to the foregoing regularly licensed companies, there are foreign unlicensed organizations, such as the New England Mutuals, Lloyds and Reciprocal Underwriters with whom a considerable amount of Canadian business is placed under privileges conferred by Section 139 of the Dominion Insurance Act, 1910.†

The total value of property insured in Canada on December 31st, 1916 (net at risk) amounted to $4,703,125,540, classifiable as follows:

Dominion licensed companies	$3,720,058,236 (79%)
Provincial licensed companies	720,263,422 (15%)
Unlicensed organizations	262,803,882 (6%)
Joint stock companies	$3,916,876,979 (83%)
Mutual companies	701,809,506 (15%)
Lloyds, etc	84,439,055 (2%)
Canadian companies	$1,354,022,848 (28.9%)
British companies	2,042,376,455 (43.4%)
American and other companies	1,306,726,237 (27.7%)
Tariff companies	$3,634,724,735 (77%)
Non-tariff companies	1,068,400,805 (23%)

*County and parish mutuals insure only isolated and non-commercial risks. Municipality mutuals are special organizations for the insurance of taxable property within municipalities. Ecclesiastical mutuals are Roman Catholic institutions insuring churches, colleges, schools and other ecclesiastical property. Farm mutuals insure only farm property and are all local in character. Other mutuals do a general non-hazardous business or confine their writing to special classes of property, such as millers' mutuals which insure flour mills only.

†Unlicensed insurance companies are not subject to government supervision, pay no fees or taxes, and cannot be sued by legal process in Canada. Surplus lines form the major part of the insurance placed with foreign organizations, such as Lloyds. Mutual companies and reciprocal underwriters insure only specific risks and classes of property of the highest grade. For this business they are in competition with the regularly licensed companies who are called upon to pay taxes and otherwise conform to government requirements. From a purely economic standpoint, unlicensed insurance serves individuals and groups of individuals at the expense of the whole country. By taking the best risks out of the general average, the ratio of loss to property at risk and average premium rate is proportionately increased.

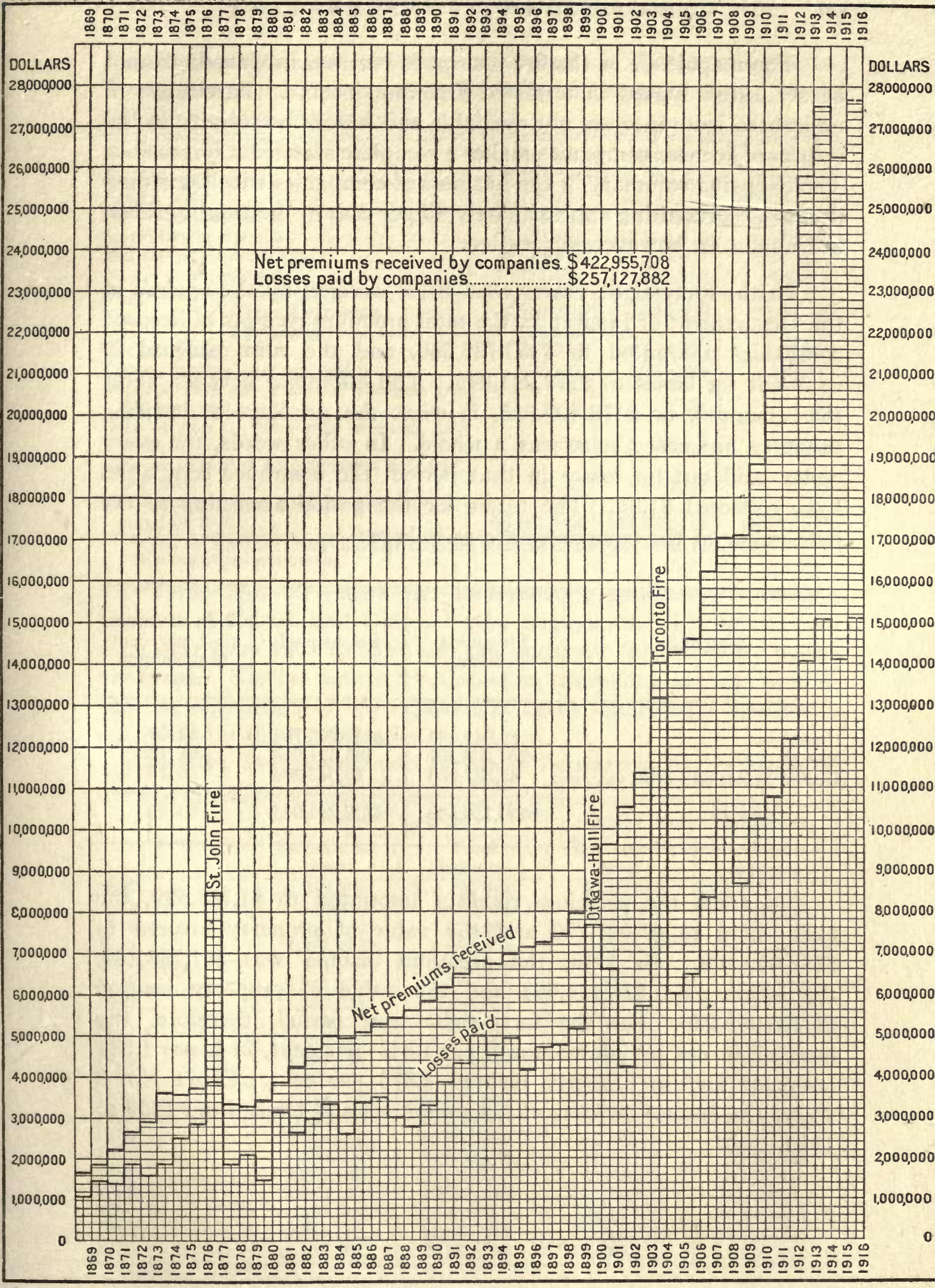

CHART No. 3—GROWTH OF INSURANCE PREMIUMS AND LOSSES IN CANADA DURING THE PERIOD 1869-1915

The magnitude of the fire insurance business in Canada cannot be accurately stated in terms of premium income. Particulars of unlicensed insurance are not available and lack of uniformity in the returns of licensed companies makes a complete statement impossible. The following summary of the business of companies with Dominion licenses, representing approximately 80 per cent of the total business in Canada, is, however, suggestive.

In the forty-eight years (1869-1916) covered by the records of the Department of Insurance, the total premium receipts of licensed companies amounted to $450,739,560, and the sum returned in payment for losses to $272,241,945. The difference between these two amounts, or $178,497,615, is what the privilege of insuring property has cost Canada as a whole. In other words, for every dollar paid out for losses in that period, the insurance companies have collected $1.65. The totals for the period according to the nationality of the companies are as follows:

Companies	Premiums received	Losses paid	Rate of losses paid per cent of premiums received
Canadian	$ 96,048,484	$ 59,795,734	62.26
British	267,308,107	163,371,003	61.12
United States and other	87,382,969	49,075,208	56.16
Totals	$450,739,560	$272,241,945	60.50

In 1869, the premium receipts amounted to $1,785,539, the losses paid to $1,027,720 and the value of property insured to $188,359,809. In 1916, the premium income was $27,783,852, the losses paid $15,114,063 and the value of property insured $3,720,058,236. For the forty-eight year period, therefore, the increase in net premiums has been 1,345 per cent, in losses 1,381 per cent and in property insured 1,875 per cent. Chart No. 3 shows the annual increase of net premiums and losses from 1869 to 1915.

The comparative standing of Canadian, British and United States companies in respect to Canadian business is shown in the following statement for 1916:

	Canadian	British	UnitedStates
Capital, paid up	$ 9,706,335*	$ 55,200,000*	$ 43,000,000*
Assets, total	21,178,243*	980,347,000*	362,000,000*
in Canada	21,178,243	28,720,800	12,133,779
Liabilities in Canada	9,576,803†	12,093,119	6,558,965
Income—Premiums (net)	4,817,876	14,294,801	8,671,173
Investments	777,492	952,689	445,970
Expenditure—Losses (net)	2,595,578	7,926,460	4,589,095
General expenses	4,040,279*	4,812,638	3,004,448
Dividends	438,319	....	....
Underwriting profit	546,242	1,555,702	1,077,629
Excess, income over exepnditure	926,151	2,780,386	1,253,747
Average rate of premium charged per $100 insured	1.19	1.08	1.04
Rate of loss to premiums received, per cent	53.87	55.45	52.96
Rate of expenses to premiums received, per cent	36.25*	33.67	34.65
Net increase over 1915 of property insured in 1916	69,561,788	168,309,114	68,814,875

*Total for home and foreign business, including branches of insurance other than fire.
†Not including capital stock.

Table No. 19 shows the underwriting profits on Canadian business of British and United States companies. The balance for each year from 1897 to 1916 and the aggregate for the entire period are given. Similar figures for Canadian companies are not obtainable, as separation of the expenses of home and foreign business is not made by these companies.

TABLE NO. 19—UNDERWRITING PROFITS OF BRITISH AND UNITED STATES COMPANIES IN CANADA, 1897-1916

Year	British Companies		United States Companies	
	Balance for year	Total balance	Balance for year	Total balance
1897	$ 356,290	$ 4,720,264	$ 51,695	$ 768,521
1898	140,610	4,860,874	91,807	860,328
1899	169,106	5,029,980	100,740	961,068
1900	1,365,476*	3,664,504	385,296*	575,772
1901	151,868*	3,512,636	80,198	655,970
1902	2,247,890	5,760,526	586,257	1,242,227
1903	1,362,518	7,123,044	447,673	1,698,900
1904	3,153,572*	3,969,472	785,843*	904,057
1905	2,546,435	6,515,907	993,349	1,897,406
1906	2,297,761	8,813,668	944,152	2,841,558
1907	1,539,204	10,352,872	701,798	3,543,356
1908	1,274,213	11,627,090	531,618	4,074,974
1909	1,899,516	13,526,606	888,028	4,963,002
1910	1,659,285	15,185,891	718,706	5,681,708
1911	1,662,507	16,848,398	1,118,451	6,800,159
1912	2,008,149	18,856,547	1,278,646	8,078,805
1913	2,052,171	20,908,718	1,228,776	9,307,581
1914	1,558,094	22,466,812	1,641,792	10,949,373
1915	2,216,783	24,683,595	1,080,831	12,030,204
1916	1,555,702	26,239,297	1,077,629	13,107,833

*Deficit.

According to the foregoing figures, the only years in which actual underwriting losses occurred were in 1900 and 1904, the years of the Ottawa and Toronto conflagrations, respectively. Contrary to general belief, such fires are not always unprofitable to the insurance business as a whole, however disastrous they may be to individual companies. The total profit balance in 1905 following the Toronto fire was greater than in 1899 before the Ottawa and Toronto fires occurred. Nevertheless, the average premium rate for Canada, which increased from $1.23 in 1899 to $1.60 in 1904-5, did not decline to the level of 1899 till twelve years later.

Insurance Legislation in Canada

Existing legislation as affecting the operation of fire insurance companies in Canada is embodied in the Dominion Insurance Act, 1910, and provincial statutes.* Under the Dominion Act, the Superintendent of Insurance is empowered to license companies to operate throughout Canada and is required to see that such companies are solvent and maintain adequate reserve funds. The provisions of the act are specifically designed to insure the financial stability of companies without, however, regulating the form of contract they issue. Provincial legislation goes a step further. The constitutional right of the provinces to legislate in respect to insurance matters is based upon Section 92 of the British North America Act which commits to them power to make laws in relation to property and civil rights. The provincial insurance acts not only provide for the licensing of companies operating within their respective boundaries, but specify requirements affecting the contract, viz., statutory conditions. These requirements were first enacted by the province of Ontario in 1874 and were the result of general complaints against the vexatious barricade of stipulations placed in policies by the companies and which enabled them to escape liability for loss on purely technical grounds. As Mr. Justice Armour said "Every person began to call upon the Legislature to put a stop to such

*Ontario Insurance Act, R.S., 1914, chap. 183.
Quebec Insurance Act, R.S., 1909, chap. 3, sec. 22.
Manitoba Insurance Act, R.S., 1913, chap. 98.
Saskatchewan Insurance Act, Stat., 1915, chap. 15.
Alberta Insurance Act, Stat., 1915, chap. 8.
British Columbia Insurance Act, Stat., 1913, chap. 33.
Nova Scotia Fire Insurance Policies Act, Stat., 1900.
New Brunswick: Act respecting Conditions in Policies of Fire Insurance, Stat. 1913.

injustice and no one called louder than the judges."* Until 1881, statutory conditions were not held to apply to the policies issued by mutual insurance companies. Neither would companies incorporated by the Dominion or Imperial governments recognize provincial authority until, in 1877, after strenuous litigation, the constitutional issue was carried to the Privy Council, where the contentions of the provinces were upheld.† At the present time, statutory conditions substantially following the Ontario provisions are in effect throughout Canada. In brief, they specifically deal with the following matters: misrepresentations or omission of material facts in obtaining insurance; changes to property voiding policies; assignment of insurable interest; disclosure of other insurance; non-liability of companies for losses due to riot, insurrection, etc., defective chimneys and stovepipes, carelessness with ashes, damage to goods to which heat is purposely applied, losses on buildings undergoing repair without a specific permit, destruction of property in which more than 5 gallons of kerosene, gasolene or other inflammable petroleum products or more than 25 pounds of gunpowder is stored, unless such storage is specifically permitted; applications for insurance; apportionment of loss; termination of insurance contracts; waiver of conditions; partial damage salvage and abandonment of property; proofs of loss and false statements of value; payment of losses; variations of conditions.

Read Your Policy

These conditions embody the whole law of fire insurance as between insurer and insured and their contravention is undoubtedly responsible for many losses. It is unfortunate that, apart from insurance

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*Ballagh v. Royal Mutual Fire Insurance Co. (1879), 44 U.C.R. at 88.

Smith v. Commercial Union Insurance Co., 33 U.C.R. at 69.

As showing the views then held as to the effect of insurance upon fire losses, the following citation from the judgment in the latter case is of interest:

"That the companies are often imposed upon by wilful fires and fraudulent conduct is too well known. But how far the companies may be answerable for the blame by the loose way in which they gather up risks by agents who look chiefly to the number and extent of them to get their commission, instead of making the character of the party and the value and nature of the property the basis of the contract, must also be considered. The proper cure for gross dishonesty on the part of those who insure is that the companies be more careful in selecting those with whom they deal. The public will be better served, rates will be lower and fewer fraudulent claims will be made. As the companies are not likely to adopt of their own accord that mode of doing business, the only way is to force them by the Legislature enabling the Courts to prohibit and restrict their contracts. And when this is done, the companies will be obliged to be more careful of the risks which they take."

†Parsons v. Citizens' Insurance Co., 43 U.C.R., 261; 32 U.C. C.P. 492; U.A.R. 96; U.S.C.R. 215; 7 App. Ca., 96.

officials, very few persons are familiar with the conditions governing insurance contracts. Men who refuse to subscribe to an ordinary business agreement without thoroughly understanding its terms, unhesitatingly enter into a purely personal contract with an insurance company and, as a former president of the United States remarked, 'relegate the unread policy to the safekeeping of a deposit vault until a fire occurs.' This confidence is a striking commentary upon the honesty of insurance companies, but is not, however, always conducive to the best interests of the public.

Take, for instance, the specific conditions relative to material misrepresentations. The basic principle of insurance is the observance of good faith by both parties to the contract. The doctrine of *caveat emptor*, applicable to ordinary contracts does not prevail. All matters within the assured's knowledge which he believes to be material and also all those which are material must be clearly stated. Misrepresentations need not be intentionally false to avoid the policy and such may relate to 'moral' as well as physical risk.* Mis-statement of title or insurable interest, over-valuation, non-disclosure of previous fires, and changes to the physical character of property are all fatal breaches of insurance contracts under the statute law.† Yet such misrepresentation is universal in Canada at the present time. One party to the insurance contract, the owner of the property, alone knows all the circumstances affecting the undertaking. In the larger places, the companies inspect many properties but this discloses only the physical hazard, leaving in doubt the still more important factors of carefulness and honesty. One inspection only is usually made and that at the time the insurance is effected. The continued conditions of the occupancy are unknown until a fire occurs. Agents occasionally visit properties when canvassing for the business but practically never thereafter. In many cases, no inspection is made, the agent filling in the application from slight information gathered from the

*Ely v. Ottawa Agricultural Insurance Co., 29 C.P. 557.
Greet v. Citizens Insurance Co., 27 Gr. 121; 5 A.R. 596.
Findlay v. Fire Insurance Co. (1894), 25 O.R. 575.

†The burden of proof is on the insurance company, Lount v. London Mutual Insurance Co. (1905), 9 O.L.R. 555. Whether the misrepresentation is material or not is a matter for judicial settlement, Jordan v. Provincial Provident (1898) 28 S.C.R. 564.

assured.* After a fire, few companies care to contest a claim even where misrepresentation and omissions of fact are found to have existed. Consequently, thousands of properties in Canada are insured that should not be insured at all, and even more numerous are those insured for amounts in excess of what the physical and moral hazards warrant. So far as the statutory conditions relative to misrepresentation of material facts are concerned, the law is of very doubtful practical value.

Of even less account are the conditions prescribing the circumstances under which companies cannot be held liable for loss. It is rarely that claims are protested where fires have originated from defective chimneys and inexcusable carelessness, despite the fact that such action would quickly bring about a material reduction of the fire waste. No insurance company is willing to commit commercial suicide by refusing payment of claims on the grounds of the insured's carelessness, the onus of proof being with the company. Consequently this particular condition is, to all intents and purposes, a dead letter.

Insurance in Europe

It is frequently contended that, in Europe, where fire losses are comparatively insignificant, insurance companies operate without undue legislative interference and that, largely on this account, insurance rates are less than in Canada. This statement is not only illogical but fails to convey more than half the truth. As a matter of fact, with the exception of Great Britain and France, where other considerations offset lack of government supervision, fire insurance is, in most European countries, materially affected by state control.†

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*In the province of Quebec, where the statutory conditions hold the agent and company to be identical in respect to drawing up applications for insurance, it frequently happens that the company is both parties to a contract and could not legally protest payment of a claim. Numerous insurance companies regard this anomalous situation as being detrimental to the public interest and an important cause of fire losses. Mr. T. L. Morrissey, Manager of the Union Assurance Society, Montreal, states the case as follows: "Attention is particularly drawn to the statutory condition which provides that the policy is void if obtained by misrepresentation but also provides that 'when the application is made out by the company's agent such application shall be deemed to be the act of the company.' What is the effect of that? Simply that the applicant, who alone knows the facts may mis-state them over his own signature and the company is liable. It may be said that the company can protect itself by insisting that the agent fill up the form, but, in practice, it results in policies being issued without any application, and the public suffers."

Matthew C. Hinshaw, Manager, Atlas Assurance Co., Montreal, says, in referring to business derived from the province of Quebec, "As a rule, all applications are completed by the agent before the applicant's signature is obtained and this provision renders nugatory the information which might be obtained in respect to previous fires and value of stock."

†In France, personal liability, as enforced under the *Code Napoleon*, has proved to be an effective fire-prevention measure.

In Germany, until 1861, fire insurance was a state monopoly. At the present time, government, joint stock and mutual institutions are all in operation. About 40 per cent of the total insurance, practically all confined to immovable property, is government controlled. Buildings are automatically covered as soon as they are erected, each owner being assessed for losses within the state, according to the appraised value of his property. Monetary compensation is rarely paid in the event of loss, the damage being repaired by the government.

In Austria, fire insurance is conducted in much the same manner as in Germany. There are four state institutions for the insurance of buildings and a number of proprietary companies and mutual societies.

In Switzerland, there are eighteen cantonal institutions for insuring buildings and two for insuring movable property.

In Denmark, insurance in a government institution is obligatory and a fixed sum is collected from property owners for fire-prevention purposes. Movable property is insured with joint stock and mutual companies.

In Sweden, there are two government institutions, one for insuring city property and the other, country property. Movable property is insured with joint stock companies.

In Norway, state insurance was established in 1767. The institution has separate branches for town and rural risks. Movable property and forests are largely insured in joint stock companies.

In Russia, an Imperial insurance bank was established in 1786. In 1864, provincial institutions were organized and insurance was made obligatory in the case of dwellings. These institutions are under the supervision of the governmental head of each province. Joint stock companies and innumerable local mutual associations are also in operation.

In New Zealand, government fire insurance was instituted in 1905. The system is one of open competition with domestic and foreign joint stock companies and, although the country is small, the scheme has proved successful.

Government Insurance Beneficial

Briefly stated, the influence of government insurance has been largely responsible for the small fire waste and low insurance rates of countries in which such is operated. Engagement in the business of insurance appears to have been an incentive to most governments to enforce stringent

WHY INSURANCE RATES IN CANADA ARE HIGH

Carelessness causes over seventy per cent of Canada's losses. The above conditions were discovered in a basement two days after insurance policies for $23,000 had been issued upon the contents of the building.

laws for the prevention of fires, the prohibition of over-insurance and the punishment of gross carelessness.

Lower Rates

Unlike the rules of private companies, which are merely optional stipulations of the contract, the regulations of the state institutions are statutory obligations. As a consequence, both losses and expenses are reduced to a minimum and the general public benefits in low insurance rates. The average rate of state and municipal institutions throughout the German Empire for 1911 was 13.4 cents per $100, and, for a period of five years, (1907-1911), 12.9 cents per $100. In 1911, the losses amounted to 84.3 per cent of the premiums, the expenses to 13 per cent and 2,292,113 marks was added to the reserve which, of course, constitutes a public fund.* In Switzerland, similarly low rates prevail, the average rate in cantonal institutions being 11.5 cents per $100.† In Norway, the average rate of the State institution in rural districts is 6.9 cents, and, in cities, 13.8 cents per $100. In New Zealand, since the establishment of government insurance in 1905, the rates on mercantile risks have been reduced 10 per cent, and on dwellings, 33⅓ per cent.‡ With reference to the public benefits accruing from this government scheme, it has been said that "the department saved to the people in the first year of its operation more than $500,000 in premiums."¶

Comparison with Canadian Rates

The figures quoted in the foregoing statement as representing average rates in European countries are illuminating when compared with the average rate in Canada. The German average rate in 1911 was 13.4 cents per $100; the Canadian was $1.35, or ten times as much. The loss on every $100 of property insured was 11.2 cents in Germany and 50.7 cents in Canada. The expenses of administration amounted to 13 per cent of the premium income in Germany and to approximately 30 per cent in Canada. The underwriting profit in Germany was 2.7 per cent of the premiums and in Canada approximately 19.46 per cent. This comparison is not altogether fair as the figures for Germany apply very largely to insurance upon buildings, while the Canadian figures cover insurance on both buildings and contents. It makes clear, however, that both losses and expenses are excessive in Canada and that a complete revolution in respect to these items will be necessary before we can even approximate to the level of insurance rates in Europe. Apart from the criminal

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***Das Deutsche Feuerversicherungswesen*, Biederman, vol. 2, p. 559.

†*Assurance contre l'Incendie par l'Etat ou les cantons en Suisse*, Alglave, p. 163.

‡Report of Insurance Department, 1913.

¶Government Insurance in New Zealand, *Independent*, vol. 61, p. 86.

waste by fire, the absurdity of paying sixty-five cents for distributing every dollar of indemnity gives food for thought especially when it is remembered that, under present government management, the collection of customs and inland revenue costs less than five per cent of the receipts.

Much of the suspicion that once attached to public control of public business is gradually disappearing and present tendencies are undoubtedly in the direction of government supervision and administration of many utilities. Both in Canada and the United States, dissatisfaction with the conduct of the fire insurance business has recently found expression in numerous legislative enquiries. These have been mainly concerned with the legality of underwriters' associations and the equitable distribution of premium rates.* In many states, anti-compact legislation and rate supervision have been adopted as palliative measures, but, as yet, the question of state insurance has not received serious consideration. Occasional reference to its possible benefits has been met by objections relative to government inefficiency, political influence and the impossibility of properly assessing losses upon the experience of a single state or province.† Such assertions, undoubtedly, contain an element of truth, but they are not more applicable to

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*No investigation has dealt satisfactorily with losses and expenses, which lie at the root of all public dissatisfaction with the insurance business. Attacks upon the methods of insurance companies are useless. The companies are well-organized and strongly entrenched behind facts and figures which are not accessible to the public and are therefore incontrovertible. With these advantages, the companies are able to control the direction of any enquiry. State investigations in New York, Illinois, Wisconsin, North Carolina, Missouri and Pennsylvania mainly revolved around the right of companies to combine for rate-making purposes—one of the points where every argument is in favour of such combination.

†Trade journals in the United States and Canada frequently advocate government insurance. For instance, one of the most influential organs of the lumbering interests recently stated:

"Some of these days the various states and cities may decide to investigate the question of state fire insurance. It has proved a success in Germany where the bulk of the premiums received are utilized for the purpose of fire prevention. The cost of insurance is nominal. If the country should decide to mobilize the capital now employed in fire insurance and use it for development along lines where greater economic advantages may accrue to the nation, it will set about it in short order. The waste in the administration of fire insurance is tremendous. It is little wonder that the mutuals keep growing in influence. Their presence is a recognition of their economic necessity."

While these articles may not express any general desire for such an experiment, it must be recognized that a considerable body of favourable opinion is being gradually built up.

state fire insurance than to workmen's compensation, railway operation, banking and many other successful government activities. There is no gainsaying the fact that, under government administration, the expenses of the insurance business could be curtailed, profits eliminated and losses greatly reduced, but such a radical step is not deemed necessary or even advisable in Canada at the present time. It is believed that many desirable changes can be equally well and far more speedily effected under the existing systems by practical legislation so designed as to secure the support of the companies. In one respect, at least, that of our disgraceful fire loss, government action is absolutely essential.

Expenditures of Insurance Companies

Fire insurance is conducted in Canada as a business and not as philanthrophy. Mutual institutions are organized in order that indemnity may be purchased on the best terms. Joint stock companies are incorporated in the expectation of securing dividends and not for the purpose of preventing fires or scattering relief to the unfortunate.* The income of the companies is primarily derived from the premiums collected from owners of property. That income must be secured in an equitable manner and be sufficient to meet the following items of expenditure:

1. Losses.
2. Expenses: (a) Acquisition expenses.
   (b) General administration expenses.
   (c) Claim settlement expenses.
   (d) Expenses imposed by governments.
3. Underwriting profits:
   (a) Reserve funds.
   (b) Dividends.

Under the general heads of losses, expenses and underwriting profits, the experience of British and United States companies in Canada during the past twenty years is shown in the following table. The figures given are percentages of the total premium income.

*"When I place insurance first among the contributing causes to the inordinately heavy fire waste of the country, I do so advisedly. The people engaged in the business of fire insurance are not free from blame but the chief responsibility rests with the public. Fire insurance is a business, and apparently gives the public what it wants. Fire insurance is only interested in collecting enough from the public to pay the losses and expenses and leave something over as a reward for the capital endangered. On the whole, it succeeds in doing that. In the final analysis, the public is the chief sufferer—it foots the bill."—*T. L. Morrissey, Manager of the Union Assurance Society, Montreal.*

TABLE No. 20—LOSSES, EXPENSES AND UNDERWRITING PROFITS OF INSURANCE COMPANIES IN CANADA, 1897-1916

Year	British Companies			United States Companies		
	Losses	Expenses	Under-writing profit	Losses	Expenses	Under-writing profit
1897......	64.56	28.54	6.90	66.61	28.08	5.31
1898......	68.10	29.21	2.69	63.56	27.32	9.22
1899......	68.42	28.59	2.99	62.68	28.01	9.31
1900......	94.34	29.02	23.36*	104.46	27.83	32.29*
1901......	74.13	28.17	2.30*	65.66	28.33	6.01
1902......	39.22	28.42	32.36	35.65	27.40	36.95
1903......	51.86	29.56	18.58	47.97	27.14	24.89
1904......	109.94	27.86	37.80*	109.25	27.00	36.25*
1905......	42.35	27.98	29.67	36.04	27.22	36.74
1906......	44.52	28.77	26.71	40.09	27.57	32.34
1907......	54.54	28.91	16.55	50.13	27.65	22.22
1908......	58.43	28.78	12.79	56.08	27.96	15.96
1909......	49.93	30.47	19.60	47.72	28.00	24.28
1910......	53.58	30.22	16.20	54.46	28.21	17.33
1911......	55.17	30.00	14.83	48.16	27.75	24.09
1912......	52.26	31.13	16.61	50.82	28.01	21.17
1913......	52.82	31.56	15.62	53.86	29.77	16.37
1914......	56.86	31.77	11.37	52.20	29.09	18.71
1915......	50.62	33.09	16.29	55.94	31.05	13.01
1916......	55.45	33.67	10.88	52.92	34.65	12.43
Average...	59.85	29.79	10.36	57.71	28.40	13.89

*Underwriting loss.

Profits of Insurance Companies

With the actual profits earned by insurance companies, this report is not directly concerned. It should, however, be pointed out that 'underwriting profit' is only part of the profit of an insurance company and that in professing to take the public into their confidence by explaining that their profits (meaning percentage surplus on turnover) have been meagre, the companies are open to serious criticism.* If money earned no interest, this would be true, but the interest upon current premiums and invested reserve funds constitutes an important source of revenue. Consequently, many companies with a limited capitalization and large accumulated reserves are enabled to distribute handsome stock dividends even when their underwriting operations show little profit.† At least three of the larger foreign companies writing business in Canada have for a number of years paid annual dividends of over 100 per cent upon

*Report of State of New York Insurance Commission, 1911, p. 56.
Report on Fire Insurance Conditions in Illinois, 1914, p. 57.

†The share capital of an insurance company is never actively employed in the business but merely constitutes a guarantee fund that may be called upon when all other reserves are exhausted.

their share capital, eight have paid from 50 to 100 per cent and fourteen from 25 to 50 per cent.* The combined accumulated reserves of these companies draw sufficient interest to provide dividends of almost 40 per cent per annum upon their invested capital and such is the extent of their current business that the apparently small underwriting profit of two per cent upon premium income would warrant an additional dividend of twenty per cent.† While the experience of the smaller Canadian companies has not been altogether fortunate, upon the whole, the results of the fire insurance business hardly justify the frequently expressed pessimism of underwriters. Apart from conflagrations, losses do not seriously affect the surplus funds or dividend-paying ability of well-established companies. Some underwriters, who look at the business from the purely commercial standpoint, say that, so long as the companies retain the power of adjusting rates to meet losses, fires are not unwelcome.‡ This view does not, however, represent the consensus of insurance opinion. Schedule rating has shown that the best interests of the companies are served by a steady or declining loss ratio. In this, the interests of the companies are consonant with the public interest but, unfortunately, both are counter to the interests of the present agency system.

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*Whether dividends should be declared upon capital stock alone or upon capital and reserve funds is a moot point. The latter view was held by the New York Insurance Investigation Commission, 1911. Report, p. 55.

†These figures represent the profits upon the total business of the companies in all countries.

‡"Were there no fires, there would be no insurance business; and on the other hand, the greater the fire damage, the greater the turn-over out of which insurance companies make profit. Speaking as manager of a company, I say we cannot make profits for our shareholders without fires, and further, that within certain well-defined limits we welcome fires."—Statement by general manager of the Scottish Union & National Insurance Co. of Edinburgh quoted in *Investigation of Fire Insurance Rates in Illinois 1914.*

"Speaking for the fire insurance companies, I should say that the reduction of the fire waste would not be a profitable thing. I think that, as a business, fire insurance is conducted with larger profits in the years when fires are plenty; a good number of fires means a good premium account."—Edward Milligan, Vice-president Phœnix Insurance Co. of Hartford, before the Illinois Insurance Commission, 1911.

"I do not care anything about a $2,500,000 or a $3,000,000 fire. Just as soon have it as not. It would put so much business on my books and put rates so high I would make it up."—Henry Evans, president, Continental Insurance Company of New York, before New York Insurance Commission, 1910, p. 289.

"I would not look for very much assistance in fire prevention work from fire insurance men, ninety per cent of whom are agents paid by commission, for you must bear in mind that the fire insurance man adjusts the rate to the risk. The higher the rate, the more money he handles and the larger the commission, and, if our fire insurance rates were reduced by improvement of risks to such a basis as obtains in older countries, such as England or Germany, many who are now getting handsome returns would find their income reduced by at least two-thirds. It is the owners of property who pay the high rates and suffer the losses. The trouble is that we have been so prosperous that no one takes fire losses seriously.—R. T. Riley, Managing Director, Canadian Fire Insurance Company, Winnipeg, Man.

High Cost of Doing Business

Of greater importance than profits in affecting the actual cost of fire insurance to the people of Canada is the expense of carrying on the business. That approximately 30 per cent of all premiums should be so expended implies extravagant administration. If a reasonable proportion of this amount were used in attempting to prevent fires, the expenditure might be justified, as is the case with boiler insurance where the cost of inspection to prevent losses exceeds the amount paid for losses. It is doubtful, however, if more than one per cent of the fire insurance premiums is directly applied to fire prevention work while, approximately, 21 per cent is distributed in agents' commissions. This is obviously a large expenditure upon middlemen who have no actual interest in the contracts they handle. It is necessary, therefore, to define the service performed by agents.* This may consist of (1) soliciting; (2) advising; (3) collecting. Originally, agents were chiefly solicitors who induced people to insure. Under present conditions in which insurance is practically compulsory, little solicitation is needed. The persuasion of the agent is therefore used, if at all, to convince property owners that he, the agent, is the particular channel through whom business should be placed or that the company, or companies, he represents is the most reliable. In many cases, friendship, reciprocal business relations and other considerations are the deciding factors in giving an agent control of business.† Manifestly, under such circumstances, no soliciting fee is earned and the service is of little real value to the assured. How much the advice of an agent is worth to property owners depends upon the agent. The one who points out where money can be saved by making improvements and how fires can be prevented is of considerable value. But, while there are exceptions, the great body of agents have neither the will nor the skill for such work; in fact, as will be shown later, the agents' own interests are directly opposed to any great improvement in the property insured. The collection feature of the work of agents

*Insurance agents may be classified as follows: (1) local or soliciting agents (2) general agents, and (3) brokers. The first two directly represent the companies. On the contrary, brokers, who control certain insurances which they place where the most advantageous terms may be secured, are usually considered as representing the insured, although their commission is paid by the companies. In the present enquiry, consideration of the separate classes of agents is unnecessary.

†"We believe the time is not far distant in the evolution of fire insurance when every person connected with the business will be required to demonstrate that he performs a service commensurate with the compensation he receives, and that he must establish some better claim to so large a proportion of the insurance tax than the fact that he is a friend or relative of the property owner whose insurance is to be written."—*Report of Illinois Fire Insurance Investigating Commission, 1911*, p. 32.

calls for no particular ability other than is required in any other business.

The Interest of the Agent

Now, while the work of insurance agents may be simply defined as soliciting, advising and collecting, the entire system is an anomalous one. The agent is the only person in direct contact with the insured and his business is invariably done on a purely personal basis. The fact that the agent has this personal clientele gives him absolute control of the business. The companies must seek the agent and, in general, must come to his terms. Legally, the agent is employed by the companies and must protect their interests; at the same time, he obtains business by means of his personal relationship to the insured who expect him to be solicitous for their interests. The companies want safe risks, the insured want low rates, but the agent, who is paid a commission upon premium receipts, is most benefitted by a large volume of business and particularly of highly-rated hazardous business irrespective of its results to the insuring companies. Add to this, the fact that the agent usually represents from two to twenty companies amongst whom he distributes his business and we have a notable example of a man serving many masters and being himself master of them all.*

Agency Abuses

Under these conditions, the tendency of the companies is to appoint agents, not for their real worth, but, because of the business they control and this even results in the appointment of persons officially connected with large institutions who are able to turn over certain special lines.† This is, of course, rebating by an indirect route, the more open method being a criminal offense.‡ Its worst results, however, are

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*"The house of insurance is a divided house. Stated briefly, the companies own the capital, while the agents and brokers own the business. A single agent may represent many companies. These companies are permitted to remain at the will of their host, and the most active phase of the competitive strife among companies is to secure the agent's favour. In many towns, one or two agencies practically monopolize the business, and the companies are simply tenants at will, whose baggage may be set on the sidewalk any day by the landlord, who is not disposed to tolerate even the mildest criticism of his accommodations or the price of his board. Needless to say, the *buyers of insurance pay* for the service of agents."—A. F. Dean, Manager, Springfield Fire and Marine Insurance Co., Chicago.

†The licensing of agents by the provincial legislatures has proved no deterrent to this evil. Any person, irrespective of qualifications, may obtain a license by payment of a small fee.

‡Rebating is a common practice in Canada although expressly forbidden by the Dominion Insurance Act, 1917, Criminal Code, Section 508d, amended 1917, and by the by-laws of the Canadian Fire Underwriters Association, section 5. In evidence given before the Ontario Insurance Commission, 1917, it was stated that brokers and agents frequently grant discounts of 12½ per cent to obtain business.

manifest in connection with the appointment of loan company and bank officials who are not only entirely ignorant of the business but who are in a position to force excessive insurance at high rates upon clients seeking financial accommodation. Speaking in the Dominion Parliament on August 11, 1917, with reference to an amendment of the Criminal Code respecting insurance, Mr. F. B. Carvell (Carleton) said:*

"I should like to see another clause added making it a criminal offence for the agent of a bank to engage in the occupation of an insurance agent. In the province of New Brunswick, we have one case where the agent of one of the big chartered banks carries on a private insurance business and practically controls the entire insurance of a very large section of the province of New Brunswick. No man can do business with or get accommodation from this bank unless all his insurance or that of the corporation to which he belongs goes to the agent of the bank. This works out in two ways. In the first place, he drives everybody else out of business. In the second place, to my personal knowledge—I am speaking now from my knowledge obtained as solicitor—people's properties are insured for a great deal more than they could be compelled to pay premiums upon, in order that this particular insurance agent may receive more commissions on premiums. An estate which I have been helping to manage for years and which was not very 'flush' financially has paid insurance to make your head ache, if you had to help to finance it, simply because we were in the hands of the bank and the banker placed the insurance without asking our leave or anything else. I brought this matter up and got an amendment made to the Bank Act, but sufficient influence was brought to bear on the House to defeat it. I do not propose an amendment, but call attention to the circumstances and say that matters are getting worse instead of better. I know from talking with members that this condition of affairs exists to some extent in very many parts of Canada."

This statement by Mr. Carvell was confirmed by Mr. Glass (Middlesex East) as follows:

"My honourable friend's references is not peculiar to the province of New Brunswick. That condition of affairs generally exists throughout Ontario. In my district, it is quite a common thing for a bank manager, especially in the smaller places, to have the supervision and control over insurance, which may not only lead to an improper use of it, but which is an injustice to those engaged in the business."

Not only, however, do companies appoint unqualified agents because they control large lines of insurance, but the tendency is to multiply agencies beyond the point where they serve an economic purpose. The agency field is practically the only one open to

*Hansard, August, 1917.

competition between companies under present methods of doing business.* The number of agents appointed is therefore far in excess of that necessary and, as the compensation is insufficient to support them all, a large proportion combine insurance with other means of gaining a livelihood. The natural result of this competition for business should be to reduce commissions or at least to limit the compensation to the amount of service rendered. That would undoubtedly be the result if the insured paid the agent directly. He is, however, paid by the companies to whom his services to the insured are of little concern so long as he secures the business. Many companies are operated upon the theory that they must be represented in every town and city and, if a way cannot be forced into an existing agency, they appoint new and ignorant agents to compete in an overdone business.

Effect on Rates

Hence, the interest that the public have in the agency system. If the sole aim of an agent is to reap commissions, he will write poor risks and the public will suffer through increased fire loss. If he is ignorant of the business or lacking in good judgment, the effect will be to encourage incendiarism. The net result in both cases will be to exact from the public larger premiums to cover the increased losses and expenses. No doubt the companies prefer experienced agents if they can be obtained, but the fact remains that thousands of agents in Canada have little conception of their duty to the insured or of their responsibility to the community at large. On this point the companies and the better class of agents agree. Sixty per cent of the communications received from insurance company officials by the Commission of Conservation with reference to the means of reducing fire waste in Canada emphasize the necessity of first reforming the present insurance agency system. Similar conclusions have been arrived at by every official enquiry into the insurance business in the United States. The report of the Illinois Fire Insurance Commission, 1911, states:

"It is indisputable that the local agent is the most important personal influence in the reduction or increase of fire losses and consequently the insurance cost, and the need is for men of character trained in the business, who know what sound underwriting means to the entire public, and who realize their personal responsibilities. Ignorance has no more place in the fire insurance business than in

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*Competition between the "tariff" companies which write 77 per cent of the insurance in Canada is practically impossible. Premium rates and agents' commissions are fixed and the forms of policies prescribed by the Boards of Underwriters. Special inducements to either agents or the insured are practically impossible.

any other activity, and dishonesty has no place anywhere. There is no function incident to modern civilization in which public interests are more closely implicated than the function of the fire insurance agent, and no quasi-public servant who is so dangerously free from personal responsibility. The railway engineer holds the lives of a trainload of people in his hands; he is not permitted to practice his vocation until he has passed a rigid examination as to his competency and character; if he blunders, he is held personally accountable for any failure in the discharge of his duty. The fire insurance agent is not required to submit to an examination as to his mental or moral fitness, but he may issue a contract that will be the direct cause of a criminal intent which may result more disastrously to life and property than a hundred railway accidents. The railway engineer has no motive to be criminally reckless; on the contrary, his life, limb, reputation, and income depend upon the faithful discharge of his duty, but the law holds him to a strict reckoning. On the other hand, the agent is offered a bounty for criminal recklessness. He commits an act which results in crime and disaster, and the law not only exonerates him from all responsibility, but encourages the fire insurance companies to offer the temptation which creates an annual destruction of life and property compared with which the loss from railway disasters is insignificant. If the statistical estimates of fires originating from moral hazard are within gunshot of the truth, the American people pay from $20,000,000 to $40,000,000 per annum for fires resulting in no small part from ignorance or criminal carelessness of fire insurance agents. The temptation which creates this carelessness is the commission paid without regard to the character of the services, and the measure of this temptation is the size of the commission."

Other investigations have been equally condemnatory of the employment of unqualified agents and recommendations have been made urging legislatures to provide for the licensing of agents only after examination. In respect to this point, the Report of the Wisconsin Fire Insurance Investigating Commission, 1913, concludes as follows:

"The problem of unqualified agents—public servants, although outside of the civil service—can be met by law like the problem of unqualified public servants within the civil service. The plan recommended for this purpose is to reduce the number of agents to those men whom the companies themselves are willing to entrust with the right of signing their contracts, and to require these men, as a condition of being licensed, to furnish the history of their business experience, to take an oath of professional character, and to submit to an examination, conducted by a competent board, which shall in a practical manner reasonably test their merit and fitness for the business. All agents should be placed more closely under the supervision and regulation of the insurance department, and should hold their license subject to revocation by it for cause, upon due notice and hearing."

Licensing Agents

In Canada, at the present time, the insurance acts of the various provinces, excepting British Columbia, Nova Scotia, New Brunswick and Prince Edward Island, provide for the licensing of agents. As these regulations call for no special qualifications, they may be regarded as purely revenue producing measures. Closer government supervision of agents is eminently desirable, for although such may be powerless to make men honest, it could certainly establish their ability for the work. There is no other business which is or could be carried on in the lax way common to the insurance business. Probably the entire system is wrong, but, if so, it is not likely to be abandoned. The only possibility, therefore, lies not in attempting to do away with the system, but in such modifications and restrictions as will eliminate some of its opportunities for harm.

Agents' Commissions

The root evil of the insurance business and one of the greatest factors in the excessive fire waste in Canada is undoubtedly the method of compensating agents.* At the present time, commissions of approximately 25 per cent of the premiums are paid upon preferred, 20 per cent upon mercantile, and 15 per cent upon manufacturing and sprinklered business, although these rates are greatly exceeded by some companies and in certain places.† Whether such commissions are high or low is apart from the present consideration. Agents control the business and they are justified in driving the purchase price as high as possible. On the other hand, the companies want the business at the least expense consistent with maintenance of quality. Again, whether agents are compensated by salary, commission or profit sharing is of no consequence to the public unless fire insurance differs essentially from other forms of business. This, however, is the crux of the whole situation. Rates of premium in fire insurance are high or low in accordance with the physical susceptibility of a risk to fire loss. Poor risks demand high premiums. The agent receives a greater compensation for insuring risks at a high premium

*With reference to this matter as affecting fire losses in the United States, the National Association of Insurance Commissioners, representing practically every state in the Union, passed the following resolution at the Mobile Convention in 1910:

"Being of the opinion that the present system of compensating agents and brokers necessarily increases fire losses and the expense of conducting the business and is the cause of conditions of which the insuring public justly complain, we believe that practically all of the unsatisfactory conditions which agitate the public and lead to unscientific and unavailing legislation can be eliminated by a radical change in methods."

†In the larger cities, such as Montreal and Toronto, commissions are determined by competition and as much as 40 and 50 per cent is frequently paid for good business.

than at a low premium. Time or value of services rendered do not affect the scale of remuneration. The careless agent is paid equally well with the careful agent. A risk rated at $6.00 per hundred involves no more work than one rated at 50 cents per hundred. Yet the agent's compensation in the former case is twelve times that of the latter. If a building rated at $2.50 be equipped with sprinklers, the rate would be reduced to 15 cents and would immediately reduce the agent's compensation in the same or a greater ratio. On every $100,000 of insurance affected by the improvement he would lose over $350 a year in commissions. Agents cannot be expected to be enthusiastic for fire prevention at such sacrifices to their personal incomes. It is the old dilapidated building, the highly inflammable property and the undesirable risk that offer the greatest advantage to the agent. The amount at risk also affects the commission to which he is entitled. The more insurance he can place on a given risk and especially a highly rated risk, the greater will be his compensation. The viciousness of the entire system was clearly summarized by Insurance Commissioner John S. Patterson in addressing the Texas Fire Insurance Agents Association. He said:

"Most vital of all is the method adopted by the company in compensating an agent. If you are faithful you are penalized; if you are unfaithful, you are rewarded. I assert that there is not one act that you can do for the protection of your company which does not diminish your compensation. If you seek to eliminate the moral hazard by reducing the insurance, you reduce your commission. If you aid your company in resisting a fraudulent claim, you lose your customer. If you over-insure, you get your share of the profit. If you refuse or cancel a hazardous risk, you lose the business and the commission to your less scrupulous competitor. Under these conditions, what chance has a faithful agent when in competition with an unfaithful one ? If you earn for your company a profit, you should share it; if you cause it a loss, you should, in part, bear it; Amid the flames which are destroying annually millions of dollars in property value, the argument as to how best to prevent fires goes merrily on. If the people will force the Legislature to write into the law a contingent commission plan of compensating local agents, they will see the fire waste cut in half and the premium rates correspondingly reduced. The careful agent will increase his vigilance. Over-insurance will pass into history and arson fires will be forgotten. Special fire marshals will not be needed. Each of the 3,500 fire insurance agents in this State will become a fire marshal. He will teach his customers the contents of the building code. Fire prevention will be his daily topic. He will see that the fire ordinances are strictly enforced. When the fire bell becomes a death knell to a share of the agent's profits, it will not be heard in the land."

The Agent and Fire Waste

While agents differ in knowledge of the business and carefulness in selecting risks, as a body they cannot be exonerated from blame for much of the fire waste of the country. Comparatively few uninsured properties burn and it is widely held that, were there no insurance, fires would practically cease. No 'bad' risk was ever written without some agent, either through lack of intelligence or integrity, being willing to write it. Both economics and social justice demand that honest and careful insurers should no longer be penalized to profit the careless, the indifferent and the criminal. The insurance companies themselves admit that the system is wrong and ought to be corrected but express the view that no correction is possible without some action by the government. This was also emphasized by nearly every company official, adjuster and fire chief in Canada replying to specific enquiries from the Commission of Conservation.* Similar representations were made to the New York Insurance Commission, 1911, and are thus summarized in the report of its findings:

"The whole subject of commissions is a matter which is in a continual state of agitation between the companies and the agents;

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*The following are representative opinions of (1) insurance companies (2) adjusters (3) general agents (4) local agents:

1. "The insurance companies are responsible in a large measure for the evils of the business. Unscrupulous, unqualified agents and lax methods of granting insurance tend to create considerable moral hazard."—The General Manager of an important Insurance Company, Montreal.

He considers the most important cause of excessive fire waste to be the absence of proper legislative and judicial control. He also places responsibility on municipal authorities and the public itself as well as on the insurance companies as indicated above.

2. "The cause of fire losses is largely lack of inspection of risks by agents, and the manner in which they obtain business. To them, it is a question of how much commission they are going to get. Until the companies insist upon agents sizing up the true condition of risks, losses will continue. From twenty-five years' experience in inspection work for many companies, I can say that the conditions found in many risks make them undesirable."—W. A. Fraser, Vancouver.

3. "Insurance companies could materially reduce the fire loss if they would exercise more care in the appointment of agents, as it is within our knowledge that many appointments are made to secure premium income and no consideration is given to the question of whether such agents possess the ability and experience necessary to enable them to select and supervise the business. This naturally results in many unqualified agents accepting risks in haphazard fashion without any investigation of the moral responsibility of the applicant for insurance or in regard to the question of what value is represented by the amount of insurance applied for. If you could secure the co-operation of the companies in this direction, good results would undoubtedly be obtained."—Allan, Killam and McKay, Ltd., Winnipeg.

4. "If the managers of companies would select proper agents to represent them, men who would consider as the first question the moral hazard of a risk, there would be little trouble about fires. At the present time, the strongest efforts put forth by the companies to increase premium income have been to appoint two or three different agents in a small town or in villages and this, of course, results in increased fires, probably not by direct incendiarism but principally through gross carelessness, which is in many cases equally as bad and almost as criminal." —F. A. Lett, Barrie.

the companies admit that conditions are wrong, but profess to be at a loss to know how to better them and many underwriters go so far as to suggest that it may be necessary for the state to limit commissions. . . . . . Theoretically it seems entirely wrong to pay an agent a flat commission upon premiums, because by this system of payment he fails to have his interest identified with the interest of the company and the public in the prevention of fire-loss. He gets his premium whether the risk burns or not, and in fact to a degree an occasional fire helps his business by bringing to people's attention the need of insurance. As to the actual workings of the system only this can be said: there are all kinds of agents as there are all kinds of men in general; some are very careless about writing risks, some are very careful. But, on the whole agents are not interested in fire-prevention to any such degree as the companies."

Remedy Suggested

Men of wide experience in the insurance business have, for years, contended that an immense public benefit would result from the remuneration of agents so as to include a certain measure of profit-sharing. Many company managers have pronounced a plan of combined straight percentage and contingent commissions as not only feasible but unqualifiedly good for the companies' interests. President Henry Evans, of the Continental Insurance Company, one of the largest and most successful American companies operating in Canada, has persistently urged the general adoption of contingent commissions by all companies. He says "the system of compensating agents should be such that their ability and responsibility should be reflected in the remuneration they receive." It is undeniable that, if the agent's pecuniary interest can be made dependent upon a low loss ratio instead of a high premium income, then the interests of the public, the companies and the agents all lie in the right direction.

Underwriters of the older school sometimes protest that the sole function of insurance being to insure the largest possible proportion of property in a community, it is for legislators, building inspectors, fire departments, and other public instrumentalities to provide safeguards, leaving the agents and the companies to take property as they find it. This traditional conception of the function of fire insurance cannot much longer remain unreservedly acceptable to the general public. There is a growing feeling that there is much burnable property in Canada, which, because of its character or that of its owners, should not be protected by insurance. Many are looking in this direction for a material reduction in the cost to the community of our appalling fire waste. Moreover, a clearer understanding of the insurance business is revealing the fact that for at least one-half of their income, agents do nothing more than accept premiums and deduct commissions.*

Profit-Sharing Commissions

While the change to a contingent commission system would not solve all problems, it is dictated by sound principles and could be carried into effect without serious injury to either companies or agents. In small agencies, and where the condition is one of chronic loss, a profit-sharing commission would have its disadvantages, but, by the inevitable process of natural selection, efficient agents would quickly replace the poor ones. Once a condition is created where skilful attention is essential to large returns, the agent lacking proper qualifications is necessarily eliminated. A profit-sharing plan of remuneration would, therefore, go far toward limiting the number of agents in Canada and would tend to do away with the 'part-time' men who have done much to bring the insurance business into disrepute. Where the man who largely determines the character and extent of the hazard a company is to assume is made to share in the results of the undertaking, there is the strongest possible assurance that his best judgment will be used. It is quite true that, however carefully selected, risks will occasionally burn, and, therefore, the amount of contingent must be properly balanced by a certain percentage of flat commission. Unless an agency is large enough to give a stable average, no conscientious agent should be asked to speculate with his entire livelihood. Owing to the economic waste involved, the amount of commissions should not be determined by competition.

The question cannot be efficiently and permanently decided by the companies whose primary interest is to reduce expenses, nor by the agents who naturally seek the largest possible remuneration. In justice it should be stated that the Canadian Fire Underwriters' Association has made many efforts to introduce a partly contingent plan of commissions, but with little success. For the members of the Association to attempt to enforce the change would place them at considerable disdavantage in competition with non-Board companies. Joint voluntary action of all companies in the matter is obviously impossible. Many complexities enter into any attempted outside interference between companies and agents, but the trend

*"In many instances, the services rendered by agents to the insured are *nil*. They consist, in some cases, of receiving from the assured a cheque for the premiums, passing it on to the company and collecting 25 per cent of it in the process. That applies more particularly to house properties in cities. I think I can say frankly from my own experience that seems to be what it comes to. I don't know of any benefit I receive, and if an agent gets 25 per cent of my premium why can't I go to the insurance company and get my insurance at 25 per cent less."—Remarks of Hon. Justice Masten at Ontario Insurance Investigation, Dec. 18, 1917, as reported in *Canadian Insurance*, Dec. 26, 1917.

of public opinion in Canada is towards radical reform either by the companies themselves or by government action.* It is, therefore, recommended that uniform legislation be drafted into the Dominion and Provincial Insurance Acts to establish the principle of profit-sharing commissions, leaving to the companies and agents the working out of details in connection therewith. Such legislation would at once solve many of the problems, affecting the excessive fire waste of the Dominion and would undoubtedly meet with the approval of the insuring public.

*"Canadian fire insurance agents who are prone to thinking their lot is not a happy one, should take a look at Queensland. In that state, the Government has tackled the thorny problem of the fire companies' expense ratio, and handled it without gloves. Commissions have been limited to 10 per cent, and can be paid only to licensed brokers or agents. Payments to general agents are limited to 5 per cent, to one such in the northern district and one such in the central district. The companies' tariffs are, at the same time, cut 20 per cent, and can only be raised if results in any district or class show the need of increased rates. This cut is met by the reduction in agents' commission, and by doing away with a 10 per cent discount to the insured, which had been uniformly made to compete with the mutual companies. Now the mutual companies will quote the same rate as the stock companies."—*Industrial Canada*, June 17, 1917.

Appendices

APPENDIX I

Notable Conflagrations in Canada

THE history of Canada records no fires of magnitude previous to the year 1750, although traces of such are evident in our forest areas and prairie lands. When towns and cities began to be built, the danger of fire and its capacity for doing harm were greatly augmented. As communities increased in size, the fire hazard and the accumulated values subject to destruction were both correspondingly multiplied.

During the last century, a great number of our cities, towns and villages have been swept by fire, and some have been practically obliterated. The following pages contain a brief description of notable fires which have occurred in Canada, arranged in chronological order.

HALIFAX, 1750—On July 11th, the first recorded fire of any proportions in Canada occurred in this town and almost entirely destroyed it. As the town was only founded in 1749, the loss, though serious enough to those interested, could not have been of great monetary importance, measured by modern standards.

QUEBEC, 1759—Set on fire during the bombardment by General Wolfe and partially destroyed.

MONTREAL, 1765—On May 26th, more than 180 houses were burned and property damaged to the extent of $900,000.

MONTREAL, 1768—On April 11th, 90 dwellings, two churches and other buildings were destroyed.

MONTREAL, 1803—On May 6th, a third serious fire occurred and 30 houses, churches, prisons and stores were burned. During the period in which these three fires occurred, Montreal was without fire protection of any kind.

QUEBEC, 1815—On September 3rd, an extensive fire destroyed property valued at $1,300,000, part of which belonged to the Government.

FREDERICTON, 1825—In October, a large section of the city was damaged by exposure to a forest conflagration, which devastated an area of more than 5,500 square miles. Many towns and villages were destroyed and relief committees were formed throughout Canada and the United States. Great Britain contributed $25,000 to aid the sufferers.

QUEBEC, 1834—On January 25th, the castle of St. Louis, the residence of the Governor-General of the Canadas, was destroyed, the loss exceeding $150,000.

ST. JOHN, 1837—On January 13th, a fire originated on Peters' wharf and in a moment extended along South Market wharf and up both sides of Water and Prince William streets. One hundred and fifteen buildings were consumed and nearly the whole business portion of the city. The property loss was estimated at $1,000,000.

St. John, 1837—In August of this year, a fire started in Nelson street and burned the entire North wharf, both sides of Dock street and Market square. The Government House barely escaped destruction.

St. John, 1841—On August 27th, the shipyard of Messrs. Owen & Duncan, together with 60 other buildings, was burned.

St. John, 1841—On November 15th, a fire broke out on the South wharf and burned several docks and vessels, the south side of Water street and Market square.

Quebec, 1845—On May 28th, fire broke out in a tannery on St. Vallier street and, before it was checked, extended over one mile from the starting point. One thousand and fifty buildings and twenty lives were sacrificed. Extremely hot weather had rendered the shingle roofs of buildings highly susceptible to ignition, and a rising wind carried sparks to a considerable distance. All the buildings destroyed were of frame construction.

Quebec, 1845—On June 28th, another serious fire broke out and destroyed the whole of St. John's ward. Twelve hundred houses, two churches, three schools and 40 persons were burned in less than eight hours. A memorial signed by the bishops of Montreal and Quebec states that, on the landward side, the city was reduced to limits less than it possessed when Wolfe fell before its walls. Fifteen thousand people were driven homeless to the fields. A relief subscription list headed by Queen Victoria was started in England.

St. John, 1845—On July 29th, 40 buildings were burned by a fire which started in Water street.

Quebec, 1846—On June 14th, the Theatre Royal was destroyed, and 47 people were burned to death.

Toronto, 1849—April 7th, a fire broke out in some outbuildings at the rear of Covey's tavern and spread to all the buildings of the block bounded by Frederick, George, Duke and King streets. A strong north-west wind was blowing, and there was evidently a lack of water as a contemporary account mentions that one engine stood useless on Jarvis, then called Nelson, street. The old city hall, which stood on the site of the present St. Lawrence market, was destroyed. St. James cathedral was set on fire by flying brands that lodged in the spire window, and the building was completely burned before the intervening structures were consumed. The conflagration would probably have swept a far greater area but for a change of wind and a down-pour of rain. The area burned over was about 15 acres and the estimated loss $500,000. One life was lost.

Montreal, 1849—On April 25th, the Houses of Parliament, with the parliamentary library and archives of Canada, were burned by a mob inflamed by political passion.

MONTREAL, 1850—On July 26th, over 100 buildings were damaged. Many of these were of brick and stone construction. The loss was said to exceed $500,000.

FREDERICTON, 1850—On November 12th, about 200 dwellings were burned.

HALIFAX, 1850—On December 24th, over 100 houses were destroyed by a fire that commenced in the North barracks.

MONTREAL, 1852—On July 8th, a fire broke out in a small butcher shop on St. Lawrence street and soon assumed alarming proportions. Spreading out fan-shaped toward the river, the flames destroyed a great triangular district with a base that reached from Jacques Cartier square to the site of the present jail. As the reservoir had been emptied for cleaning purposes, no water was available, and the fire spread with great rapidity. An area of 350 acres was burned over, 1,108 dwellings, besides churches, markets, barracks and stores were destroyed, and 2,886 families, comprising almost 15,000 people, were bereft of their homes. Army tents were loaned to the sufferers by the military authorities until the houses could be rebuilt. The property loss was estimated at over $5,000,000.

QUEBEC, 1854—On February 1st, fire destroyed the Parliament Buildings and the costly library. The buildings were valued at $300,000.

MONTREAL, 1856—On December 10th, the Roman Catholic cathedral was destroyed. The loss was heavy.

MONTREAL, 1857—On January 8th, the English cathedral shared the same fate.

HALIFAX, 1861—A very destructive fire which broke out in the Exchange, spread to the Oddfellows hall, the United States consulate and a number of the principal business buildings.

QUEBEC, 1862—On June 7th, 120 houses in the St. Louis suburbs were destroyed.

QUEBEC, 1865—On June 22nd, over 100 dwellings of the poorer classes were burned.

QUEBEC, 1866—On August 17th, an extensive fire destroyed a large number of buildings. It was supposed to have been started at several points by Fenian emissaries.

QUEBEC, 1866—A sweeping conflagration, started by Fenians, consumed 2,500 dwellings and 17 churches and convents and rendered 18,000 people homeless. Four persons were killed and a total damage estimated at $3,000,000 resulted. The following account is taken from the *Illustrated London News* of October, 1866.

"On the night of October 14th, fire broke out in a grocer's shop on St. Joseph street and raged for thirteen hours. The wind blew strongly from the east and, owing to delay in getting out the fire brigade and the lack of water, the fire gained great headway and, in a short time, assumed proportions of a conflagration. The entire district west of Crown street to the St. Sauveur toll-gate, a distance of a mile, was destroyed."

Petrolia, Ont., 1867—In October, this place was entirely destroyed. The loss of oil was said to be tremendous.

Hull, P.Q., 1870—On May 4th, a great conflagration started in Sisson's sawmill, and spread to a number of the adjoining lumber yards.

Quebec, 1870—On May 24th, 500 houses and many other buildings in the St. Roch suburb, were burned. The loss exceeded $300,000.

Saguenay, P.Q., 1870—During the month of June, several forest fires took place in this district and whole villages and towns were destroyed. The loss was said to have run into millions of dollars and caused the failure of two insurance companies.

Ottawa, 1874—On January 16th, the Dominion Government buildings occupied by the engineers of the Canadian Pacific Ry. surveys and several other buildings were burned with a loss of over $1,000,000.

Quebec, 1876—On May 30th, 700 frame dwellings were destroyed in the St. Louis suburb with a loss of $800,000. This fire brought to light the fact that the city was dependent for its water supply upon a single 18-inch main connected with the Lorette reservoir, and that the supply was so scanty that it was turned on to one part of the city in the morning and to the other part in the afternoon. The following is taken from the *Chronicle* of that date:

> "The mayor explained to a meeting of insurance representatives that it always took thirty-five minutes to turn on the water, and that was the cause of the fire making such headway. The fire brigade was next to useless. An attempt is being made to bind the insurance companies not to insure wooden buildings."

St. Johns, P.Q., 1876—On June 18th, a conflagration broke out in the business section and destroyed the entire length of Richelieu and Champlain streets, including seven hotels, nine churches, the customs house, court house, woollen mill, docks, bridge and 200 stores and dwellings. The burned district was one mile long and 600 feet wide, and the damage was estimated at $3,500,000.

St. Hyacinthe, P.Q., 1876—On September 3rd, an incendiary fire broke out in a bakery near the post-office and, fanned by a strong wind, swept the entire business section of the town. The post-office, court house, three banks, several factories, 80 stores and 500 other buildings, constituting four parallel streets, were destroyed. The waterworks broke down at an early stage in the fire and the fire department proved inefficient and poorly equipped. Assistance was rendered by the Quebec, Levis and Montreal brigades. The area burned was approximately 100 acres and the loss was estimated at $1,250,000.

St. John, 1877—On March 8th, a fire broke out in a building on Prince William street and, before it was arrested, caused a loss of $2,000,000 in property and seven lives.

St. John, 1877—On June 20th, a fire, which originated in Fairweather's building, York point, destroyed more than two-thirds of the city. A fierce north-west wind swept the flames from the point of outbreak toward the business section, and everything in the path of the fire was consumed. The conflagration raged unimpeded for 18 hours and only died out when the harbour and Courtenay bay were reached. The burned area exceeded 200 acres, and 1,612 dwellings, 15 vessels and all the churches and stores in the city were destroyed. Thirteen thousand people were rendered homeless and relief funds were collected throughout Canada, United States and England. A contemporary writer places the monetary loss at $27,000,000, only a small proportion of which was fully insured.

The Provincial, Stadacona, Mutual of Montreal, Canada Fire, St. John Mutual and Maritime Mutual insurance companies were bankrupted by the conflagration.

Quebec, 1881—On June 8th, fire broke out in a small frame stable, the supposed origin being a carter's lighted pipe. Three other stables adjoining were soon in flames and burning shingles from the roofs of these were carried to near-by stores. The water supply of the city was such that only one section could be provided with water at a time. In one district it was twenty minutes after the firemen arrived before the water could be turned on. The fire, in the meantime, had gained great headway, passing from roof to roof, all of which were of shingles. The wind was about 16 miles an hour and the fire was under control in 10 hours. The burned area covered 50 acres, and the property loss reached $2,000,000. The Quebec Fire Insurance Company was nearly ruined by this conflagration.

Toronto, 1890—On February 14th, Toronto University, the finest example of Norman architecture in the Dominion, was entirely destroyed. The fire was caused by an oil lamp being upset upon a recently waxed floor. No water was at hand, and the public fire alarm box was situated a considerable distance from the building. When an alarm had been sent in and the firemen arrived, delay occurred as the few hydrants in the grounds were frozen. A north-westerly gale was blowing at the time and practically nothing could be done to arrest the flames. The loss amounted to about $400,000.

Toronto, 1895—On January 6th, a fire started in the boiler room of the *Globe* newspaper and, in twenty minutes, had extended to the top storey. The fire rapidly spread to the McKinnon building. The water pressure was insufficient to reach the five-storey buildings, and it was with considerable difficulty that the fire was at last extinguished. One death resulted, that of the fire chief, and the property loss amounted to $1,250,000.

On January 10th, the Osgoodby building which adjoined the ruins of the *Globe* fire, was set on fire by an incendiary. A strong wind was blowing and the fire leaped Wellington street, 66 feet wide, and would have continued unchecked but for a good fire wall and a heavy fall of wet snow which commenced during the progress of the fire. Estimated loss, about $750,000.

On March 3rd, the Simpson departmental store was destroyed. Eleven minutes after the alarm, the flames burst through the roof and part of the walls fell in. The velocity of the wind was sufficient to carry burning embers as far as the Don river. The fire spread south as far as the Tremont house. Flying brands lodging on the steeple of the Presbyterian church consumed the spire and belfry, but the body of the church was saved. The T. Eaton Co.'s premises fronting the Simpson building were endangered and badly scorched, but private extinguishing appliances in the hands of their employees checked incipient fires as they broke out. The total loss amounted to about $800,000.

These three fires, though not properly classed as conflagrations in extent, were peculiar by reason of their similarity. Each broke out in a building five storeys or more in height, in each case the rapid spread of the fire was due to unprotected vertical openings, and all were arrested more by natural causes than by the efforts of the fire department.

WINDSOR, N.S., 1897—On October 17th, a fire started in a stable on a wharf in the rear of stores on Water street. The firemen had nearly extinguished the blaze when, without warning, the wind increased to a sixty mile gale from the bay of Fundy. Burning sparks and shingles were carried almost 1,000 yards and isolated buildings all over the town were set on fire. As the fire became unmanageable, the firemen deserted their hose lines to protect their own homes. The fire lasted for nine hours, an area of about 150 acres was burned over, and the damage to property amounted to $1,500,000.

NEW WESTMINSTER, B.C., 1898—On Sept. 10th, an outbreak of fire occurred in a large wooden warehouse on the waterfront, containing about 200 tons of hay. It was supposed that either a spark from one of the steamers at the wharf ignited the hay or a match thrown down by a smoker. Fanned by a strong wind the fire spread to several adjacent structures before the firemen arrived. The steamers *Edgar*, *Gladys* and *Bon-Accord* caught on fire and floated down the river close to the wharves. They set fire to frame sheds, structures and canneries for a distance of over 500 yards. From this water front fire, the flames spread up the streets to the business blocks. The wind had increased to a gale and the fire was literally blown across Columbia street, 99 feet wide. Before the arrival of assistance from Vancouver, the main portion of the city was destroyed. During the last stages of the fire, the water supply failed owing to closed gate valves and open hydrants left behind as the firemen retreated from the advancing flames. The total property loss amounted to approximately $2,000,000, and the insurance loss, $1,100,000. An area of about 75 acres was fire-swept.

OTTAWA-HULL, 1900—On April 26th, fire broke out in the roof of a small frame dwelling in the city of Hull. The immediate cause was said to be a chimney spark. A gale of wind was blowing and shingles from the roof were carried to many of the adjoining houses. Nearly all the buildings in Hull being of frame construction and having shingle roofs, the flames spread rapidly and within two hours the fire had reached the Ottawa river. Flying embers were quickly carried over the river, 1000 feet, and set fire to a number of buildings in Ottawa. As the wind increased the fire spread, destroying everything in its path to the city limits, with the exception of a sawmill, which was saved by private sprinklers on the roof, and a carbide works, which was constructed of concrete and steel. The extensive character of the fire was almost wholly due to flying shingles, as these were carried by the wind to distant buildings, thus multiplying the points of outbreak. The fire departments of Hull and Ottawa were helpless in the face of a fire of such dimensions and confined their operations to fighting along the edges of the fire to prevent the widening of the path of flame. Help was telegraphed for to Montreal, Toronto, Brockville, Smiths Falls, Peterborough and other places. All afternoon the blaze raged in both Ottawa and Hull, and by sun-down it had covered an area over three miles long, and from a quarter to half a mile wide. Seven lives were lost. Fifteen thousand persons were homeless. The area burned over was approximately 800 acres, the total property loss amounted to $9,500,000, and the insurance loss $3,800,000. A relief fund was started, and contributions for the aid of the sufferers were received from all parts of Canada, the United States and the British Empire.

Montreal, 1901—On January 23rd, 1901, fire broke out in the warehouse and clothing factory of Saxe & Sons, a building four and a half storeys high, of ordinary joist construction, with wooden ceilings on some floors, with open stairway and open elevator. When the firemen arrived, the flames were burning fiercely in the upper floors of the building and, within a few minutes, they had crossed St. Peter street and ignited the wholesale warehouse of Nelson & Sons, dealers in fancy goods, toys and brooms. Their warehouse was in two sections with a weak fire wall between, having several protected openings. It was of ordinary joist construction with open stairways and elevators and, with the inflammable stock, it burned fiercely. The flames extended from this to the adjoining buildings to the south facing St. Peter street, and also upon Evans court. When the Nelson building fell, the collapse of the north wall, which had no opening, allowed the burning mass to radiate heat directly upon the Board of Trade building, 20 feet away. In a few moments it was ignited, the flames rapidly extending in several directions. There was very little wind and the weather was not severe. The flames were not checked until they had reached Commissioners street, 120 feet wide. An area of five acres was swept by fire and 30 buildings were burned, with a loss of over $3,000,000.

Sydney, N.S., 1901—A fire broke out on October 19th, in a furniture warehouse on Main street. The water had been turned off that block to make a connection with another water main, and the pressure on the other mains was very weak owing to low water in the reservoir. The furniture store was a 3-storey wooden building with open stairways, and, in a few minutes, the flames crossed the street as well as igniting the adjoining premises. Aid was summoned from two neighbouring towns and the fire was subdued after an area of 8 acres was burned over, with property loss of $400,000, and insurance loss of $235,000. The private waterworks of the Dominion Iron & Steel Co. were connected with the town mains, but there was great delay in making use of this auxiliary aid.

OTTAWA, 1903—On the 10th of May, fire broke out in a small lumber yard situated at the extreme south-western point reached by the great fire of 1900. There was a high wind blowing and the weather had been very dry for some weeks. The burning lumber ignited a few adjacent dwellings and embers were then carried from these dwellings to others, the fire gradually widening its path and spreading in a northeasterly direction. The development of this fire into a conflagration was largely due to the fact that one of the largest supply mains leading from the pump-house burst just outside that building a few minutes after the fire broke out and it was more than an hour before temporary repairs could be made and a supply of water made available. Every building was burned in 34 blocks, the total area burned over being 75 acres. Nearly all the buildings destroyed were occupied as dwellings and, while the majority were of wooden construction, the roofs were almost entirely of metal and composition. The property loss was nearly $1,000,000, with insurance loss about $450,000.

ST. HYACINTHE, P.Q., 1903—Fire broke out at noon on May 20th, in a four-storey boot and shoe factory. The waterworks had a pumping capacity of 3,640,000 gallons per 24 hours. The factory collapsed in about half an hour, by which time several frame dwellings across the road were on fire. The breeze freshened and the fire got beyond control. Aid was summoned from Montreal and other municipalities. Every building in 32 blocks was consumed, while a number of buildings on the outskirts were damaged. The weather had been very dry for more than a month previous to the outbreak. The property loss was $700,000, and the insurance loss, $350,000.

TORONTO, 1904—Fire broke out on April 19th, in the four-storey brick building occupied by the E. & S. Currie Co. as a neckwear factory and warehouse. The building was about 35 x 175 feet, the rear half being only two storeys high, with the front half rising four storeys. It was of ordinary joist construction, with open staircases and elevators. A few minutes after the fire broke out, it spread across a 12-foot lane to a building of similar construction, six storeys high, occupied as a hat, cap and fur warehouse. This building was 50 x 110 feet; 5,500 feet ground floor area; total floor area, 33,000 feet. An accident to the chief of the brigade somewhat demoralized the men, and the flames spread very rapidly to the adjoining buildings, crossing a second lane about 25 feet in width, into a building fronting on Bay street. From that point the flames were driven before the wind until they reached the Esplanade and there was nothing further to consume, gradually extending eastward at right angles as well as burning up against the strong breeze which blew very steadily from the north-west. Ninety-eight buildings were destroyed, all of which were of brick, or ordinary joist construction and with an average height of four storeys. The burned area was about 20 acres in extent, the total property loss, $10,500,000 and the loss to insurance companies, $8,400,000.

VICTORIA, 1904—On August 9th, fire broke out in a wooden building forming part of the Albion Iron Works. It was only about 40 x 60 feet in size, but was roofed with shingles. The building was old and dry and burned very quickly. The firemen were protecting the surrounding property and overcoming the fire, when they discovered that burning shingles from the foundry building had been carried over the intervening buildings to the roofs of houses 200 to 500 yards away. In a few minutes, a number of houses were on fire, and in a district commencing 200 yards from the original fire to a point 500 yards therefrom, where some large fields commenced, many houses were consumed, while the roofs on as many more were damaged.

THREE RIVERS, P.Q., 1908—At noon on June 22nd, fire, presumably started by children lighting matches, was discovered in a small wooden stable at the rear of a business block. The stable burned rapidly and ignited several adjoining outbuildings. Within an hour of the outbreak, fanned by a moderate breeze, the fire had developed into a conflagration which swept toward the river through the heart of the city. Brigades from Grand'mère, Shawinigan, Montreal and Quebec, were of great assistance in fighting the conflagration to prevent it spreading north and south and also from backing up into the residential district to the west against the wind, which had considerably freshened during the afternoon. Within the limits of the conflagration everything was entirely consumed, but on the edges several wooden structures escaped, while solid brick or stone buildings adjoining them were burned. The fire burned an area 1500 by about 1000 feet, comprising about 30 acres. The city waterworks drew water direct from the St. Maurice river. The pumps had a total capacity of 4,500,000 gallons. The ordinary pressure on the mains was 125 lbs., an unusually high pressure, but when several streams were drawn it fell very rapidly. There was abundance of water and large pumping capacity, but the mains were too small, and the pumps could not force it through them to give an adequate pressure where it was so badly wanted. The defects in the waterworks and fire extinguishing appliances had been repeatedly pointed out to the civic authorities, who were always going to lay new and larger mains, to improve their appliances and to install a new fire alarm service. Fires were infrequent in Three Rivers, however, the improvements were postponed, the fire brigade became lax about drills, and what, in 999 cases would have been a small stable fire became this thousandth time, a conflagration. The property loss was estimated at considerably over $2,000,000, with insurance losses amounting to $1,132,400.

FERNIE, B.C., 1908—Forest fires raging in the Elk River district during the month of August completely destroyed the towns of

Fernie and Michel, besides causing considerable damage to buildings at Hosmer and Coal Creek. About eighty lives were lost and 3,000 homeless refugees were forced to seek shelter at Cranbrook and neighbouring towns. The fire started at Cokato and swept northward up the Elk valley. It was stated that flaming tree branches five and six inches in diameter were carried over half a mile by the wind. At Fernie the heat was of such intensity as to ignite the frame buildings without the direct communication of flame. The aggregate property loss amounted to approximately $4,000,000. Relief was contributed by public bodies and individuals throughout Canada and the United States.

Campbellton, N.B., 1910—On July 11th a fire started in the centre of the town and travelled with great rapidity through the thickly inhabited districts until at noon on the following day it finally burned itself out. The whole of Campbellton and the greater part of Richardsville, a small village situated a mile distant, was laid waste, only seven small houses remaining of what was one of the most prosperous and flourishing towns of the province. The principal buildings destroyed included six churches, the public school, a new stone post office and all the factories, hotels and stores. Four thousand people were rendered homeless and four met their deaths as the result of the fire. An eye-witness describing the scene after the disaster, said:

> "Not a building could be discerned almost as far as the eye could see, the few that had escaped the flames being situated on the outskirts of the town. The place was a mass of ruins and people walked around or gathered at the sites of their former homes hoping some little keepsake or some cherished thing had escaped the fire. On the outskirts of the town, the scene was a pitiful one. Mothers and fathers, with their children grouped around them, were sitting on the ground, and here and there could be seen members of the relief crew passing among the sufferers ministering to their wants and supplying them with food and water."

The property destroyed had an estimated value of almost $2,000,000 and the insurance loss was in the neighbourhood of $1,200,000. Relief funds were started immediately and assistance was rendered by both the Dominion and Provincial governments.

Northern Ontario, 1911—Between July 9th and 11th, an extensive area near and south of the National Transcontinental railway was swept by forest fires. The dry spell had rendered the bush like tinder and there were fires in every direction. The towns of Cochrane, South Porcupine, Pottsville and other new settlements were completely wiped out. The mining camps were destroyed and hundreds of men, women and children were forced to take refuge in the lakes and streams. It is estimated that 100 persons lost their lives. Many unknown persons were drowned in the lakes in their efforts to escape, others perished in the bush too far from water to save themselves, and the record of these lies buried in the ashes of the great fire. Conservative estimates placed the actual property loss at $1,450,000, of which about one half was covered by insurance.

Ottawa, 1916—On the night of February 3rd, the Dominion Parliament buildings were destroyed by a fire that broke out in the reading room from an unknown cause. The building was erected in 1859-1860. It was one of the finest architectural structures upon the continent and was of massive sandstone construction. To the casual observer, its destruction would have appeared impossible, but the interior construction of dry and seasoned woodwork burned like tinder and soon wrought irreparable damage to the entire fabric. When erected, it cost over $6,000,000.

The fire was first discovered in the reading room but it spread so rapidly from this central point that the building was doomed from the commencement. Such was the rapidity with which it swept through the corridors, that the members of Parliament escaped with difficulty. Two women, guests of the Speaker, were found unconscious by firemen and eventually died. The entire interior was gutted with the exception of the valuable library. The principal causes ascribed for the rapid destruction of the building were, the large amount of wood employed in interior construction, the extensive area unbroken by fireproof partitions and the free communication for the flames down the many intersecting corridors. The actual property loss was estimated at $3,000,000. There was no insurance.

Northern Ontario, 1916—Forest fires, exceeding in extent the conflagration of 1911, swept over large areas of the north country. Owing to the exceptionally dry season, the coniferous forest had been converted into a tinder box awaiting a chance spark and the whole country had been subjected to constant outbreaks of fire for almost a month. The climax was reached towards the end of July when a number of local fires combining, the flames swept down upon towns and villages in a waving wall. All the terrors of the great fire of 1911 were repeated and the number of lives lost was estimated at approximately 243. An official report by the fire marshall of Ontario placed the aggregate property loss at $2,134,349 and the insurance recovered or claimed at $1,045,585. Subscriptions for the relief of sufferers were received from all parts of the country, and the Provincial Government undertook to assist destitute settlers by loans from a fund specially allocated for the purpose.

The fire which destroyed the main portion of the town of Cochrane was not due to the general conflagration that devastated so large an area of the surrounding country. The Cochrane fire originated, as far as can be ascertained, in a dry muskeg near the junction of the Glackmeyer and Lamarche town-line road with Second ave. The first fire came in a northerly direction for about 600 feet, and, through the efforts of the brigade and townspeople, was practically checked and under control when another fire started up in a muskeg between Fifth and Sixth streets. All the available hose and men were taken to cope with this fire and appeared to be getting it under control when a gale sprang up and fanned the embers of the first fire into flames. These drove the men back and caught the buildings of the planing mill, from which sparks were blown over the railway tracks to the town. The business section, about 24 frame dwellings, planing mill, etc., were destroyed.

While the adoption of satisfactory building ordinances is eminently desirable in these northern towns such as Cochrane, it is of no less importance that steps be taken to prevent, as far as possible, the origin of fires in the future. In this case, the fire started in a muskeg. The underwriters' inspector who visited the scene following the fire reported as follows:

> "I walked all over the muskeg, entering it at about the point the fire first started. I found that, with the exception of a few places where it went deeper, only the top had been burnt and, should the dry conditions recur, there is every likelihood of a similar fire occurring again."

The only certain way of preventing muskeg fires is to plough the whole area and sow it down with clover or grass. It was noticeable that throughout the whole of the districts burned in the general conflagration, the fire worked around cultivated land, leaving it almost untouched.

HALIFAX, 1917—On December 6th, as the result of a collision in the harbour, a vessel laden with high explosives caught fire and the ensuing explosion destroyed a large portion of the city. The explosion occurred at a point where the harbour is not over half a mile wide, and its full force struck the section of the city lying directly opposite. An area of approximately two and a half square miles was wrecked, about 1,300 persons were killed and over 3,000 more or less seriously injured. The buildings in the section of the city most seriously affected by the explosion were frame dwellings, which caught fire as they collapsed. The fire then swept the district and more substantial buildings that had withstood the force of the explosion were destroyed by the flames. In spite of a fairly good fire department, equipped with 25 pieces of horse apparatus and 3 motor pumping engines and the assistance of brigades from adjacent towns, the extent of the fire-swept area overwhelmed the best efforts of the firemen. Early in the struggle the chief and deputy chief of the Halifax brigade were killed by the explosion of a fire engine which they were operating. A blinding snow storm finally quelled the flames but augmented the death roll of the injured and added to the miseries of the homeless. All business in the city was suspended and the inhabitants, aided by soldiers and sailors, set about the work of rescue. Medical aid was immediately sent by near-by towns and the larger cities of Canada and the New England states. Emergency hospitals were extemporized, food, clothing and money were generously contributed by the people of Canada, the Dominion government granted the sum of $1,000,000 and the Imperial government $1,000,000 as measures of relief. The property loss was at first stated to be $25,000,000 and the number of destitute 20,000 persons. Subsequent and more careful estimates place the value of the property destroyed at from

$7,000,000 to $10,000,000. Although from a monetary viewpoint, greater losses have occurred, it is doubtful if the total effects of any previous disaster have been so appalling. By comparison, the earthquake and fire at San Francisco in 1906 was not nearly so terrible in its results, the total loss of life being less than 500.

The most significant lessons of the Halifax calamity appear to be (1) that ships containing cargoes of explosives should not be permitted to enter the harbours of populous centres, but should be loaded and inspected at points remote from large cities ; (2) that the congested frame sections of cities and towns in Canada constitute a tremendous fire danger that should be corrected by stringent regulations prohibiting the future erection of wooden buildings within municipal areas.

APPENDIX II

Need of Provincial Legislation Governing Building Construction

OPINIONS of representative architects and engineers in Canada as to the advisability of securing provincial legislation to govern building construction, are given on the following pages. They were received in reply to letters of enquiry in which the present lack of uniformity in municipal building laws in Canada was pointed out.

W. W. PEARSE, CITY ARCHITECT AND SUPT. OF BUILDINGS, TORONTO: In my opinion you will be carrying out a much felt want. This Department, at the present time, is working on the revision of the city building by-law and we have found great difficulty in getting accurate data with reference to Canadian products which might be used in buildings in order to protect them from fire.

I think it would be an excellent thing if some central bureau could be maintained whereby the different municipalities could get full information with reference to the fire-resisting qualities and also the strength of the different materials used in buildings. In a great many cases, this Department is forced to get its information either from the Fire Underwriters or from cities in the United States. This, it appears to me to be a very poor policy to have to pursue. At the present time we are making use of the testing laboratory of the University of Toronto, but, unfortunately, this is closed to us during the time the University is in session.

It would also be an excellent thing if an advisory code were prepared to guide the different Canadian municipalities with reference to the minimum requirements which the municipalities should enforce with reference to fire protection, leaving it to the municipalities themselves to enforce a more rigid code if they so desire to do. I do not think it would be possible to have a uniform building code for all sections of the Dominion on account of the great differences in climatic and physical conditions, water supplies, etc.

ALCIDE CHAUSSÉ, ARCHITECT AND SUPERINTENDENT OF BUILDINGS, MONTREAL, QUE.: I am in favor of the adoption, in each province, of a standard of minimum building requirements graded according to the population of the towns to which it is applicable.

E. H. ROGERS, INSPECTOR OF BUILDINGS, WINNIPEG, MAN.: I am heartily in accordance with such a movement as a model code. A model code could not be framed in every detail that would suit the individual requirements of each city in the Dominion, as the conditions existing are so different. With a model code, each municipality could enact by-laws with the model code before them and make such amendments to or additions to any sections that would not be in accordance with their conditions or requirements and still maintain the objects of said code.

O. F. FALLS, BUILDING INSPECTOR, REGINA, SASK.: I am in full accord with any movement which will tend to decrease the losses occasioned by fire, or the enactment of legislation which has this end in view.

I am glad to know that the Dominion Government is taking this matter in hand, as more good can be accomplished than if it were left to the different provinces to enact such legislation as they may see fit.

It is uniformity in our building ordinances that we require, and I see no reason why the laws for the prevention of or protection from fire should differ in one province from another, except in some minor details due to local conditions.

In the fall of 1912, the building inspectors of the provinces west of the Great lakes held a conference in Calgary and discussed this matter with a view to drafting and adopting a uniform code for the West. A committee was appointed and a draft copy was prepared and sent out to all of the larger towns and cities for approval, but the difficulty we experienced was that the legislation enacted from time to time by the different provincial governments was not uniform, and what was provided in the municipal act for one province differed from that of another.

Personally, I favour a uniform code for the whole Dominion, graded according to the population of the towns or cities, and made compulsory in so far as local conditions would permit. When I say local conditions, I mean the varying quality of the soil as regards the capacity, or similar conditions, but the requirements of a fire wall in Regina or Calgary should be the same as in Toronto or Ottawa, and any legislation along these lines compelling the cities to make uniform laws will, I feel, be to their interest, and result in a very marked curtailment in the annual fire loss.

N. A. McIVOR, INSPECTOR OF BUILDINGS, EDMONTON, ALTA.: I have for upwards of two years put forth every effort to induce our local authorities, both provincial and municipal, to adopt a uniform building code for all cities and towns in the province.

I am firmly of the opinion that the Government is equally as responsible for the conditions under which our cities and towns are built and our people are housed and employed, as for the charters under which we are governed.

The encouragement of fire-resistive buildings and conditions (not necessarily fireproof) would allow labour and capital to be employed in new fields of development, instead of being used to restore needless waste. This waste, I am quite confident, could be cut down 40 per cent by the appointment in each province of a provincial building and fire inspector, a trained and competent man who would investigate, or cause to be investigated by trained assistants, the cause of all fires and fix the responsibility of any fires caused by carelessness or neglect.

A provincial ordinance administered by competent officials for the construction of and maintenance of all buildings and, more especially, buildings of a public or semi-public nature, and the use and storage and transportation of all inflammable liquids or explosive substances, would, in my opinion, improve conditions by removing the situation from local patronage and personal interest.

There is a universal sentiment that a certain undefined number of fires is inevitable, and some go so far as to express the conviction that they are beneficial. To the writer, it would be equally as logical to argue that a person or corporation can become richer by the destruction of what they already have.

The appalling loss by fire of the homes and natural resources of Canada can, by a campaign of education on the use of fire and the methods of fire prevention, be reduced so that, with few exceptions, we shall have no fires except what are occasioned by the most unavoidable accident or causes beyond the control of human agency.

C. H. Rust, City Engineer, Victoria, B.C.: I quite agree with your idea of adopting in each province a standard of building requirements.

F. P. Adams, City Engineer, Chatham, Ont.: Chatham is a city of about 12,000 population and, until the present time, has not had an effective by-law regulating the construction of buildings, either from the standpoint of safety or fire protection. The Council has instructed me to prepare a by-law upon which work I am now engaged. Very few of the smaller cities and towns in Ontario have building restrictions, and such an act would be of great benefit.

The administration of a local building by-law is very often hampered and obstructed by local interests. I have known of cases where a Council, in order to cheapen the cost, undertook to annul certain restrictions to favour the construction of what I considered a dangerous building.

A Dominion act covering the essential constructional details of buildings, especially those to be used for public assembly and commerce, would take these matters out of the hands of local councils which are often influenced by the specious arguments of owners and contractors whose principal motive is to get up a building as cheaply and quickly as possible without regard to its safety either from fire or collapse.

The minimum requirements of such an act should not be severe. It could well form the basis of more elaborate local by-laws where the growing needs of a town suggested that such were necessary.

F. McArthur, City Engineer, Guelph, Ont.: The suggestions with reference to the advisability of adopting a standard of requirements are a decided step in the right direction, and, I think, will receive the hearty support of architects and especially municipal officers whose duty it is to look after building regulations. In a great many cities, the building by-law is a most cumbersome and unwieldly document and is probably the source of more trouble than any other city regulation.

W. P. NEAR, CITY ENGINEER, ST. CATHARINES, ONT.: I believe the Commission could be of vast assistance, especially to the smaller municipalities, in this matter. In St. Catharines we revised our building by-law a year or so ago and, since then, several cases have come to my notice where parties have threatened to withdraw from St. Catharines and build in another locality where the requirements are less strict. Our by-law is not radical, and this would indicate the need of a minimum requirement at least for all municipalities, so that one would not be placed at a disadvantage with another when reasonable restrictions are applied. I think all municipalities would welcome such an ordinance as you suggest.

C. J. YORATH, CITY COMMISSIONER, SASKATOON, SASK.: There is no doubt that there has been throughout Canada a lack of uniformity in building ordinances, particularly in the West where the growth of cities has been rapid. I have recently been drafting a building ordinance for this city, which is compiled largely from the building ordinances now in operation in Winnipeg, Calgary and Vancouver.

I found that the greatest loss from fire in Saskatoon was occasioned chiefly through the following:—

(1) The accumulation of rubbish and the large number of wooden shacks and outbuildings within the business portion of the city. (2) The lack of a solid brick partition wall carried up from the foundations to the roof between buildings occupied by different tenants. (3) The close proximity to one another of wooden residences, there being no specified minimum distance between buildings constructed on adjoining lots. (4) The lack of proper regulations governing the installation of electric wiring.

There is no doubt that a standard of minimum building requirements which should be of national application would greatly tend to the reduction of fire loss, and in this connection I would refer you to the model building code issued by the Local Government Board of Great Britain.

J. W. B. BLACKMAN, CITY ENGINEER, NEW WESTMINSTER, B.C.: There is no doubt in my mind but that all building by-laws should be uniform throughout Canada. The suggestion in your letter is an excellent one.

WICKSON & GREGG, ARCHITECTS, TORONTO, ONT.: We are in thorough accord with the suggestion for the adoption of legislation to regulate building throughout the country. Our idea would be that a minimum standard should be made compulsory in all communities, and this would form the basis for more stringent regulations in localities where so desired.

At the present time, the requirements of the Factory Act and the Underwriters' Association have general application throughout the country with beneficial effects, but these, of course, only affect certain buildings. In congested sections in small towns, the danger of general conflagrations seems just as great as in cities, and should be regulated accordingly. It is also necessary from the standpoint of safety of life that churches, theatres, etc., should be under stringent regulations wherever built.

Another point which might be covered by the enactment would be the standardization of fire equipment appliances, so that in cases of large conflagrations the fire appliances in one city or town could be made use of in another one nearby.

If the Commission of Conservation undertakes the preparation of such a code, we sincerely trust that it will be possible for this code to include regulations regarding safe building construction as well as matters pertaining to fire prevention. One of the difficulties experienced by architects and others interested in building, is the number of different building by-laws, insurance requirements, etc., to which they have to conform and which do not always harmonize. For this reason a law covering both fire protection and safe building construction, similar to the building by-laws of large cities, would be desirable, and in the preparation of the code the regulations of the Underwriters' Association, the Hydro-Electric Power Commission (*re* wiring) and the Factory Act should be considered.

JOHN M. LYLE, ARCHITECT, TORONTO, ONT.: I have felt strongly for many years that compulsory legislation of some kind should be undertaken by the government to compel all those contemplating building to conform to certain regulations. As you suggest in your letter, it would probably be advisable that these restrictions should be graded according to the size of the municipality.

On the whole, our by-law in Toronto is an excellent one. There are some minor defects, but, if it could be truthfully said that all buildings in Canada had to conform to the Toronto standard, there would unquestionably be a gigantic saving to the people of Canada and the fire losses would be materially reduced.

It would be advisable not only to have the necessary by-laws to cover building operations, but an important point to remember also is that there should be sufficient inspectors appointed to see that the by-laws are properly carried out. The salaries of these inspectors would be saved a thousand fold in the reduction in the fire losses. Take for example the simple matter of electric wiring. In my opinion, it ought to be compulsory that all electric wiring be encased in metal conduit. This might be somewhat of a hardship in a small community, but none whatever in the larger communities. To encourage the more general use of fireproof construction, the municipalities might be urged to make a reduction in the tax rate for buildings of this character.

The subject, of course, is a large and complicated one but, as you have asked my opinion on this matter, I can only conclude by saying that, if compulsory legislation were enacted by the government with the idea of encouraging a better type of construction and of preventing the erection of fire-traps, the government would accomplish a very real reform, the magnitude of which would probably stagger the public.

E. J. LENNOX, ARCHITECT, TORONTO, ONT.: It would be much easier for every one in the building line and especially for architects if a code of by-laws could be so compiled that it would generally apply in connection with the erecting of buildings throughout the

Dominion. In the larger cities, of course, these by-laws have been compiled and amended from time to time, but, in the smaller districts, care has not been taken along this line. At all events, in my estimation, it is time the matter was taken hold of.

STEWART & WITTON, ARCHITECTS, HAMILTON, ONT.: We believe that all will agree that there should be a standard minimum of building requirements, and, personally, we are inclined to favour grading, not according to population, but according to the density of the population of the district in which the building is to be erected.

WATT & BLACKWELL, ARCHITECTS, LONDON, ONT.: We are heartily in accord with the idea of having minimum building requirements, graded according to the population of the towns, enforced throughout the whole province.

JOHN M. MOORE, ARCHITECT AND CIVIL ENGINEER, LONDON, ONT.: I am of the opinion that it would be advisable to have a central Dominion advisory code and a provincial enactment making it compulsory for every incorporated community to adopt the building code. Each province should have special central permanent officials to administer the code. Congested districts in all incorporated communities should be inspected periodically by local and provincial inspectors. All public buildings, schools, churches, etc., should be under provincial regulations and inspected periodically by special provincial inspectors.

There can be no doubt but that the standard system of building regulations with periodical inspection would reduce the fire losses, increase the efficiency of fire protection, add to the safety of life and property, and reduce the cost of fire insurance.

JOHN S. ARCHIBALD, ARCHITECT, MONTREAL: There is, undoubtedly, a lack of uniformity in local building by-laws and, in fact, an entire lack of any governing by-law in the majority of municipalities throughout this province. Even in large centres, such as our city, the subject is side-tracked on every possible occasion. Some four years ago, the Montreal city council appointed a committee to revise and bring up to date the building by-laws, paying particular attention to the prevention of fire loss. The committee, submitted for the consideration of the council, a complete new by-law two years ago, but, up to date, the Council has refrained from considering the matter and the by-law has been pigeon-holed. Undoubtedly the adoption of a standard of minimum building requirements, graded according to the population for towns, would be a benefit to the whole community.

You will meet with a good deal of opposition based upon ignorance and short-sightedness, and, in order to overcome this local prejudice I consider that another side of the question must be discussed frankly. I refer to the position of the Canadian Fire Underwriters' Association. To my mind, the question of fire prevention is more or less a question of education and compensation. The Canadian Fire Underwriters' Association must be compelled to recognize the fact that additional money expended in construction for fire prevention must receive due compensation in the way of reduction in premium. The Fire Underwriters' Association, working through its respective boards in different localities, is one of the strongest combinations in trade that is to be met with throughout the Dominion. They are autocratic in their methods and are not progressive. There is no attempt at true specific rating based on any scientific principles. I could give you numbers of cases where we have approached the Fire Underwriters' Association on behalf of clients, offering to install certain fire-prevention appliances, which of course meant additional capital invested, and which, needless to say, received no consideration at the hands of the underwriters.

Further, it should be illegal for any insurance company to accept a risk without first making an examination of it. There are millions of dollars worth of property insured to-day in the Dominion of Canada where insurance companies have not even taken the trouble to see if such a risk was in actual existence.

I am of the opinion that the fire insurance companies of Canada should be brought under some jurisdiction, such as is exercised by the Board of Railway Commissioners, and that the present method of fixing rates should be declared illegal. In a word, there will be no use in drawing up any elaborate by-law governing the erection of buildings, and looking towards prevention of fire loss, unless the insurance companies are brought into line to recognize that all money expended in buildings for the above aim should receive due compensation in the way of reduction in rates.

T. Pringle & Son, Limited, Architects and Industrial Engineers, Montreal: We feel it would be a very good thing if such regulations could be adopted and enforced. The enforcing of building regulations seems to be one of the most difficult things in connection with the building codes, and, in our practice, we have frequently met instances where glaring defects in construction have been passed over, even when we have gone out of our way to bring them to the notice of the authorities. We would welcome any regulations that would tend to improve the standard of building construction.

W. G. Van Egmond, President, Saskatchewan Association of Architects, Regina, Sask.: Your communication was placed before the last council meeting and it was decided that the Association is strongly in favour of action being taken towards the adoption of a standard of minimum building requirements for different centres as suggested in your letter.

The larger cities of this province have by-laws which provide good fire protection, but in the smaller towns and villages the only control is in the hands of the Canadian Fire Underwriters' Association.

APPENDIX III

Fire Conditions in New Ontario

Place and Population	General Construction	Bush Hazard	Protection
Charlton (300)	Scattered frame.	Distant bush only.	None.
Cobalt (3,000)	Largely frame; congested.	None.	Municipal system.
Cochrane	Largely frame.	Light fringes of bush to N. and N. E. Unstumped clearings to W. Town extending easterly towards bush. Light timber with heavy undergrowth within 250 yards of power station on S.E. Large patches of muskeg create serious hazard.	Municipal system.
Dane	Wooden shacks and one 2-storey frame store.	Heavy bush exposure.	None.
Earlton Junction (150)	One street of scattered frame buildings.	Patches of thin bush within 500 yards of buildings to S.W. and within 800 yards to N.W. Saw mill 200 yards distant from bush.	None.
Englehart (800)	Practically all frame.	Town-site cleared and largely cultivated. Patches of light bush within 300 yards to N. E. Extensive areas of muskeg about ½ mile east.	Municipal system.
Grant (70)	All frame except railway buildings. Divisional point of N. T. Ry. with offices, roundhouse, repair shop and stores. No streets, buildings in unstumped clearing.	Heavy bush to within 100 yards interspersed with swamp and muskeg.	70,000-gal. elevated steel tank, 12 hydrants and 1,500 ft. of hose.

FIRE CONDITIONS IN NEW ONTARIO—*Continued*

Place and Population	General Construction	Bush Hazard	Protection
Haileybury (2,500)	About half frame.	None.	Municipal system.
Hearst (100)	All frame. N. T. Ry. roundhouse and storehouses.	Solid bush exposure in all directions. About 150 settlers in surrounding district have cleared little land so far.	90,000-gal. steel elevated tank, 8 hydrants and 1,000 ft. of hose.
Iroquois Falls (300)	All frame, dwellings spaced 40 feet. Town owned by Abitibi Power and Paper Co.	Bush burnt over in 1916 but still approaches to within 300 yards of one corner of town and creates considerable hazard. Pulpwood piles within 200 yards of buildings.	15 hydrants on 8-in. mains supplied with water from pulp mill. Pulp and paper mill sprinklered with good yard protection.
Jacksonboro (300)	All frame, owned by the Ontario Colonization Co.	No bush hazard except to the E. where danger is reduced by the intervening Mattagami river.	Pulp mill well protected.
Kelso	All frame.	Bush within ¼ mile. Clearing unstumped.	None.
Latchford (200)	Scattered frame in poor condition. Two saw mills and rossing mill outside town limits.	No serious bush hazard. Heavy bush across Montreal river ¾ mile S. W. Light scrub to within ¼ mile on N. W.	6-in. surface main through town and 1,000 ft. of hose.
Macpherson (Kapuskasing) camp	Detention camp and soldiers' settlement. All frame.	Light bush hazard; 800 acres cleared and 200 stumped and cultivated.	None.
Matheson (350)	Being rebuilt after fire. All frame.	None, practically eliminated by conflagration of 1916.	None.
Monteith (200)	All frame.	Light bush within ¼ mile to S. of town. Heavy bush within 200 yards on east.	None.
New Liskeard (2,800)	Largely frame.	Only bush exposure is to W. of town about 400 yards distant.	Municipal system.
Nushka	Being rebuilt after fire.	Light bush hazard.	None.
Porcupine (200)	All frame; congested.	Light bush to within 500 yards on north, west and east.	None.

FIRE CONDITIONS IN NEW ONTARIO—*Continued*

Place and Population	General Construction	Bush Hazard	Protection
Porquis Junction (100)	All frame.	Bush to within 100 yards of some buildings.	None.
Schumacher (300)	All frame; congested.	None.	250-gal. electric pump, 5-in. main through town, 4 hydrants, 2,000 ft. of hose and one 40-gal. chemical extinguisher.
Sesekinika	Two old hotels, one store and a few dwellings, all frame.	None.	None.
Smooth Rock Falls	Pulp Co.'s townsite. All frame.	Situated in clearing approximately one mile across. Surrounding bush largely poplar.	To be fully protected.
South Porcupine (1,000)	Practically all frame.	Original bush to within 800 yards N. of town.	6-in. main through town, 5 hydrants and 500 ft. of hose.
Swastika	All frame; in poor condition.	Bush to within 400 yards S. of town.	None.
Temagami (100)	All frame.	Rocky land with light scattered bush to within 100 yards of some buildings.	None.
Thornloe (130)	All frame.	Light patches of bush to within 100 yards on east and west sides of village. Surrounding country generally cleared.	None.
Timmins (2,500)	Practically all frame. Growing rapidly in adjoining townsites of Moneta and Mattagami Heights.	Scattered buildings are within 170 yards of bush. No exposure on E. and on W. land is cleared to Mattagami river.	Municipal system with temporary water mains to adjoining townsites.
Uno Park	Frame general store and few dwellings.	Patches of light bush to within 300 yards on N. and S. W. Land generally cleared and cultivated.	None.

APPENDIX IV

Fire Prevention in Germany

IN addition to their professional duties, fire brigade officers are required to enforce the fire police regulations, which concern principally building construction. Regular inspections are made of all buildings and especially of factories, theatres, public assembly halls, department stores, show windows, lighting apparatus, storehouses, cellars for spirits, minerals, oils and explosives, and plants that are particularly liable to outbreaks of fire. Some features of the work are:

In *theatres* only the absolutely necessary amount of decoration is permitted on the stage. No packing material, boxes, or any other easily ignitible material, is allowed to remain under the stage. The doors of the stage leading to corridors and dressing rooms must be smokeproof and fireproof and must open outwards. *Workshops of carpenters and painters* must have no connection with the auditorium, stage rooms, stairways or corridors.

Smoking is forbidden. All corridors, stairways and landings must be kept free of all obstacles tending to interfere with quick passage. The doors of the auditorium must open outwards. Emergency lights must be at all exits and must be often tested.

All fire-extinguishing apparatus must be in serviceable condition and not covered by other objects. During the night and between acts the fire curtain must remain down and before each performance it must be tested. This work is in the hands of the fire brigade and the assignment to theatres often changes, thus bringing the men and inspectors in contact with varied conditions. There is a place provided on each side of the stage for fire watchmen who are on duty during each performance.

Emergency lights must be placed in *all public assembly halls, churches and schools.*

No workshops or factories subject to outbreaks of fire are permitted to exist over or under public assembly halls. Assembly halls must have only fireproof decorations or non-fireproof decorations covered with waterglass up to a height of 2 metres. Iron stoves must be completely surrounded by an iron screen for the protection of women's clothing.

Large department stores. Severe regulations are generally applied only when department stores consist of several floors. Smoking is forbidden and it is a part of the regulation that a conspicuous sign to that effect be hung up at the entrances. Heating plant must be central only. Radiators must be protected. Lighting by petroleum is forbidden. Chandeliers must hang free and be protected from all contact. Show windows must be lighted from the outside. Exception to this rule is made when show windows are made fireproof and shut off from the store proper. Packing and exhibition rooms must be fireproof and not connected with salesrooms. Cellars must not be larger than 500 square metres and must be provided with fire walls. Stairways must not lead to cellar rooms. Elevators running to cellar rooms must be enclosed within fire walls. Emergency lights and exits must also be provided. Fire escapes must be run to within 3 to 4 metres of the ground.

Regulations Regarding Fire and Light

By far the most fires are caused by carelessness with fire and lights.

In contracts covering the rent of apartments, it is forbidden for the lessee to *carry an open light* into either *attic or cellar rooms.* There is also an imperial law forbidding this, reference to which is posted on attic and cellar doors.

In *workshops and packing rooms*, after the day's work has ended, all combustible material, such as paper, shavings, etc., must be removed to a place of safety for the night.

All fires for the purpose of drying out damp walls and newly constructed houses, open signal lights, etc., must have a watchman.

Piles of firewood are not allowed to be stored outside or allowed to remain without cover for any length of time, and it is required that the wood shall be so packed inside that in case of fire the living rooms will not be in danger; it must also not interfere with escape from the house.

Preventive Measures Concerning Buildings in General

When show windows extend to the basement, the rooms located in immediate vicinity must have fireproof walls.

Entrances to stores, magazines, workshops, etc., leading from the street must be of fireproof construction. Doors leading from staircase to rooms in which explosive material is handled must be fireproof.

Show windows in large stores or storage rooms must not open on to staircases, and must not have other openings leading to adjacent rooms except by fireproof doors.

Windows or ventilator openings in cellars or attic rooms, also other rooms in which easily combustible material is kept, must be provided with spark nets, the mesh being at least 144 to the square centimetre.

Ashes, wood and coal are not allowed to be stored in attic rooms. In workshops and storehouses, ashes and burnt coals, when not immediately removed from the building, must be kept in fireproof receptacles.

Cellars and attics must always be under lock and key. Smoking is strictly forbidden.

Cellars and other rooms in which carbide, celluloid, and fluids or material likely to develop explosive gases must be properly ventilated.

All factories and industrial buildings must have at least *two staircases*, which shall serve for those employed in the upper floors as a means of escape.

Windows in the upper floors of such buildings must not be provided with either blinds or roll-blinds. Windows in iron frames must be so constructed that at least one square in each will be sufficiently large enough to permit a man of ordinary size to get in or out.

Between the ceiling and light protector for lamps there must be a free space of 5 centimetres.

Transmission belts or supports for same must not be brought in over doors.

Exit doors in churches, concert halls and theatres must open outwards.

In all hospitals, barracks, churches, concert halls, hotels, railroad stations, etc., reserve means for lighting purposes must be provided.

Fire Protection in Exhibitions

As the buildings usually constructed for exhibitions are of light construction, it requires a special permit from the police to erect them. The regular fire regulations do not apply here, but special precautions are taken in planning and locating the various buildings. If there are a number of structures of various heights and sizes they are so grouped that two very high buildings do not stand opposite each other, but one high building may be surrounded by several smaller ones, because the spreading of a fire by sparks is most certain when two very high buildings stand opposite each other. During the exhibition a very close watch is kept by a large staff of men.

The Duty of a Fire Brigade During and After a Fire

Upon arriving at a fire the first duty of a brigade chief is to ascertain whether or not human life is in danger. The firemen are at once ordered to search the rooms of the burning building. This work goes hand in hand with the work of extinguishing the fire. After it is definitely known that life is no longer in danger, the fire chief immediately decides upon the point which he considers the most dangerous and one from which the fire is most likely to spread.

In the fire departments of both Germany and Austria there is essentially a military spirit. "Attack is the best means of defence." The officers of the fire department are selected very carefully, and if personal characteristics do not include courage, quickness of decision and far-sightedness, technical training and practical experience will avail nothing. A chief is expected, upon arrival at a fire, or as soon as he can take in the situation, to determine quickly the extent and possibilities of the fire and whether or not he will be able to handle it alone. The principle generally followed in Germany is to be on the safe side and call several brigades and thereby create a reserve.

The designation, "large fire," is given when two or more lines of hose are used; "medium," when one line is used, and "small" when the fire is extinguished by other means.

Fires in spinning and cotton mills are often caused by badly arranged heating and lighting apparatus (especially short circuit), and by pieces of cotton becoming ignited by friction of machinery.

The only effective means of prevention here is to have the several rooms separated by fireproof walls. The sprinkler apparatus is also good and has been the means of retarding the progress of many fires in Germany.

Fires in chemical and mineral oil factories, benzine washeries, distilleries and cellulose factories, present many difficult problems on account of the constant danger of explosion and the high degree of heat that is developed. Establishments of this nature should keep the fire brigades of the immediate vicinity constantly informed concerning the amount of stock, its location, etc., in order that when fire breaks out the firemen can work more to advantage.

All repair work done on churches and on other buildings with high towers is carried out under the eyes of fire brigade watchmen who are on duty as long as the repair work goes on. Work requiring the use of open fires, such as for soldering, is specially watched.

Lumber yards are a constant source of danger. A very effective method of prevention is the system employed in stacking lumber in sections with at least 12 metres between each section. Roadways at least 50 to 60 metres in length and 20 metres wide are also provided; they must be kept free of all kinds of combustible material, especially bark, chips, shavings, etc., which are easily ignited.

When fires break out in living apartments, the fire brigades give a great deal of attention to protecting property. Furniture, pictures, etc., liable to be damaged by water or smoke are removed to a place of safety and covered. In some cases, however, the danger of the fire spreading is so great that this work of saving property cannot be attended to.

During the Christmas shopping period the security of large department stores is placed in the hands of professional firemen, a large number of whom are on duty continually. Some of the largest department stores have their own firemen and a modern equipment of signal apparatus.

Watchmen in theatres and public assembly halls must report for duty one hour before the time for the performance or meeting and make tests of all apparatus, lights, signals, etc. No single chairs are allowed in such places. Chairs must either be fastened together in sets of at least six, or, if single, secured to the floor.

Notes from Berlin Building Regulations

Viewed from the standpoint of hygiene and safety, the Berlin building regulations, which have been in force since 1883, are probably the best of all large cities of the world.

The height of buildings is limited to 22 metres—72 feet, upon which a roof with slant of 45 degrees may be added.

One of the best features of the regulations is the size of courtyards and the proportionally extensive surface of the ground space which must be left unbuilt. Light and air cannot be taken from adjoining property. To compute the surface of any ground space which must be left free for courts, the plan of the same is divided into zones by means of lines running parallel to the street line. The first zone reaches to a depth of six metres (1 m. = 3 feet

4 inches), the second reaching from here to a depth of 32 metres measured from the street line.

The first zone can be entirely built on; of the second zone 3/10 must be left for a court or courts. If the ground space is deeper than 32 metres, 4/10 of the space lying behind the second zone cannot be built on.

The fractional parts of the space (zones) thus reckoned are added together, the result being the surface to be left for courts for the entire ground space, the position and size of which the architect then determines according to special regulations.

Every room, office or loft intended for home industry, having no window opening on the street, must be lighted direct and air admitted from a so-called main court, which must contain at least 80 square metres or about 200 square feet, and measure at least 20 feet across. If ground space is so small that the computed court surface is less than 800 square feet, the size of the court can be reduced to 600 square feet with 20 feet minimum distance across, on condition that a second small court or airshaft at least 100 square feet in size (6 feet 8 inches) is the smallest dimension across.

If the surface in the rear of the first zone does not exceed 500 square feet a main court is not compulsory, provided all the rooms, offices or lofts receive direct light and air from the street, but the building must contain a so-called by-court or secondary court occupying at least 250 square feet and measuring at least 13 feet 6 inches across. Rooms receiving their sole light and air from such secondary courts must not be used for permanent living abodes.

Half the surface of a main court of larger size than 800 square feet of a building for business purposes only, containing living quarters solely for porter or watchman, can be utilized on the ground floor, but must be covered by a glass roof not higher than 6 feet 4 inches above the ceiling of the ground floor. This surface can also be separated from the rest of the court by a wall reaching to the glass roof. Factories, restaurants and cafés, industrial plants that incur danger from fire, and workshops which do not belong to a business establishment in the house, are not accorded this privilege.

The planning of courts is hampered by the regulations governing the height of the building surrounding the court, neither side of which may exceed the width of the court at right angles to it by more than 20 feet. If the court is rectangular, having two long and two short sides, a mean height can be given to all four sides, *i. e.*, the long side walls can be built higher than 20 feet in excess of the opposite width of the court, if the short side walls are reduced in height proportionately.

The height of any wall abutting on a court must never exceed double the width of the court measured at right angles to the wall, and in no case exceed 73 feet.

The safety, security and good hygienic conditions of Berlin's apartment, business and industrial buildings of later date are the results of these regulations.

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