NRC Publications Archive
Archives des publications du CNRC

Fire separations in the National Building Code (1953)

Katnick, J. N.; Ferguson, R. S.

For the publisher's version, please access the DOI link below./ Pour consulter la version de l'éditeur, utilisez le lien DOI ci-dessous.

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/20338043
Report (National Research Council of Canada. Division of Building Research), 1957-12-01

NRC Publications Archive Record / Notice des Archives des publications du CNRC :
https://nrc-publications.canada.ca/eng/view/object/?id=ac5e142a-98f3-41a3-9311-6131cdfeed20
https://publications-cnrc.canada.ca/fra/voir/objet/?id=ac5e142a-98f3-41a3-9311-6131cdfeed20

Access and use of this website and the material on it are subject to the Terms and Conditions set forth at
https://nrc-publications.canada.ca/eng/copyright
READ THESE TERMS AND CONDITIONS CAREFULLY BEFORE USING THIS WEBSITE.

L'accès à ce site Web et l'utilisation de son contenu sont assujettis aux conditions présentées dans le site
https://publications-cnrc.canada.ca/fra/droits
LISEZ CES CONDITIONS ATTENTIVEMENT AVANT D'UTILISER CE SITE WEB.

Questions? Contact the NRC Publications Archive team at
PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca. If you wish to email the authors directly, please see the first page of the publication for their contact information.

Vous avez des questions? Nous pouvons vous aider. Pour communiquer directement avec un auteur, consultez la première page de la revue dans laquelle son article a été publié afin de trouver ses coordonnées. Si vous n'arrivez pas à les repérer, communiquez avec nous à PublicationsArchive-ArchivesPublications@nrc-cnrc.gc.ca.

National Research Council Canada | Conseil national de recherches Canada

NATIONAL RESEARCH COUNCIL OF CANADA

DIVISION OF BUILDING RESEARCH

FIRE SEPARATIONS IN THE NATIONAL BUILDING CODE (1953)

by

J.N. Katnick and R.S. Ferguson

Report No. 135

of the

Division of Building Research

Ottawa

December 1957

PREFACE

When the National Building Code was revised in 1953 the regulations for the prevention of fire spread were completely rewritten in a form and language more suitable to the regulations of architecture and building today. In accepting a new approach based on recent theories in fire engineering, the Associate Committee anticipated that a higher degree of safety would be possible at less cost to the owner and with less restriction on design expression. It was realized, however, that a compromise had to be made with the ideal approach in order not to effect too great a departure from current practice.

Even the best regulations are of little value if they are not clearly understood. This report has been prepared as an explanation of the regulations so that misunderstandings arising from their use will be lessened. J.N. Katnick, architectural student at the University of British Columbia, prepared this report while on the staff of the Division this past summer. R.S. Ferguson, Secretary of the Associate Committee on the National Building Code, guided his investigations.

This paper, while answering some questions, will undoubtedly raise others. It is hoped that, through the comments and suggestions of readers, which will be welcomed, the fire regulations in the National Building Code can be still further improved.

Ottawa
December 1957

R.F. Legget
Director

TABLE OF CONTENTS

FIRE SEPARATIONS

IN THE NATIONAL BUILDING CODE, 1953

by

J.N. Katnick and R.S. Ferguson

Records show that a large proportion of American and Canadian cities have been subjected to a conflagration at some time during their history. These conflagrations started unpretentiously as does almost every fire. Since there was usually very little resistance given to the fire, however, it spread uncontrolled from building to building, laying waste large areas, sapping the economy of the city, and causing a tragic loss of life. During the early development of America, cities often grew rapidly and with little control.

1. DEVELOPMENT OF THE SCIENCE OF FIRE PROTECTION

As a result of these early conflagrations, regulations to limit the use of materials that presented a potential fire hazard were developed and gradually the practice of requiring more solid "fireproof" construction spread, particularly in the congested districts which were usually the victims of such conflagrations. Despite attempts to combat them, conflagrations continued and so-called fireproof buildings were gutted along with the rest. Gradually fire departments became more efficient, water supply was improved, and more effective methods of construction to prevent fire spread were developed. In time knowledge of fire behavior and fire defence became more refined and the general problem of the holocaust could be countered by specialized precautions against better-defined hazards. With the aid of laboratory research, ways of measuring fire intensities and the effectiveness of protection were devised. This field of knowledge is becoming known as fire engineering.

It is largely upon the new knowledge of fire engineering that the fire requirements of the National Building Code are based. The requirements are a refinement over previous regulations and make possible the design of buildings which have greater fire safety provided at less cost than has previously been possible. An understanding of the terms used and the functions that have been developed as a result of research is desirable if these regulations are to be applied to best advantage. The next few paragraphs describe the fire research and fire engineering that apply. A full discussion of the fire separation requirements of the National Building Code follows.

a. Research Work

Among the earliest research work conducted was that of the Fire Offices Committee formed in Britain in 1858. This Committee became the British Fire Prevention Committee in 1897 (1). Its major task was to perform tests so that data concerning the fire resistance of various materials and systems of construction used in building practice could be compiled, and that particulars concerning fire preventive, fire alarm, or fire extinguishing appliances could be collected. By the end of the century many different materials had been subjected to these tests, and tables for assistance to builders had been drawn up recording the fire resistance of floors, ceilings, doors, partitions and the like.

Earlier still in the United States, due to the large number of disastrous fires, the Underwriters' Laboratories Incorporated was formed in 1894 by a group of American insurance companies (2). Its function was similar to the British Fire Prevention Committee. Various types of equipment, appliances and materials were tested to meet safe standards of fire practice. This organization also published lists of products that were tested and found acceptable.

Much of the material gathered by these early associations has been superseded by later developments; the principles formulated prove valid today, however, and, in many cases, have formed a valuable foundation for later research.

b. Fire Resistance Tests

In the course of time, investigations into the fire resistivity of materials led to the development of standards for comparing the results of tests of different kinds of components carried out by different organizations in different places, and in both England and the United States permanent testing stations were set up by the government. Standard furnaces and testing procedures were developed so that materials could be tested under conditions closely approximating those of actual practice. The standards for tests are reasonably comparable between countries, and will become more so as this technique develops. The extent to which walls, columns, floors, and types of construction are able to withstand fire is recorded by these tests. The American Society for Testing Materials has prescribed methods which measure and specify according to a common standard, the fire resistive properties of materials and assemblies. This standard is applicable to a wide variety of materials, situations, and conditions of exposure (3).

It is interesting to note how a building component is subjected to fire conditions in a fire resistance test. The principal element that an assembly must resist is heat; therefore, furnaces are designed so that the object tested forms a wall of the fire box; and thus the heat is distributed over the surface of the assembly. The dimensions of the sample tested compare with building units such as wall or floor panels and the sample can be subjected to whatever loads it would carry in a building. The temperature in the furnace is controlled to an agreed-upon rate of rise during the period of the test. This relationship between temperature rise and time is known as the time-temperature curve, which is shown graphically in Fig. 1. This curve represents the conditions which may occur in a severe fire. Any specimen, therefore, which is subjected to the test and achieves a rating in hours or minutes can, with reason, be expected to last for the same length of time under similar fire conditions in a building.

It is evident that an assembly of materials that can withstand a standard fire-resistance test for a period of three hours is subjected to more heat than is an assembly that can withstand a test for one hour, and to produce this heat more fuel is consumed. The fuel used and hence the heat produced in the tests can be measured. The amount of fuel used when a sample fails gives some idea of the amount of combustibles that could burn before that assembly will fail, if erected in a building. The next step was to determine the amount of combustibles in different types of buildings. When this was known it was possible to recommend the degree of fire resistance required to withstand a burn-out of the contents of different buildings.

Fire Load Concept: Doctor Ingberg of the National Bureau of Standards in Washington was the pioneer whose studies led to measurable relationships between the fire resistance determined in tests and the fire resistance necessary in buildings (4). It was found that the temperatures attained at certain time intervals and the amount of fuel burned in the standard fire resistance tests were related. From repeated tests it was discovered that fuel equivalent to 10, 20, 30 and 35 pounds per square foot of floor area was burned during the standard fire test at the end of 1, 2, 3, and 4 hours, respectively. Thus the fuel used to raise the temperature to 1700°F. at the end of one hour would be equivalent to a fire load of 10 pounds of combustibles per square foot of floor area. To attain a temperature of 1850°F. at the end of two hours, fuel equivalent to 20 pounds per square foot would be needed. By using 10 pounds per square foot as the value to produce a fire intensity of 1700°F. a margin of safety is provided because actually an intensity of 1700°F. is produced by burning combustibles equivalent to 12 pounds per square foot.

It seems true, at least hypothetically, that if a building containing a ten-pound fire load was built of elements having a one-hour fire rating it could just stand a burn-out without collapsing. By the use of the relationship between the combustible contents of a building and the fire resistance there is reasonable assurance that any assembly of materials receiving a 1-, 2-, or 3-hour rating could withstand complete content burn-out of a building with a 10-, 20-, or 30-pound fire load respectively. This fire load concept permits the application of adequate, but not excessive fire resistance to a building when the weight of its combustible contents are known.

To obtain data on actual fire loads in buildings, surveys of buildings were made in which the combustible contents were weighed and recorded. This work was done largely by the Bureau of Standards in Washington, D.C. (5). The weight of combustibles is measured in pounds per square foot just as is the live load. In fact the fire load is the live load but only of the combustible contents. It is not unnatural, therefore, that it should be called the "fire load".

When it is said that an assembly having a fire resistance of one hour withstands a burn-out of contents equal to a 10-pound fire load this relationship is a convenient approximation and is adequate for practical purposes. It should not be forgotten, however, that combustibles burn at different rates and some release more heat than others. For practical purposes all solids can be regarded has having the same calorific value as paper or wood - i.e., 7,000 - 8,000 Btu's per pound of material. Roughly speaking all liquids can be regarded as having a calorific value of double that of wood. A fire in a paint shop or hardware store can be expected to be more intense than in a dry goods establishment. In the National Building Code these differences are dealt with in the occupancy classification.

c. <u>Thermal Radiation from Burning Buildings</u>

From the foregoing discussion the terms <u>fire load</u> and <u>fire resistance</u> are established and the relationship between the two is indicated. In addition to these two elements it is necessary to recognize the significance of space for a full appreciation of the fire requirements of the National Building Code. Extensive studies on thermal radiation from burning buildings were performed recently in Great Britain. From this research it was possible to some extent, to determine what distance between buildings would give sufficient safety to one building from thermal radiation from another. The intensity of heat radiated from a burning building to another building depends on many factors:

(i) Window area on the elevation of a building;

(ii) Temperature attained by the radiating surface (directly related to the fire load of the building);

(iii) Time during which the temperature is maintained; and

(iv) The distance between the buildings.

It may be assumed, in general, that the degree of thermal radiation is inversely proportional to the square of the distance between opposing facades. An interesting fact was that the time element was of little importance to the spread of fire due to radiation, when the exposed facade was of combustible material. Another interesting discovery was that 150°C. was the safe value that a body of combustible materials could reach without fire occurring due to radiation, and that if this surface was of non-combustible materials, and the openings were fire glazed, then the safe temperature that could be reached was 300°C.

For a detailed account of thermal radiation the reader is referred to "Investigations on Building Fires" (6). In this same pamphlet tables are published which indicate the relationship of fire radiation to height and length of buildings, their window openings, and the distance between them. By the use of these tables approximate calculations for distances between buildings to overcome radiation effects can be made.

Several assumptions affecting the reliability of these tables had to be made when collecting the data. These follow:

(i) That the temperature of the radiating fire is 1,000°C. (variations from this temperature would cause major differences because the intensity of radiation is directly proportional to the fourth power of the absolute temperature of the radiating surface); and

(ii) That the emissivity of radiation is constant;

(iii) That heat is being radiated from all openings simultaneously.

This last assumption is highly improbable for a number of reasons. Firstly, the fire resistance of the construction which would enclose a fire within small compartments would hinder total conflagration. Secondly, the combustible contents of the buildings are not the same throughout and its ignitability and rate of burning would limit fire spread. Thirdly, fire fighting would have a significant effect on both the severity of the fire and the rate of its spread. When considering these facts, it is apparent that the tables in the publication were compiled from data collected during extreme fire conditions. Conditions probably would not become so extreme in an actual fire and, therefore, the distances required for safety would not be so great.

2. THE NATIONAL BUILDING CODE

The National Building Code was first published in 1941 under the auspices of the Department of Finance and the National Research Council. As building techniques changed and new materials were introduced this early edition of the Code became outmoded and in many instances was unnecessarily restrictive. The fire regulations, particularly, did not meet the problems presented in contemporary buildings nor did they incorporate the advances made in fire engineering. When revision of the Code commenced in 1948, studies were made to make possible its improvement. It was imperative that the revised code should not restrict materials and types of construction and that its form should permit subsequent revisions.

An entirely new arrangement for the Code was developed treating general requirements first, followed by more detailed and specific clauses. These again were divided into the general and specific wherever necessary. Committees and panels were established to prepare drafts of the different parts and sections. Under the Use and Occupancy Committee, four panels were set up to consider requirements for fire, health, exit and live loads.

a. Fire Regulations

The requirements of the fire regulations in the 1941 Code were carefully considered by the Fire Panel and whenever proved inadequate or unnecessary by developments in fire engineering, they were revised and improved. The fire load concept was studied and finally accepted as the best method available for gauging the relative severity of fire in different occupancies, and as the criterion for determining the fire resistance needed.

The consistency of fire regulations in the National Building Code was achieved through the adoption of the fire load of buildings as the criterion for determining fire safety requirements. The survey of the National Bureau of Standards (5) made it possible for the fire panel to classify occupancies of buildings into groups and divisions according to similarity of function and extent of hazard - this classification is found in section 3.2 of the Use and Occupancy Section - and then to tabulate these uses according to their appropriate fire loads in table 3.1. This fire load classification forms the basis for further regulations.

The primary functions of all fire regulations are twofold: one, to save lives; and the other to prevent the spread of fire. These are closely related and one is achieved only by adequate coverage by the other. In order to save lives sufficient fire exits from a building must be supplied. To create a maximum of life safety fires must be controlled, their spread retarded, and the transfer of heat, gas and smoke nullified. One method of controlling fires is by adequate fire separations which would confine fires within a limited area setting up a barrier to the transfer of all hazards caused by a fire.

b. Fire Separations Defined

The National Building Code, Part 2, defines a separation as follows:

> "Separation means a barrier against the spread of fire between buildings or parts of buildings in the form of fire-resistive construction, or of clear unobstructed space as measured by the distance across such space, or of a combination of both construction and space."

This definition is important. It establishes two kinds of separations - construction and space. It should also be noted that these are alternatives, since either a construction or a space separation can be used between buildings. It is obvious that construction separations only can be used when separating areas within a building. Another alternative which is allowed for separation between buildings is a combination of a construction separation with a space separation, so arranged that the sum of the protection provided is equal to the grade of separation required in table 3.7 referred to in article 3.4.5.1 of the Code.

The acceptance of space as an equivalent to construction is a novelty of the new National Building Code. The assumption made is that a specified distance separation measured in feet is the equivalent of a construction barrier having a specified fire resistance in hours (Fig. 2). Thus, according to the Code the same safety will be provided behind (for example) a one-hour fire resistive barrier adjacent to the fire as at a 30-foot distance with no barrier.

c. Grading and Requirements of Separations

As pointed out previously there is a relationship between intensity of fire and fire resistance and also between intensity and its dissipation with distance. The committee was able to obtain quite reliable data on which a practical decision could be made and it was agreed that the equivalent should be:

Distance	Construction
30 feet equivalent to	1 hour fire resistance
40 feet equivalent to	2 hours fire resistance
50 feet equivalent to	3 hours fire resistance

The values shown in the Code for separation by space are half these distances because in the critical case, i.e., two adjacent buildings with no exterior fire resistive walls, the required separation is obtained if one-half the required distance is provided by each building. Therefore space separations are classified into three grades:

Grade	Distance
Grade 1	15 feet
Grade 2	20 feet
Grade 3	25 feet

These distances are to be measured from the property line to the wall of a building. Thus space separations, like construction separations, are independent of the neighbouring building. The use of space separations allows unprotected openings to be used and the exterior wall need not be fire resistive (it must be non-combustible when non-combustible construction is used). By space, a clear space is inferred, without sheds or rubbish which would have a wicking action between buildings.

It must be emphasized that these values are a practical compromise. They do not provide a guarantee that in every case fire spread will be stopped. The aim of the committee was to set values that would greatly improve the hazardous conditions now permitted by most building by-laws. Good design might dictate more fire resistance in some instances. The code requirement was considered to be a suitable minimum requirement.

The arrangement of section 3.4.5 of the Code deserves note. There is 3.4.5.1 which is the principle article and 3.4.5.2 to 3.4.5.5 which deal with the protection of openings in construction separations. These articles should all be read if separations are to be fully understood. The reader's attention is drawn especially to the second paragraph of 3.4.5.2. Here is the exceptional case when a construction separation is permitted with unprotected openings. The use of unprotected openings not exceeding 20 per cent of the wall area is allowed only when the wall conforms to the grade of construction separation required and when the wall is set back a distance that is half the distance required for that grade of space separation. Therefore, if a "Grade One" separation is required, the wall must have a one-hour fire resistance and must be set back from the property line a distance of 7 1/2 feet. With these qualifications the committee was willing to regard this separation as equivalent to a regular construction separation. The advantage of the compromise is that it represents a form of construction which is still very common.

It will be noticed in table 3.7 that a construction separation means a complete barrier between two spaces, including closures and shafts, to protect all openings. It must be "fire-tight" as the hull of a ship is water-tight. It will be observed, when studying table 3.7, that the required ratings for separations, door, and shafts, are not identical. For example:

Grade 1 ..... 1 hour ...... 3/4 hour ...... 3/4 hour

Doors are less because it was assumed unlikely that furniture or goods would be piled against a door; hence, higher temperature on the unexposed face of a door could be permitted.

Shafts are required when openings are continuous from floor to floor one above the other (stair well, elevator shafts, air ducts, etc.) (Fig. 3). The fire requirements of shafts are less than those of construction separations because a fire must first break into the shaft and then break out to get to the next floor. In essence, there are two barriers to resist the fire and therefore, it was agreed that the sum of the fire resistance of the barriers should equal the required grade of separation (Fig. 4). The openings of a staircase would be as in Diagram A, Fig. 3. The fire resistance of the floor construction would be of little value; the staircase is enclosed within a shaft as in Diagram B, Fig. 3. The fire resistance of the shaft can be found from table 3.7, column 4 of the Code. The doors leading to the staircase must provide fire resistance equivalent to that required in column 3 of table 3.7. The separation of the shaft helps to isolate a fire on one floor. Fire resistive closures keep the stair shaft free from smoke, heat, gas, and flame, thus providing safe egress past a burning section of a building and also safe access for fire-fighting purposes.

Ducts: In some cases continuous openings are made in interior construction separations to allow for the passage of ducts. It is impractical in many instances for such ducts to be enclosed within a fire resistive shaft, yet if they were allowed to pass through the separation without any protection then the separation would be incomplete. In order that the separation and openings in a building perform efficiently when the building is burning there must be an automatic fire damper within the duct at the separation; thus, if a fire should burn through a duct its spread from one separated compartment to another would be hindered. Fire resistive closures and the types which are allowed are indicated in article 3.4.5.5 of the Code.

Spandrel and Apron Walls: Article 3.4.5.4 requires that openings in exterior walls of any building with a fire load of over 20 pounds per square foot and required separations between floors, be separated by an apron or spandrel wall not less than 3 feet in height (Fig. 5). This is an example of applying the principle of preventing fire spread. When a fire separation between floors is required it is advisable to consider additional protection at the edge. The fire could escape around the edge of the floors and into the floor above. To overcome this danger the Code requires a spandrel or apron wall.

Such a precaution is not required in a building having a fire load of less than 20 pounds because the lower intensity of a possible fire would, in most cases, cause this hazard to be less significant.

Having studied section 3.4.5 of the Code attention should be next directed to section 3.4.6. It is important to understand the basic difference between these two sections.

3.4.5. Section 3.4.5 is definitive. It should be read in conjunction with the definition in part 2 and the explanatory notes on separations. All these sections define what separations are, and classify them according to grades.

3.4.6. Section 3.4.6 is regulatory. This section establishes where separations are required between buildings and what grade they must be. Sections 3.4.7 to 3.4.11 are similar to 3.4.6 except that they deal with rooms and parts of buildings instead of the whole building.

It will be observed that throughout the requirements the grade of separation required is dependent on the fire load. This can be seen in the direct reference to the fire load in section 3.4.6. In the other sections the fire load is not mentioned, but the relationship is quite evident.

d. Fire Separation Between Buildings

In section 3.4.6 a grade of separation relative to the fire load is required as follows:

Fire Load	Separation construction or space
10 lbs.	Grade 1
20 lbs.	Grade 2
30 lbs.	Grade 3

To determine the construction required to comply with these fire separation requirements:

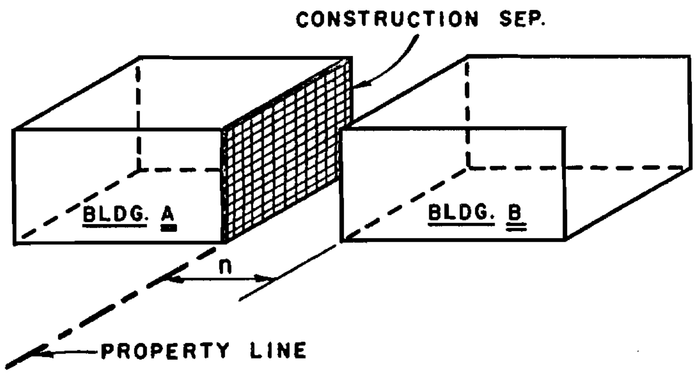
(i) the fire load of the occupancy must be known (table 3.1);

(ii) from the table in 3.4.6 the required grade of separation can be found; and

(iii) the type of construction to comply with this grade of separation can be determined from table 3.7.

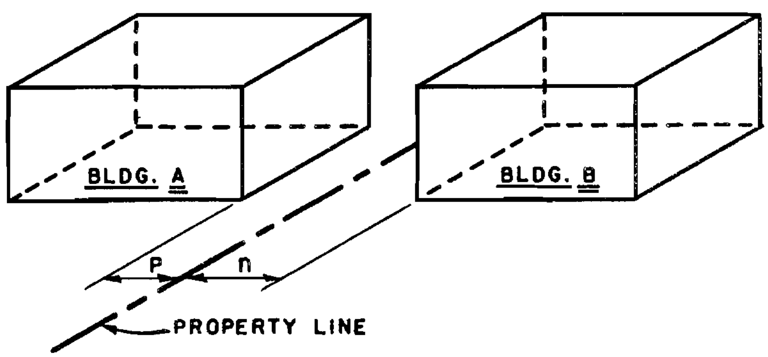
The following examples illustrate how the separations can be used:

EXAMPLE I



1. Buildings A and B are two adjacent buildings.
2. Building A is built to the property line; therefore a construction separation with no openings must be used.
3. The grade of the construction separation is determined by the fire load of building A.
4. Since a space separation (n) is being used for building B the wall facing the property line may have unlimited unprotected openings, and the wall finish need not be fire resistive, provided, however, that a non-combustible finish is used in a non-combustible building.
5. The space separation (n) is determined by the grade of separation required by the fire load of building B.

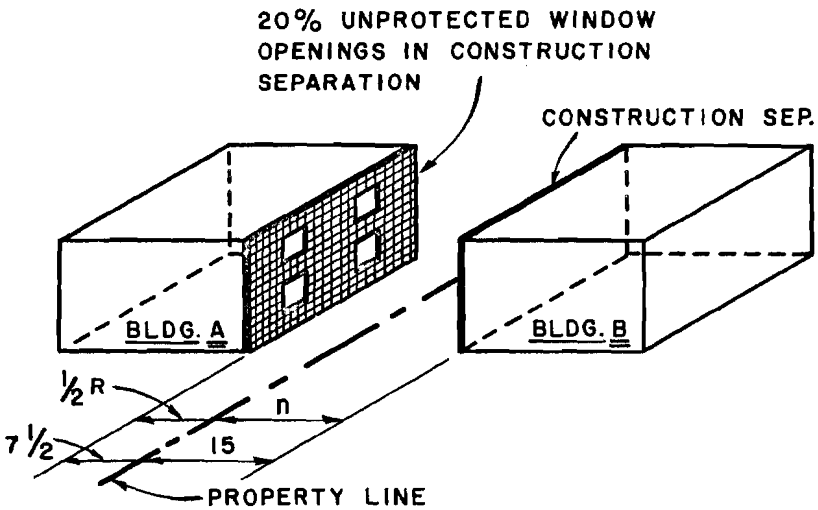
EXAMPLE II



1. Both buildings A and B use space separations.
2. (n) and (p) are determined by the grade of separation required by the fire loads of the respective buildings.
3. The same regulations apply to buildings A and B as to building B in Example I.
4. The minimum distance which (n + p) could equal is 30 feet - if both A and B have 10-lb fire loads then each is required to have an offset of 15 feet.

Suppose building A is an office with a 10-pound fire load and building B is a store with a 20-pound fire load. In Example I building A would need a 1-hr fire wall and (n) for building B would be 20 feet. In Example II (p) and (n) would be 15 and 20 feet respectively.

EXAMPLE III



1. Building A requires openings in the wall which do not exceed 20% of the wall area. Assuming fire loads as before, the separation requirements are as follows:

Building A

Exterior walls of 2 hours fire resistance and a side yard (p) of 7' 6" (1/2 of a Grade 1 space separation)

Building B

The owner of building B elects to use a Grade 1 construction separation plus a Grade 1 space separation thus achieving the required total Grade 2 separation.

e. Separation by Fire Walls

The next few paragraphs describe another use of separations. This is a separation down the middle of a building by a fire wall (section 4.1.5) (Fig. 6). Here a new principle must be introduced. This is the principle that certain kinds of buildings present too great a risk if they are built of unlimited size. When a large building is required, therefore, it is often possible to build it only if it is divided by a fire wall giving the effect for fire purposes of two separate buildings with a construction separation between. A fire wall is, in fact, a construction separation but the requirements for fire walls have been developed from experience, while the construction separations as defined in 3.4.5 are the result of theoretical studies, hence there are differences in detail between them.

It is evident, therefore, that height and area limitations and fire walls are linked together. Heights and areas and types of construction are also linked. The relationship between these three safety measures is as follows:

All buildings must be classified according to the type of construction. If the area or height required is greater than that allowed in table 3.6 then two choices are open:

(i) the owner may divide the building by fire walls as necessary to meet the area requirements; or

(ii) he may prefer to choose another type of construction which permits greater height or area.

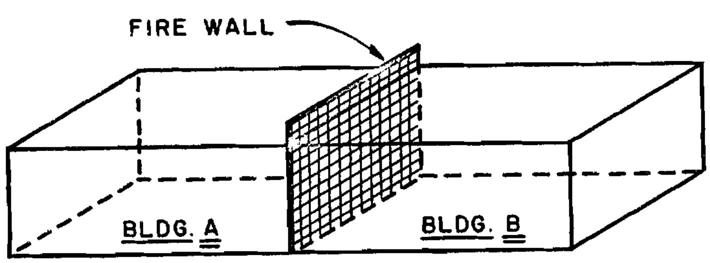
Section 4.1.5 deals with the use of fire walls as fire separations between buildings or parts of buildings. Any part of a building separated by a fire wall may be considered a separate building, and the area so produced must meet all requirements of fire exits, separations, etc. A fire wall is a party wall for it is shared by two separate areas of the same building or two different buildings. The grades of fire walls which must be used are:

Fire Load	Grade of Separation for Fire Wall
10 lbs	Grade 2
20 lbs	Grade 3
30 lbs	Grade 4

The grade of separation is determined by using the maximum value of the fire loads of either of the adjacent occupancies.

It has been shown how construction and space separations can be used; however, reference was made to the fact that fire walls (or party walls) could be used to separate two buildings. The following example deals with this problem:

EXAMPLE IV

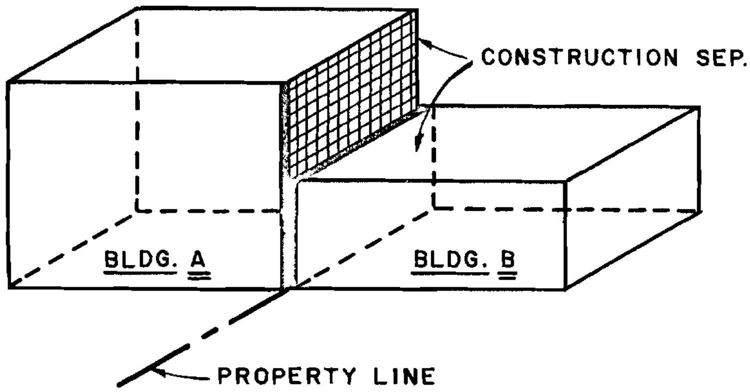


1. If buildings A and B have 10-lb fire loads then the fire wall must be a Grade 2 construction separation - i.e. 2-hour fire resistance.

2. If the fire load of either A or B is 20 lbs then the fire wall must have a 3-hour rating.

3. If the fire load of either A or B is 30 lbs then the fire wall must have a 4-hour rating.

EXAMPLE V



1. If each individual area A and B were to be built with individual construction separations at the property line, (Example V), the regulations pertaining to construction separations would be valid.

2. If A and B were both 10 lbs then the construction separation for each would be 1 hour adding to 2 hours together.

3. If A had a 10-lb fire load and B had a 20-lb fire load then the total fire separation = 3 hours.

4. If A had a 10-lb fire load and B had a 30-lb fire load then the sum of the separation would be 4 hours.

5. N.B. At this point the parallel ends, because if A had a 20-lb fire load and B had a 20-lb fire load then the construction separation would equal 4 hours. If A had a 20-lb fire load and B had a 30-lb fire load then the construction separations would equal 5 hours. If both A and B had 30-lb fire loads then the construction separations would equal 6 hours. It is evident that when individual fire separations are built by the adjoining areas the fire protection is increased considerably. This may be justified by the fact that the occupancy of the adjacent building and the hazards it would present are not always known.

When fire walls are used, a number of conditions must be met which are not required when using construction separations. When two areas are being separated by a fire wall, a parapet (3 feet in most cases, 6 inches between dwelling units) must be used so that there will be a complete break in the roof construction. A construction separation does not require a parapet. In both cases fire spread through roof construction would be hindered, but with the fire wall this effect would be more positive.

In buildings of combustible construction a fire wall must be supported on the foundation and continuous from the foundation to the parapet. When the construction of the building is of non-combustible materials then the fire wall may be supported by the structural frame provided the fire resistance of the structural frame is as great as, or greater than, that of the fire wall. As mentioned, the fire wall must be continuous. Offsets at floor levels are permitted but the construction of the offset floors and walls must have fire resistance equal to that of the fire wall (Fig. 7).

Other requirements of fire walls are stated in articles 4.1.5.3 and 4.1.5.4 of the NBC.

f. Fire Separation Within Buildings

Although it is possible to use fire separations anywhere inside buildings when, in the opinion of the owner or architect, they appear to be useful, the National Building Code requires fire separations in certain places as a basic minimum standard. The greatest contribution to internal fire safety is the separation or isolation of one story from another to combat spread of fire vertically, and the provision of safe means of escape by the enclosure and separation of units. Fire separations are also used to separate major occupancies and special hazards as indicated in the following paragraphs, explained in the order in which they appear in the Code.

Major Occupancies: When there are two or more major occupancies in the same building they must be separated as stated in section 3.4.7 and table 3.8 (Fig. 8). If one of the major occupancies requires a Grade One separation and the other requires a Grade Two separation, the grade of separation must be the greater of the two, in this case Grade Two. Thus, if a mercantile and a residential occupancy were to be the major occupancies of a building the grade of separation required according to section 3.4.7 and table 3.8 would be a Grade Two separation.

Exits: The separation of exits from the floor areas of a building is one of the most important life safety factors incorporated into any building (section 3.4.8). A numerous supply of exits is commendable; however, if these are full of flames, smoke and gases during a fire they are of no use to the occupants of the building. Because of this, each exit must be separated from the rest of the building so that it is a continuous and independent vertical member, and its separation must be supported from the ground so that the collapse of any floor will not endanger an exit nor the people using it during a fire. The separation requirements of exits according to section 3.4.8 are:

Fire Load of Occupancy	Grade of Separation
10 - 20 lbs	Grade 1
greater than 30 lbs	Grade 2

The separation is required only between the "floor areas" of the building and the exit (Fig. 9); therefore, if the exit should be on an exterior wall facing a street, then the sides of the exit facing the street are not required to be fire resistant (as previously stated, these walls must be non-combustible in non-combustible construction). Fire separations are required for every exit. Number of exits, size etc. are determined in Use and Occupancy Section 3.20.

Special Occupancy: Many special purpose rooms, such as kitchens and furnace rooms, present fire hazards to buildings. To overcome the hazards which would arise from the occupancy of these rooms, special regulations were established which are effective regardless of the use of the building and of any other fire protection requirements. These regulations are stated in section 3.4.10 of the Code.

Attic, Crawl and Duct Spaces: When buildings are separated by construction separations, all attic, crawl and duct spaces must also be separated (Fig. 10). If this is not done then the fire could spread by way of the attic, crawl, or duct space from one enclosed area to another. Section 3.4.11 deals with these requirements (refer directly to section 3.4.5.3 in the case of ducts not enclosed in fire resistive shafts).

3. CONCLUSION

In conclusion, and after the consideration of so many details it is well to remember the general principle that regulations are for the purpose of ensuring a minimum standard of safety. This is not always too easy to define.

The minimum is always set by agreement based on expert opinion on the degree of safety which the public will tolerate. From this point onward technical information, resulting from research or some form of methodical investigation can often show how the desired safety measures can be achieved with less interference or restriction on the actions of those who build. Such improved regulations may result in building economies, or a more consistent standard of safety, or both. Whichever is the case it should be welcomed because efficiency and safety go hand-in-hand.

The new regulations in the National Building Code are based on information gained from research. Although not perfect they have been acclaimed by many as a considerable improvement over other contemporary regulations. The lack of understanding which results from their newness is a limiting factor in their use. It is hoped that this paper will help materially to correct this condition.

The authors of these regulations, while defending them are, at the same time, their most severe critics. Development of improved regulations did not stop with the printing of the 1953 National Building Code but has continued, and improvements will be announced from time-to-time. Today, with new technology much of the old method of control for safety no longer applies. Unless building regulations advance with the times they will be put aside or overlooked as a measure for safety. It is to be hoped that if building regulations are ever less used than they are today it will be because they are less needed and not because they have become inadequate for their task.

References

1. Bird, E.L. and S.J. Docking. Fire in buildings. Editors, Adam and Charles Black. London 1949. p. 30.

2. National Fire Prevention Association. Handbook of fire protection. 11th edition, 1954. p.53.

3. Standard methods of fire tests of building construction and materials. A.S.T.M. Designation: E119-55, A.S.T.M. Standards Part 4, 1955. p. 1177-1187.

4. Bird, E.L. and S.J. Docking. Fire in buildings. Editors, Adam and Charles Black, London 1949. p. 90.

5. Ingberg, S.H. Combustible contents in buildings. U.S. National Bureau of Standards, Wash., B.M.S. 149, July 1957.

6. Investigations on building fires. National Building Studies: Part 111 Radiation from Building Fires, Tech. Paper No. 5, London, June 1950. 24 p.

Bibliography

Wood, B.L. Fire protection through modern building codes. (A correlation of factual data and regulatory procedure.) American Iron and Steel Institute, New York, N.Y., 1950. 156 p.

U.S. National Bureau of Standards. Fire resistance classification of building constructions. B.M.S. Report 92, Washington, October 1942.

President's Conference on Fire Prevention. Report of the committee on building construction, operation and protection. Washington May 1947. 30 p.

British Standards Institution. Fire tests on building materials and structures. B.S. 476: 1953. 24 p.

Great Britain, Ministry of Works. Post-War Building Studies No. 20. Fire grading of buildings. Part 1:General principles and structural precautions by a joint committee of the Building Research Board, D.S.I.R., and Fire Offices' Committee. London 1946. 116 p.

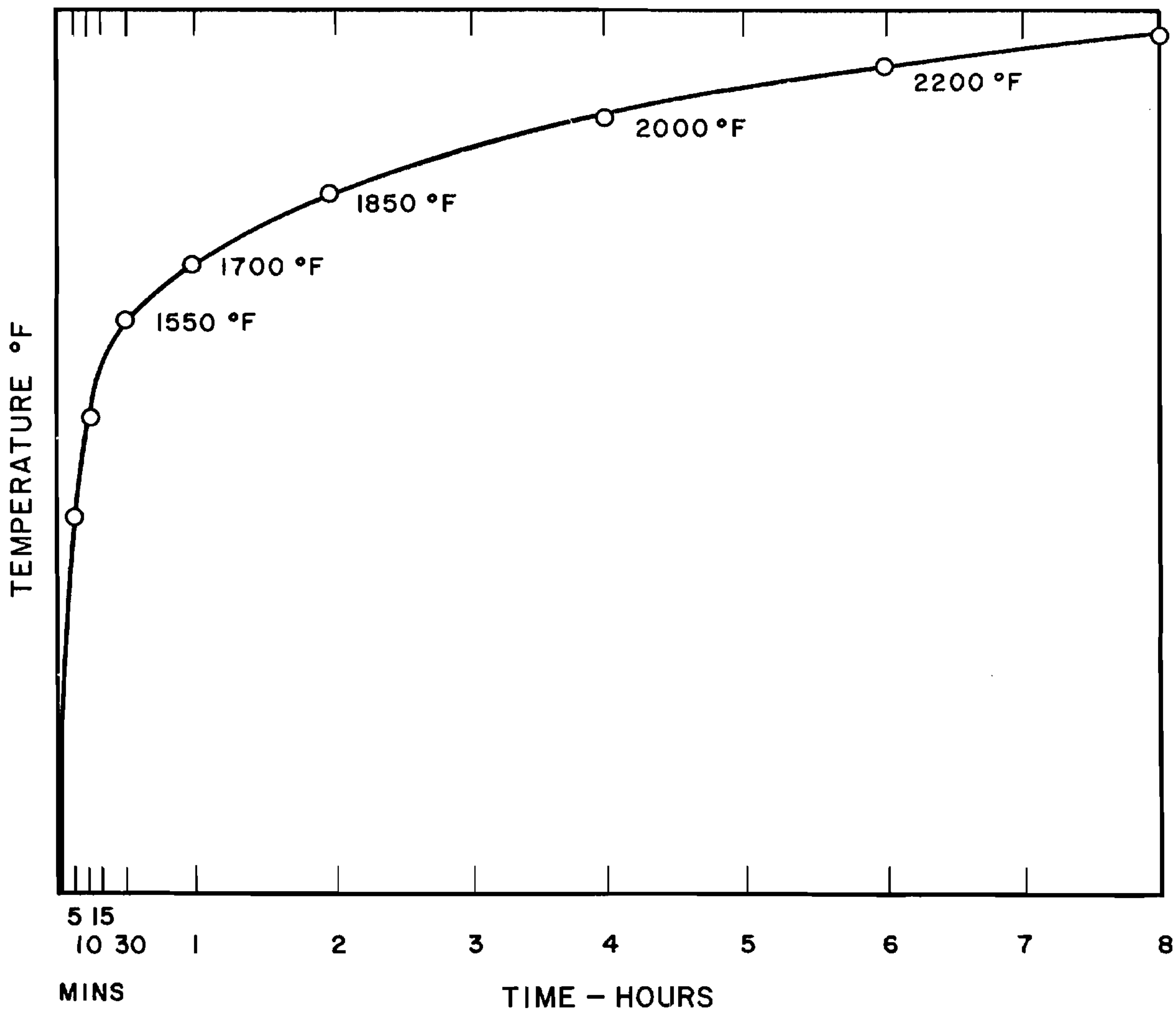


FIGURE 1

TIME TEMPERATURE CURVE

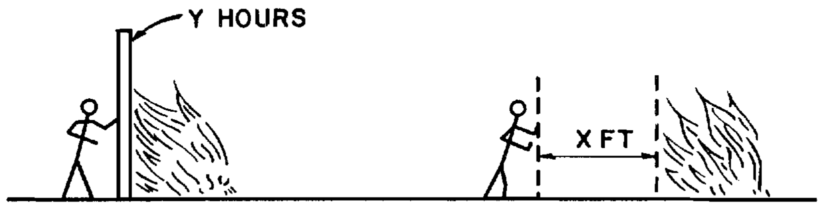
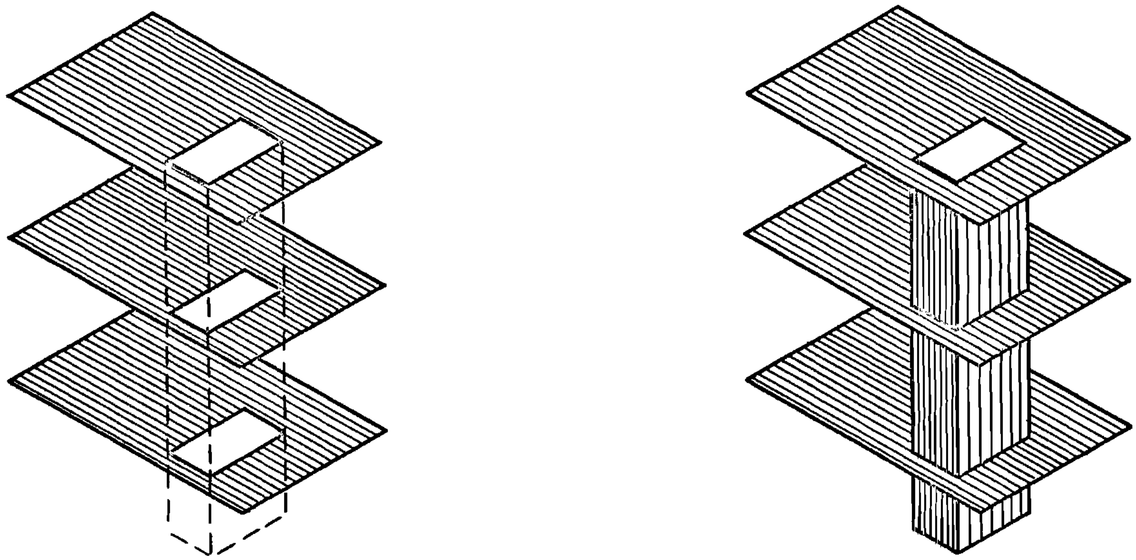


FIGURE 2

SKETCH SHOWING SPACE AS AN EQUIVALENT TO A CONSTRUCTION BARRIER



DIAG A

DIAG B

FIGURE 3

DIAGRAMS SHOW HOW SHAFTS ARE REQUIRED FOR CONTINUOUS FLOOR TO FLOOR OPENINGS (STAIRCASE)

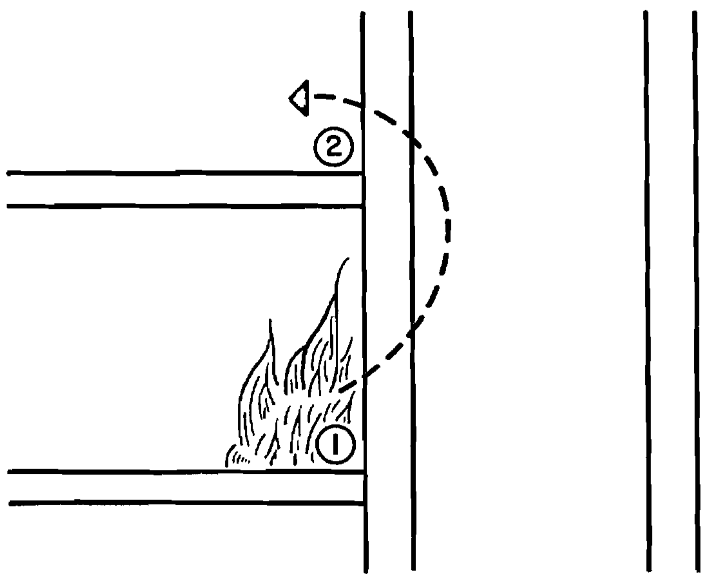


FIGURE 4

SHAFT ACTS AS TWO BARRIERS PERMITTING LOWER FIRE RESISTANCE THAN THAT REQUIRED FOR FLOORS

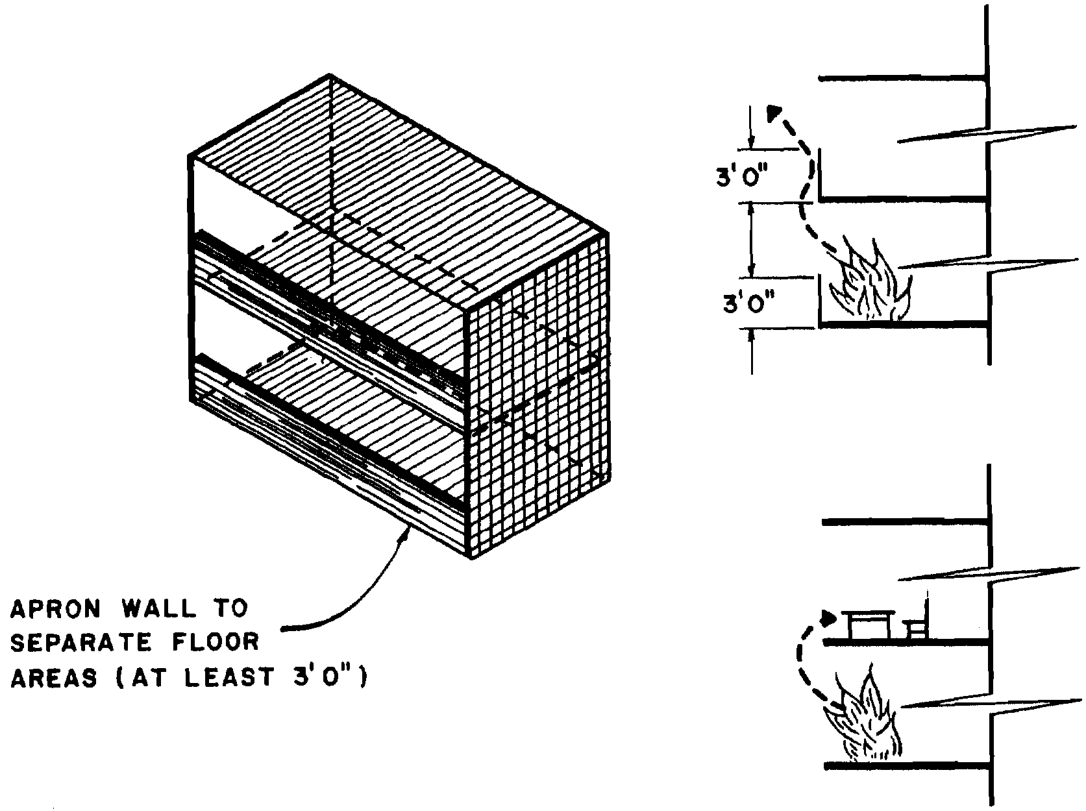


FIGURE 5

SKETCHES SHOWING HOW APRON AND SPANDREL WALLS PREVENT FIRE SPREAD FROM FLOOR TO FLOOR

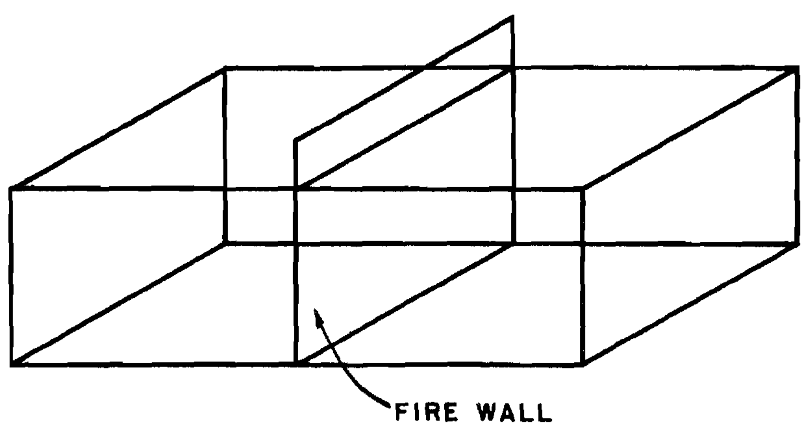


FIGURE 6

SKETCH OF FIRE WALL SHOWING ONE BUILDING DIVIDED IN TWO SO THAT AREAS ON EACH SIDE WILL NOT EXCEED CODE REQUIREMENTS

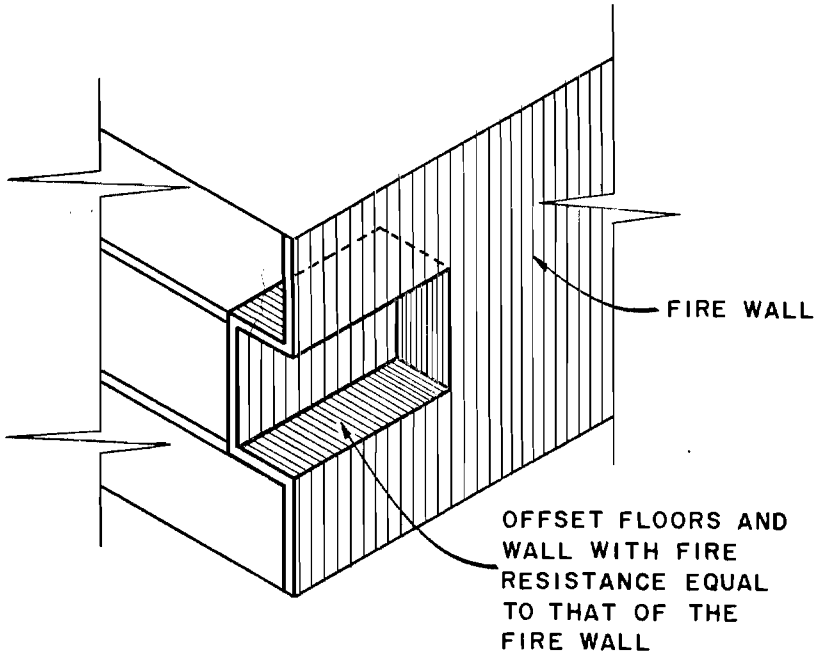


FIGURE 7

SKETCH OF OFFSET FLOORS AND WALL

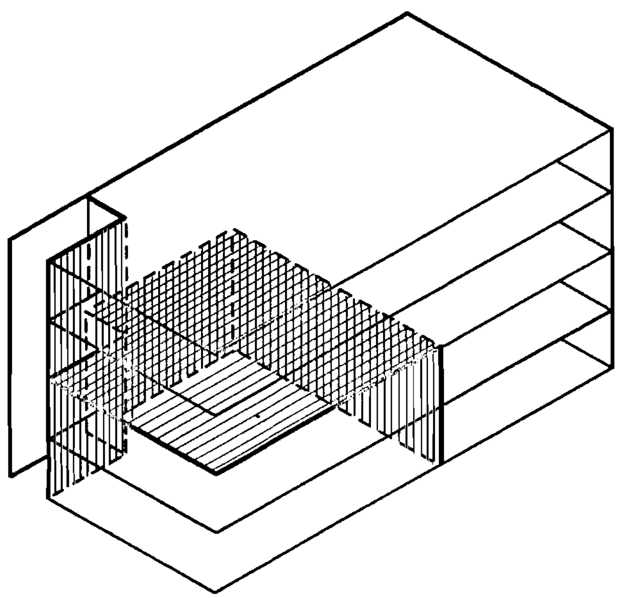


FIGURE 8

CONSTRUCTION SEPARATION OF TWO MAJOR OCCUPANCIES

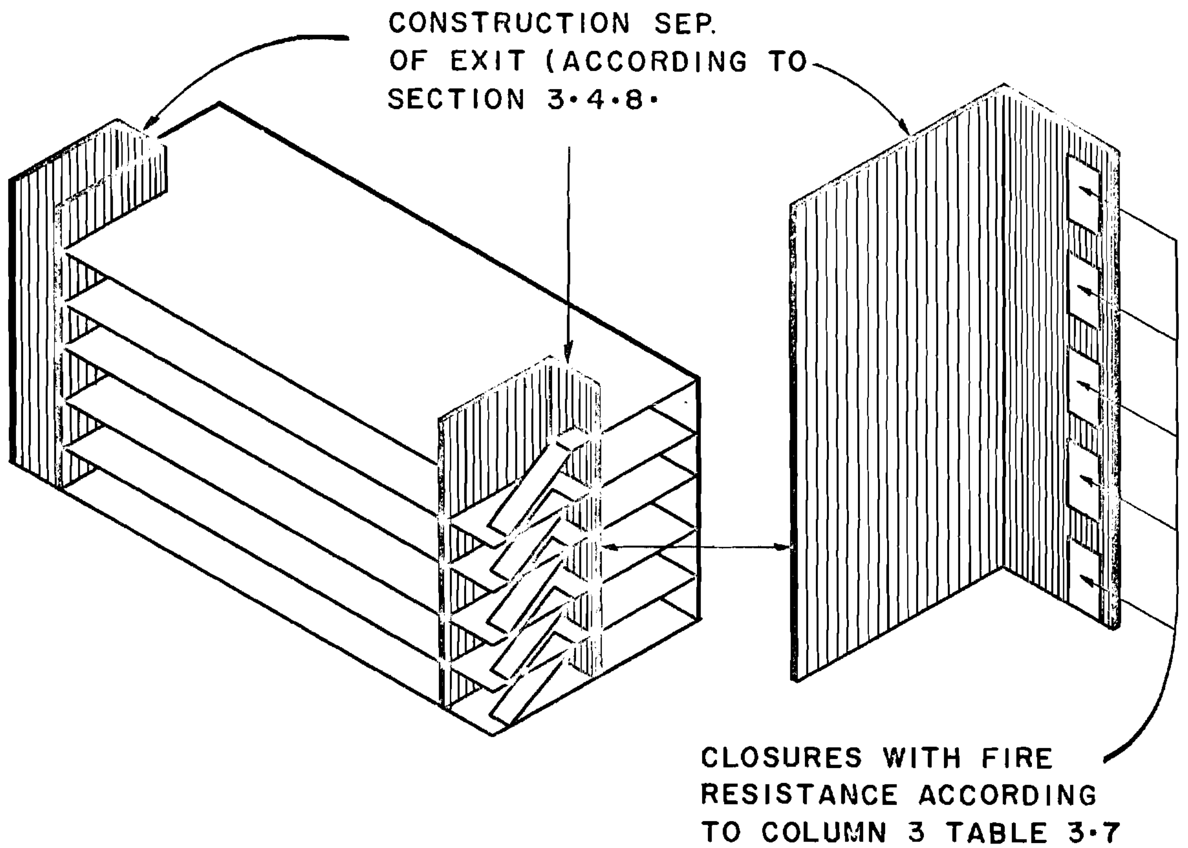


FIGURE 9

CONSTRUCTION SEPARATION OF EXIT

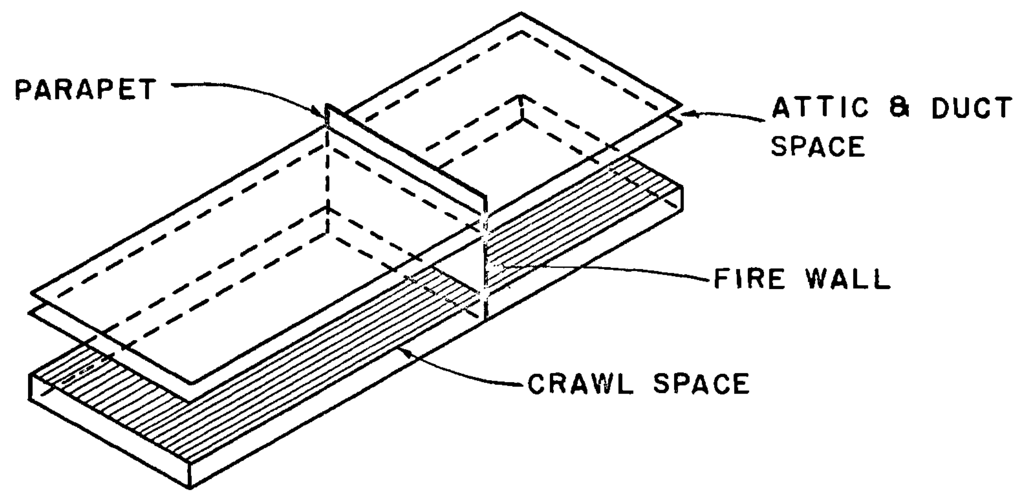


FIGURE 10

SEPARATION OF ATTIC, CRAWL AND DUCT SPACES