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NFPA 80A
Protection of Buildings from Exterior Fire Exposure
1993 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 80A

Recommended Practice for

Protection of Buildings from Exterior Fire Exposures

1993 Edition

This edition of NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, was prepared by the Technical Committee on Exposure Fire Protection, released by the Correlating Committee on Building Construction, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 16-18, 1992, in Dallas, Texas. It was issued by the Standards Council on January 15, 1993, with an effective date of February 12, 1993, and supersedes all previous editions.

The 1993 edition of this document has been approved by the American National Standards Institute.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 80A

In 1924, the NFPA Committee on Protection of Openings in Walls and Partitions developed a *Suggested Practice for Protection Against Exposure of Openings in Fire-Resistive Walls* to meet the demand for a method of evaluating the severity of exposure and a uniform practice for specifying protection. This pamphlet was presented as a Tentative Recommended Practice and was adopted by the NFPA in 1925.

In 1930, this pamphlet was added to the *Standard for the Protection of Openings in Walls and Partitions Against Fire* as an appendix, but it was not published until the 1944 edition of the National Fire Codes, Vol. III, except as part of the NFPA Proceedings. It also was summarized in the 9th edition (1941) of the *Handbook of Fire Protection*.

In 1963, a new NFPA Committee on Exposure Fire Protection was formed and was charged with the task of updating the 1925 edition of NFPA 80A. The committee submitted a complete revision of the 1925 text to the Association for tentative adoption in 1967 and a revision of the tentative text for official adoption in 1970.

In the 1987 edition there were substantive and editorial changes. For 1993, revisions continue to examine the effect of fire on an exposed structure and calculative methods to help ensure a reduction in fire impact due to exposure fires.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Committee Scope: To develop recommendations on protection of buildings from fire exposure, excluding installation details for outside sprinklers, which are handled by the Committee on Automatic Sprinklers.

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To the User

Metric units of measurement in this Recommended Practice are in accordance with the modernized metric system known as the International System of Units (SI). The unit liter, which is outside of but recognized by SI, is commonly used in fire protection and is therefore used in this Recommended Practice. In this document, values for measurements are followed by an equivalent in SI units. The first stated value shall be regarded as the requirement because the given equivalent value may be approximate.

NFPA 80A

Recommended Practice for

Protection of Buildings from Exterior Fire Exposures

1993 Edition

NOTICE: An asterisk (*) following the number or letter designating a section indicates explanatory material in Appendix A.

Information on referenced publications can be found in Chapter 5 and Appendix C.

Foreword

The hazards of exposure to a structure from adjacent exposing fires and the multiple conditions under which such exposure may occur make it impossible to develop a table, formula, or set of rules that will adequately cover all conditions. It is recommended that the user of this recommended practice become familiar with the general theory of radiation exposure hazard as outlined in Appendix A.

Chapter 1 General Information

1-1 Scope. These recommendations are aimed at protecting combustibles within, and on the exterior of, an exposed building. They contemplate effective fire fighting activity.

1-2 Purpose. This pamphlet is prepared for the guidance of persons concerned with the protection of property from external building fires.

1-3 Definitions.

Approved. Means "acceptable to the authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials, nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction: The "authority having jurisdiction" is the organization, office, or individual responsible for "approving" equipment, an installation, or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local, or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Exposure. The heat effect from an external fire, which might cause ignition of, or damage to, an exposed building or its contents.

Exposure Severity.* The intensity of an exposing fire.

Noncombustible Materials. Materials, no part of which will ignite and burn when subjected to fire.

Pilot Ignition. The radiant ignition of a material by radiation where a local high temperature igniting source is located in the stream of gases and volatiles issuing from the exposed material. In practice, a glowing ember or a flash of flame might constitute the high temperature ignition source, which often serves to ignite the flammable gases and volatiles.

The mechanism differs from spontaneous ignition by radiation in which there is no local high temperature igniting source and for which higher intensities of radiation are required.

Should. Indicates a recommendation or that which is advised but not required.

1-4 Types of Exposure. There are two basic types of exposure to be considered, as follows:

1-4.1 Exposure to Radiation. Exposure to radiation can result:

(a) From radiant energy passing through windows or other openings in the facade of a burning building,

(b) From flames issuing from the windows of a burning building, or

(c) From flames issuing from the burning facade of a building.

1-4.2 Exposure to Flames. Exposure to flames issuing from the roof or top of a burning building in cases where the exposed building is higher than the burning building.

Chapter 2 Classification of Exposures and Recommended Separation Distances

2-1 Exposure from Buildings of Greater or Equal Height. Where a building is exposed by a building of greater or equal height, only the thermal radiation from walls or wall openings of the exposing building will be considered.

Separation distances must be determined so that pilot ignition of the exposed building or its contents is unlikely, assuming no means of protection are installed in connection with either building.

2-2 Explanation. The following explain the column headings in Tables 2-3 and 2-4.

2-2.1 Width of Exposing Fire (w). The length in ft (m) of the exposing wall between interior fire separations or between exterior end walls where no fire separations exist. Fire separations (such as partition walls or fire walls) should have sufficient fire resistance to contain the expected fire.

2-2.2 Height of Exposing Fire (h). The height in ft (m) of the number of stories involved in the exposing fire, considering such factors as building construction, closure of vertical openings, and fire resistance of floors. The relevant fire separations must have sufficient fire resistance to contain the expected fire.

2-2.3 Percent of Opening in Exposing Wall Area. This is the percentage of the exposing wall made up of doors, windows, or other openings within the assumed height and width of the exposing fire. Walls without the ability to withstand fire penetration for more than 20 minutes should be treated as having 100 percent openings. Walls having the ability to withstand fire penetration for more than 20 minutes, but less than the expected duration of the fire, should be treated as having 75 percent openings.

2-2.4 Severity. Three levels of exposure severity are assumed: light, moderate, and severe. Two of the important properties influencing fire severity are:

(a) The average combustible load per unit of floor area.

(b) The characteristics and average flame spread ratings of the interior wall and ceiling finishes.

Tables 2-2.4(a) and 2-2.4(b) serve as a guide in assessing severity based on these properties. In using these tables, the more severe of the two classifications should govern.

Table 2-2.4(a)

Classification of Severity	Fire Loading in lbs per sq ft (kg/m^2) of Floor Area	
Light	0–7[1]	(–34)
Moderate	7–15	(34–73)
Severe	15 and up	(73 and up)

[1]Excluding any appreciable quantities of rapidly burning materials such as certain foamed plastics, excelsior, or flammable liquids. Where these materials are found in substantial quantities, the severity should be classed as moderate or severe.

2-2.5 Width vs. Height or Height vs. Width. This is a measure of the configuration of the exposing facade expressed as a ratio.

Table 2-2.4(b)

Classification of Severity[1]	Average Flame Spread Rating of Interior Wall and Ceiling Finish[2]
Light	0–25
Moderate	26–75
Severe	75 and up

[1]Where only a portion of the exposed building has combustible interior finish (i.e., some rooms only, ceiling only, some walls only, etc.), this factor is considered in judging severity classification.
[2]See NFPA 225, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

2-3* Distances. Table 2-3 determines the separation distance necessary between two buildings so that pilot ignition of the exposed building or its contents is unlikely, assuming no means of protection are installed in connection with either building. Guide numbers are obtained from this table. To determine distances, the lesser dimension, width (w) or height (h), should be multiplied by the guide number and 5 ft (1.52 m) added to the result. Table 2-3 is based on a maximum tolerable level of incident radiation (I) at the facade of an unprotected exposed building of 12.5 kW/m^2 (0.3 $cal/cm^2/sec$ or 66 Btu/sq ft/min). This assumes that the facade is constructed of typical cellulosic materials. Where other combustible materials are used and I is indicated by appropriate tests to be less than 12.5 kW/m^2 or where I is indicated to be greater than 12.5 kW/m^2 and where there are no openings in the facade of the exposed building, the percentage openings should be adjusted by multiplying by the ratio of 12.5 $kW/m^2/I$. Suggested separation distances contemplate fire department response. Where no organized fire fighting facilities are available, the distances derived from guide numbers in Table 2-3 should be increased by a factor of up to 3.

2-4* Exposure from Buildings of Lesser Height. Where the exposing building is of lesser height than the exposed building, the separation distance should first be determined from Table 2-3. Where the roof assembly of the exposing building is combustible and has no fire resistance rating, means of protection should be provided above the roof level of the exposing building in accordance with Table 2-4.

Where separation distances derived from Table 2-3 are less than distances indicated in Table 2-4, means of protection should be applied on the side of the exposed building to a height equal to the separation distance, commencing at the height of the top of the wall of the exposing building.

2-4.1 Where the roof of the exposing building has a sufficient fire resistance rating to contain the expected fire (based on the fire loading within the area), no exposure hazard is considered to exist throughout the roof.

2-4.2 Where the roof has a fire resistance rating less than necessary to contain an expected fire, means of protection should be provided in accordance with Table 2-4, taking into consideration the fire stability of the roof assembly involved, the fuel it may contribute, including roof insulation and covering, and its tendency to inhibit flaming through the roof.

Table 2-3* Guide Numbers for Minimum Separation Distances

Severity: Light	Moderate	Severe	Width/Height or Height/Width: 1.0	1.3	1.6	2.0	2.5	3.2	4.	5.	6.	8.	10.	13.	16.	20.	25.	32.	40.
Percent Openings*			Guide Number (multiply by lesser dimension, add 5 feet, to obtain building-to-building seperation)																
20	10	5	0.36	0.40	0.44	0.46	0.48	0.49	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
30	15	7.5	0.60	0.66	0.73	0.79	0.84	0.88	0.90	0.92	0.93	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.95
40	20	10	0.76	0.85	0.94	1.02	1.10	1.17	1.23	1.27	1.30	1.32	1.33	1.33	1.34	1.34	1.34	1.34	1.34
50	25	12.5	0.90	1.00	1.11	1.22	1.33	1.42	1.51	1.58	1.63	1.66	1.69	1.70	1.71	1.71	1.71	1.71	1.71
60	30	15	1.02	1.14	1.26	1.39	1.52	1.64	1.76	1.85	1.93	1.99	2.03	2.05	2.07	2.08	2.08	2.08	2.08
80	40	20	1.22	1.37	1.52	1.68	1.85	2.02	2.18	2.34	2.48	2.59	2.67	2.73	2.77	2.79	2.80	2.81	2.81
100	50	25	1.39	1.56	1.74	1.93	2.13	2.34	2.55	2.76	2.95	3.12	3.26	3.36	3.43	3.48	3.51	3.52	3.53
—	60	30	1.55	1.73	1.94	2.15	2.38	2.63	2.88	3.13	3.37	3.60	3.79	3.95	4.07	4.15	4.20	4.22	4.24
—	80	40	1.82	2.04	2.28	2.54	2.82	3.12	3.44	3.77	4.11	4.43	4.74	5.01	5.24	5.41	5.52	5.60	5.64
—	100	50	2.05	2.30	2.57	2.87	3.20	3.55	3.93	4.33	4.74	5.16	5.56	5.95	6.29	6.56	6.77	6.92	7.01
—	—	60	2.26	2.54	2.84	3.17	3.54	3.93	4.36	4.82	5.30	5.80	6.30	6.78	7.23	7.63	7.94	8.18	8.34
—	—	80	2.63	2.95	3.31	3.70	4.13	4.61	5.12	5.68	6.28	6.91	7.57	8.24	8.89	9.51	10.05	10.50	10.84
—	—	100	2.96	3.32	3.72	4.16	4.65	5.19	5.78	6.43	7.13	7.88	8.67	9.50	10.33	11.15	11.91	12.59	13.15

*See A-2-3 for treatment of unequally distributed windows.

Table 2-4*

Number of Stories Likely to Contribute to Flaming Through the Roof	Horizontal Separation Distance or Height of Protection Above Exposing Fire—ft (m)
1	25 (7.6)
2	32 (9.8)
3	40 (12.2)
4	47 (14.3)

2-4.3 Subject to 2-4.1 and 2-4.2, the number of stories expected to contribute to flaming through the roof should be taken to be the top story together with those successively beneath it that are not separated from it as indicated in 2-2.2.

2-4.4 High attic spaces should be counted as a story subject to 2-4.1 and 2-4.2. Where the height of the attic is small, interpolation between the values given in Table 2-4 may be made.

Chapter 3 Means of Protection

3-1 Types. The various means of protecting buildings from fire damage resulting from exterior exposure are listed below. They are not listed in any specific order with regard to adequacy.

3-1.1 Buildings.

(a) Clear space between buildings.

(b) Total automatic sprinkler protection.

3-1.2 Walls.

(a) Blank walls of noncombustible materials.

(b) Barrier walls (self-supporting) between building and exposure.

(c) Extension of exterior masonry walls to form parapets or wings.

(d) Automatic outside water curtains for combustible walls.

3-1.3 Wall Openings.

(a) Elimination of openings by filling with equivalent construction.

(b) Glass block panels in openings.

(c) Wired glass in steel sash (fixed or automatic closing) in openings.

(d) Automatic or deluge sprinklers outside over openings.

(e) Automatic (rolling steel) fire shutters on openings.

(f) Automatic fire doors on door openings.

(g) Automatic fire dampers on wall openings.

3-1.4 Additional means of protection that may be developed should also be considered. Examples of such protection might include double-glazed glass in metal sash, flame-retardant coatings, and other future arrangements. Before implementing such means of protection, they should be approved.

3-2 Evaluation. In evaluating any of the types of protection, the adverse effects of convected heat, flame impingement, and small flying brands associated with winds, as well as the beneficial effects of fire department operations, have been considered. Large flying brands have not been considered.

3-3 Means of Protection. Means of protection selected should be approved for the individual application and should be installed in accordance with appropriate standards (e.g., fire doors installed in accordance with NFPA 80, *Standard for Fire Doors and Fire Windows*; automatic sprinklers installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*).

3-4 Manual Operation. Manually operated window shutters or sprinklers are not recommended. The excessive time needed to close or activate them at the time of a fire incident and the fact that the property exposed may be vacant or uninhabited at the time of the fire incident make their value questionable.

Chapter 4 Application of Means of Protection

4-1 Application. Application of the various means of protection indicated in Chapter 3 will allow a reduction of the separation distances indicated in Table 2-3 and Table 2-4 in accordance with the guidelines listed below:

4-2* Separation Adjustments. *(For SI units: 1 ft = 0.3048 m.)*

Means of Protection	Separation Distance Adjustment

4-2.1 Frame or Combustible Exposed Exterior Walls.

(a) Replace with blank fire-resistive wall (3-hour minimum) .... reduce to 0 ft

(b) Install automatic deluge water curtain over entire wall with no windows or with wired glass windows or with windows closed by ¾-hour protection .... reduce to 5 ft

(c) Install automatic deluge water curtain over entire wall with ordinary glass windows .... reduce 50%

4-2.2 Frame or Combustible Exposed Exterior Wall (I greater than 12.5 kW/m^2) with Openings.

(a) Replace with blank fire-resistive wall (3-hour minimum) .... reduce to 0 ft

(b) Install automatic deluge water curtain over entire wall with no windows or with wired glass windows or with windows closed by ¾-hour protection .... reduce to 5 ft

(c) Install automatic deluge water curtain over entire wall with ordinary glass windows .... reduce 50%

(d) Close all wall openings with material equivalent to wall, or close with ¾-hour protection and eliminate combustible projections that have I less than wall .... reduce to Table 2-3 values

4-2.3 Noncombustible Exposed Exterior Wall (Fire Resistance Less than 3 Hours).

(a) Replace wall with blank fire-resistive wall (3-hour minimum) .... reduce to 0 ft

(b) Close all wall openings with material equivalent to wall, or close with ¾-hour protection and eliminate combustible projections .... reduce 50%

(c) Install automatic deluge water curtain over entire wall with no windows or with wired glass windows or with windows closed by ¾-hour protection .... reduce to 5 ft

(d) Install automatic deluge water curtain on all wall openings equipped with ordinary glass and on combustible projections .... reduce 50%

4-2.4 Veneered Exposed Exterior Wall [Combustible Construction Covered by a Minimum of 4 in. (100 mm) of Masonry].

(a) Replace wall with blank fire-resistive wall (3-hour minimum) .... reduce to 0 ft

(b) Close all wall openings with ¾-hour protection and eliminate combustible projections .... reduce 50%

(c) Close all wall openings with material equivalent to wall construction and eliminate combustible projections .... reduce to 5 ft

(d) Install automatic deluge water curtain over windows equipped with wired glass or over ¾-hour closed openings and on combustible projections .... reduce to 5 ft

(e) Install automatic deluge water curtain over windows equipped with ordinary glass and on combustible projections .... reduce 50%

4-2.5 Fire-Resistive Exposed Exterior Wall (Minimum 3-hour Rating).

(a) Close all openings with material equivalent to wall or protect all wall openings with 3-hour protection .... reduce to 0 ft

(b) Protect all openings with 1½-hour protection .... reduce by 75% (max. req'd. = 10 ft)

(c) Protect all wall openings with ¾-hour protection .... reduce by 50% (max. req'd. = 20 ft)

(d) Install automatic deluge water curtain on all wall openings with wired glass or with ¾- or 1½-hour protection .... reduce to 5 ft

(e) Install automatic deluge water curtain on all wall openings equipped with ordinary glass .... reduce 50%

4-3 Combustible Eaves. Where combustible eaves, cornices, and other exterior ornamentation occur on exposed buildings, they should be treated as unprotected openings. Protection in accordance with Section 4-2 should be provided in these cases.

4-4* Protected Exposing Building. Where the exposing building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, no exposure hazard is considered to exist.

4-5* Protected Exposed Building. Where the exposed building or structure is protected throughout by an approved properly maintained system of automatic sprinklers of adequate design for the hazard involved, the exposure hazard to the total exposed building and its contents is substantially reduced.

Chapter 5 Referenced Publications

5-1 The following documents or portions thereof are referenced within this recommended practice and should be considered part of the recommendations of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

5-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 1991 edition

NFPA 80, *Standard for Fire Doors and Fire Windows,* 1992 edition

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials,* 1990 edition

Appendix A Explanatory Notes

This Appendix is not a part of the recommendations of this NFPA document but is included for information purposes only.

A-1-3 Exposure Severity. For the purpose of this document, exposure severity has been defined as "the intensity of an exposing fire." It is intended to be a measure of radiation level developed per unit window area by the exposing fire. It represents a combination of radiation through the window itself as well as that from the flames that project out the window and up the front of the building. Thus, since radiant transfer from the flames as well as interior room walls is involved, the flame emissivity, dependent on fuel character as well as flame dimensions, may be of great importance.

The emission of flames and hot gases from the window of a room or building compartment during a fire may result from the establishment of a thermal pump. This pump, acting due to buoyancy differences between the hot combustion products and the surrounding outside ambient air, provides a positive means for furnishing fresh air to the fire and discharging of flames and combustion products through the window. If the room involved is provided with only a single window and no internal source of air, this window must serve the dual purpose of a passage for entry of fresh air and the discharge of flames and other hot combustion products. If, however, an internal duct or passage is available for supply of fresh air to the fire room, a much larger fraction of the window may be effectively used for discharge of flaming gases. Winds could also significantly influence the ventilation behavior of a building fire and, thus, the exposure severity.

In addition to ventilation, a number of other system variables influence exposure severity. The most important of these may be:

(a) The combustible load, including both the occupancy and building construction combustibles.

(b) The fuel dispersion or surface-to-volume ratio of the fuel.

(c) The size, geometry, and surface-to-volume ratio of the room involved.

(d) The thermal properties, conductivity, specific heat, and density of the interior finish.

The present state of the art of fire protection engineering is such that it is not possible to define clearly how all or even a few of these variables interact to influence exposure severity. However, this general discussion should provide a feel for trends.

A-2-3 Derivation of Table 2-3. The principles underlying the derivation of the separations listed in Table 2-3 are discussed in detail in "Fire and the Spatial Separation of Buildings" (*Fire Technology,* Vol. 1, No. 4, November 1965, published by NFPA).

The spread of fire from one building to another across a vacant space may be due to convective or radiative heat transfer or flying brands. The hazard created by large flying brands was not considered in these recommendations. Convective heat transfer is also disregarded where the source of hazard is associated with openings in the facade of the exposing building, because ignition by radiation can occur at distances substantially greater than those at which flame impingement and convective heat transfer will usually constitute a hazard. Ignition as a result of radiative heat transfer is thus the event that these recommendations are intended to combat.

The applicable relationship for radiant heat transfer is $I = I_0\phi$, or the Intensity at an exposed building is equal to the unit Intensity at the exposing building multiplied by the configuration factor (ϕ) based on radiator size, geometry, and the spatial distance.

The maximum tolerable level of radiation (I) at the facade of an unprotected exposed building has been taken to be 12.5 kW/m^2/min (0.3 cal/cm^2/sec or 66 Btu/sq ft/min). This value, originally derived from work by the Joint Fire Research Organization in the United Kingdom is now generally accepted as that below which the pilot ignition of most cellulosic materials is not likely to occur. Substantially higher levels of radiation are necessary to cause spontaneous ignition. It was felt that a local high temperature ignition source would usually be present; thus, the selection of pilot ignition was indicated. Where materials are located in an enclosure irradiated through a small opening, appreciably lower levels can cause ignition. This factor has been ignored because irradiation times of more than 30 minutes are usually involved.

Since the origin of Table 2-3, new building materials other than cellulosic (wood) and having greater or lesser ability to resist ignition have been developed. Greater separation distances are needed for materials with greater propensity to ignite. Those offering greater resistance to ignition need lesser distances.

Information on the radiation levels (I_0) near burning buildings was established by a number of case histories and by a series of experimental burns known as the "St. Lawrence Burns." The most important findings of the latter experiments were that radiation levels were related to the percentage of openings in building walls and that combustible interior walls or ceiling linings give rise to particularly high levels of radiation outside the building.

Another noteable conclusion of the St. Lawrence Burns was that maximum radiation levels were not greatly affected by the type of exterior covering. In all the experiments the exterior walls were not near to being penetrated by the fire at the times of these maximum radiation levels.

It was found during the St. Lawrence Burns that the maximum levels of radiation were so high that protection against them would involve unduly large distances of separation. However, much lower levels prevailed for at least the first 20 minutes. It was decided to base separation recommendations on these lower values. It was felt that the likelihood of fire department attendance at an early stage of a fire justified this approach. Subsequently, a field incident has confirmed that the recommended separations cannot be considered universally adequate and that an unusual combination of adverse conditions could permit fire spread even though the indicated separation distances existed.

In calculating the recommended separations, a uniform rectangular radiator has been assumed, the emissive power being taken as proportional to the percentage of window openings. The expression for the configuration factor (ϕ) of a rectangular radiator at an elemental receiving surface (i.e., the ratio of the radiant intensity at the receiver to that at the radiator) is:

$$\phi = \frac{2}{\pi}\left[\frac{X}{\sqrt{X^2+Y^2}}\arctan\left(\frac{Z}{\sqrt{X^2+Y^2}}\right)+\frac{Z}{\sqrt{Y^2+Z^2}}\arctan\left(\frac{X}{\sqrt{Y^2+Z^2}}\right)\right]$$

Where x = half-length of rectangular radiating surface
z = half-height of rectangular radiating surface
y = separation distance between radiator and receiving surface

Three levels of radiation from a burning building were considered: light, moderate, and severe hazard. For light, moderate, and severe hazard levels, configuration factors of 0.14, 0.07, and 0.035, respectively, were adopted.

An additional 5 ft (1.52 m) was added to the computed values of separation distance, partly to account for the horizontal projection for flames from windows and partly to guard against the risk of ignition by direct flame impingement where small separations were involved.

Uniformity of Openings

The derivation of Table 2-3 assumes that openings will be uniformly distributed on the facade considered and that the separation (blank wall) between openings will be small (i.e., no more than a third) compared to the separation between the buildings. Where this is not the case, insufficient spatial separations can be predicted. The following measures will largely remedy this deficiency.

(1) Where an area of the facade considered includes a region of high window density, a separate calculation should be made with respect to the smallest rectangle conveniently including all the windows in this region. In many cases, a single window will constitute this rectangle. The spatial separation chosen for this area should be the largest value of any of the calculations involving the particular windows concerned.

(2) Where the separation (blank wall) between openings is appreciably more than a third of the separation between the buildings (as provisionally estimated) an additional calculation relating to a single window should be made. If a higher building spatial separation results, it is this latter value that should be used.

It is fundamental to the derivation of Table 2-3 that a row of results relating to percentage window openings less than 20 percent (severe hazard), 10 percent (moderate hazard), or 5 percent (light hazard), cannot be validly inserted in the table. Separations less than those given by the first row of the table can, however, often be derived by considering individual windows or groups of windows. The radiation level opposite a particular point on a facade is hardly influenced by radiation from a region of the facade further removed from the point than twice the estimated separation required between buildings. If windows or groups of windows are separated by more than this distance (which is likely if the percentage of openings is small), individual calculations can be validly made. The resulting building separations can then be used even though they need to be lower than those that would be predicted in association with a large area of facade and the smallest percentage opening area given by the table.

A-2-4 Derivation of Table 2-4. The NFPA carried out a search of its photographic records of building fires in which flames penetrated the roof. Of thousands of photographs, 176 showed flames above roofs at what appeared to be maximum or near maximum heights. No great correlation between flame height and occupancy was apparent, and, in fact, the principal relationship was the number of stories involved in the fire. Table A-2-4 provides the average of the flame heights illustrated in some of the records. This table is reproduced from the May 1968 issue of *Fire Journal*.

Table A-2-4

No. of Stories Burning	Flame Height Above Roof
1	1.4 stories
2	1.8 stories
3	2.2 stories
4	2.6 stories
5	2.9 stories
6	3.1 stories

The relationships shown in the table do not agree with those suggested by British and Japanese work from theoretical and experimental considerations, which, in general, would produce much higher values. The NFPA study does indicate that flame heights can be great under unusual circumstances, such as the heavy involvement of liquid fuels. The recommendations listed here are not intended to provide adequate protection under such circumstances.

In the event of a moderate wind, flames can be expected to extend horizontally for as great a distance as they might otherwise extend upwards. It is for this reason that protection is called for if the separation between the two buildings is no more than the height to which the flames might otherwise extend.

A-4-2 Distance Modifications. Varying reductions in separation distance for blank fire-resistive walls with less than 3-hour ratings have not been made, since present test data are insufficient to properly evaluate appropriate reductions. It is hoped that future studies and tests will produce varying reductions with varying resistance ratings. Three-hour fire-resistance rated walls are assumed to be clad with noncombustible material.

A-4-4 Where the exposing building is properly protected by automatic sprinklers, a fire in that building is assumed to be controlled, and exposure, therefore, also is controlled.

A-4-5 Where the exposed building is properly protected by automatic sprinklers, ignition within the exposed building is possible where separation distances are less than recommended or where means of protection are not provided on exposed openings, walls, or projections with lesser separation distances. Such an ignition, however, is assumed to be controlled by sprinklers in the exposed structures.

Where water curtain protection is provided for exposed openings in sprinklered buildings, as recommended in Section 4-2, such sprinklers could be located on the inside of the building adjacent to the opening being protected and in a position where the sprinkler can "see" the exposing fire. Under these conditions, such sprinklers could be closed type supplied by the wet pipe system within the building. Their water demand, however, should be calculated in addition to or separate from the demand of the remainder of the system.

Appendix B

This Appendix is not part of the recommendations of this NFPA document but is included for information purposes only.

Example of Use of NFPA 80A

Construction:

Walls: North — 4-hour openings as illustrated
South — 4-hour openings as illustrated
East — 4-hour openings as illustrated
West — Nonrated wall

Floors: Reinforced concrete — 3 hours
Floor openings: 2-hour enclosures
Roof: 2 hours
Interior finish: Noncombustible, except ceiling of office 100 flamespread

Occupancy:

Second floor: Office
First floor: Receiving and shipping
Manufacturing — electronic parts
Warehouse — palletized storage to 26 ft (7.9 m) height

Analysis of Exposure:

North: Width of exposing fire (w) — 75 ft (22.9 m) (The blank wall casts no exposure, and the wall is of sufficient fire resistance to contain the expected fire.)
Height of exposing fire (h) — 15 ft (4.6 m). [The floor is of sufficient fire resistance to contain the expected fire, and openings are protected. If openings in the floor were unprotected, h would be 30 ft (9.1 m).]
Severity [from Table 2-2.4(a) and 2-2.4(b)]
Office fire loading — light
Average interior finish — moderate
Shipping and receiving fire loading — moderate, interior finish, light
Severity is classed as moderate
w/h or h/w — 75 ft/15 ft (22.9 m/4.6 m) = 5
Percent openings — 30 percent
Guide number (from Table 2-3) — 1.85
Separation distance 1.85 × 15 (4.6) + 5 (1.52) = 28 (8.5) + 5 (1.52) = 33 ft (10 m)

South: Exposure hazard from the two-story section of the building would be the same as the north wall. The one-story section must then be calculated.
Width of exposing fire (w) — 125 ft (38 m)
Height of exposing fire (h) — 15 ft (4.6 m)
Severity [from Tables 2-2.4(a) and 2-2.4(b)]
Fire loading — moderate
Interior finish — light
Severity — moderate
w/h or h/w — 125/15 (38 m/4.6 m) = 8
Percent openings — 20 percent
Guide number (from Table 2-3) — 1.32
Separation distance 1.32 × 15 (4.6) + 5 (1.52) = 20 (6.1) + 5 (1.52) = 25 ft (7.6 m)
Separation distance from south wall should therefore be 33 ft (10 m). (The required separation distance from the two-story section, which is calculated as greater than that from the one-story section.)

East: Width (w) — 200 ft (61 m)
Height (h) — 15 ft (4.6 m)
Severity — moderate
w/h or h/w — 200/15 (61 m/4.6 m) = 13
Percent openings — 80 percent
Guide number — 5.01
Separation distance — 5.01 × 15 (4.6) + 5 (1.52) = 75 (22.9) + 5 (1.52) = 80 ft (24.4 m)

West: Manufacturing area
Width (w) — 100 ft (30.5 m)
Height (h) — 15 ft (4.6 m)
Severity — moderate
w/h or h/w — 100/15 (30.5 m/4.6 m) = 6.6

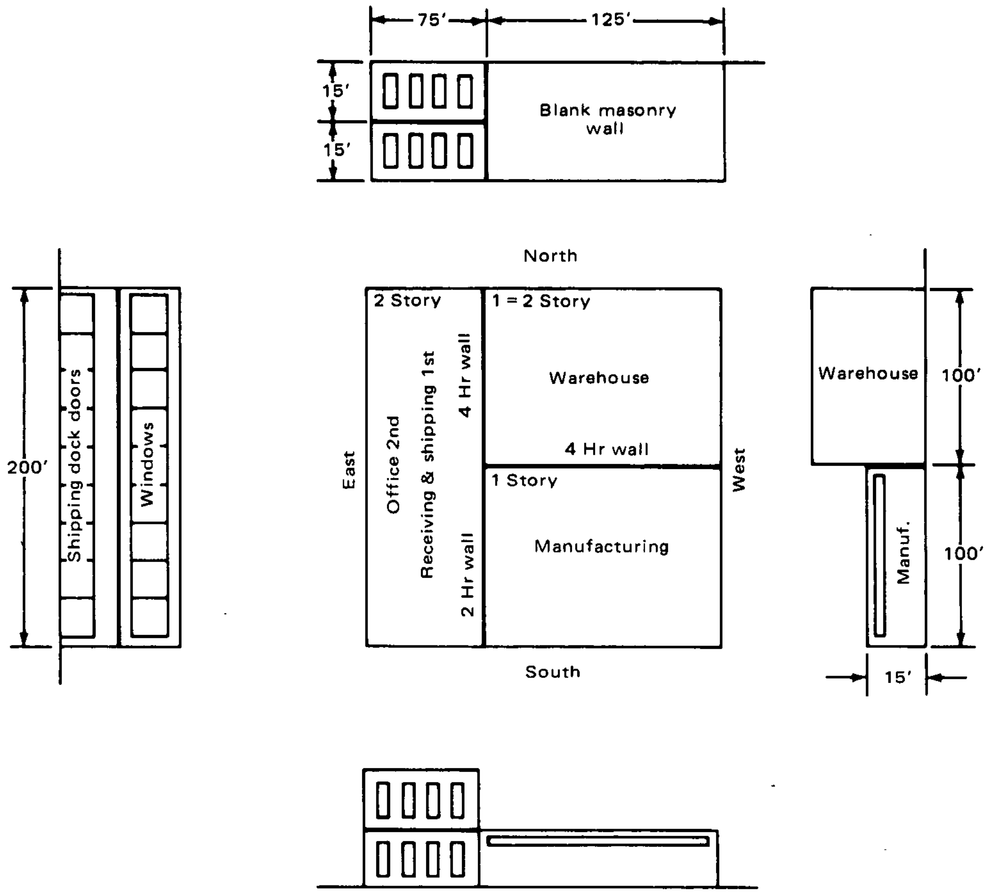

Figure B-1 Illustration for example of use of NFPA 80A.

Percent openings — 100 percent (nonrated wall)
Guide number — 4.74
Separation distance — 4.74 × 15 (4.6 m) + 5 (1.52) = 71 (21.6) + 5 (1.52) = 76 ft (23.2 m)
Warehouse
Width (w) — 100 ft (30.5 m)
Height (h) — 30 ft (9.1 m)
Severity — fire loading — severe
Interior finish — light
Severity — severe
w/h or h/w — 100/30 (30.5/9.1) = 3.3
Percent openings — 100 percent
Guide number — 5.19
Separation distance — 5.19 × 30 (9.1) + 5 (1.52) = 156 (47.5) + 5 (1.52) = 161 ft (49.1 m)

Appendix C Referenced Publications

C-1 The following documents or portions thereof are referenced within this recommended practice for informational purposes only and thus are not considered part of the recommendations of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

C-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

Los Angeles Fire Department, *Operation School Burning No. 2*, 1961

Fire Protection Handbook, 17th ed., 1991

Moysey, E. B., Space Separation for Prevention of Farm Fire Spread, *Fire Technology*, Vol. 1, No. 1, Feb. 1965, pp. 62-68

Moysey, E. B. and Muir, W. E., Pilot Ignition of Building Materials by Radiation, *Fire Technology*, Vol. 4, No. 1, Feb. 1968, pp. 46-50

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C-1.2.2 Journal Articles.

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Lawson, D. I., Ignition of Wood by Radiation, *British Journal of Applied Physics*, Vol. 3, No. 9, Sept. 1952, pp. 288-292

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C-1.2.4 Reports.

Browne, F. L., Theories of the Combustion of Wood and Its Control, Report No. 2136, Dec. 1958, Forest Products Laboratory, U.S. Department of Agriculture, Madison, WI

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