

**First Revision No. 6-NFPA 555-2014 [ Section No. 2.2 ]****2.2 NFPA Publications.**

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, ~~2011~~ 2015 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, ~~2013~~ 2016 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, ~~2013~~ 2016 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, ~~2013~~ 2016 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, ~~2012~~ 2017 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, ~~2011~~ 2016 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, ~~2009~~ 2013 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*, ~~2009~~ 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, ~~2011~~ 2017 edition.

NFPA 92, *Standard for Smoke Control Systems*, ~~2012~~ 2015 edition.

NFPA 204, *Standard for Smoke and Heat Venting*, ~~2012~~ 2015 edition.

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*, ~~2011~~ 2015 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, ~~2011~~ 2015 edition.

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, ~~2009~~ 2013 edition.

NFPA 556, *Guide on Methods for Evaluating Fire Hazard to Occupants of Passenger Road Vehicles*, ~~2011~~ 2016 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, ~~2010~~ 2015 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, ~~2012~~ 2015 edition.

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**Committee Statement**

**Committee Statement:** Reference update.  
**Response Message:**

**First Revision No. 3-NFPA 555-2014 [ Section No. 2.3.1 ]****2.3.1 ASTM Publications.**

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

*ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials, 2012a.*

ASTM E603, *Standard Guide for Room Fire Experiments, 2007 2013* .

ASTM E1321, *Standard Test Method for Determining Material Ignition and Flame Spread Properties, 2009 2013* .

ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter, 2001a 2014* .

ASTM E1474, *Standard Test Method for Determining the Heat Release Rate of Upholstered Furniture and Mattress Components or Composites Using a Bench Scale Oxygen Consumption Calorimeter, 2010 2014* .

ASTM E1537, *Standard Test Method for Fire Testing of Upholstered Furniture, 2007 2013* .

ASTM E1590, *Standard Test Method for Fire Testing of Mattresses, 2007 2013* .

ASTM E1740, *Standard Test Method for Determining the Heat Release Rate and Other Fire-Test-Response Characteristics of Wall Covering or Ceiling Covering Composites Using a Cone Calorimeter, 2010*.

ASTM E1822, *Standard Test Method for Fire Testing of Stacked Chairs, 2009 2013* .

ASTM E2061, *Guide for Fire Hazard Assessment of Rail Transportation Vehicles, 2009a 2012* .

ASTM E2067, *Standard Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests, 2008 2012* .

ASTM E2257, *Standard Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies, 2008 2013a* .

ASTM E2280, *Standard Guide for the Fire Hazard Assessment of the Effect of Upholstered Seating Furniture Within Patient Rooms of Health Care Facilities, 2009 2013* .

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[Public Input No. 6-NFPA 555-2014 \[Chapter 2\]](#)

[Public Input No. 2-NFPA 555-2014 \[Section No. 2.3.1\]](#)

[Public Input No. 9-NFPA 555-2014 \[Section No. 2.3.1\]](#)

**First Revision No. 10-NFPA 555-2014 [ Section No. 2.4 ]**

**2.4** References for Extracts in Advisory Sections.  
NFPA 101<sup>®</sup>, *Life Safety Code*<sup>®</sup>, ~~2012~~ 2015 edition.

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**First Revision No. 9-NFPA 555-2014 [ Section No. 3.3.4 ]****3.3.4\*** Interior Finish.

The exposed surfaces of walls, ceilings, and floors within buildings.  
[~~101,2012~~ 2015]

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## First Revision No. 1-NFPA 555-2014 [ Section No. 9.3 ]

### 9.3 Full-Compartment Fire Tests.

#### 9.3.1

Ideally, the heat release rate from the combination of contents, furnishings, and interior finishes contained in a compartment is obtained by carrying out a full compartment fire test, wherein each major combustible item, product, or fuel package is included, replicating as much as possible the locations where the items are to be placed in the compartment under investigation. ASTM E603, *Standard Guide for Room Fire Experiments*, provides proper guidance for the various choices that should be made. These include information on operator safety and on the most appropriate experimental techniques for various measurements. This approach is best suited for cases where multiple compartments with very similar contents and distributions are to be constructed. ASTM E2067, *Standard Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests*, describes the methods to construct, calibrate, and use full-scale oxygen consumption calorimeters to help minimize testing result discrepancies between laboratories. The ASTM E2067 practice goes beyond standardized test methods in discussing the conduction of different types of tests, including some in which the objective is to assess comparatively the fire performance of products releasing low amounts of heat or smoke and some in which the objective is to assess whether flashover will occur. It also describes the equations required for calculations of heat and smoke release.

#### 9.3.2

One of the most important issues that needs to be addressed by the designer of a full-scale test is the selection of an ignition source.

##### 9.3.2.1

If the only objective is to ensure that flashover cannot occur with the existing combustible contents, the size of the ignition source used is of little importance as long as it is not large enough to cause flashover on its own. An initial test should be carried out, with the ignition source as the only item present, to confirm that flashover does not occur in the absence of other combustible items. The objective of this test is extremely limited.

##### 9.3.2.2

If the experiment is being carried out to determine the fire hazard inherent in the compartment being considered, the choices of ignition source and its location are crucial to the results of the test. They should be chosen to represent a realistic fire source in the occupancy under investigation.

##### 9.3.2.3

If the experiment is being carried out in order to make a decision between various types of items or fuel packages of a particular type (e.g., an upholstered chair or a mattress), the ignition source should be sufficiently large to be a realistic fire source but small enough so that total consumption of the item is not inevitable. Therefore, the ignition source for such a full-scale test should not be so large as to overwhelm the product, irrespective of its fire performance.

#### 9.3.3

Disadvantages to carrying out full compartment fire tests include the following:

- (1) They are costly, both in terms of actual expense and in terms of preparation.
- (2) They are less susceptible to generalization, because small differences in item or fuel package location can have major effects on fire performance.
- (3) They cannot easily identify the effects of individual items or fuel packages on the overall fire performance of the whole compartment.

#### 9.3.4

The ultimate objective of the tests should be to determine whether the compartment, as configured, is expected to reach flashover. If flashover is not reached, the results can be used for comparisons between items or products with similar functions but differing construction or materials. Results from tests that do not reach flashover should be compared with the calculated heat release rates necessary for flashover or the upper gas layer temperatures necessary for flashover. The potential for flashover should be assessed in light of the reproducibility of test results and the impact of test result variability on achieving flashover conditions.

#### 9.3.5

The concept of the typical heat release curve for residential fires is based on work of Simon Ingberg of the National Bureau of Standards. He published a paper in 1928 on the severity of fire in which he equated the gross combustible fuel load (combustible content in mass per unit area) to the potential fire exposure in terms of duration of exposure to a fire following the standard (ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*) time-temperature curve for fire resistance tests. This means that Ingberg demonstrated that the standard ASTM E119 fire curve was representative of the typical severity of the fires associated with combustible contents present in buildings in the 1920s (i.e., their fire load). More recent studies, (e.g., by UL) where full scale experiments were conducted to examine the changes in fire development in a modern room's contents versus contents that might have been found in a mid-20th century house (legacy rooms). The modern rooms utilized synthetic contents that were readily available new at various retail outlets, and the legacy rooms utilized contents that were purchased used from a number of second-hand outlets. The rooms measured 12 by 12 ft with an 8 ft ceiling and an 8 ft wide by 7 ft tall opening on the front wall. Both rooms contained similar types and amounts of like furnishings. Both rooms were ignited by placing a lit candle on the right side of the sofa and allowed to go to flashover and maintain flashover for a period of time before being extinguished. The fire in the modern room transitioned to flashover in 3 minutes and 30 seconds; the fire in the legacy room did the same (with a slightly lower peak temperature) after 29 minutes and 30 seconds. It is clear that modern rooms result in hotter fires that go to flashover faster, so that the time temperature curve of the ASTM E119 fire test (which is based on the fire growth in legacy rooms) is less likely to be representative of the actual fire hazard. Therefore, protection required in the 21st century must be at least as high as that required in the 1970s. This might need to be taken into account when assessing heat release for flashover.

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### Committee Statement

**Committee Statement:** This brings into NFPA 555 some added information resulting from recent studies.  
**Response Message:**



[Public Input No. 8-NFPA 555-2014 \[Section No. 9.3\]](#)



## First Revision No. 2-NFPA 555-2014 [ Section No. 9.4.6.4 ]

### 9.4.6.4 Furniture Calorimeter Tests.

Furniture calorimeter test methods are useful techniques to assess the heat release and other fire properties of individual fuel packages. UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, is intended to assess the heat release and rate of fire development of products containing foamed plastics to be used for displays, stage settings, and other decorative applications. It uses a 340 g wood crib as the ignition source. More recently, NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, was developed as a furniture calorimeter test, which uses several gas burner ignition sources at incident gas levels of 20 kW, 40 kW, 70 kW, 100 kW, 160 kW, and 300 kW, to expose individual fuel packages.

#### 9.4.6.4.1

Furniture calorimeter test methods are useful techniques to assess the heat release and other fire properties of individual fuel packages. Such tests consist of an ignition source that exposes a product or an individual fuel package, with the ignition source and the item to be exposed placed on a load cell and under a hood.

#### 9.4.6.4.2

UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, ~~is intended~~ was developed with the intent to assess the heat release and rate of fire development of products containing foamed plastics to be used for displays, stage settings, and other decorative applications. It uses a ~~340 g~~ 12 oz (340 g) wood crib as the ignition source. It is being used in codes for other products, usually ones containing foam plastics, including signs and components of children's playgrounds.

#### 9.4.6.4.3

More recently, NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, was developed as a generic furniture calorimeter test, which uses several gas burner ignition sources at incident gas levels of 20 kW, 40 kW, 70 kW, 100 kW, 160 kW, and 300 kW, to expose individual fuel packages. It is normally used in codes at the incident gas level of 20 kW, typically for decorative materials (such as artificial vegetation, including Christmas trees) and as a potential replacement for UL 1975. NFPA 289 can also be used at other incident gas levels when intended for research, such as the assessment of probability of flashover.

#### 9.4.6.4.4

In spite of the name, furniture calorimeter tests are not limited to exposing furniture. However, standard tests intended to assess the fire performance of upholstered furniture and mattresses, such as ASTM E1537, *Standard Test Method for Fire Testing of Upholstered Furniture* and ASTM E1590, *Standard Test Method for Fire Testing of Mattresses*, can be conducted in both a room and as furniture calorimeter tests.

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### Committee Statement

**Committee Statement:** Updates section and adds additional references and guidance on furniture calorimeter tests.

**Response Message:**

[Public Input No. 4-NFPA 555-2014 \[Section No. 9.4.6.4\]](#)



## First Revision No. 7-NFPA 555-2014 [ Section No. 10.3.4.1 ]

### 10.3.4.1

The radiator is described as a cylinder with a radius determined by the size of the base of the fuel package. The height of the radiator is determined by a flame height correlation. Table 10.3.4.1 shows the flame height expressions used in the two models. The emissive powers used in the two models are given in Table 10.3.4.1 and are illustrated in Figure 10.3.4.1(a) and Figure 10.3.4.1(b). The radiant flux to

the target from the fuel package,  $\dot{q}_{r,fp}''$ , is determined by the following equation:

$$\dot{q}_{r,fp}'' = F_{fp-dt} E \quad \text{[10.3.4.1]}$$

where:

$F_{fp-dt}$  = configuration factor between the cylindrical radiator (fuel package)

$E$  = emissive power of the radiator

Table 10.3.4.1 Flame Height and Emissive Power

Expression	Model 1*	Model 2†
Flame height	$H = 420 \left( \frac{\dot{Q}}{\rho_a \Delta H_c \sqrt{gD}} \right)$	$H = 0.23\dot{Q}^{2/5} - 1.02D$ [m,kW]
Emissive power	$E = 140(e^{-0.12d/D}) + 20(1 - e^{-0.12d/D})$	$E = 58(10^{-0.00823d/D})$

$H$  = flame height (m);  $\dot{Q}$  = heat release rate (kW);  $\rho_a$  = density of air (kg/m<sup>3</sup>);  $\Delta H_c$  = heat of combustion (kJ/kg);  $g$  = gravitational constant (9.81 m/sec<sup>2</sup>);  $D$  = the diameter of the fire (m);  $E$  = emissive power of the radiator (kW/m<sup>2</sup>);  $d$  = distance between objects (m).

\*Mudan and Croce, 1988.

†Shokri and Beyler, 1989.

**Figure 10.3.4.1(a) Configuration Factor for a Vertical Target and a Vertical Cylindrical Radiator.**

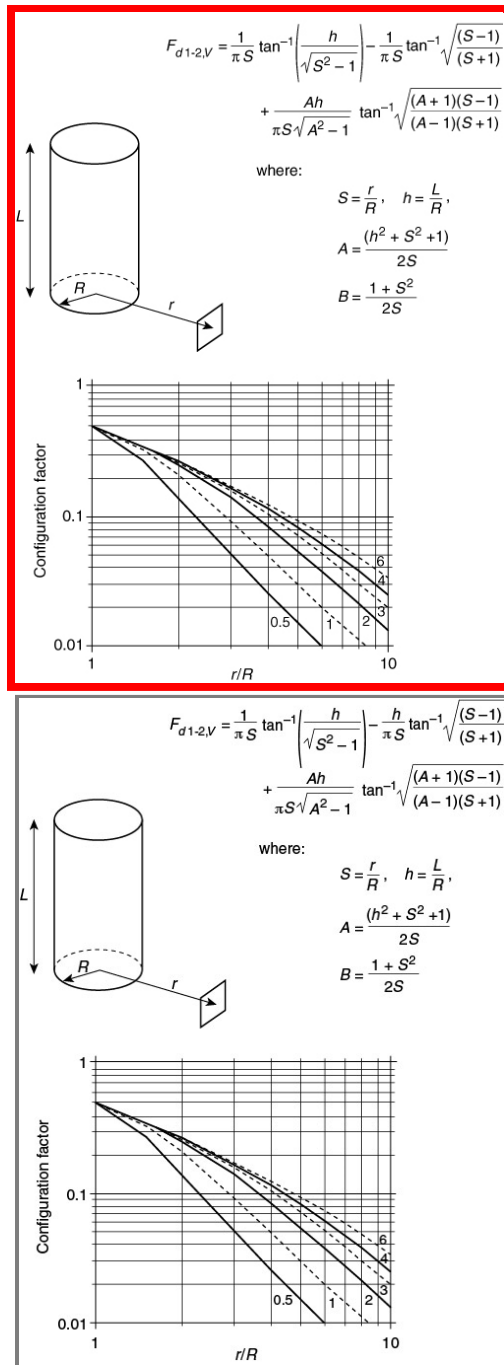
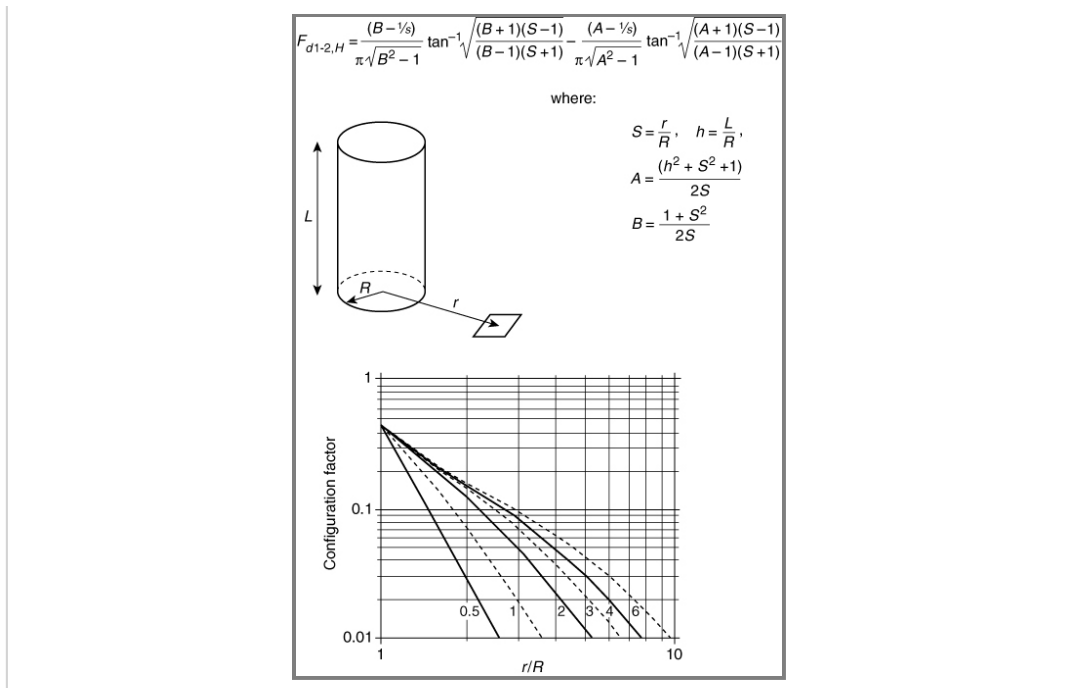


Figure 10.3.4.1(b) Configuration Factor for a Horizontal Target and a Vertical Cylindrical Radiator.



## Supplemental Information

<u>File Name</u>	<u>Description</u>
Figure_10.3.4.1_a_.pdf	
G555-4r1.jpg	Figure 10.4.1(a)-revised

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## Committee Statement

**Committee Statement:** Both equations for the Emissive Power in table 10.3.4.1 Flame Height and Emissive Power are incorrect. The Emissive Power equations are based on the effective pool diameter. Both of these equations use 'd', which stated below the table is the 'distance between objects'. Both of these equations can be seen in the SFPE Handbook of Fire Protection Engineering under Fire Hazard Calculations for Large, Open Hydrocarbon Fires. The equation for the Configuration Factor from a cylinder to a vertical surface is also incorrect. As can be seen in the attached PDF, and 'h' is missing in the equation.

**Response Message:**

[Public Input No. 1-NFPA 555-2013 \[Section No. 10.3.4.1\]](#)

CHANGE TO 'h'

$$F_{d1-2V} = \frac{1}{\pi S} \tan^{-1} \left( \frac{h}{\sqrt{S^2 - 1}} \right) - \frac{1}{\pi S} \tan^{-1} \sqrt{\frac{S-1}{S+1}}$$

Click on image to open

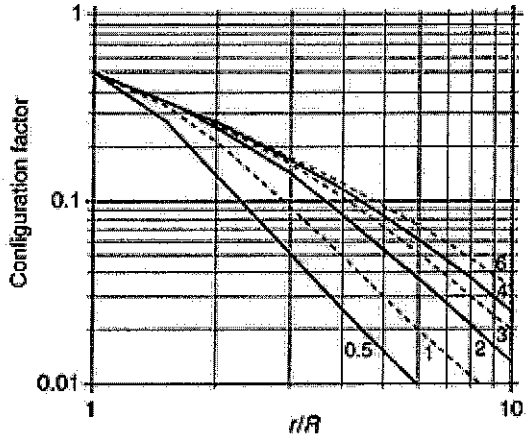
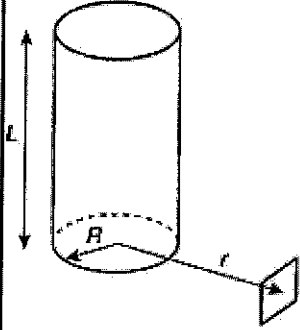
$$+ \frac{Ah}{\pi S \sqrt{A^2 - 1}} \tan^{-1} \sqrt{\frac{(A+1)(S-1)}{(A-1)(S+1)}}$$

where:

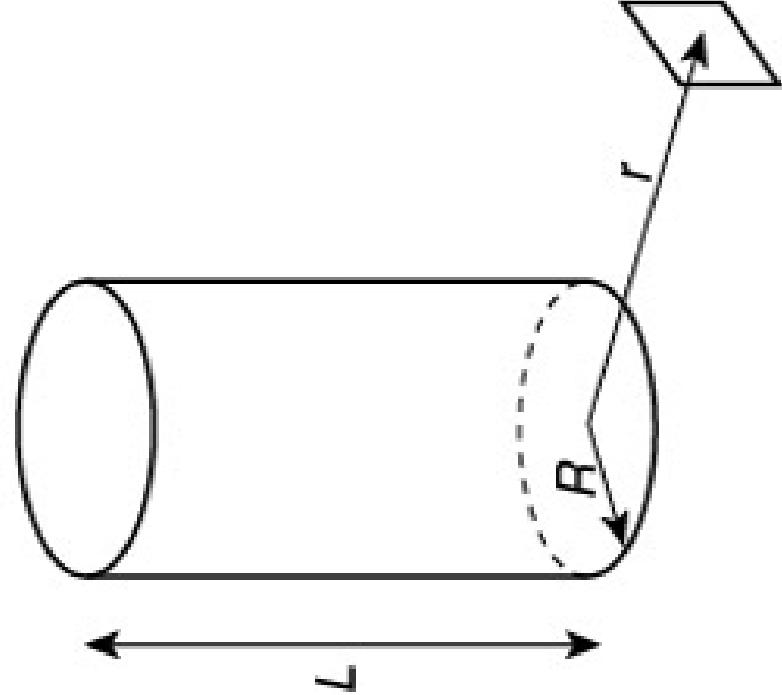
$$S = \frac{r}{R}, \quad h = \frac{L}{R}$$

$$A = \frac{(h^2 + S^2 + 1)}{2S}$$

$$B = \frac{1 + S^2}{2S}$$



$$F_{d1-2,V} = \frac{1}{\pi S} \tan^{-1} \left( \frac{W}{\sqrt{S^2 - 1}} \right) - \frac{W}{\pi S} \tan^{-1} \sqrt{\frac{S-1}{S+1}} + \frac{Ah}{\pi S \sqrt{A^2 - 1}} \tan^{-1} \sqrt{\frac{(A+1)(S-1)}{(A-1)(S+1)}}$$

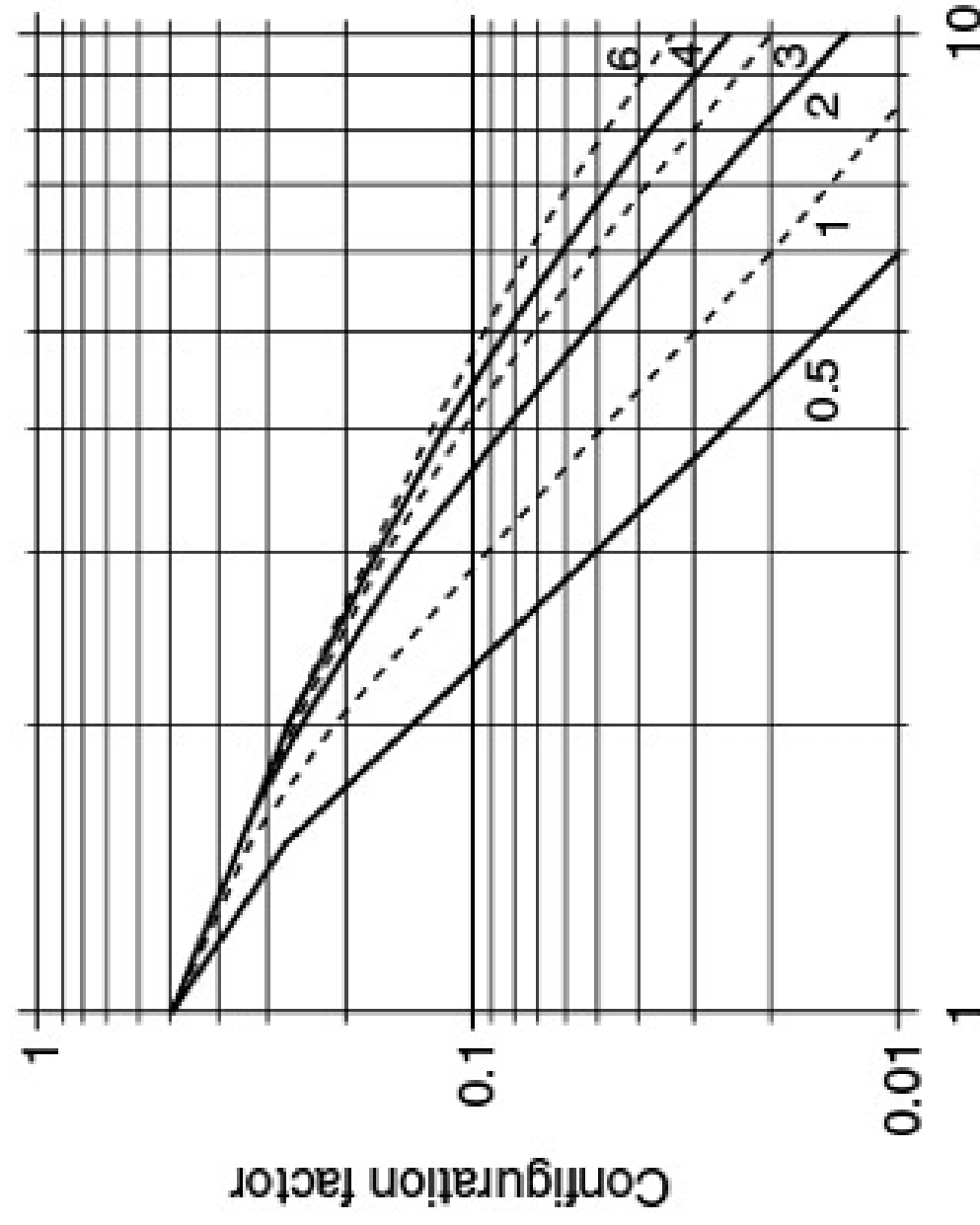


where:

$$S = \frac{r}{R}, \quad h = \frac{L}{R},$$

$$A = \frac{(h^2 + S^2 + 1)}{2S}$$

$$B = \frac{1 + S^2}{2S}$$





**First Revision No. 8-NFPA 555-2014 [ Section No. C.1.1 ]****C.1.1 NFPA Publications.**

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, ~~2012~~ 2015 edition.

NFPA 92, *Standard for Smoke Control Systems*, ~~2012~~ 2015 edition.

NFPA 101<sup>®</sup>, *Life Safety Code*<sup>®</sup>, ~~2012~~ 2015 edition.

NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*, ~~2010~~ 2017 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, ~~2011~~ 2015 edition.

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*, ~~2011~~ 2015 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, ~~2011~~ 2015 edition.

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, ~~2009~~ 2013 edition.

NFPA 301, *Code for Safety to Life from Fire on Merchant Vessels*, 2013 edition.

NFPA 556, *Guide on Methods for Evaluating Fire Hazard to Occupants of Passenger Road Vehicles*, ~~2011~~ 2016 edition.

NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*, ~~2010~~ 2013 edition.

NFPA 914, *Code for Fire Protection of Historic Structures*, ~~2010~~ 2015 edition.

NFPA 5000<sup>®</sup>, *Building Construction and Safety Code*<sup>®</sup>, ~~2012~~ 2015 edition.

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**First Revision No. 4-NFPA 555-2014 [ Section No. C.1.2.1 ]****C.1.2.1** ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, ~~2010b~~ 2014 .

ASTM E648, *Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source*, ~~2010~~ 2014c .

ASTM E906/E906M, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products*, ~~2010~~ 2014 .

ASTM E1321, *Standard Test Method for Determining Material Ignition and Flame Spread Properties*, ~~2009~~ 2013 .

ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, ~~2011a~~ 2014 .

ASTM E1474, *Standard Test Method for Determining the Heat Release Rate of Upholstered Furniture and Mattress Components or Composites Using a Bench Scale Oxygen Consumption Calorimeter*, ~~2010~~ 2014 .

ASTM E1537, *Standard Test Method for Fire Testing of Real Scale Upholstered Furniture*, ~~2007~~ 2013 .

ASTM E1590, *Standard Test Method for Fire Testing of Mattresses*, ~~2007~~ 2013 .

ASTM E1822, *Standard Test Method for Fire Testing of Stacked Chairs*, ~~2009~~ 2013 .

ASTM E2061, *Guide for Fire Hazard Assessment of Rail Transportation Vehicles*, ~~2009a~~ 2013 .

ASTM E2257, *Standard Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies*, ~~2008~~ 2013a .

ASTM F1550, *Standard Test Method for Determination of Fire-Test-Response Characteristics of Components or Composites of Mattresses or Furniture for Use in Correctional Facilities after Exposure to Vandalism, by Employing a Bench Scale Oxygen Consumption Calorimeter*, 2010.

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[Public Input No. 7-NFPA 555-2014 \[Chapter C\]](#)

[Public Input No. 3-NFPA 555-2014 \[Section No. C.1.2.1\]](#)



## First Revision No. 5-NFPA 555-2014 [ Section No. C.2 ]

### C.2 Informational References.

The following documents or portions thereof are listed here as informational resources only. They are not directly referenced in this guide.

ASTM D6113, *Standard Test Method for Using a Cone Calorimeter to Determine Fire-Test Response Characteristics of Insulating Materials Contained in Electrical or Optical Fiber Cables*, 2010 2011 .

ASTM E1623, *Standard Test Method for Determination of Fire and Thermal Parameters of Materials, Products, and Systems Using an Intermediate Scale Calorimeter (ICAL)*, 2009.

Janssens, M., "Room Fire Models, General," *Heat Release in Fires*, Babrauskas, V., and Grayson, S. J. (eds.), Elsevier, London, pp. 113–158, 1992.

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### Committee Statement and Meeting Notes

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