

**Report of the Committee on
Fire Tests**

William E. Fitch, Chair
Omega Point Laboratories Inc., TX [RT]

Jesse J. Beitel, Hughes Associates, Inc., MD [SE]
April L. Berkol, Starwood Hotels & Resorts Worldwide, Inc., NY [U]
 Rep. American Hotel & Lodging Association
Robert G. Bill, Jr., FM Global, MA [I]
John A. Blair, The Dupont Company, DE [M]
 Rep. Society of the Plastics Industry Inc.
Gordon H. Damant, Inter-City Testing & Consulting Corp. of California, CA [SE]
Thomas W. Fritz, Armstrong World Industries, Inc., PA [M]
Pravinray D. Gandhi, Underwriters Laboratories Inc., IL [RT]
James R. Griffith, Southwest Research Institute, TX [RT]
Gordon E. Hartzell, Hartzell Consulting, Inc., TX [SE]
Marcelo M. Hirschler, GBH International, CA [SE]
Alfred J. Hogan, Reedy Creek Improvement District, FL [E]
 Rep. International Fire Marshals Association
William E. Koffel, Koffel Associates, Inc., MD [SE]
James R. Lawson, National Institute of Standards & Technology, MD [RT]
Rodney A. McPhee, Canadian Wood Council, Canada [M]
Frederick W. Mowrer, University of Maryland, MD [SE]
David T. Sheppard, US Department of Justice, MD [RT]
 Rep. American Forest & Paper Association
Kuma Sumathipala, American Forest & Paper Association, DC [M]
T. Hugh Talley, Hugh Talley Company, TN [M]
 Rep. Upholstered Furniture Action Council
Rick Thornberry, The Code Consortium, Inc., CA [SE]
Robert A. Wessel, Gypsum Association, DC [M]
Robert J. Wills, American Iron and Steel Institute, AL [M]
Peter J. Willse, GE Global Asset Protection Services, CT [I]

Alternates

Robert M. Berhing, Underwriters Laboratories Inc., IL [RT]
 (Alt. to Pravinray D. Gandhi)
Delbert F. Boring, Jr., American Iron and Steel Institute, OH [M]
 (Alt. to Robert J. Wills)
Richard J. Davis, FM Global, MA [I]
 (Alt. to Robert G. Bill)
Sam W. Francis, American Forest & Paper Association, PA [M]
 (Alt. to Kuma Sumathipala)
Richard G. Gann, US National Institute of Standards & Technology, MD [RT]
 (Alt. to James R. Lawson)
Paul A. Hough, Armstrong World Industries, Inc., PA [M]
 (Alt. to Thomas W. Fritz)
James K. Lathrop, Koffel Associates, Inc., CT [SE]
 (Alt. to William E. Koffel)
James A. Milke, University of Maryland, MD [SE]
 (Alt. to Frederick W. Mowrer)
Arthur J. Parker, Hughes Associates, Inc., MD [SE]
 (Alt. to Jesse J. Beitel)
Ronald A. Schulz, GE Global Asset Protection Services, MI [I]
 (Alt. to Peter J. Willse)
Ineke Van Zeeland, Canadian Wood Council, Canada [M]
 (Alt. to Rodney A. McPhee)
Joe Ziolkowski, American Furniture Manufacturers Association, NC [M]
 (Alt. to T. Hugh Talley)

Nonvoting

Tod L. Jilg, Hoechst Celanese Corporation, NC [M]
 Rep. American Fiber Manufacturers Association
Rohit Khanna, US Consumer Product Safety Commission, MD [C]
Robert H. Barker, American Fiber Manufacturers Association, VA [M]
 (Voting Alt. to Nonvoting Principle)

Staff Liaison: **Milosh T. Puchovsky**

Committee Scope: This Committee shall have primary responsibility for documents on fire testing procedures, for reviewing existing fire test standards and recommending appropriate action to NFPA, for recommending the application of and advising on the interpretation of acceptable test standards for fire problems of concern to NFPA technical committees and members, and for acting in a liaison capacity between NFPA and the committees of other organizations writing fire test standards. This Committee does not cover fire tests that are used to evaluate extinguishing agents, devices, or systems.

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. A key to classifications is found at the front of this book.

The Technical Committee on **Fire Tests** is presenting five Reports for adoption, as follows:

Report I: The Technical Committee proposes for adoption, a complete revision to NFPA 251, **Standard Methods of Tests of Fire Endurance of Building Construction and Materials**, 1999 edition. NFPA 251 is published in Volume 7 of the 2003 National Fire Codes and in separate pamphlet form.

NFPA 251 has been submitted to letter ballot of the **Technical Committee on Fire Tests**, which consists of 23 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

Report II: The Technical Committee proposes for adoption, a complete revision to NFPA 253, **Standard Methods of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source**, 2000 edition. NFPA 253 is published in Volume 7 of the 2003 National Fire Codes and in separate pamphlet form.

NFPA 253 has been submitted to letter ballot of the **Technical Committee on Fire Tests**, which consists of 23 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

Report III: The Technical Committee proposes for adoption, a complete revision to NFPA 255, **Standard Method of Test of Surface Burning Characteristics of Building Materials**, 2000 edition. NFPA 255 is published in Volume 7 of the 2003 National Fire Codes and in separate pamphlet form.

NFPA 255 has been submitted to letter ballot of the **Technical Committee on Fire Tests**, which consists of 23 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

Report IV: The Technical Committee proposes for adoption, a complete revision to NFPA 285, **Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components Using the Intermediate-Scale, Multistory Test Apparatus**, 1998 edition. NFPA 285 is published in Volume 7 of the 2003 National Fire Codes and in separate pamphlet form.

NFPA 285 has been submitted to letter ballot of the **Technical Committee on Fire Tests**, which consists of 23 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

Report V: The Technical Committee proposes for adoption, a complete revision to NFPA 286, **Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth**, 2000 edition. NFPA 286 is published in Volume 7 of the 2003 National Fire Codes and in separate pamphlet form.

NFPA 286 has been submitted to letter ballot of the **Technical Committee on Fire Tests**, which consists of 23 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

Note: To assist in review and comment, a draft of NFPA 251 is available and downloadable from the NFPA website at www.nfpa.org. It is also in CD ROM and print versions available from NFPA upon request by calling Customer Service at 1-800-344-3555.

251-1 Log# CP1 FIZ-AAA **Final Action: Accept**
(Entire Document (MOS))

Submitter : Technical Committee on Fire Tests

Recommendation: Completely revise entire document to comply with the NFPA Manual of Style as follows:

1. Revise Chapter 1 to contain administrative text only as follows: (show revised text here or indicate where revised text can be found)
2. Revise Chapter 2 to contain only referenced publications cited in the mandatory portions of the document.
3. Revise Chapter 3 to contain only definitions.
4. Appendices are to be restructured and renamed as “Annexes.”
5. All mandatory sections of the document must be evaluated for usability, adoptability, and enforceability language. Generate necessary committee proposals as shown (or indicate where shown).
6. Reword exceptions as requirements.
7. Single sentences per requirement as shown (or indicate where shown).

A draft of NFPA 251 is on the NFPA website. Additionally, proposals with affirmative actions were incorporated into this complete revision of the document with technical changes indicated in legislative text with the corresponding proposal number noted.

Substantiation: Editorial restructuring, to conform with the 2000 edition of the NFPA Manual of Style.

Committee Meeting Action: Accept

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-2 Log# CP6 FIZ-AAA **Final Action: Accept**
(Entire document)

Submitter : Technical Committee on Fire Tests

Recommendation: 1. Revise the term “classification” to read “fire resistance rating” as indicated in the preprint.

2. Revise the term “fire endurance classifications” to read “fire resistance ratings” as indicated in the preprint.

3. Revise the term “classification period” to read “fire test exposure period” as indicated in the preprint.

Substantiation: These are editorial changes that more accurately reflect the subject matter.

Committee Meeting Action: Accept

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-3 Log# 7 FIZ-AAA **Final Action: Reject**
(Entire Document)

Submitter : Karin Rountree, Roseanne Gullo , Ampco Safety Tools

Recommendation: Add text to read as follows:

Anywhere ignition sources are a concern please include as a requirement: Non-Sparking Tools are required where hazardous, combustible or flammable gases, liquids, dusts, or residues are present.

Substantiation: Ordinary hand tools are usually made of steel and if struck, scraped, or dropped, can cause sparks which can be disastrous in an explosive environment. Non-Sparking Tools eliminate this hazard, however, standards regarding their application are incomplete, inconsistent and in some cases inaccurate.

We feel prevention is one of the most effective means of ensuring safety. If we can prevent an accident and save someone’s life and business, if we can implement standards and codes to educate and inform before an accident happens, then we should make the necessary standards and codes to solve the problem. The standards and recommended practices developed by NFPA are designed to improve overall safety and protection of property and personnel. Implementing a Non-Sparking Tools requirement wherever an ignition source is concern would reduce the risk of fire and explosion where hazardous conditions are present.

Non-Sparking Tools are recommended by Safety Engineers and Insurance Companies and meet OSHA and EPA requirements where hazardous, combustible or flammable gases, liquids, dusts and residues are present. Non-Sparking Tools should be used when storing, processing, handling hazardous materials as well as maintenance and repair operations within hazardous environments. All it takes is just one spark to cause an explosion.

Committee Meeting Action: Reject

Committee Statement: The submitter’s recommendation is not applicable to NFPA 251.

Number Eligible to Vote: 23

Ballot Results: Affirmative: 21 Negative: 1

Ballot Not Returned: 1 GRIFFITH

Explanation of Negative:

SCHULZ: Agree with committee that the proposed wording does not apply to this document.

251-4 Log# 4 FIZ-AAA **Final Action: Accept**
(Title)

Submitter : Marcelo M. Hirschler , GBH International

Recommendation: Revise the title to read as follows:

Standard Methods of Tests of Fire ~~Endurance~~ Resistance of Building Construction and Materials

Substantiation: 1. The term fire resistance is more descriptive of the applicability of this test method than the term fire endurance, and it has been, to a large extent, adopted by most codes and standards documents. This proposal is one of a set designed to change all references to “fire endurance” into references to “fire resistance” and references to “fire endurance classification” into references to “fire resistance rating”.

2. Applicable sections:

“fire endurance”: title, 1.3, 2.3.4 (2 times), 3.2.2, 4.1, 4.1.1, 4.2.1 (2 times), 5.2, 5.3 (2 times), 6.2 (2 times), 7.2.1, 7.2.2 (2 times), 7.3, 8.4, 9.3 (2 times), 10.3, Annex A.2.2, D.11 (2 times), Annex F title, F.1.1, F.1.2, F.1.3, F.2, F.4 (2 times), F.5 (5 times), G.8.1, G.8.3, and G.10.2.

“fire endurance classification”: 4.1.2, 9.1.2, 9.1.3, 9.5 (3 times), 10.1 (2 times), 10.4, 11.1 (2 times), 13.1, 14.1.5, 14.2.1, 14.2.2, Annex E.1, E.1.2, E.1.6 (2 times), G.7.5, G.9, and G.10.4.

3. ASTM E05, committee on Fire Standards, has recently approved a change in the title of its subcommittee E05.11 from Fire Endurance to Fire Resistance.

4. ASTM E05 has also eliminated the definition of fire endurance from its terminology standard E 176, and uses the following two definitions:

- fire resistance, n - the ability of a material, product, or assembly to withstand fire or give protection from it for a period of time. (contrast fire resistance rating)

Discussion: As applied to elements of buildings fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating.

- fire resistance rating, n - a measure of the elapsed time during which a material, product, or assembly continues to exhibit fire resistance under specified exposure conditions. (contrast fire resistance)

Discussion: This term is defined because it is used in codes. As applies to elements of buildings, it is commonly measured by the methods and to the criteria defined in Test Methods E 199 or E 1509.

5. NFPA 251 talks about the property of fire endurance and the result being a fire endurance classification, but does not really define either: it just uses the terms. It also uses the term “fire resistance” as an explanation in the annex several times.

6. NFPA defines fire resistance rating as follows: “Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials. (See NFPA 220, Standard on Types of Building Construction.)”

NFPA 5000 defines the following: “3.3.444.2 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this Code.

7. NFPA does not define “fire endurance” or “fire endurance classification”.

8. NFPA does not define “fire resistance” but defines “fire resistant” in NFPA 495, as “3.3.23* Fire Resistance. Construction designed to provide reasonable protection against fire.” It also defines “Fire-Resistant-Rated Construction. Construction in which the structural members, including walls, partitions, columns, floors, and roof construction, have fire resistance ratings of time duration not less than that specified in this standard.”

9. In NFPA 5000 and in NFPA 101, the term fire endurance does not appear other than as a reference to the title of a document.

10. In NFPA codes and standards the term “fire endurance classification” appears 17 times (15 of them in NFPA 251 and once each in the annexes of NFPA 909 and NFPA 914). On the other hand, the term “fire resistance rating” appears some 700 times in 100 documents, including in such codes as NFPA 5000, NFPA 101, NFPA 1, NFPA 70, NFPA 52, NFPA 54, NFPA 30, and NFPA 30A, NFPA 301 and NFPA 909, and in the construction standards NFPA 220 and NFPA 221. Other standards referencing fire resistance rating include NFPA 13, NFPA 99, NFPA 90A, and NFPA 90B, NFPA 75, and NFPA 230. Most documents state that fire resistance rating is assessed by NFPA 251. Clearly, the NFPA technical committees have chose fire resistance rating of fire endurance classification.

11. Fire comparison purposes, the 2003 edition of the International Code Council set of codes uses the term “fire resistance” a total of 904 times and the term “fire endurance” a total of 16 times, mostly in references to equations and all 16 times in the Chapter 7 of the International Building Code, called “Fire-resistance rated construction”, in Sections 710 (Prescriptive fire resistance and 720 (Calculated Fire Resistance). All those references have been eliminated editorially by ICC staff to be replaced by references to fire resistance.

Committee Meeting Action: Accept

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-5 Log# 9 FIZ-AAA

Final Action: Accept

(Title)

Submitter : Marcelo M. Hirschler , GBH International

Recommendation: Revise text to read as follows:

Standard Methods of Tests of Fire Endurance Resistance of Building Construction and Materials

Substantiation: * The term fire resistance is more descriptive of the applicability of this test method than the term fire endurance, and it has been, to a large extent, adopted by most codes and standards documents. This proposal is one of a set designed to change all references to “fire endurance” into references to “fire resistance” and references to “fire endurance classification” into references to “fire resistance rating”.

* Applicable sections:

“fire endurance”: title, 1.3, 2.3.4 (2 times), 3.2.2, 4.1, 4.1.1, 4.2.1 (2 times), 5.2, 5.3 (2 times), 6.2 (2 times), 7.2.1, 7.2.2 (2 times), 7.3, 8.4, 9.3 (2 times), 10.3, Appendix A2.2, D11 (2 times), Appendix F title, F1.1, F1.2, F1.3, F2, F4 (2 times), F5 (5 times), G8.1, G8.3, and G10.2

“fire endurance classification”: 4.1.2, 9.1.2, 9.1.3, 9.5 (3 times), 10.1 (2 times), 10.4, 11.1 (2 times), 13.1, 14.1.5, 14.2.1, 14.2.2, Appendix E1, E1.2, E1.6 (2 times), G7.5, G9, and G10.4

* ASTM E05, committee on Fire Standards, has recently approved a change in the title of its subcommittee E05.11 from Fire Endurance to Fire Resistance.

* ASTM E05 has also eliminated the definition of fire endurance from its terminology standard E 176, and uses the following two definitions:

* fire resistance, n - the ability of a material, product, or assembly to withstand fire or give protection from it for a period of time. (contrast fire resistance rating)

Discussion: As applied to elements of buildings fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating.

* fire resistance rating, n - a measure of the elapsed time during which a material, product, or assembly continues to exhibit fire resistance under specified exposure conditions. (contrast fire resistance)

Discussion: This term is defined because it is used in codes. As applied to elements of buildings, it is commonly measured by the methods and to the criteria defined in Test Methods E 119 or E 1509.

* NFPA 251 talks about the property of fire endurance and the result being a fire endurance classification, but does not really define either: it just uses the terms. It also uses the term “fire resistance” as a explanation in the appendix several times.

* NFPA defines fire resistance rating as follows: “Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials. (See NFPA 220, Standard on Types of Building Construction.)” NFPA 5000 defines the following: “3.3.444.2 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this Code.”

* NFPA does not define “fire endurance” or “fire endurance classification”.

* NFPA does not define “fire resistance” but defines “fire resistant” in NFPA 495, as “3.3.23* Fire Resistant. Construction designed to provide reasonable protection against fire.” It also defines “Fire-Resistant-Rated Construction. Construction in which the structural members, including walls, partitions, columns, floors, and roof construction, have fire resistance ratings of time duration not less than that specified in this standard.”

* In NFPA 5000 and in NFPA 101, the term fire endurance does not appear other than as a reference to the title of a document.

* In NFPA codes and standards the term “fire endurance classification” appears 17 times (15 of them in NFPA 251 and once each in the appendixes of NFPA 909 and 914). On the other hand, the term “fire resistance rating” appears some 700 times in 100 documents, including in such codes as NFPA 5000, NFPA 101, NFPA 1, NFPA 70, NFPA 52, NFPA 54, NFPA 30 and 30A, NFPA 301 and NFPA 909, and in the construction standards NFPA 220 and NFPA 221. Other standards referencing fire resistance rating include NFPA 13, NFPA 99, NFPA 90A and 90B, NFPA 75 and NFPA 230. Most documents state that fire resistance rating is assessed by NFPA 251. Clearly, the NFPA technical committees have chosen fire resistance rating over fire endurance classification.

* For comparison purposes, the 2003 edition of the International Code Council set of codes uses the term “fire resistance” a total of 904 times and the term “fire endurance” a total of 16 times, mostly in references to equations and all 16 times in the chapter 7 of the International Building Code, called “Fire-resistance rated construction”, in sections 719 (Prescriptive fire resistance) and 720 (Calculated Fire Resistance). All those references have been eliminated editorially by ICC staff to be replaced by references to fire resistance.

Committee Meeting Action: Accept

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-6 Log# 3 FIZ-AAA

Final Action: Accept

(1.3, 2.3.4, 3.2.2, 4.1, 4.1.1, 4.2.1, 5.2, 5.3, 6.2, 7.2.1, 7.2.2, 7.3, 8.4, 9.3, 10.3 Annex A.2.2, D.11, Annex F title, F.1.1 F.1.2, F.1.3, F.2, F.4, F.5 G.8.1, G.8.3, and G.10.2)

Submitter : Marcelo M. Hirschler , GBH International

Recommendation: Replace references to “fire endurance” by references to “fire resistance” at all locations mentioned.

Substantiation: 1. The term fire resistance is more descriptive of the applicability of this test method than the term fire endurance, and it has been, to a large extent, adopted by most codes and standards documents. This proposal is one of a set designed to change all references to “fire endurance” into references to “fire resistance” and references to “fire endurance classification” into references to “fire resistance rating”.

2. Applicable sections:

“fire endurance”: title, 1.3, 2.3.4 (2 times), 3.2.2, 4.1, 4.1.1, 4.2.1 (2 times), 5.2, 5.3 (2 times), 6.2 (2 times), 7.2.1, 7.2.2 (2 times), 7.3, 8.4, 9.3 (2 times), 10.3, Annex A.2.2, D.11 (2 times), Annex F title, F.1.1, F.1.2, F.1.3, F.2, F.4 (2 times), F.5 (5 times), G.8.1, G.8.3, and G.10.2.

“fire endurance classification”: 4.1.2, 9.1.2, 9.1.3, 9.5 (3 times), 10.1 (2 times), 10.4, 11.1 (2 times), 13.1, 14.1.5, 14.2.1, 14.2.2, Annex E.1, E.1.2, E.1.6 (2 times), G.7.5, G.9, and G.10.4.

3. ASTM E05, committee on Fire Standards, has recently approved a change in the title of its subcommittee E05.11 from Fire Endurance to Fire Resistance.

4. ASTM E05 has also eliminated the definition of fire endurance from its terminology standard E 176, and uses the following two definitions:

• fire resistance, n - the ability of a material, product, or assembly to withstand fire or give protection from it for a period of time. (contrast fire resistance rating)

Discussion: As applied to elements of buildings fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating.

• fire resistance rating, n - a measure of the elapsed time during which a material, product, or assembly continues to exhibit fire resistance under specified exposure conditions. (contrast fire resistance)

Discussion: This term is defined because it is used in codes. As applied to elements of buildings, it is commonly measured by the methods and to the criteria defined in Test Methods E 199 or E 1509.

5. NFPA 251 talks about the property of fire endurance and the result being a fire endurance classification, but does not really define either: it just uses the terms. It also uses the term “fire resistance” as a explanation in the annex several times.

6. NFPA defines fire resistance rating as follows: “Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials. (See NFPA 220, Standard on Types of Building Construction.)” NFPA 5000 defines the following: “3.3.444.2 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this Code.”

7. NFPA does not define “fire endurance” or “fire endurance classification”.

8. NFPA does not define “fire resistance” but defines “fire resistant” in NFPA 495, as “3.3.23* Fire Resistance. Construction designed to provide reasonable protection against fire.” It also defines “Fire-Resistant-Rated Construction. Construction in which the structural members, including walls, partitions, columns, floors, and roof construction, have fire resistance ratings of time duration not less than that specified in this standard.”

9. In NFPA 5000 and in NFPA 101, the term fire endurance does not appear other than as a reference to the title of a document.

10. In NFPA codes and standards the term “fire endurance classification” appears 17 times (15 of them in NFPA 251 and once each in the annexes of NFPA 909 and NFPA 914). On the other hand, the term “fire resistance rating” appears some 700 times in 100 documents, including in such codes as NFPA 5000, NFPA 101, NFPA 1, NFPA 70, NFPA 52, NFPA 54, NFPA 30, and NFPA 30A, NFPA 301 and NFPA 909, and in the construction standards NFPA 220 and NFPA 221. Other standards referencing fire resistance rating include NFPA 13, NFPA 99, NFPA 90A, and NFPA 90B, NFPA 75, and NFPA 230. Most documents state that fire resistance rating is assessed by NFPA 251. Clearly, the NFPA technical committees have chose fire resistance rating of fire endurance classification.

11. Fire comparison purposes, the 2003 edition of the International Code Council set of codes uses the term “fire resistance” a total of 904 times and the term “fire endurance” a total of 16 times, mostly in references to equations and all 16 times in the Chapter 7 of the International Building Code, called “Fire-resistance rated construction”, in Sections 710 (Prescriptive fire resistance and 720 (Calculated Fire Resistance). All those references have been eliminated editorially by ICC staff to be replaced by references to fire resistance.

Committee Meeting Action: Accept

Committee Statement: See Committee Action and Statement for Proposal 251-2 (Log #CP6).

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-7 Log# 12 FIZ-AAA **Final Action: Accept in Principle**
(1.4 Fire Resistance, Fire Resistance Rating)

Submitter : Marcelo M. Hirschler , GBH International

Recommendation: Add definitions of “fire resistance” and “fire resistance rating” as follows. Also add annex notes to the definitions, as follows. Also, put all definitions into section 3 of the revised standard with the applicable Manual of Style corrections.

Fire Resistance. The ability of a material, product, or assembly to withstand fire or give protection from it for a period of time.

Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, Standard Methods of Tests of Fire Resistance of Building Construction and Materials.

Annex Note to Fire Resistance:

As applied to elements of buildings fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating. The term fire endurance is often used with the same meaning as fire resistance.

Annex Note to Fire Resistance Rating:

The term fire endurance classification has been used with the same meaning as fire resistance rating.

Substantiation: * The term fire resistance is more descriptive of the applicability of this test method than the term fire endurance, and it has been, to a large extent, adopted by most codes and standards documents. This proposal is one of a set designed to change all references to “fire endurance” into references to “fire resistance” and references to “fire endurance classification” into references to “fire resistance rating”.

* Applicable sections:

“fire endurance”: title, 1.3, 2.3.4 (2 times), 3.2.2, 4.1, 4.1.1, 4.2.1 (2 times), 5.2, 5.3 (2 times), 6.2 (2 times), 7.2.1, 7.2.2 (2 times), 7.3, 8.4, 9.3 (2 times), 10.3, Appendix A2.2, D11 (2 times), Appendix F title, F1.1, F1.2, F1.3, F2, F4 (2 times), F5 (5 times), G8.1, G8.3, and G10.2

“fire endurance classification”: 4.1.2, 9.1.2, 9.1.3, 9.5 (3 times), 10.1 (2 times), 10.4, 11.1 (2 times), 13.1, 14.1.5, 14.2.1, 14.2.2, Appendix E1, E1.2, E1.6 (2 times), G7.5, G9, and G10.4

* ASTM E05, committee on Fire Standards, has recently approved a change in the title of its subcommittee E05.11 from Fire Endurance to Fire Resistance.

* ASTM E05 has also eliminated the definition of fire endurance from its terminology standard E 176, and uses the following two definitions:

* fire resistance, n - the ability of a material, product, or assembly to withstand fire or give protection from it for a period of time. (contrast fire resistance rating)

Discussion: As applied to elements of buildings fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating.

* fire resistance rating, n - a measure of the elapsed time during which a material, product, or assembly continues to exhibit fire resistance under specified exposure conditions. (contrast fire resistance)

Discussion: This term is defined because it is used in codes. As applied to elements of buildings, it is commonly measured by the methods and to the criteria defined in Test Methods E 119 or E 1509.

* NFPA 251 talks about the property of fire endurance and the result being a fire endurance classification, but does not really define either: it just uses the terms. It also uses the term “fire resistance” as an explanation in the appendix several times.

* NFPA defines fire resistance rating as follows: “Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials. (See NFPA 220, Standard on Types of Building Construction.)” NFPA 5000 defines the following: “3.3.444.2 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this Code.”

* NFPA does not define “fire endurance” or “fire endurance classification”.

* NFPA does not define “fire resistance” but defines “fire resistant” in NFPA 495, as “3.3.23* Fire Resistant. Construction designed to provide reasonable protection against fire.” It also defines “Fire-Resistant-Rated Construction. Construction in which the structural members, including walls, partitions, columns, floors, and roof construction, have fire resistance ratings of time duration not less than that specified in this standard.”

* In NFPA 5000 and in NFPA 101, the term fire endurance does not appear other than as a reference to the title of a document.

* In NFPA codes and standards the term “fire endurance classification” appears 17 times (15 of them in NFPA 251 and once each in the appendixes of NFPA 909 and 914). On the other hand, the term “fire resistance rating” appears some 700 times in 100 documents, including in such codes as NFPA 5000, NFPA 101, NFPA 1, NFPA 70, NFPA 52, NFPA 54, NFPA 30 and 30A, NFPA 301 and NFPA 909, and in the construction standards NFPA 220 and NFPA 221. Other standards referencing fire resistance rating include NFPA 13, NFPA 99, NFPA 90A and 90B, NFPA 75 and NFPA 230. Most documents state that fire resistance rating is assessed by NFPA 251. Clearly, the NFPA technical committees have chosen fire resistance rating over fire endurance classification.

* For comparison purposes, the 2003 edition of the International Code Council set of codes uses the term “fire resistance” a total of 904 times and the term “fire endurance” a total of 16 times, mostly in references to equations and all 16 times in the chapter 7 of the International Building Code, called “Fire-resistance rated construction”, in sections 719 (Prescriptive fire resistance) and 720 (Calculated Fire Resistance). All those references have been eliminated editorially by ICC staff to be replaced by references to fire resistance.

Committee Meeting Action: Accept in Principle

Accept the submitter’s proposed text with the following revisions.

~~Fire Resistance. The measure of the ability of a material, product, or assembly to withstand fire or give protection from it for a period of time .~~

Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a standard fire exposure ~~as established~~ in accordance with the test procedures of NFPA 251, Standard Methods of Tests of Fire Resistance of Building Construction and Materials.

Annex Note to Fire Resistance:

~~As applied to elements of buildings, fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating. The term fire endurance is often used with the same meaning as fire resistance.~~

Annex Note to Fire Resistance Rating:

~~Once a measure of time is obtained for fire resistance using NFPA 251 that result is the fire resistance rating. The term fire endurance classification has been used with the same meaning as fire resistance rating.~~

Committee Statement: Editorial changes that better reflect the meanings of the terms identified.

Number Eligible to Vote: 23

Ballot Results: Affirmative: 21 Negative: 1

Ballot Not Returned: 1 GRIFFITH

Explanation of Negative:

HIRSCHLER: The definitions proposed should have been accepted. The deletion of the phrase “for a period of time” from the definition of “fire resistance” is incorrect.

Comment on Affirmative

SCHULZ: Agree with committee statement.

THORNBERRY: There is an editorial correction needed to the Committee Meeting Action. This first sentence after the Annex Note to Fire Resistance Rating should be shown underlined. It was text that was actually relocated from the previous Annex Note and somewhat modified for inclusion in this Annex Note.

251-8 Log# CP4 FIZ-AAA **Final Action: Accept**
(2.3.1(4,5) (New))

Submitter : Technical Committee on Fire Tests

Recommendation: Renumber sections C.1(3) and (5) as 2-3.1(4) and 2-3.1(5). Note that section 2-3.1 is to be revised as section 4.3.1.

Substantiation: The committee believes that this information is necessary in conducting the test and in obtaining accurate test results, and should be included as part of the requirements of the standard.

Committee Meeting Action: Accept

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-9 Log# 8 FIZ-AAA **Final Action: Reject**
(2.4)

Note: Note: Since the ballot on this Proposal did not confirm the Committee Action, the Committee is soliciting public comment for review when the proposal is reconsidered by the Committee as a Public Comment.

Submitter : Jesse J. Beitel , Hughes Assoc., Inc.

Recommendation: Revise Section 2.4 as:

Delete existing section and replace with:

2.4 Furnace Pressure

2.4.1 The pressure differential between the exposed and the unexposed surfaces of the test assembly shall be measured and controlled in accordance with 4.1.2 through 4.1.8.2.

2.4.2 The pressure sensing probes shall be shown in Figure 2.4.1(a).2.4.3 The

pressure shall be measured using a differential pressure instrument capable of reading in graduated increments no greater than 0.01 in. wg (2.5 Pa) with a precision of not more than ±0.005 in. wg (±1.25 Pa). The differential pressure instrument(s) shall be located to minimize stack effects caused by vertical runs of pressure tubing between the pressure sensing probes and the differential pressure measurement instrument locations.

2.4.4 Control of the furnace pressure shall be established beginning no later than 5 min after the start of the test and shall be maintained throughout the remainder of the fire test period.

2.4.5 The furnace pressure shall be measured and recorded throughout the fire test at intervals not exceeding 1 minute. It is permitted to report pressure based on a running average using the prior two measurements (i.e. 3 minute running average)

2.4.6 The vertical pressure distribution within the furnace shall be measured by a minimum vertical distance of 5 ft (1.5 m) inside the furnace. A calculation of the neutral pressure plane (zero differential pressure) location shall be made, based on the vertical separation and differences in pressure valves between the pressure sensing probe.

2.4.7 Vertical test specimens.

2.4.7.1 The pressure sensing probes shall be located within 6 in. (152 mm) of the vertical centerline of the test specimen.

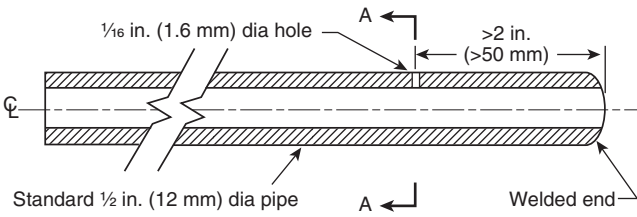
2.4.7.2 When the fire test is to be conducted under positive pressure, the neutral plane in the furnace shall be established at 40 in. (1016 mm) or less above the bottom of the test specimen.

2.4.7.3 When the fire test is to be conducted under negatives pressure, the neutral plane in the furnace shall be established at 3 in. ±3 in. (76 mm ± 76 mm) above the top of the test specimen.

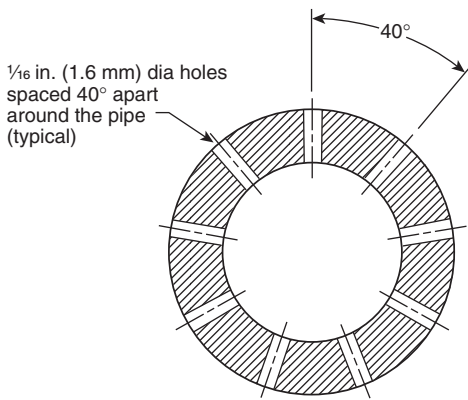
2.4.8 Horizontal test specimens

2.4.8.1 The pressure sensing probes shall be located at the vertical centerline (± 12 in. (300 mm)) of one of the horizontal furnace walls. The tip of the probes shall protrude into the furnace a minimum of 18 in. (460 mm) from the interior surface of the furnace wall.

2.4.8.2 During the fire test, the neutral pressure plane in the furnace shall be established at 12 in. ± 3 in. (300 mm ± 76 mm) below the exposed face of test specimen and such that a positive pressure exists over the entire exposed face of the test specimen.



CROSS-SECTION ALONG PROBE AXIS



SECTION A-A

Note: All tolerances for measurements shown are ±0.05 mm.

Figure 2.4.1(a) Pressure Measurement Probe (Pipe)

Substantiation: This proposal will provide a standard procedure to apply the pressure exposure to the test specimens. It provides for a standard exposure condition depending on the test sponsor's needs and provides a uniform manner to measure and locate the neutral pressure plane during the test.

Committee Meeting Action: Accept in Principle

Accept the submitter's proposed language for sections 2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 2.4.7, 2.4.7.1, 2.4.8, 2.4.8.1, and 2.4.8.2 including figure 2.4.1(a) without modification. Accept the submitter's proposed language for sections 2.4.5, 2.4.6, 2.4.7.2 and 2.4.7.3 as indicated below.

2.4.5 * The furnace pressure shall be measured and recorded throughout the fire test at intervals not exceeding 1 minute. It is permitted to report pressure based on a running average using the prior two measurements (i.e. 3 minute running average)

A.2.4.5 This is equivalent to a 3 minute running average .

2.4.6 The vertical pressure distribution within the furnace shall be measured by a minimum vertical distance of 5 ft (1.5 m) apart inside the furnace. A calculation of the neutral pressure plane (zero differential pressure) location shall be made, based on the vertical separation and differences in pressure valves between the pressure sensing probe.

2.4.7.2 When the fire test is to be conducted under positive pressure, the neutral pressure plane in the furnace shall be established at 40 in. (1016 mm) or less above the bottom of the test specimen.

2.4.7.3 When the fire test is to be conducted under negatives pressure, the neutral pressure plane in the furnace shall be established at 3-in. ±3 in. (76 mm ± 76 mm) above the top of the test specimen (±12 in.)

Committee Statement: These changes are more representative of actual practices conducted by testing laboratories. The committee believes that these practices should be included as part of the standard.

Number Eligible to Vote: 23

Ballot Results: Affirmative: 12 Negative: 10

Ballot Not Returned: 1 GRIFFITH

Explanation of Negative:

BILL: The test has been conducted and accepted without the proposed language for many years. The substantiation provides no technical data concerning the impact on test results. Such data is necessary to evaluate the need for the change which otherwise appears to be arbitrary.

BLAIR: Insufficient evidence is presented to justify the proposal. This item should be reviewed further before action is taken. This change, if approved, would result in excessive retesting of products, with no proven increase in consumer safety.

FRITZ: In 2.4.6 there is a misprint. Substitute values for valves. In 2.4.8.2 the revision calls for maintaining the neutral plane from 9 to 15 in. below the horizontal specimen. The pressure should be measured closer to the surface of the horizontal specimen; otherwise no one knows what the actual pressure at the specimen surface is. Rewrite to say the pressure probe, and neutral plane is to be located 6 in. or less below the surface of horizontal specimens.

GANDHI: Proposed pressure magnitudes are not in compliance with requirements in ISO 834. Comparison between ISO 834 and the proposed requirements are:

	ISO 834	Proposal 251-9 (Log #8)
Horizontal Sample	20 Pa, 100 mm below ceiling	0 Pa, 300 mm below ceiling
Vertical Sample	0 Pa 500 mm above floor Maximum pressure at top of sample — 20 Pa	0 Pa at 1016 mm or less above floor.

The ISO 834 pressure requirements have been in place for several years. The same pressure requirements are in EN standards. No substantiation has been given to deviate from the ISO requirements.

HOGAN: Insufficient evidence has been submitted to show a change is needed. **MCPHEE:** I am voting negative on incorporation of changes to introduce new provisions for positive pressure. Such a change will likely bring question to bear on the usefulness of existing fire test data. I don't believe that the Committee has addressed the implications of such a possibility. In the least, a commentary on this issue should accompany any such change. The change should be withdrawn and reconsidered later.

SUMATHIPALA: Following are the explanations for my negative votes on the above referenced ballot on NFPA 251 "Fire Test of Building Construction and Materials." The proposed text establishes two furnace pressure options: (a) positive furnace pressure, where the neutral plane is within 40 in. from the bottom, and, (b) negative furnace pressure, where the neutral plane is within 12 in. of the top of the specimen.

1. NFPA 251 test has been conducted without the proposed furnace pressure provisions for decades. The results of the test have meaning to the regulatory community as they compare assemblies tested using this test method, not as they simulate "real world conditions." Substantial changes to the test, such as the proposed, preclude making judgment based upon performance compared to other tested assemblies.

2. Acceptance of this proposal could make the existing database of listed wall and floor/ceiling assemblies obsolete. Tests where the neutral plane was located outside the (arbitrary) limits set in this proposal would be invalid. To put it another way, having the neutral plane outside of the specified locations in this proposal should not make an otherwise successful fire resistance test invalid.

3. The choice of neutral plane location is arbitrary. No technical justification is provided to quantify the impact, if any, of the specified neutral plane locations on any assembly. Further, there is no substantiation for picking any particular location over another for the neutral plane. It also lacks evidence that the current systems is broken and it needs a fix.

4. The Substantiation states that this proposal provides an option for a test sponsor to conduct a test under positive pressure. ISO 834 Fire Resistance test standard already provides for positive pressure thus satisfying such a sponsor's

need.

Delete proposed Section 2.4.

TALLEY: I agree with Mr. Sumathipala's reasoning.

WESSEL: I am voting negative on Proposal 251-9 (Log #8). NFPA 251 has been used for years without specific provisions for conducting tests under various pressure conditions. When a sponsor wanted to conduct a test with a pressure differential for research or any other purpose, he did so by specifying the pressure conditions under which the system was to be evaluated. Standardizing the pressures and neutral plane positions is no more representative of real fires than testing under neutral or slightly negative pressures. Pressures in actual fires run the full range of possibilities making it an exercise in futility to try and "standardize" on some specific pressure condition. The current method is as standardized as the proposed method, making the proposed change unnecessary. We realize that the intent is to provide an option for running the test under pressure, however, we have had years of experience with options in fire resistance testing and it has created the "my option is better than your option" scenario that serves no function other than to fuel unrealistic product comparisons and industry battles. There are many features of a real fire (whatever a "real" fire is) that are not represented in NFPA 251, if the intent is to provide a test method for fire resistance that replicates a "real" fire, then a new test method should be designed to allow for variations in all the conditions that vary in such a real fire, including fire lads, fire development curves, pressures and pressure variations, loads, etc.

We see no reason to jeopardize the many years (and millions of dollars) of testing in inventory by making piecemeal changes to this widely accepted method for comparing systems under standardized exposure condition. It is our opinion that adding the specific requirements, even optional requirements, for furnace pressure would be far more detrimental than beneficial and could have a severe negative impact on the industry for no apparent gain.

WILLS: I agree with some of the points raised by Sam Francis and believe these issues deserve more discussion at the committee level.

Comment on Affirmative

SCHULZ: Agree with committee statement.

THORNBERRY: I have voted Affirmative with Comment on this item because it needs some editorial corrections.

Section 2.4.6; my notes show that some additional language was added to the first sentence of this section so it reads as follows:

The vertical pressure distribution within the furnace shall be measured by pressure sensing probes located a minimum vertical distance of 5 ft (1.5 m) apart inside the furnace.

Section 2.4.6; In the second sentence the word "valves" needs to be changed to "values".

Section 2.4.7.3; The word "negatives" should be changed to "negative".

General Comment: Section 2.4 on Furnace Pressure should have a scoping section that clearly indicates that it only applies to fire tests involving barriers such as walls, partitions, floors, and roofs. Certainly, it is not necessary for testing individual structural items such as columns.

251-11 Log# 2 FIZ-AAA **Final Action: Accept**
(4.1.2, 9.1.2, 9.1.3, 9.5, 10.1 10.4, 11.2 13.1, 14.1.5, 14.2.1, 14.2.2, Annex E.1, E.1.2, E.1.6 G.7.5, G.9, and G.10.4)

Submitter : Marcelo M. Hirschler , GBH International

Recommendation: Replace reference to "fire endurance classification" by references to "fire resistance rating" at all locations mentioned.

Substantiation: 1. The term fire resistance is more descriptive of the applicability of this test method than the term fire endurance, and it has been, to a large extent, adopted by most codes and standards documents. This proposal is one of a set designed to change all references to "fire endurance" into references to "fire resistance" and references to "fire endurance classification" into references to "fire resistance rating".

2. Applicable sections:

"fire endurance": title, 1.3, 2.3.4 (2 times), 3.2.2, 4.1, 4.1.1, 4.2.1 (2 times), 5.2, 5.3 (2 times), 6.2 (2 times), 7.2.1, 7.2.2 (2 times), 7.3, 8.4, 9.3 (2 times), 10.3, Annex A.2.2, D.11 (2 times), Annex F title, F.1.1, F.1.2, F.1.3, F.2, F.4 (2 times), F.5 (5 times), G.8.1, G.8.3, and G.10.2.

"fire endurance classification": 4.1.2, 9.1.2, 9.1.3, 9.5 (3 times), 10.1 (2 times), 10.4, 11.1 (2 times), 13.1, 14.1.5, 14.2.1, 14.2.2, Annex E.1, E.1.2, E.1.6 (2 times), G.7.5, G.9, and G.10.4.

3. ASTM E05, committee on Fire Standards, has recently approved a change in the title of its subcommittee E05.11 from Fire Endurance to Fire Resistance.

4. ASTM E05 has also eliminated the definition of fire endurance from its terminology standard E 176, and uses the following two definitions:

- fire resistance, n - the ability of a material, product, or assembly to withstand fire or give protection from it for a period of time. (contrast fire resistance rating)

Discussion: As applied to elements of buildings fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating.

- fire resistance rating, n - a measure of the elapsed time during which a mate-

rial, product, or assembly continues to exhibit fire resistance under specified exposure conditions. (contrast fire resistance)

Discussion: This term is defined because it is used in codes. As applies to elements of buildings, it is commonly measured by the methods and to the criteria defined in Test Methods E 199 or E 1509.

5. NFPA 251 talks about the property of fire endurance and the result being a fire endurance classification, but does not really define either: it just uses the terms. It also uses the term "fire resistance" as an explanation in the annex several times.

6. NFPA defines fire resistance rating as follows: "Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with the test procedures of NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials. (See NFPA 220, Standard on Types of Building Construction.)" NFPA 5000 defines the following: "3.3.444.2 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this Code.

7. NFPA does not define "fire endurance" or "fire endurance classification".

8. NFPA does not define "fire resistance" but defines "fire resistant" in NFPA 495, as "3.3.23* Fire Resistance. Construction designed to provide reasonable protection against fire." It also defines "Fire-Resistant-Rated Construction. Construction in which the structural members, including walls, partitions, columns, floors, and roof construction, have fire resistance ratings of time duration not less than that specified in this standard."

9. In NFPA 5000 and in NFPA 101, the term fire endurance does not appear other than as a reference to the title of a document.

10. In NFPA codes and standards the term "fire endurance classification" appears 17 times (15 of them in NFPA 251 and once each in the annexes of NFPA 909 and NFPA 914). On the other hand, the term "fire resistance rating" appears some 700 times in 100 documents, including in such codes as NFPA 5000, NFPA 101, NFPA 1, NFPA 70, NFPA 52, NFPA 54, NFPA 30, and NFPA 30A, NFPA 301 and NFPA 909, and in the construction standards NFPA 220 and NFPA 221. Other standards referencing fire resistance rating include NFPA 13, NFPA 99, NFPA 90A, and NFPA 90B, NFPA 75, and NFPA 230. Most documents state that fire resistance rating is assessed by NFPA 251. Clearly, the NFPA technical committees have chose fire resistance rating of fire endurance classification.

11. Fire comparison purposes, the 2003 edition of the International Code Council set of codes uses the term "fire resistance" a total of 904 times and the term "fire endurance" a total of 16 times, mostly in references to equations and all 16 times in the Chapter 7 of the International Building Code, called "Fire-resistance rated construction", in Sections 710 (Prescriptive fire resistance and 720 (Calculated Fire Resistance). All those references have been eliminated editorially by ICC staff to be replaced by references to fire resistance.

Committee Meeting Action: Accept

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-12 Log# 5 FIZ-AAA **Final Action: Accept in Principle**
(4.2)

Submitter : Rick Thornberry , The Code Consortium, Inc. / Rep. National Concrete Masonry Association

Recommendation: Revise text as follows:

4.2 Hose Stream Test.

4.2.1 For walls having a resistance period, as determined in the fire endurance test, of not less than 1 hour, a hose stream test shall be conducted in accordance with Section 4.2 as Where required by the conditions of acceptance specified in Section 5.3 or 6.2.

4.2.2, The hose stream test shall be conducted on the test specimen that meets either one of the following conditions:

1. the original test specimen immediately following the termination of the fire endurance test or

2. a duplicate test specimen shall be immediately after it has been subjected to a the fire endurance exposure test for a period equal to one-half of that indicated as the resistance period in the fire endurance test for the original test specimen, but not for not more than 1 hour immediately after which

4.2.3 The test specimen shall be subjected to the impact, erosion, and cooling effects of a the hose stream directed first at the middle and then at all parts of the exposed face, with changes in direction made slowly.

Exception: The hose stream test shall not be required in the case of construction having a resistance period, as specified in the fire endurance test, of less than 1 hour.

4.2.4 The hose stream shall be delivered through a 2 1/2-in. (64-mm) hose discharging through a national standard play pipe as specified in ANSI/UL 385, Standard for Safety Play Pipes for Water Supply Testing in Fire Protection Service. The play pipe shall have an overall length of 30 in. (762 mm) and shall be equipped with a 1 1/8-in. (28.4-mm) discharge tip of the standard-taper, smooth bore pattern without shoulder at the orifice. The play pipe shall be fitted with a 1 1/2-in. (64-mm) inside diameter by 6-in. (153-mm) long nipple mounted between the hose and the base of the play pipe.

The pressure tap for measuring the water pressure at the base of the nozzle

shall be normal to the surface of the nipple, centered in its length, and shall not protrude into the water stream. The water pressure shall be measured with a suitable pressure gauge [as minimum 0 to 50 psi (0 to 345 kPa)] graduated in no more than 2-psi (13.8-kPa) increments. The water pressure and duration of application shall be as specified in Table 4.2. 4 2 .

Renumber Table 4.2.2 Hose Stream Test as Table 4.2.4 and renumber existing Section 4.2.3 as 4.2.5. NOTE: No revisions are proposed to the text in Table 4.2.2 or Section 4.2.3.

Substantiation: When the 1990 edition of NFPA 251 was revised to create the 1995 edition, the provision for allowing the hose stream test to be conducted immediately after the test specimen has been removed from the test furnace at the end of the fire endurance test was inadvertently omitted. The purpose of this proposal is to reinstate the hose steam test requirement for that situation while retaining the present hose stream test which is allowed to be conducted on a duplicate test specimen which has been tested for one half the fire endurance rating of the original test specimen and then removed from the furnace to have the hose stream test applied. This would then make NFPA 251 consistent with ASTM E 119 and UL 263.

Committee Meeting Action: Accept in Principle

1. Revise section 4.2 to read as follows:

4.2.1 Where required by the conditions of acceptance specified in Section 5.3 or 6.2, for walls or partitions having a fire resistance rating of not less than 1 hour, a hose stream test shall be conducted in accordance with Section 4.2.

4.2.2. Unless otherwise provided for in 4.2.3, the hose stream test shall be conducted on a duplicate test specimen immediately after it has been subjected to the fire resistance test for a period equal to one-half of the period indicated as the fire resistance rating, but for not more than 1-hour.

4.2.3 It shall be permitted to conduct the hose stream test on the original test specimen.

4.2.4 The test equipment and test procedures for conducting the hose stream test shall be as described in ASTM E 2226, Standard Practice for Application of Hose Stream. the water pressure and duration of application shall be as specified in Table 4.2.4.

2. Renumber Table 4.2.2 as Table 4.2.4.

Committee Statement: Editorial corrections.

Number Eligible to Vote: 23

Ballot Results: Affirmative: 21 Abstain: 1

Ballot Not Returned: 1 GRIFFITH

Explanation of Abstention:

THORNBERRY: I am required to abstain on this item in accordance with the NFPA regulations because I have a client interest.

Comment on Affirmative

SCHULZ: Agree with committee statement.

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

251-13 Log# 6 FIZ-AAA
(4.2)

Final Action: Accept in Principle

Submitter : Jesse J. Beitel , Hughes Assoc., Inc.

Recommendation: Revise Section 4.2 as:

Section 4.2.1 – Retain to include Exception

Add new Section 4.2.2 to read:

The test equipment and the test procedures for conducting the hose stream test shall be as described in ASTM E2226.

Section 4.2.2 – Eliminate entire section except for last sentence:

“The water pressure and duration of application shall be as specified in Table 4.2.2.

Table 4.2.2 – Retain.

Section 4.2.3 – Eliminate.

Add new reference to Chapter 15 to read:

ASTM E2226-02, “Standard Practice for Application of Hose Stream”

Substantiation: The ASTM E2226 provides a standard practice for the equipment and the procedures to be used in the application of the hose stream. It is more appropriate to reference this practice than to keep the existing language in the standard.

Committee Meeting Action: Accept in Principle

Committee Statement: See Committee Action and Statement for Proposal 251-12 (Log #5).

Number Eligible to Vote: 23

Ballot Results: Affirmative: 22

Ballot Not Returned: 1 GRIFFITH

Comment on Affirmative

SCHULZ: Agree with committee statement.

251-14 Log# CP5 FIZ-AAA
(A.1.1.2)

Final Action: Accept

Submitter : Technical Committee on Fire Tests

Recommendation: Delete section A.1.1.2 which is being renumbered as section A.1.2.2 in its entirety without replacement.

Substantiation: The Committee believes that the section is misleading.

Committee Meeting Action: Accept

**Standard Methods of Tests of Fire Endurance Resistance of
Building Construction and Materials [ROP 251-4]**

2005 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Information on referenced publications can be found in Chapter 2 and Annex H.

Chapter 1 Administration

1.1* Scope. This standard provides methods of fire tests for the fire-resistive properties of building members and assemblies.

1.2 Purpose.

1.2.1 This standard describes methods to evaluate the duration for which the types of assemblies noted in 1.3.1 contain a fire, retain their structural integrity, or exhibit both properties, depending on the type of assembly involved during a predetermined test exposure.

1.2.2 It is the intention of this standard that classifications fire resistance ratings be based on performance during the period of exposure and not be used to determine suitability for use after fire exposure. [ROP 251-2]

1.2.3* The results of these tests are one factor in assessing fire performance of building construction and assemblies.

1.3 Application.

1.3.1 These methods of fire tests apply to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs.

1.3.2 They also apply to other assemblies and structural units that constitute permanent integral parts of a finished building.

1.3.3 This standard requires a specimen to be exposed to a standard fire exposure that is controlled to achieve specified temperatures throughout a specific time period.

1.3.4 In some instances, the fire exposure is followed by the application of a specified standard fire hose stream.

1.3.5 The exposure is not to be considered representative of all fire conditions, which vary with changes in the amount, nature, and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment.

1.3.6 The test provides a relative measure of fire performance of comparable assemblies under specified fire exposure conditions.

1.3.7 Variations in the construction or conditions (e.g., size, method of assembly, and materials) that are tested substantially varies the performance characteristics of the assembly.

1.3.8 The standard provides methods to measure the following:

- (1) In walls, partitions, and floor or roof assemblies:
 - (a) Transmission of heat
 - (b) Transmission of hot gases through the assembly sufficient to ignite cotton waste
 - (c) Load-carrying ability of the test specimen during the test exposure where load-bearing elements are included
- (2) For individual load-bearing assemblies such as beams and columns, a load-carrying ability under the test exposure with some consideration for the end support conditions (i.e., restrained or unrestrained)

1.3.9 The standard does not provide the following:

- (1) Full information on the performance of assemblies constructed with components or lengths other than those tested
- (2) Evaluation of the degree to which the assembly contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion
- (3) Measurement of the degree of control or limitation of the passage of smoke or products of combustion through the assembly
- (4) Simulation of the fire behavior of joints between building elements, such as floor-to-wall or wall-to-wall connections
- (5) Measurement of flame spread over the surface of the tested element
- (6) Effect on fire endurance of conventional openings in the assembly

1.4 Units. The inch-pound value for a measurement and the SI value given in parenthesis shall each be acceptable for use as primary units for satisfying the requirements of this standard.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. (Reserved)

2.3 Other Publications.

2.3.1 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM C 569, *Test for Indentation Hardness of Prefformed Thermal Insulations*, 1989.

ASTM E 2226, *Standard Practice for Application of Hose Stream*, 2002.

2.3. UL Publication. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 385, *Standard for Safety Play Pipes for Water Supply Testing in Fire Protection Service*, 1994.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1 Shall. Indicates a mandatory requirement.

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

3.2.3 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an annex or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1* Fire Resistance. The measure of the ability of a material, product, or assembly to withstand fire or give protection from it. [ROP 251-7]

3.3.2* Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a standard fire exposure. The rating should be determined in accordance with the test procedures of this standard. [ROP 251-7]

Chapter 4 Control of Fire Tests

4.1 Temperature–Time Curve.

4.1.1* The conduct of fire tests of materials and construction shall be controlled by the standard temperature–time curve shown in Figure 4.1.1.

FIGURE 4.1.1 Temperature–Time Curve. [Existing Figure 2-1.1, 99 ed., (no change)]

4.1.2 The temperature inside the furnace shall be ambient when the test begins.

4.2* Furnace Temperatures.

4.2.1* The temperature fixed by the curve shall be the average temperature obtained from the readings of no fewer than nine thermocouples for a floor, roof, wall, or partition and no fewer than eight thermocouples for a structural column.

4.2.1.1 The thermocouples shall be symmetrically disposed and distributed to show the temperature near all parts of the sample and shall be enclosed in protection tubes of such materials and dimensions that the time constant of the protected thermocouple assembly lies within the range of 5.0 minutes to 7.2 minutes.

4.2.1.2 The exposed length of the pyrometer tube and thermocouple in the furnace chamber shall be not less than 12 in. (305 mm).

4.2.1.3 Other types of protecting tubes or pyrometers shall be permitted to be used that, under test conditions, provide the time range of 5.0 minutes to 7.2 minutes within the accuracy requirement that applies for the measurement of furnace temperature.

4.2.1.4 For floors and columns, the junction of the thermocouples shall be placed 12 in. (305 mm) away from the exposed face of the specimen at the beginning of the test and, during the test, shall not touch the sample as a

result of its deflection.

4.2.1.5 In the case of walls and partitions, the thermocouples shall be placed 6 in. (152 mm) away from the exposed face of the specimen at the beginning of the test and shall not touch the specimen during the test in the event of deflection.

4.2.2 The temperatures shall be measured at intervals not exceeding 1 minute during the test period.

4.2.3 The accuracy of the furnace control shall be such that the area under the temperature–time curve, obtained by averaging the results from the pyrometer readings, is within the following percentages of the corresponding area under the standard temperature–time curve shown in Figure 4.1.1:

- (1) 10 percent for fire tests of 1 hour or less
- (2) 7.5 percent for fire tests over 1 hour and not more than 2 hours
- (3) 5 percent for fire tests exceeding 2 hours

4.3 Temperatures of Unexposed Surfaces of Floors, Roofs, Walls, and Partitions.

4.3.1* Temperatures of unexposed surfaces shall be measured with thermocouples or thermometers placed under thermocouple pads.

4.3.1.1 Thermocouple pads shall meet the following requirements or otherwise shall be demonstrated to be equivalent by comparative NFPA 251 tests:

- (1) Length and width, 6 in. \pm $\frac{1}{8}$ in. (152 mm \pm 3.2 mm)
- (2) Thickness, 0.40 in. \pm 0.05 in. (10.2 mm \pm 1.3 mm)
- (3) Thermal conductivity [at 150°F (65°C)], 0.38 \pm 0.027 Btu-in./hr-ft²-F (0.55 \pm 0.039 W/m-K)
- (4) Dry weight, 0.147 lb \pm 0.053 lb (67 g \pm 24 g). [**ROP 251-8**]
- (5)* Hardness indentation on soft face, 0.075 in. \pm 0.025 in. (1.9 mm \pm 0.6 mm), with indentation determined in accordance with ASTM C 569, *Test for Indentation Hardness of Preformed Thermal Insulations*. [**ROP 251-8**]

4.3.1.2 The wire leads of the thermocouple or the stem of the thermometer shall have an immersion under the pad and shall be in contact with the unexposed surface for not less than $3\frac{1}{2}$ in. (90 mm).

4.3.1.3 The hot junction of the thermocouple or the bulb of the thermometer shall be placed under the approximate center of the pad.

4.3.1.4 The outside diameter of protecting or insulating tubes and of thermometer stems shall be not more than $\frac{5}{16}$ in. (8 mm).

4.3.1.5 The pad shall be held firmly against the surface and shall fit closely about the thermocouples or thermometer stems.

4.3.1.6 Thermometers shall be of the partial-immersion type, with a length of stem, between the end of the bulb and the immersion mark, of 3 in. (76 mm).

4.3.1.7 The wires for the thermocouple in the length covered by the pad shall be not heavier than No. 18 B & S gauge [0.04 in. (1.02 mm)] and shall be electrically insulated with heat-resistant and moisture-resistant coatings.

4.3.2 Temperature measurements shall be obtained from at least nine points on the surface, as follows:

- (1) Five thermocouples shall be symmetrically disposed as follows:
 - (a) One located approximately at the center of the specimen
 - (b) Four located approximately at the center of each quadrant
- (2) The other four thermocouples shall be located at the discretion of the testing authority to obtain representative information on the performance of the construction under test.
- (3) All of the thermocouples shall be located at a distance of at least $1\frac{1}{2}$ times the thickness of the construction or 12 in. (305 mm) from the edges of the test specimen.
- (4) The distance requirements specified in 4.3.2(3) shall not apply where an element of the assembly is located near the edge only.
- (5) None of the thermocouples shall be located opposite or on top of beams, girders, pilasters, or other structural members if temperatures at such points are lower than at more representative locations.
- (6) None of the thermocouples shall be located opposite or on top of fasteners such as screws, nails, or staples that are higher or lower in temperature than at more representative locations if the aggregate area of any part of such fasteners projected to the unexposed surface is less than 1 percent of the area within any 6 in. (152 mm) diameter circle.
- (7) The fasteners specified in 4.3.2(6) shall not be required to extend through the assembly.

4.3.3 Temperature readings shall be measured at intervals not exceeding 1 minute.

4.3.4 Where the conditions of acceptance place a limitation on the rise of the temperature of the unexposed surface, the temperature end point of the fire endurance resistance period shall be determined by the average of the

measurements taken at individual points. [**ROP-251-6**]

4.3.5 Where a temperature rise of 30 percent in excess of the specified limit occurs at any one of the individual measurement points, all other points shall be ignored, and the fire endurance period shall be judged as ended.

4.4 Furnace Pressure—

4.4.1 The pressure-sensing probes shall be as shown in Figure 4.4.1(a) or Figure 4.4.1(b):

FIGURE 4.4.1(a) Static pressure-sensing probe dimensions. [Existing Figure 2.4.1(a), 1999 edition, no change]

FIGURE 4.4.1(b) Pressure-sensing probe. [Existing Figure 2.4.1(b), 1999 edition, no change]

4.4.2 The pressure shall be measured using a differential pressure instrument capable of reading in increments no coarser than 0.01 in. wg (2.5 Pa) with a precision of not less than \pm 0.005 in. wg (\pm 1.25 Pa).

4.4.3 The differential pressure measurement instrument(s) shall be located to minimize stack effects caused by vertical runs of pressure tubing between the furnace probe(s) and instrument locations.

4.4.4 The furnace pressure(s) shall be measured and recorded at intervals not exceeding 1 minute throughout the test.

4.4.5 Control of the furnace pressure shall be established no later than 10 minutes after the start of the test and shall be maintained throughout the remainder of the test:

4.4.5.1 For vertical specimens, the vertical pressure distribution within the furnace shall be measured by at least two probes separated by a vertical distance [minimum of 6 ft (1.8 m)] within the furnace.

4.4.5.1.1 A calculation of the neutral plane's (zero differential pressure) location shall be made based on the vertical separation of the probes and their pressure differences.

4.4.5.1.2 The pressure measurements made inside the furnace, along with the calculation showing the position of the neutral plane with respect to the top of the vertical assembly during the test, shall be reported.

4.4.5.2 For horizontal specimens, the following criteria shall be met:

- (1) The pressure shall be measured at two locations along the centerline of the specimen and 12 in. (305 mm) below the specimen.
- (2) The pressure (the average of the two readings) during the test shall be reported. [**ROP 251-9**]

Chapter 5 Test Specimen

5.1 Specimen.

5.1.1 The test specimen shall be a true representation of the construction for which classification fire resistance rating is to be determined with respect to materials, workmanship, and details such as dimension of parts. [ROP 251-2]

5.1.1.1 The specimen shall be built under conditions representative of those properties that are applied in actual building construction and operation.

5.1.1.2 The physical properties of the materials and ingredients used in the test specimen shall be determined and recorded.

5.1.2 The following shall apply to the size and dimensions of the test specimen:

- (1) They shall be recognized as intending to apply in rating constructions of dimensions within the normal general range used in buildings.
- (2) Where the conditions of use limit the construction to smaller dimensions, a proportionate reduction shall be permitted to be made in the dimensions of the specimens for a test used to qualify them for such restricted use.

5.1.3 Where it is desired to include a built-up roof covering, the following criteria shall be met:

- (1) The test specimen shall have a roof covering of 3-ply, 15 lb (6.8 kg) type felt not in excess of 120 lb (54.4 kg) per 100 ft² (9.3 m²) of hot mopping asphalt without gravel surfacing.
- (2) Tests of assemblies with such roof covering shall not preclude the field use of other built-up roof coverings.

5.2 Protection and Conditioning of Test Specimen. The test specimen shall be protected during and after fabrication to ensure its quality and condition when tested.

5.2.1 The specimen shall not be tested until close to its full strength, and, if it contains moisture, it shall not be tested until the excess moisture has been removed to achieve an air-dry condition in accordance with the requirements of 5.2.2 through 5.2.5.

5.2.2 The testing equipment and sample undergoing the fire test shall be protected from any condition of wind or weather that might lead to abnormal results.

5.2.3 The ambient air temperature at the beginning of the test shall be within the range of 50°F to 90°F (10°C to 32°C).

5.2.4 The velocity of air across the unexposed surface of the sample, measured immediately before the test begins, shall not exceed 4.4 ft/sec (1.3 m/sec) as determined by an anemometer placed at right angles to the unexposed surface.

5.2.5 If mechanical ventilation is used during the test, an airstream shall not be directed across the surface of the specimen.

5.2.6* Prior to the fire test, the construction shall be conditioned with the objective of providing a moisture condition within the specimen representative of that likely to exist in similar construction in buildings.

5.2.6.1 For purposes of standardization, the moisture condition shall be considered to be that which would exist at equilibrium as a result of drying in an ambient atmosphere of 50 percent relative humidity at 73°F (23°C),

5.2.6.2 Where it is difficult or impossible to achieve such a condition within a reasonable time, specimens shall be permitted to be tested when the dampest portion of the structure [i.e., the portion at 6 in. (152 mm) depth below the surface of massive constructions] has achieved a moisture content corresponding to drying to equilibrium with air in the range of 50 percent to 75 percent relative humidity at 73°F ± 5°F (23°C ± 3°C).

5.2.6.3 The following also shall apply to the requirements for conditioning of the test specimen:

- (1) In the event that specimens dried in a heated building fail to meet the requirements of Section 5.2 through 5.2.6.2 after a 12-month conditioning period, or in the event that the nature of the construction is such that it is evident that drying of the specimen interior is prevented by hermetic sealing, these requirements shall be permitted to be waived.
- (2) The requirement for testing of the specimen only after nearing its full strength shall not be permitted to be waived.

5.2.7 If, during the conditioning of the specimen it appears desirable or is necessary to use accelerated drying techniques, it shall be the responsibility of the laboratory conducting the test to avoid procedures that significantly alter the structural or fire endurance characteristics of the specimen, or both, from those produced as the result of drying in accordance with procedures in 5.2.1.

5.2.8* Within 72 hours prior to the fire test, information on the actual moisture content and distribution within the specimen shall be obtained and included in the test report.

Chapter 6 Conduct of Fire Tests

6.1 Fire Endurance Resistance Test. [ROP 251-6]

6.1.1 A fire endurance resistance test on the specimen, including its applied load, if any, shall be continued until failure occurs, or until the specimen has withstood the test conditions for a period equal to that herein specified in the

conditions of acceptance for the given type of construction. [ROP 251-6]

6.1.2 For the purpose of obtaining additional performance data, the test shall be permitted to be continued beyond the time the fire endurance classification is determined.

6.2 Hose Stream Test.

6.2.1 Where required by the conditions of acceptance, a duplicate specimen shall be subjected to a fire exposure test for a period equal to one-half of that indicated as the resistance period in the fire endurance test, but not for more than 1 hour and the following also shall apply:

(1) Immediately following the fire exposure test, the specimen shall be subjected to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed face, with changes in direction made slowly.

(2) The hose stream test shall not be required in the case of construction having a resistance period, as specified in the fire endurance test, of less than 1 hour.

6.2.2 The stream shall be delivered through a 2¹/₂-in. (64-mm) hose discharging through a national standard play pipe as specified in ANSI/UL 385, *Standard for Safety Play Pipes for Water Supply Testing in Fire Protection Service*. 6.2.2.1 The play pipe shall have an overall length of 30 in. (762 mm) and shall be equipped with a 1¹/₈-in. (28.4-mm) discharge tip of the standard-taper, smooth-bore pattern without shoulder at the orifice.

6.2.2.2 The play pipe shall be fitted with a 2¹/₂-in. (64-mm) inside diameter by 6-in. (153-mm) long nipple mounted between the hose and the base of the play pipe.

6.2.2.3 The pressure tap for measuring the water pressure at the base of the nozzle shall be normal to the surface of the nipple, centered in its length, and shall not protrude into the water stream.

6.2.2.4 The water pressure shall be measured with a pressure gauge [as a minimum 0 to 50 psi (0 to 345 kPa)] graduated in no more than 2-psi (13.8-kPa) increments.

6.2.2.5 The water pressure and duration of application shall be as specified in Table 6.2.2.

6.2.3 The nozzle shall be located as follows:

(1) The nozzle orifice shall be 20 ft (6 m) from the center of the exposed surface of the test sample if the nozzle is so located that, when directed at the center, its axis is normal to the surface of the test sample.

(2) If otherwise located, the distance of the nozzle from the center shall be less than 20 ft (6 m) by a distance equal to 1 ft (0.3 m) for each 10 degrees of deviation from normal. [ROP 251-12]

6.2.1 Where required by the conditions of acceptance specified in Section 7.3 or Section 8.2, for walls or partitions having a fire resistance rating of not less than 1 hour, a hose stream test shall be conducted in accordance with Section 6.2.

6.2.2 Unless otherwise provided for in 6.2.3, the hose stream test shall be conducted on a duplicate test specimen immediately after it has been subjected to the fire resistance test for a period equal to one-half of the period indicated as the fire resistance rating, but for not more than 1 hour.

6.2.3 It shall be permitted to conduct the hose stream test on the original test specimen.

6.2.4 The test equipment and test procedures for conducting the hose stream test shall be as described in ASTM E 2226, *Standard Practice for Application of Hose Stream*. [ROP 251-12]

6.2.5 The water pressure and duration of application shall be as specified in Table 6.2.5. [ROP 251-12]

Table 6.2.5 Hose Stream Test

Resistance Period	Water Pressure at Base of Nozzle		Duration of Application to Exposed Area	
	psi	kPa	min/100 ft ²	min/9.3 m ²
8 hr and over	45	310	6	0.65
4 hr and over, if less than 8 hr	45	310	5	0.54
2 hr and over, if less than 4 hr	30	207	2 ¹ / ₂	0.27
1 ¹ / ₂ hr and over, if less than 2 hr	30	207	1 ¹ / ₂	0.16
1 hr and over, if less than 1 ¹ / ₂ hr	30	207	1	0.11
Less than 1 hr, if desired	30	207	1	0.11

Chapter 7 Tests of Bearing Walls and Partitions**7.1 Size and Restraint of Specimen.**

7.1.1 The area exposed to fire shall be not less than 100 ft² (9.3 m²), with neither dimension less than 9 ft (2.7 m).

7.1.2 The test specimen shall not be restrained on its vertical edges.

7.2* Loading. Throughout the fire endurance and fire and hose stream tests, a constant superimposed load shall be applied to simulate a maximum load condition.

7.2.1 The applied load shall be, as nearly as practicable, the maximum load permitted by design under nationally recognized structural design criteria.

7.2.2 The tests also shall be permitted to be conducted by applying to the specimen a load less than the maximum and shall be identified in the test report as having been conducted under restricted load conditions.

7.2.3 The applied load, and the applied load expressed as a percentage of the maximum permitted design load, shall be included in the report.

7.2.4 A double-wall assembly shall be loaded during the test to simulate field use conditions, with either side loaded separately or both sides loaded together and the method used reported.

7.3 Conditions of Acceptance. The test shall be regarded as valid if the following conditions are met:

- (1) The wall or partition shall have sustained the applied load during the fire endurance test, without passage of flame or gases hot enough to ignite cotton waste, for a period equal to that required for the classification fire resistance rating desired. [ROP 251-2]
- (2) The wall or partition shall have sustained the applied load during the fire and hose stream test, as specified in Section 6.2, without passage of flame, gases hot enough to ignite cotton waste, or the hose stream.
- (3) The wall or partition shall be considered to have failed the hose stream test specified in Section 6.2 if an opening develops that allows a projection of water from the stream beyond the unexposed surface during the hose stream test.
- (4) Transmission of heat through the wall or partition during the fire endurance test shall not be sufficient to raise the temperature on the unexposed surface more than 250°F (140°C) above the assembly's initial temperature.

Chapter 8 Tests of Nonbearing Walls and Partitions**8.1 Size and Restraint of Specimen.**

8.1.1 The area exposed to fire shall be not less than 100 ft² (9.3 m²), with neither dimension less than 9 ft (2.7 m).

8.1.2 The test specimen shall be restrained on all four edges.

8.2 Conditions of Acceptance. The test shall be regarded as valid if the following conditions are met:

- (1) The wall or partition shall have withstood the fire endurance test, without passage of flame or gases hot enough to ignite cotton waste, for a period equal to that required for the classification fire resistance rating desired. [ROP 251-2]
- (2) The wall or partition shall have withstood the fire and hose stream tests, as specified in Section 6.2, without passage of flame, gases hot enough to ignite cotton waste, or the hose stream.
- (3) The wall or partition shall be considered to have failed the hose stream test specified in Section 6.2 if an opening develops that allows a projection of water from the stream beyond the unexposed surface during the hose stream test.
- (4) Transmission of heat through the wall or partition during the fire endurance test shall not be sufficient to raise the temperature on the assembly's unexposed surface more than 250°F (140°C) above the assembly's initial temperature.

Chapter 9 Tests of Columns**9.1 Size and Connections of Specimen.**

9.1.1 The length of the column exposed to fire shall, where practicable, approximate the maximum clear length contemplated by the design and, for building columns, shall be not less than 9 ft (2.7 m).

9.1.2 The contemplated details of connections, and their protection, if any, shall be applied according to the methods of standard field practice.

9.2 Loading.

9.2.1 Throughout the fire endurance test, the column shall be exposed to fire on all sides and shall be loaded in a manner calculated to develop as nearly as practicable, in theory, the working stresses contemplated by the design.

9.2.2 Provision shall be made for transmitting the load to the exposed portion of the column without unduly increasing the effective column length.

9.2.3 If the submitter and the testing body jointly so decide, the column shall be permitted to be subjected to $1\frac{3}{4}$ times its designed working load before the

fire endurance test is undertaken.

9.2.4 Where the test permitted by 9.2.3 has been performed, it shall not be construed as having had a deleterious effect on the fire endurance test performance.

9.3 Conditions of Acceptance. The test shall be regarded as valid if the column sustains the applied load during the classification fire endurance test for a period equal to that required for the fire resistance rating desired. [ROP 251-2]

Chapter 10 Alternative Test of Protection for Structural Steel Columns

10.1 Application. This test procedure shall not require column loading at any time and shall be permitted to be used at the discretion of the testing laboratory to evaluate steel column protection that is not required by design to carry any of the column load.

10.2 Size and Character of Specimen.

10.2.1 The size of the steel column used as a specimen shall be a true representation of the design, materials, and workmanship required for the classification fire resistance rating desired. [ROP 251-2]

10.2.1.1 The protection shall be applied in accordance with the methods of standard field practice.

10.2.1.2 The length of the protected column shall be at least 8 ft (2.4 m).

10.2.1.3 The column shall be vertical during application of the protection and during the fire exposure.

10.2.2 The applied protection shall be restrained against longitudinal temperature expansion greater than that of the steel column by rigid steel plates or reinforced concrete attached to the ends of the steel column before the protection is applied.

10.2.3 The size of the plates or amount of concrete required by 10.2.2 shall be adequate to provide direct bearing for the entire transverse area of the protection.

10.2.4 The ends of the specimen, including the means for restraint, shall be provided with sufficient thermal insulation to prevent appreciable direct heat transfer from the furnace.

10.3 Temperature Measurement. The temperature of the steel in the column shall be measured by at least three thermocouples located at each of four levels as follows:

- (1) The upper and lower levels shall be 2 ft (0.6 m) from the ends of the steel column
- (2) The two intermediate levels shall be spaced equally.
- (3) The thermocouples at each level shall be placed to measure significant temperatures of the component elements of the steel section.

10.4 Exposure to Fire. Throughout the fire endurance test, the specimen shall be exposed to fire on all sides for its full length.

10.5 Conditions of Acceptance. The test shall be considered to be valid if the transmission of heat through the protection during the period of fire exposure required for the classification fire resistance rating desired meets one of the following criteria: [ROP 251-2]

- (1) It does not raise the average (arithmetical) temperature of the steel at any one of the four levels above 1000°F (530°C).
- (2) It does not raise the temperature above 1200°F (649°C) at any one of the measured points.

Chapter 11 Tests of Floor and Roof Assemblies**11.1 Application.**

11.1.1 This test procedure shall apply to floor and roof assemblies with or without attached, furred, or suspended ceilings, and the underside of the specimen under test shall be exposed to fire.

11.1.2* The following two classifications fire resistance ratings shall be determined for assemblies restrained against thermal expansion: [ROP 251-2]

- (1) A restrained assembly classification fire resistance rating based upon the conditions of acceptance specified in Section 11.5(a) through Section 11.5(e) [ROP 251-2]
- (2) An unrestrained assembly classification fire resistance rating based upon the conditions of acceptance specified in Sections 11.6(1) and (2), in addition to Section 11.6(3), Section 11.6(4), Section 11.6(5), or Section 11.6(6) [ROP 251-2]

11.1.3 One classification fire resistance rating shall be determined from tests of assemblies not restrained against thermal expansion based on the conditions of acceptance specified in Section 11.6(1) and (2). [ROP 251-2]

11.1.4 Individual unrestrained classifications fire resistance ratings shall

be permitted to be determined for beams tested in accordance with this test method using the conditions of acceptance specified in Section 13.3(1), (2), or (3). [ROP 251-2]

11.2 Size and Characteristics of Specimen.

11.2.1 The area exposed to fire shall be not less than 180 ft² (16.7 m²), with neither dimension less than 12 ft (3.6 m).

11.2.2 Structural members, if a part of the construction under test, shall lie within the combustion chamber and shall have a side clearance of not less than 8 in. (203 mm) from the combustion chamber walls.

11.2.3 The specimen shall be installed in accordance with recommended fabrication procedures for the type of construction and shall be representative of the design for which a classification fire resistance rating is desired. [ROP 251-2]

11.2.4 Where a restrained classification fire resistance rating is desired, specimens representing forms of construction in which restraint to thermal expansion occurs shall be reasonably restrained in the furnace. [ROP 251-2]

11.3 Loading. Throughout the fire endurance resistance test, a superimposed load shall be applied to the specimen to simulate a maximum load condition. [ROP 251-2]

11.3.1 The maximum load condition shall be, as nearly as practicable, the maximum load allowed by the limiting condition of design under nationally recognized structural design criteria.

11.3.2 A fire endurance test shall be permitted to be conducted by applying a restricted load condition to the specimen that shall be identified for a specific load condition other than the maximum permitted load condition.

11.4 Temperature Measurement.

11.4.1 For specimens using structural members (e.g., beams, open-web steel joists) spaced at more than 4 ft (1.2 m) on center, the following criteria shall be met:

- (1) The temperature of the steel in the structural members shall be measured by thermocouples at three or more sections spaced along the length of the members, with one section preferably located at midspan.
- (2) In cases where the cover thickness is not uniform along the specimen length, at least one of the sections at which temperatures are measured shall include the point of minimum cover.

11.4.2 For specimens using structural members (e.g., beams, open-web steel joists) spaced at 4 ft (1.2 m) on center or less, the temperature of the steel in the structural members shall be measured by four thermocouples placed on each member, and the following criteria also shall be met:

- (1) No more than four members shall be so instrumented.
- (2) The thermocouples shall be placed at significant locations, such as at midspan, over joints in the ceiling, and over light fixtures.

11.4.3 For reinforced or prestressed concrete structural members, thermocouples shall be located on each of the tension-reinforcing elements unless there are more than eight such elements, in which case thermocouples shall be placed on eight elements selected to obtain representative temperatures of all the elements.

11.4.4* For steel structural members, four thermocouples shall be located at each section.

11.4.4.1 Where only four thermocouples are required on a member, the thermocouples shall be permitted to be distributed along the member at significant locations as specified in 11.4.2.

11.4.4.2 Two thermocouples shall be located on the bottom of the bottom flange or chord, one on the web at the center, and one on the top flange or chord.

11.4.5* For steel floor or roof units, four thermocouples shall be located as follows on each section, which shall equal the width of one unit:

- (1) One located on the bottom plane of the unit at an edge joint
- (2) One located on the bottom plane of the unit remote from the edge
- (3) One located on a sidewall of the unit
- (4) One located on the top plane of the unit

11.4.5.1 The thermocouples shall be applied, where practicable, to the surface of the units that are remote from fire and shall be spaced across the width of the unit.

11.4.5.2 Not more than four nor fewer than two sections shall be required to be instrumented as specified in 11.4.5 and 11.4.5.1 in each representative span.

11.4.5.3 The groups of four thermocouples shall be placed in representative locations.

11.5 Conditions of Acceptance — Restrained Assembly. In obtaining a restrained assembly classification fire resistance rating, the following conditions shall be met: [ROP 251-2]

- (1) The specimen shall sustain the applied load during the classification-period fire test exposure period without developing unexposed surface conditions that ignite cotton waste. [ROP 251-2]

- (2) The transmission of heat through the specimen during the classification-period fire test exposure period shall not raise the average temperature on its unexposed surface more than 250°F (140°C) above its initial temperature. [ROP 251-2]
- (3) For specimens using steel structural members (e.g., beams, open-web steel joists) spaced more than 4 ft (1.2 m) on center, the beams shall achieve a classification fire resistance rating on the basis of the temperature criteria specified in Section 11.6(3), (4), (5), or (6) for assembly classifications ratings up to and including 1 hour. [ROP 251-2]
- (4) For specimens using steel structural members, as specified in 11.5(3) and tested for classifications greater than 1 hour, the temperature criteria of Section 11.6(3), (4), (5), or (6) shall apply for a period equal to one-half the period for the classification fire resistance rating of the assembly or 1 hour, whichever is greater. [ROP 251-2]
- (5) For specimens using steel structural members (e.g., beams, open-web steel joists) spaced 4 ft (1.2 m) or less on center, the assembly shall achieve a classification fire resistance rating on the basis of the temperature criteria specified in Section 11.6(4) for assembly classifications fire resistance ratings up to and including 1 hour. [ROP 251-2]
- (6) For specimens using steel structural members, as specified in Section 11.5(5) and tested for classifications fire resistance ratings greater than 1 hour, the temperature criteria of Section 11.6(4) shall apply for a period equal to one-half the period for the classifications fire resistance rating of the assembly or 1 hour, whichever is greater. [ROP 251-2]
- (7) For specimens using conventionally designed concrete beams spaced more than 4 ft (1.2 m) on center, the assembly shall achieve a classification fire resistance rating on the basis of the temperature criteria specified in Section 11.6(5) for assembly classifications fire resistance rating up to and including 1 hour. [ROP 251-2]
- (8) For specimens using conventionally designed concrete beams, as specified in Section 11.5(7) and tested for classification fire resistance rating greater than 1 hour, the temperature of Section 11.6(5) criteria shall apply for a period equal to one-half the period for the classification fire resistance rating of the assembly or 1 hour, whichever is greater. [ROP 251-2]

11.6 Conditions of Acceptance — Unrestrained Assembly. In obtaining an unrestrained assembly classification fire resistance rating, the following conditions shall be met: [ROP 251-2]

- (1) The specimen shall sustain the applied load during the classification-period fire test exposure period without developing unexposed surface conditions that ignite cotton waste. [ROP 251-2]
- (2) The transmission of heat through the specimen during the classification-period fire test exposure period shall not raise the average temperature on its unexposed surface more than 250°F (140°C) above the specimen's initial temperature. [ROP 251-2]
- (3) For specimens using steel structural members (e.g., beams, open-web steel joists) spaced more than 4 ft (1.2 m) on center, the following criteria shall be met:
 - (a) The temperature of the steel shall not exceed 1300°F (704°C) at any location during the classification-period fire test exposure period. [ROP 251-2]
 - (b) The average temperature recorded by four thermocouples at any section shall not exceed 1100°F (593°C) during the classification-period fire test exposure period. [ROP 251-2]
- (4) For specimens using steel structural members (e.g., beams, open-web steel joists) spaced 4 ft (1.2 m) or less on center, the average temperature recorded by all joist or beam thermocouples shall not exceed 1100°F (593°C) during the classification-period fire test exposure period. [ROP 251-2]
- (5) For specimens using conventionally designed concrete structural members (excluding cast-in-place concrete slabs having spans equal to or less than those tested), the average temperature of the tension steel at any section during the classification-period fire test exposure period shall not exceed the following: [ROP 251-2]
 - (a) 800°F (426°C) for cold-drawn prestressing steel
 - (b) 1100°F (593°C) for reinforcing steel [ROP 251-2]
- (6) For specimens using steel floor or roof units intended for use in spans greater than those tested, the average temperature recorded by all thermocouples located on any one span of the floor or roof unit shall not exceed 1100°F (593°C) during the classification-period fire test exposure period. [ROP 251-2]

Chapter 12 Tests of Loaded Restrained Beams

12.1 Application. An individual fire resistance rating of a restrained beam shall be permitted to be determined by this test procedure and shall be based

on the conditions of acceptance specified in Section 12.4.

12.1.1 This ~~fire endurance classification~~ fire resistance rating shall apply to the beam where used with a floor or roof construction that has a comparable or greater capacity for heat dissipation from the beam than the floor or roof with which it is tested. [ROP 251-2]

12.1.2 The ~~fire endurance classification~~ fire resistance rating determined by this method shall not apply to beams smaller than those tested. [ROP 251-2]

12.2 Size and Characteristics of Specimen. The test specimen shall be installed in accordance with the recommended fabrication procedures for the type of construction and shall be representative of the design for which the ~~fire endurance classification~~ fire resistance rating is to be determined. [ROP 251-2]

12.2.1 The length of beam exposed to the fire shall be not less than 12 ft (3.7 m), and the member shall be tested in its normal horizontal position.

12.2.2 A section of a representative floor or roof construction not more than 7 ft (2.1 m) wide, symmetrically located with reference to the beam, shall be permitted to be included with the test specimen and exposed to the fire from below.

12.2.3 The beam, including that part of the floor or roof element forming the complete beam as designed (such as composite steel or concrete construction), shall be restrained against longitudinal thermal expansion in a manner simulating the restraint in the construction represented.

12.2.4 Only that part of the perimeter of the floor or roof element specimen that forms part of a beam as designed shall be supported or restrained.

12.3 Loading.

12.3.1 Throughout the fire endurance test, a superimposed load shall be applied to the specimen.

12.3.2 The superimposed load, together with the weight of the specimen, shall be, as nearly as practicable, the maximum theoretical dead and live loads permitted by nationally recognized design standards.

12.4 Conditions of Acceptance. The following conditions shall be met:

- (1) The specimen shall sustain the applied load during the ~~classification period~~ fire test exposure period. [ROP 251-2]
- (2) The specimen shall achieve a ~~classification~~ fire resistance rating on the basis of the temperature criteria specified in Section 11.6(3), (4), or (5) equal to one-half the period for the ~~classification~~ fire resistance rating of the assembly or 1 hour, whichever is greater. [ROP 251-2]

Chapter 13 Alternative Procedure for Loaded Beams

13.1 Application. Individual unrestrained ~~classifications~~ fire resistance ratings shall be permitted to be determined for beams tested as part of a floor or roof assembly as described in Sections 11.1 through 11.4 (except 11.1.3) or for restrained beams tested in accordance with the procedure described in Sections 12.1 through 12.3. [ROP 251-2]

13.1.1 These ~~classifications~~ fire resistance ratings shall apply to beams where used with a floor or roof construction that has a comparable or greater capacity for heat dissipation from the beam than the floor or roof with which it is tested. [ROP 251-2]

13.1.2 The ~~classifications~~ fire resistance ratings determined by this method shall not apply to beams smaller than those tested. [ROP 251-2]

13.2 Temperature Measurement.

13.2.1 The temperature of the steel in structural members shall be measured by thermocouples at three or more sections spaced along the length of the members, with one section preferably located at midspan.

13.2.2 In cases where cover thickness is not uniform along the specimen length, at least one of the sections at which temperatures are measured shall include the point of minimum cover.

13.2.3 For steel beams, four thermocouples shall be located at each section as follows:

- (1) Two located on the bottom of the bottom flange
- (2) One located on the web at the center
- (3) One located on the bottom of the top flange

13.2.4 For reinforced or prestressed concrete structural members, thermocouples shall be located on each of the tension-reinforcing elements unless there are more than eight such elements, in which case thermocouples shall be placed on eight elements selected to obtain representative temperatures of all the elements.

13.3 Conditions of Acceptance. In obtaining an unrestrained beam ~~classification~~ fire resistance rating, the following conditions shall be met: [ROP 251-2]

- (1) The specimen shall sustain the applied load during the ~~classification period~~ fire test exposure period. [ROP 251-2]
- (2) For steel beams, the following criteria shall be met:

- (a) The temperature of the steel shall not exceed 1300°F (704°C) at any location during the ~~classification period~~ fire test exposure period. [ROP 251-2]
 - (b) The average temperature recorded by four thermocouples at any section shall not exceed 1100°F (593°C) during the exposure period.
- (3) For conventionally designed concrete beams, the average temperature of the tension steel at any section during the fire test exposure shall not exceed the following:
 - (a) 800°F (426°C) for cold-drawn prestressing steel
 - (b) 1100°F (593°C) for reinforcing steel

Chapter 14 Alternative Test of Protection for Solid Structural Steel Beams and Girders

14.1 Application.

14.1.1 Where the loading required in Section 11.3 is not feasible, this alternative test procedure shall be permitted to be used to evaluate the protection of steel beams and girders without application of design load, provided that the protection is not required by design to function structurally in resisting applied loads.

14.1.2 The conditions of acceptance of this alternative test shall not apply to tests performed under design load as provided in tests for floors and roofs in Sections 11.2, 11.5, and 11.6.

14.2 Size and Character of Specimen.

14.2.1 The size of the steel beam or girder shall be a true representation of the design, materials, and workmanship required for the ~~classification~~ fire resistance rating desired. [ROP 251-2]

14.2.1.1 The protection shall be applied in accordance with the methods of field practice, and the projection below the ceiling, if any, shall be representative of the conditions of intended use.

14.2.1.2 The length of the beam or girder exposed to the fire shall be not less than 12 ft (3.7 m), and the member shall be tested in a horizontal position.

14.2.1.3 A section of a representative floor construction not less than 5 ft (1.5 m) wide, symmetrically located with reference to the beam or girder and extending its full length, shall be included in the test assembly and exposed to fire from below.

14.2.1.4 The rating of performance shall not apply to beams or girders smaller than those tested.

14.2.2 The applied protection shall be restrained against longitudinal expansion greater than that of the steel beam or girder by rigid steel plates or reinforced concrete attached to the ends of the specimen before the protection is applied.

14.2.3 The ends of the specimen, including the means for restraint, shall be provided with sufficient thermal insulation to prevent appreciable direct heat transfer from the furnace to the unexposed ends of the specimen or from the ends of the specimen to the outside of the furnace.

14.3 Temperature Measurement. The temperature of the steel in the beam or girder shall be measured with not less than four thermocouples.

14.3.1 The thermocouples shall be located at each of four sections equally spaced along the length of the beam, symmetrically disposed, and not nearer than 2 ft (0.6 m) from the inside face of the furnace.

14.3.2 The thermocouples at each section shall be placed symmetrically so as to measure significant temperatures of the component elements of the steel section.

14.4 Conditions of Acceptance. The test shall be accepted as valid if the transmission of heat through the protection during the period of fire exposure required for the ~~classification~~ fire resistance rating desired meets one of the following: [ROP 251-2]

- (1) It does not raise the average (arithmetical) temperature of the steel at any one of the four sections above 1000°F (538°C).
- (2) It does not raise the temperature above 1200°F (649°C) at any one of the measured points.

Chapter 15 Performance of Protective Membranes in Wall, Partition, Floor, or Roof Assemblies

15.1 Application.

15.1.1 Where the thermal protection afforded by membrane elements in wall, partition, floor, or roof assemblies is to be determined, the nonstructural performance of protective membranes shall be obtained by following the procedure outlined in Sections 15.2 through 15.4.

15.1.2 The performance of protective membranes is supplementary information only and shall not be used as a substitute for the ~~fire endurance classification~~ fire resistance rating determined by Chapters 7 through 14.

15.2 Characteristics and Size of Sample.

15.2.1 The characteristics of the sample shall conform to 5.1.1.

15.2.2 The size of the sample shall conform to one of the following:

- (1) Section 7.1, for bearing walls and partitions
- (2) Section 8.1, for nonbearing walls and partitions
- (3) Subsection 11.2.1, for floors or roofs

15.3 Temperature Performance of Protective Membranes.

15.3.1 The temperature performance of protective membranes shall be measured with thermocouples, the measuring junctions of which shall be in intimate contact with the exposed surface of the elements being protected.

15.3.1.1 The diameter of the wires used to form the thermo-junction shall not be greater than the thickness of sheet metal framing or panel members to which they are attached, and in no case shall they be greater than 18 AWG gauge [0.040 in. (1.02 mm)].

15.3.1.2 The lead shall be electrically insulated with heat-resistant and moisture-resistant coatings.

15.3.2 For each class of elements protected, temperature readings shall be taken at not less than five representative points.

15.3.2.1 None of the thermocouples shall be located nearer to the edges of the test assembly than 12 in. (305 mm).

15.3.2.2 In those cases in which there exists an element or feature of the construction that is not otherwise represented in the test assembly, thermocouples shall be permitted to be located closer to the edges of the test assembly than 12 in. (305 mm).

15.3.2.3 None of the thermocouples shall be located opposite, on top of, or adjacent to fasteners such as screws, nails, or staples where such locations are excluded for thermocouple placement on the unexposed surface of the test assembly as detailed in 4.3.2.

15.3.3 Thermocouples shall be located to obtain representative information on the temperature of the interface between the exposed membrane and the substratum or element being protected.

15.3.4 Temperature readings shall be taken at intervals not exceeding 1 minute for the duration of the test.

15.4 Conditions of Performance. Unless otherwise specified, the performance of protective membranes shall be considered to be the time at which the following conditions occur:

- (1) The average temperature rise of any set of thermocouples for each class of element protected is more than 250°F (140°C) above the initial temperature.
- (2) The temperature rise of any one thermocouple of the set for each class of element protected is more than 325°F (180°C) above the initial temperature.

Chapter 16 Report of Results

16.1 Classification Fire Resistance Rating as Determined by Test. [ROP 251-2]

16.1.1 Results shall be reported in accordance with the performance specifications in the tests prescribed in these methods.

16.1.1.1 The time of resistance shall be expressed as the nearest integral minute.

16.1.1.2 Reports shall include observations of significant details of the behavior of the material or construction during the test and after the furnace fire is cut off, including information on the following:

- (1) Deformation
- (2) Spalling
- (3) Cracking
- (4) Burning of the specimen or its component parts
- (5) Continued flaming
- (6) Production of smoke

16.1.2 Reports of tests involving wall, floor, beam, or ceiling constructions in which restraint is provided against expansion, contraction, or rotation of the construction shall describe the method used to provide this restraint.

16.1.3 Reports of tests in which other than maximum load conditions (*see Section 11.3*) are imposed shall fully define the conditions of loading used in the test and shall be designated in the title of the test report as a restricted load condition.

16.1.4* Where the indicated resistance period is $\frac{1}{2}$ hour or more, as determined by the average or maximum temperature rise on the unexposed surface or within the test specimen or by failure under load, an adjustment shall be made for variation of the furnace exposure from that prescribed.

16.1.4.1 In those cases where the adjustment will affect the classification fire resistance rating, it shall be made using the following two consecutive steps: [ROP 251-2]

- (1) Multiplying the indicated resistance period by two-thirds of the difference in the area between the curve of the average furnace temperature and the standard curve for the first three-fourths of the period

- (2) Dividing the product determined in 16.1.4.1(1) by the area between the standard curve and a baseline of 68°F (20°C) for the same portion of the indicated period

16.1.4.2 The area specified in 16.1.4.1(2) shall be increased by 54°F-hr or 30°C-hr (3240°F-min or 1800°C-min) to compensate for the thermal lag of the furnace thermocouples during the first part of the test.

16.1.4.3 For fire exposure that occurs during the test that is higher than standard, the indicated resistance period shall be increased by the amount of the correction and shall similarly be decreased for fire exposure below standard.

16.1.5 Asymmetrical wall assemblies shall be permitted to be tested as follows:

- (1) Either side exposed to the fire, with the report indicating the side so exposed
- (2) Both sides tested, with the report indicating the classification fire resistance rating applicable to each side [ROP 251-2]

16.2 Test of Floor and Roof Assemblies.

16.2.1 The classification fire resistance rating of a restrained assembly shall be reported as that developed by applying the conditions of acceptance specified in Sections 11.5(1) through 11.5(5). [ROP 251-2]

16.2.2 The classification fire resistance rating of an unrestrained assembly shall be reported as that determined by applying the conditions of acceptance to a specimen tested in accordance with this test procedure as specified in Sections 11.6(1) and (2) and, where applicable, Sections 11.6(3), through (5), or Section 11.6(6). [ROP 251-2]

16.3 Performance of Protective Membranes.

16.3.1 The protective membrane performance for each class of element being protected shall be reported to the nearest integral minute.

16.3.2 The test report shall identify each class of element being protected and shall show the location of each thermocouple.

16.3.3 The test report shall show the temperature–time data recorded for each thermocouple and the average temperature for the set of thermocouples on each element being protected.

16.3.4 The test report shall record any visual observations that are pertinent to the performance of the protective membrane.

16.4 Tests of Load-Bearing Assemblies. Reports of tests in which loading is used shall describe the following:

- (1) How the applied load was calculated
- (2) Design standard used
- (3) Governing stress in each structural member (e.g., bending, shear)
- (4) Details of the system used to apply the load
- (5) Time of load application relative to the start and finish of the test

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 The performance of walls, columns, floors, and other building members under fire exposure conditions is an issue of major importance in ensuring construction that is safe and not a menace to neighboring structures or the public. This factor is recognized by the codes of many authorities, municipal and otherwise.

It is important to create a balance among the many units in a single building and in buildings of like character and use in a community, and also to promote uniformity in the requirements of the various authorities throughout the country. Therefore, it is necessary that the fire-resistive properties of materials and assemblies be measured and specified in accordance with a common standard and expressed in terms that are applicable to a wide variety of materials, situations, and conditions of exposure.

These test methods are such a standard. They prescribe a uniform exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure that elapses before the first critical point in behavior is observed. Results are reported in units in which field exposures can be judged and expressed.

The methods are cited as the “Standard Fire Tests,” and the performance or exposure is expressed as “2 hr,” “6 hr,” “ $\frac{1}{2}$ hr,” and so forth. Where a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified classification fire resistance rating. [ROP 251-2]

A.1.2.2 A method of fire hazard classification based on rate of flame spread is covered in NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

[ROP 251-14]

A.1.2.3 These methods prescribe a standard fire exposure for comparing the

performance of building construction assemblies. Application of these test results to predict the performance of actual building construction requires careful evaluation of test conditions.

A.3.3.1 Fire Resistance. As applied to elements of buildings, fire resistance is characterized by the ability to confine a fire or to continue to perform a given structural function or both. More specific examples of this ability include retention of stability, integrity, or thermal insulation. Once a measure of time is defined for fire resistance, and exposure conditions specified for that measure, the result is a fire resistance rating. The term *fire endurance* is often used with the same meaning as fire resistance. [ROP 251-7]

A.3.3.2 Fire Resistance Rating. Once a measure of time is obtained for fire resistance using NFPA 251, that result is the fire resistance rating. The term *fire endurance classification* has been used with the same meaning as fire resistance rating. [ROP 251-7]

A.4.1.1 For a more precise definition of the temperature–time curve, see Annex B.

A.4.2 The following provides guidance on the desired characteristics of instrumentation for recording the flow of fuel to the furnace burners. Fuel flow data is useful for a furnace heat balance analysis, for measuring the effect of furnace or control changes, and for comparing the performance of assemblies of different properties in the fire endurance test.

The integrated (cumulative) flow of gas (or other fuel) to the furnace burners should be recorded at 10 minutes, 20 minutes, 30 minutes, and at least every 30 minutes thereafter. The total gas consumed during the test period also should be determined. A recording flowmeter has advantages over periodic readings on an instantaneous or totalizing flowmeter. A measuring and recording system should be selected to provide flow rate readings accurate to within ± 5 percent.

The type of fuel, its higher (gross) heating value, and the fuel flow [corrected to standard conditions of 60°F (16°C) and 30.0 in. Hg] as a function of time should be reported.

A.4.2.1 A typical thermocouple assembly that meets specified time constant requirements can be fabricated by fusion-welding the twisted ends of 18 AWG Chromel-Alumel wires, mounting the leads in porcelain insulators, and inserting the assembly so the thermocouple bead is $\frac{1}{2}$ in. (13 mm) from the sealed end of a standard weight nominal $\frac{1}{2}$ in. (13 mm) iron, steel, or Inconel® pipe. The time constant for this and for several other thermocouple assemblies was measured in 1976. The time constant is also calculated from knowledge of the thermocouple assembly's physical and thermal properties.

A.4.3.1 Under certain conditions, it is unsafe or impracticable to use thermometers.

For the purpose of testing roof assemblies, the unexposed surface is defined as the surface exposed to ambient air.

Additional information on refractory pads can be found in Section C.1.

A.4.3.1.1(5) Modified Brinell values of hardness are obtained from the following equation,

$$\text{Hardness} = \frac{2.24}{y}$$

where

y = the measured indentation in inches:

[ROP 251-8]

A.4.4.5.2 This is equivalent to a 3-minute running average. [ROP 251-9]

A.5.2.6 A recommended method for determining the relative humidity within a hardened concrete specimen with electric sensing elements is described in Annex I of Menzel, "A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity." A similar procedure with electric sensing elements can be used to determine the relative humidity within fire test specimens made with other materials.

With wood constructions, the moisture meter based on the electrical resistance method can be used, where appropriate, as an alternative to the relative humidity method to indicate when wood has attained the proper moisture control. Electrical methods are described on pages 320 and 321 of the 1955 edition of the "Wood Handbook of the Forest Products Laboratory," U.S. Department of Agriculture.

The relationships between relative humidity and moisture content are illustrated by the graphs in Figure 23 on p. 327 of the "Wood Handbook of the Forest Products Laboratory." They indicate that wood has a moisture content of 13 percent at a relative humidity of 70 percent for a temperature of 70°F to 80°F (21°C to 27°C).

A.5.2.8 If the moisture condition of the fire test assembly is likely to change drastically from the sample taken 72 hours prior to this test, the sample should be taken not later than 24 hours prior to the test.

A.7.2 The choice depends on the intended use and whether the load on the exposed side will be transferred to the unexposed side after the exposed side has failed.

If, in the intended use, the load from the structure above is supported by both walls as a unit and would be or is transferred to the unexposed side in the event of collapse of the exposed side, both walls should be loaded for the test by a single unit.

If, in the intended use, the load from the structure above each wall is supported by each wall separately, the walls should be loaded separately for the test by separate load sources.

In tests conducted with the walls loaded separately, the condition of acceptance requiring the walls to maintain the applied load is based on the time at which the first wall fails to sustain the load.

If the intended use of the construction system being tested involves situations of both loading conditions described above, the walls should be loaded separately for the test by separate load sources.

A.11.1.2 Annex E should be consulted for guidance in determining the conditions of thermal restraint that apply to floor and roof constructions and individual beams in actual building construction.

A.11.4.4 Figure A.11.4.4 provides examples of thermocouple distribution at each section.

FIGURE A.11.4.4 Examples of Thermocouple Distribution. [Existing Figure A-9-4.4, 99 ed., (no change)]

A.11.4.5 Figure A.11.4.5 provides examples of typical thermocouple locations for a unit section.

FIGURE A.11.4.5 Typical Location of Thermocouples. [Existing Figure A-9-4.5, 99 ed., (no change)]

A.16.1.4 The correction can be expressed by the following formula:

$$C = \frac{2I(A - A_s)}{3(A_s + L)}$$

where:

- C = correction in the same units as I
- I = indicated fire resistance period
- A = area under the curve of the indicated average furnace temperature for the first three-fourths of the indicated period
- A_s = area under the standard furnace curve for the same part of the indicated period
- L = lag correction in the same units as A and A_s [54°F-hr or 30°C-hr (3240°F-min or 1800°C-min)]

Annex B Operating Criteria for Fire Tests

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Temperature–Time Curve. Control of fire tests for testing of fire-rated assemblies should be done as demonstrated by the standard temperature–time curve as highlighted in Table B.1.

Annex C Recommendations for Thermocouple Pads

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Refractory Fiber Pads. Specific product information is being provided for informational purposes only and has not been independently verified, certified, or endorsed by NFPA or any of its Technical Committees.

C.1.1 Comparative fire tests have demonstrated that a refractory fiber material designated Ceraform 126®, placed with the softer surfaces in contact with the thermocouple, can be substituted for the previously specified asbestos pad where the distortion of the unexposed face of the sample is minimal. Ceraform 126® is a registered trade name of Manville Specialty Products Group, P.O. Box 5108, Denver, CO 80217.

C.1.2 The pads are relatively rigid and should not be used on surfaces subject to sharp distortions or discontinuities during the test.

C.2 Properties of Ceraform 126. The properties of Ceraform 126® material are as follows:

- (1) Length and width, 6 in. $\pm \frac{1}{8}$ in. (152 mm \pm 3 mm)
- (2) Thickness, 0.375 in. \pm 0.063 in. (9.5 mm \pm 1.6 mm), with measurement made under the light load of a $\frac{1}{2}$ in. (13 mm) diameter pad of a dial micrometer gauge
- (3) Thermal conductivity [at 150°F (66°C)], 0.37 Btu-in./hr-ft²-°F \pm 0.03 Btu-in./hr-ft²-°F (0.053 W/m-K \pm 0.004 W/m-K)
- (4) Pads shaped by wetting, forming, and then drying to constant weight to provide complete contact on sharply contoured surfaces

C.3 Supporting Data. Supporting data are available from The American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Request RR:E05-1004.

Table B.1 Standard Temperature–Time Curve for Control of Fire Tests

Time (hr: min)	Temperature		Area Above 68°F Base		Temperature		Area Above 20°C Base	
	°F	°F-min	°F-hr	°C	°C-min	°C-hr		
0:00	68	0	0	20	0	0		
0:05	1000	2330	39	538	1290	22		
0:10	1300	7740	129	704	4300	72		
0:15	1399	14,150	236	760	7860	131		
0:20	1462	20,970	350	795	11 650	194		
0:25	1510	28,050	468	821	15 590	260		
0:30	1550	35,360	589	843	19 650	328		
0:35	1584	42,860	714	862	23 810	397		
0:40	1613	50,510	842	878	28 060	468		
0:45	1638	58,300	971	892	32 390	540		
0:50	1661	66,200	1103	905	36 780	613		
0:55	1681	74,220	1287	916	41 230	687		
1:00	1700	82,330	1372	927	45 740	762		
1:05	1718	90,540	1509	937	50 300	838		
1:10	1735	98,830	1647	946	54 910	915		
1:15	1750	107,200	1787	955	59 560	993		
1:20	1765	115,650	1928	963	64 250	1071		
1:25	1779	124,180	2070	971	68 990	1150		
1:30	1792	132,760	2213	978	73 760	1229		
1:35	1804	141,420	2357	985	78 560	1309		
1:40	1815	150,120	2502	991	83 400	1390		
1:45	1826	158,890	2648	996	88 280	1471		
1:50	1835	167,700	2795	1001	93 170	1553		
1:55	1843	176,550	2942	1006	98 080	1635		
2:00	1850	185,440	3091	1010	103 020	1717		
2:10	1862	203,330	3389	1017	112 960	1882		
2:20	1875	221,330	3689	1024	122 960	2049		
2:30	1888	239,470	3991	1031	133 040	2217		
2:40	1900	257,720	4295	1038	143 180	2386		
2:50	1912	276,110	4602	1045	153 390	2556		
3:00	1925	294,610	4910	1052	163 670	2728		
3:10	1938	313,250	5221	1059	174 030	2900		
3:20	1950	332,000	5533	1066	184 450	3074		
3:30	1962	350,890	5848	1072	194 940	3249		
3:40	1975	369,890	6165	1079	205 500	3425		
3:50	1988	389,030	6484	1086	216 130	3602		
4:00	2000	408,280	6805	1093	226 820	3780		
4:10	2012	427,670	7128	1100	237 590	3960		
4:20	2025	447,180	7453	1107	248 430	4140		
4:30	2038	466,810	7780	1114	259 340	4322		
4:40	2050	486,560	8110	1121	270 310	4505		
4:50	2062	506,450	8441	1128	281 360	4689		
5:00	2075	526,450	8774	1135	282 470	4874		
5:10	2088	546,580	9110	1142	303 660	5061		
5:20	2100	566,840	9447	1149	314 910	5248		
5:30	2112	587,220	9787	1156	326 240	5437		
5:40	2125	607,730	10,129	1163	337 630	5627		

5:50	2138	628,360	10,473	1170	349 090	5818
6:00	2150	649,120	10,819	1177	360 620	6010
6:10	2162	670,000	11,167	1184	372 230	6204
6:20	2175	691,010	11,517	1191	383 900	6398
6:30	2188	712,140	11,869	1198	395 640	6594
6:40	2200	733,400	12,223	1204	407 450	6791
6:50	2212	754,780	12,580	1211	419 330	6989
7:00	2225	776,290	12,938	1218	431 270	7188
7:10	2238	797,920	13,299	1225	443 290	7388
7:20	2250	819,680	13,661	1232	455 380	7590
7:30	2262	841,560	14,026	1239	467 540	7792
7:40	2275	863,570	14,393	1246	479 760	7996
7:50	2288	885,700	14,762	1253	492 060	8201
8:00	2300	907,960	15,133	1260	504 420	8407

Annex D Report Information

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Sample Report Form. See Figure D.1 for a sample of a report form cover sheet.

FIGURE D.1 Sample Report Cover Sheet. [Existing Figure D.1, 99 ed., (no change)]

D.2 Description of Laboratory Test Facility. Describe items such as the furnace, restraining frame, and details of end conditions, including wedges, and bearing.

D.2.1 If construction is to be tested under load, indicate how the load is applied and controlled (provide loading diagram). Indicate whether the load is a maximum load condition or a restricted load condition, and, for either condition, report the specific loads and the basis for limitation, such as bending stress, and shear. A restricted load condition is reported as a percentage of the maximum load condition.

D.2.2 If construction is to be tested as nonload-bearing, indicate whether the frame is rigid or moves during the test, or whether the test is for temperature rise only.

D.3 Description of All Materials. Describe type, size, class, strength, densities, trade name, and any additional data necessary to define materials. The testing laboratory should indicate whether materials meet NFPA standards by markings, by statement of sponsor, or by physical or chemical test by the testing laboratory.

D.4 Description of Test Assembly. The following information should be provided:

- (1) Size of test specimen
- (2) Details of structural design, including safety factors of all structural members in test assembly
- (3) Plan, elevation, principal cross section, and other sections as needed for clarity
- (4) Details of attachment of test panel in frame
- (5) Location of thermocouples, deflection points, and other items for test
- (6) Description of general ambient conditions for all of the following times:
 - (a) Time of construction
 - (b) During curing (time from construction to test)
 - (c) Time of test

D.5 Description of Test. The following information should be reported:

- (1) Temperature at start of test and every 1 minute thereafter
- (2) Where charts are included in report, clear indication of time and temperature for all of the following:
 - (a) In furnace space
 - (b) On unexposed surface
 - (c) On protected framing members as stipulated in this standard

- (3) Temperature observations that are useful but not required by this standard, documented in the annex to the report, and include the following:
 - (a) Temperatures on the face of framing members in back of protection
 - (b) Other temperatures required by various building codes
- (4) Furnace pressure at start of test and every 1 minute thereafter
- (5) Deflections every 5 minutes for the first 15 minutes of test and during the last hour with a report every 10 minutes in between
- (6) Appearance of exposed face as follows:
 - (a) Every 15 minutes
 - (b) When any noticeable development occurs, including cracking, buckling, flaming, smoking, and loss of material, with provision of details and time
 - (c) At end of test, including items such as amount of dropout, condition of fasteners, and sag
- (7) Appearance of unexposed face as follows:
 - (a) Every 15 minutes
 - (b) When any noticeable development occurs, including cracking, smoking, and buckling, with provision of details and time
 - (c) At end of test
- (8) Time of failure caused by the following:
 - (a) Temperature rise
 - (b) Failure to carry load
 - (c) Passage of flame, heat, and smoke

D.6 Hose Stream Test. If a hose stream test is required, repeat appropriate parts of Sections D.2 and D.4. If failure occurs in the hose stream test, provide a description.

D.7 Official Comments. The following information should be included:

- (1) Statement to the effect that the construction is a true representation of field construction or, where construction does not represent typical field construction, notation of deviations
- (2) If construction is asymmetrical (different details on each face), specification of which face is exposed to the fire, with comments on fire resistance from opposite side
- (3) Comment on fire test

D.8 Summary of Results. A summary of results should include the following:

- (1) Endurance time
- (2) Nature of failure
- (3) Hose stream test results

D.9 List of Official Observers. Provide signatures of responsible persons.

D.10 Annex. Include all data not specifically required by test standard but useful to better understanding of test results. Special observations for building code approvals should be included in the annex.

D.11 Photographs. Photographs should be used to show items not covered in a report or to clarify information and should include the following:

- (1) Assembly in construction
- (2) Exposed face prior to fire test
- (3) Unexposed face at start of endurance test, including recording equipment where possible
- (4) Unexposed face at end of fire endurance test
- (5) Exposed face at end of fire endurance test
- (6) Unexposed face at end of fire exposure before hose test
- (7) Exposed face at end of fire exposure before hose test
- (8) Exposed face after hose stream test
- (9) Unexposed face after hose stream test

D.12 Other Pertinent Information. It is essential to include the following:

- (1) Detailed drawing of test assembly
- (2) Photographs [see Sections D.11(1), (4), (8), and (9)] for every test report

Annex E Guide for Determining Conditions of Restraint for Floor and Roof Assemblies and for Individual Beams

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 Introduction. The revisions adopted in 1970 introduced, for the first time in the history of this standard, the concept of classifications fire resistance ratings based on two conditions of support: restrained and unrestrained. As a result, most specimens are fire tested in a manner that seeks to derive these two classifications fire resistance ratings. [ROP 251-2]

E.1.1 A restrained condition in fire tests, as used in this method, is one in which expansion at the supports of a load-carrying element resulting from the effects of fire is resisted by forces external to the element. An unrestrained condition is one in which the load-carrying element is free to expand and rotate at its supports.

E.1.2 It is recognized that there can be some difficulty in determining the condition of restraint that is anticipated at elevated temperatures in actual structures. Until a more satisfactory method is developed, it is recommended that all construction should be classified temporarily as either restrained or unrestrained. This classification fire resistance rating enables the architect, engineer, or building official to correlate the classification fire resistance rating, based on conditions of restraint, with the construction type under consideration. [ROP 251-2]

E.1.3 For the purpose of this annex, restraint in buildings is defined as follows: Floor and roof assemblies and individual beams in buildings are considered restrained where the surrounding or supporting structure is capable of resisting substantial thermal expansion throughout the range of anticipated elevated temperatures. Construction not complying with this definition is assumed to be free to rotate and expand and therefore is considered as unrestrained.

E.1.4 The definition of restraint in buildings specified in E.1.3 necessitates the exercise of engineering judgment to determine what constitutes restraint to substantial thermal expansion. Restraint can be provided by the lateral stiffness of supports for floor and roof assemblies and intermediate beams forming part of the assembly. In order to develop restraint, connections have to adequately transfer thermal thrusts to such supports. The rigidity of adjoining panels or structures should be considered in assessing the capability of a structure to resist thermal expansion. Continuity, such as that occurring in beams acting continuously over more than two supports, induces rotational restraint that usually adds to the fire resistance of structural members.

E.1.5 Table E.1.5 specifies only the common types of constructions. These classifications fire resistance ratings, as well as the philosophy expressed in A.1.1, are helpful in determining the less common types of construction. [ROP 251-2]

E.1.6 The foregoing methods of establishing the presence or absence of restraint according to type and detail of construction are considered to be temporary but necessary for the determination of dual classifications fire resistance ratings. It is anticipated that methods for realistically predetermining the degree of restraint applicable to a particular classification fire resistance rating will be developed soon. [ROP 251-2]

Table E.1.5 Construction Classifications, Restrained and Unrestrained

I. Wall Bearing	
Single span and simply supported end spans of multiple bays: ¹	
1. Open-web steel joists or steel beams, supporting concrete slab, precast units, or metal decking	unrestrained
2. Concrete slabs, precast units, or metal decking	unrestrained
Interior spans of multiple bays:	
1. Open-web steel joists, steel beams or metal decking, supporting continuous concrete slab	restrained
2. Open-web steel joists or steel beams, supporting precast units or metal decking	unrestrained
3. Cast-in-place concrete slab systems	restrained
4. Precast concrete where the potential thermal expansion is resisted by adjacent construction ²	restrained
II. Steel Framing.	
1. Steel beams welded, riveted, or bolted to the framing members	restrained
2. All types of cast-in-place floor and roof systems (such as beams-and-slabs, flat slabs, pan joists, and waffle slabs) in which the floor or roof system is secured to the framing members	restrained
3. All types of prefabricated floor or roof systems in which the structural members are secured to the framing members and the potential thermal expansion of the floor or roof system is resisted by the framing system or the adjoining floor or roof construction ²	restrained
III. Concrete Framing.	
1. Beams securely fastened to the framing members	restrained
2. All types of cast-in-place floor or roof systems (such as beam-and-slabs, flat slabs, pan joists, and waffle slabs) where the floor system is cast with the framing members	restrained
3. Interior and exterior spans of precast systems with cast-in-place joints resulting in restraint equivalent to that which exists in condition III(I)	restrained
4. All types of prefabricated floor or roof systems in which the structural members are secured to such systems and the potential thermal expansion of the floor or roof system is resisted by the framing system or the adjoining floor or roof construction ²	restrained
IV. Wood Construction.	
All types.	unrestrained

¹Floor and roof systems can be considered restrained where they are tied to walls with or without tie beams, the walls being designed and detailed to resist thermal thrust from the floor or roof system.

²Resistance to potential thermal expansion is considered to be achieved where the following criteria are met:

- (a)Continuous structural concrete topping is used.
- (b)The space between the ends of precast units or between the ends of the units and the vertical face of supports is filled with concrete or mortar.
- (c)The space between the ends of precast units and the vertical faces of supports, or between the ends of solid or hollow core slab units, does not exceed 0.25 percent of the length for normal weight concrete members or 0.1 percent of the length for structural lightweight concrete members.

Annex F Method of Correcting Fire Endurance for Concrete Slabs Determined by Unexposed Surface Temperature Rise for Nonstandard Moisture Content

This annex is not a part of the requirements of this NFPA document but is

included for informational purposes only.

F.1 Scope.

F.1.1 The standard fire endurance is the time determined by the unexposed surface temperature rise of a test specimen at a standard moisture level.

F.1.2 This annex provides a procedure for correction of the fire endurance of unprotected vertical or horizontal slabs (solid or hollow) made from essentially inorganic building materials and conditioned on both sides, where moisture content at the time of test is other than at a standard moisture level.

F.1.3 Among the common inorganic building materials, only the hydrated Portland cement products can hold (after due conditioning in accordance with Section 5.2) sufficient amounts of moisture to affect the result of the fire test significantly. Consequently, correcting the experimental fire endurance of constructions containing less than 5 volume percent of Portland cement paste is not necessary.

F.2 Symbols. The symbols used in this annex are defined as follows:

- A = factor characterizing the drying conditions [see Table F.2(a)]
- b = factor characterizing the permeability of the specimen [see Table F.2(b)]
- FE = fire endurance of specimen (hr)
- m = moisture content in volume fraction (ft³/ft³ or cm³/cm³)
- m_a = average moisture content of test specimen
- m_c = average moisture content of cement paste
- m_e = nominal equilibrium moisture content of cement paste for a given relative humidity [see Table F.2(c)]
- m_{es} = equilibrium moisture content of cement paste at the standard relative humidity level [see Table F.2(c)]
- m_s = average moisture content of a standard conditioned concrete specimen of same concrete and cement paste volume as the test specimen
- RH = relative humidity
- v = volume fraction of cement paste (ft³/ft³ or cm³/cm³)

F.3 Calculation of Moisture Content.

F.3.1 The average moisture content (m_a) is the volume fraction of moisture [ft³/ft³ (cm³/cm³)] in the material relative to its dry condition, where dry condition is defined as that resulting when the material is heated in an oven at 221°F ± 1°F (105°C ± 0.5°C) until no further weight loss occurs.

F.3.2 The average moisture content of the cement paste can be estimated from the known value of RH at middepth (assuming the material has never been subject to rewetting) by calculating first the moisture content in the cement paste as follows:

$$m_c = A \cdot m_e$$

F.3.3 The average moisture content of the test specimen then is calculated as follows:

$$m_a = v \cdot m_c$$

F.3.4 The average moisture content of a standard conditioned specimen is calculated as follows:

$$m_s = v \cdot m_{es}$$

where m_{es} is the value of m_e in Table F.2(c) pertaining to the standard RH level.

F.4 Correction Procedure. The correction procedure begins with the selection of an empirical factor to reflect the permeability of the material as suggested in Table F.2(b). The known values of m_a and m_s are used to calculate the products bm_a and bm_s. On the nomograph (see Figure F.4), lines are drawn from point R to values of bm_a and bm_s on the right-hand scale. From the point representing the actual fire endurance time (FE) on the left-hand scale, a line is drawn parallel to R-bm_a to intersect the curve. From this point on the curve, a line is drawn parallel to R-bm_s and the corrected fire endurance is determined from the FE scale.

F.5 Example. A wall made from normal weight concrete having 23.2 volume percent of paste is conditioned at 200°F (93°C) and 5 percent RH until the RH at its middepth is reduced to 70 percent. It has a 2.90-hour fire endurance. The adjusted fire endurance is calculated as shown in F.5.1 through F.5.6.

F.5.1 Calculate m_a as follows:

For 70 percent RH,

$$m_c = 0.225 \text{ [see Table F.2(c)]}$$

For 200°F (93°C) and 5 percent RH conditioning, for normal weight concrete,

$$A = 0.45 \text{ [see Table F.2(a)]}$$

$$m_c = 0.45 \times 0.225 = 0.101 \text{ (see F.3.2)}$$

$$\text{For } v = 0.232$$

$$m_a = 0.232 \times 0.101 = 0.0234 \text{ (see F.3.3)}$$

that is, the concrete contains 2.34 volume percent moisture at time of test.

F.5.2 Calculate m_s as follows:

Example: If the standard moisture level is assumed to correspond to a middepth RH of 75 percent, m_e = 0.24, then

$$m_s = 0.232 \times 0.24 = 0.0557 \text{ (see F.3.4)}$$

that is, the standard moisture level is 5.57 volume percent.

F.5.3 Calculate bm as follows:

$$b = 5.5 \text{ [see Table F.2(b)]}$$

$$bm_a = 5.5 \times 0.0234 = 0.129$$

$$bm_s = 5.5 \times 0.0557 = 0.306$$

F.5.4 Draw lines on the nomogram from point R to bm_a and bm_s (see Figure F.5.4).

F.5.5 Draw a line from the FE ordinate, 2.90, parallel to line R-bm_a to intersect the curve.

F.5.6 Draw a line parallel to R-bm_s from a point on the curve to intersect the FE ordinate scale. The value, 3.19, is the adjusted fire endurance; that is, the fire endurance if the specimen had been tested at the standard moisture level, which is assumed in this example to correspond to 75 percent RH at middepth.

Table F.2(a) Factor Characterizing Drying Conditions

Conditioning Environment	Middepth RH of Test Specimen (%)	Factor A for Portland Cement	
		Normal Weight Concrete	Lightweight Concrete
60°F–80°F (15.6°C–26.7°C) atmospheric conditions	any	1.0	1.0
120°F–160°F (48.9°C–71.1°C), 2035%RH	7075	0.7	0.7
190°F–200°F (87.8°C–93.3°C), 05%RH	7075	0.45	0
120°F–200°F (48.9°C–93.3°C), 535%RH	less than 70	0	0

Table F.2(b) Factor Characterizing Permeability of Test Specimen

Material	b
Normal weight and gun-applied concrete [dry unit weight greater than 135 lb/ft ³ (2162 kg/m ³)]	5.5
Lightweight concrete [dry unit weight 85 lb/ft ³ –115 lb/ft ³ (1361 kg/m ³ –1841 kg/m ³)]	8.0
Lightweight insulating concrete [dry unit weight less than 50 lb/ft ³ (801 kg/m ³)]	10.0

Table F.2(c) Equilibrium Moisture Content (Desorption) of Cement Paste at Given Relative Humidity

RH at Middepth (%)	m _e
90	0.30
85	0.274
80	0.255
75	0.24
70	0.225
65	0.21
60	0.195
55	0.185
50	0.175
45	0.16
40	0.15

FIGURE F.4 Nomograph for Correcting Fire Endurance for Nonstandard Moisture Content. [Existing Figure F-5(4), 99 ed., (no change)]

Annex G Commentary

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

G.1 Introduction.

G.1.1 This commentary has been prepared to provide the user of this standard with background information on the development of the standard and its application in the fire protection of buildings. It also provides guidance in the planning and performance of fire tests and in the reporting of results. No attempt has been made to incorporate into this commentary all the available information on fire testing. The serious student of fire testing is strongly urged to consult the referenced documents for a better appreciation of the history of fire-resistant design and the intricate problems associated with testing and with interpretation of test results.[1, 2]

G.1.2 Floors and walls designed as fire separations have been recognized for many years as efficient tools for restricting fires to the area of origin or limiting their spread.[3–11] Prior to 1900, relative fire safety was achieved by mandating use of specific materials. By the year 1900, the appearance of a multitude of new materials and innovative designs and constructions accelerated the demand for performance standards. The British Fire Prevention Committee, established in 1894, was the first to produce tables that provided fire-resistive floors, ceilings, doors, and partitions.[5] Test furnaces in the United States were constructed shortly after 1900 at the Underwriters Laboratories Inc., Columbia University, and the National Bureau of Standards (NBS).[1, 12] These early furnaces eventually led to the development of ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, and its counterpart, NFPA 251.

G.2 Historical Aspects. ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, was first published as ASTM C 19 in 1918. A number of refinements have been made to the standard since that time. However, several provisions, including the temperature–time curve, the major apparatus, and the acceptance criteria have remained essentially unchanged. The roots of fire testing as defined today can be traced back to about 1800. A comprehensive review of early fire testing has been published.[1]

G.3 Fire Load Concept.

G.3.1 Specifications for fire resistance in regulatory documents continue to be based largely on the fire load concept developed by NBS in the 1920s and reported in the 1928 NFPA *Quarterly* by S. H. Ingberg. The concept incorporates the premise that the duration of a fire is proportional to the fire loading (i.e., the mass of combustible materials per unit floor area). The relationship between the mass of combustible materials and fire duration was established on the basis of burnout tests in structures incorporating materials having calorific or potential heat values equivalent to wood and paper [i.e., 7000 Btu/lb to 8000 Btu/lb (16.3 MJ/kg to 18.6 MJ/kg)]. The fire loads of noncellulosic materials, such as oils, waxes, and flammable liquids, were interpreted on the basis of their equivalent calorific content.[5, 13–15] In the simplest terms, the calorific content premise means that 10 lb (50 kg) of combustible materials per ft² (m²) of floor area produce a fire of 1-hour duration.

G.3.2 Increasing sophistication in the understanding of materials and the fire process is the result of numerous research activities.[9, 11, 13–27] It is now generally conceded that fire severity as well as the temperature–time relationship of a fire depends on several factors, including the following:

- (1) Amount and type of the fire load
- (2) Distribution of the fire load
- (3) Specific surface characteristics of the fire load[5, 27]
- (4) Ventilation, as determined by the size and shape of openings [17–19, 21, 27–29]
- (5) Geometry (the size and shape) of the fire compartment
- (6) Thermal characteristics of the enclosure boundaries
- (7) Relative humidity of the atmosphere

G.3.3 For the purposes of this annex, fire severity is defined in terms of temperature (one measure of an effect of fire intensity) and fire duration. It is expressed in terms of minutes or hours of fire exposure and, in NFPA 251, is assumed to be equivalent to that defined by the standard temperature–time (*T-t*) curve (i.e., the area under the *T-t* curve).[27]

G.4 Scope and Significance.

G.4.1 This standard is intended to evaluate, in terms of endurance time, the ability of an assembly to contain a fire or to retain its structural integrity, or both, during the test conditions imposed by the standard. It also contains standard conditions for measuring heat transfer through membrane elements protecting combustible framing or surfaces.

G.4.2 The end-point criteria by which the test result is assessed are related to the following:

- (1) Transmission of heat through the test assembly
- (2) Ability of the test assembly to withstand the transmission of flames or gases hot enough to ignite combustible material
- (3) Ability of the assembly to carry the load and withstand restraining forces during the fire test period
- (4) Temperature of the steel under some conditions

G.4.3 Classifications Fire resistance ratings should reflect performance during the period of exposure and performance should not be construed as having determined suitability for use after the exposure. [ROP 251-2]

G.4.4 This standard, although specific regarding the assembly to be tested, enables the testing laboratory to determine whether the specimen is a true representation of the assembly intended for evaluation. This is necessary because of the wide variation in assemblies. For instance, wall test specimens generally do not contain electric switches and outlets, which in some designs can affect test results. Floor test specimens might or might not contain electrical raceways and outlets or pull boxes for power and communications wiring. Cover plates over trench headers also are present in some designs. The testing laboratory is in the best position to judge the effects of such components.

G.5 Test Furnaces. This standard does not provide specific construction details for the furnace. Users are urged to consult reference documents for a more comprehensive review of furnace design and performance.[25]

G.6 Temperature–Time Curve.

G.6.1 A specific temperature–time relationship for the test fire is defined in the standard and in Table B.1. The actual recorded temperatures in the furnace are required to be within specified percentages of those of the standard curve. Accuracy in measuring temperature generally is easier to achieve after 1 hour due to stabilizing of the furnace and the slope of the *T-t* curve. The number and type of temperature-measuring devices are outlined in the standard. Specific standard practices for location and use of these temperature-measuring devices also are outlined in the standard. However, no uniformity of the temperatures within the fire chamber is specified.

G.6.2 The standard *T-t* curve used in this standard represents a severe building fire.[5] The curve was adopted in 1918 as a result of several conferences by eleven technical organizations, including testing laboratories, insurance underwriters, fire protection associations, and technical societies.[1, 16, 30] The *T-t* relationship of these test methods represents only one fire situation. Data is available to evaluate the performance of assemblies under fire exposure conditions that are more representative of particular fire situations (i.e., using different *T-t* relationships to simulate specific fire conditions).[9, 11, 16, 19, 22, 23, 27, 29, 31, 32]

G.6.3 Furnace pressure is not specified and is generally slightly negative. The pressure can have an effect on the test results, and the test conditions always should be controlled carefully.

G.7 Test Specimen.

G.7.1 The test specimen is required to represent as closely as possible the actual construction in the field subject to the limits imposed by the test facilities.

G.7.2 All specimens are required to be conditioned so as to attain a moisture content comparable to that in the field prior to testing. For uniformity, the standard moisture content is defined as that in equilibrium with an atmosphere of 50 percent relative humidity at 73°F (23°C). Massive concrete units that need unusually long drying periods can be fire-tested after a 12-month conditioning period. Annex F describes how the test result should be corrected to account for any variation from the standard moisture condition.[33]

G.7.3 With few exceptions, only the interior face of exterior wall assemblies and the ceiling portion or underside of floor or roof assemblies are exposed to the standard fire.[24, 25] The rationale for this practice is based on the assumption that the outside face of exterior walls is not usually subjected to the same fire exposure as the interior face and that the fire exposure of the upper side of a floor or roof assembly is seldom as intense as that of the underside.

G.7.4 Although this standard does not contain specific criteria for judging the impact of through-joints or poke-through devices, such as electrical or telephone outlets, it should be recognized that these components should be evaluated with respect to structural performance and temperature-rise criteria if they constitute a significant part of the tested assembly.

G.7.5 For obvious reasons, symmetrical walls and partitions are tested only on one side. Asymmetrical walls and partitions might be required to be tested with either or both sides individually exposed to the fire. If both sides are exposed, the report should indicate the fire endurance classification for each case.

G.8 Loading.

G.8.1 Floors and roofs generally are loaded during tests to provide a

maximum load condition determined by the applicable nationally recognized design criteria. This practice is intended to accommodate those designs that are loaded to maximum design conditions in actual intended use. Through the application of engineering principles, those fire endurance ratings developed can be applied to assemblies having spans greater than those tested.

G.8.2 Where a floor or roof assembly is designed for a specific use, such as in prefabricated housing units, the assembly can be tested with a restricted load condition. The loading condition used for such tests is to be defined in the test report. This standard does not require specific loading devices. Some laboratories use large containers of water; others use a system of hydraulic rams for floor and roof assemblies. Where a uniformly distributed load is simulated by point-loading (several small-area loads), it is recommended that the load at any such area not exceed 25 percent of the total load and that the individual load have a width at least equal to the depth of the floor. Wall furnaces generally are equipped with hydraulic rams.

G.8.3 This standard requires that load-bearing walls and partitions sustain the applied test load during the fire endurance and hose stream tests. A former provision that required load-bearing walls and partitions to sustain twice the specified superimposed test load after cooling but within 72 hours of the test period has been deleted from the method as being unrealistic. Nonbearing walls and partitions are not loaded during the test but are restrained on all sides. This restraint could impose more stress than a load on top. The ASTM Committee E-5 has reviewed the loading procedures for framed walls and partitions several times. It was the committee's unanimous decision that such a wall be tested either with calculated maximum design load or with a load expected to occur in practice. The method used to compute the design loads should be reported.

G.8.4 Some important stresses, such as those caused by creep and shrinkage in the wall itself and its supporting frame, are present, and the designer should recognize these stresses in the analysis. The ASTM Committee E-5 has investigated the possibility of openings occurring in joints at the corners of nonload-bearing enclosures due to differential movement. While the possibility exists that this will occur, the committee has not found it feasible to amend the test based on available data.

G.8.5 Double walls pose a unique problem for load application. Which wall should be loaded? Should both walls be loaded simultaneously? The ASTM Committee E-5 devoted considerable time to debating this problem and recommends the decision be made by the user after an analysis of the loading conditions anticipated in service both before and after a fire. Such loading conditions are to be reported.

G.9 Integrity. All walls and partitions that qualify for a fire endurance classification of 1 hour or more are required to be subjected to the cooling impact and erosion effects of a stream of water from a 2½ in. (63.5 mm) hose discharging through a standard play pipe equipped with a 1⅞ in. (28.6 mm) tip under specified pressures. In this hose stream test, the ability of the construction to resist disintegration under adverse conditions is examined. The requirement for a hose stream test was removed from the test procedure for columns and floor or roof assemblies because of impracticality and the possibility of excessive damage to the furnace.

G.10 Conditions of Tests.

G.10.1 Columns generally are tested with all four sides exposed to the test fire. However, it is possible to test a column with three sides exposed (with the fourth side against a wall). This standard requires that specimens be tested under conditions contemplated in the design. The former general practice of testing columns with pin connection at the top and bottom to simulate the most critical condition is no longer a criterion.

G.10.2 Columns are required to sustain successfully the design load during the test period. This standard also permits columns to be loaded up to 1¼ times the design load prior to the fire test if desired by the submitter. Such loading, however, should not be construed as having had a deleterious effect on the fire endurance test performance. Instead of loading, steel columns, whose protective covering does not carry a load, can be assigned a fire resistance classification on the basis of the temperature of the steel only. With such columns, the protective cover should be restrained against longitudinal expansion. Wood columns are tested for load-carrying ability only.

G.10.3 Test results have established that variations of restraint conditions can influence the time of fire resistance for a structure or a structural element considerably. Restraints generally are beneficial to fire resistance; however, there are conditions under which restraint can have a detrimental effect on the performance of a specimen during a fire resistance test.[34, 35] The users of test results are advised to study the reference documents as well as Annex E and Table E.1.5.

G.10.4 An unrestrained classification fire resistance rating for a steel beam or a reinforced concrete beam used as part of an assembly tested in restrained condition can be assessed from the temperature records obtained for the steel or the reinforcing steel, respectively (see Chapter 13). It is also possible to evaluate the protective cover of steel beams by measuring the temperature of the steel that is protected (see Chapter 14). The fire resistance rating determined under the provisions of Chapter 13 is applicable only to beams used with a floor or roof construction that has a comparable or greater capacity for heat dissipation from the beam than the floor or roof with which

the beam is tested. [ROP 251-2]

G.11 Other Observations.

G.11.1 No limitation is imposed on the deformation of the specimen during or after the test period. It is assumed that the deflection or deformation of an assembly is limited only by its ability to stay in place (under load, where specified) during the test period.

G.11.2 A complete record of deformation during the endurance test is helpful in the application of test results and should be reported.

G.11.3 Other observations, such as the evolution of unusual quantities of visible smoke, vapors, or gases that could affect the proper decision regarding use of the test results, should be reported.

G.12 Protective Membranes. This standard provides criteria for evaluating the protection that membrane elements can offer to combustible framing and paneling (e.g., joists, wall studs, and paneling or boards on the unexposed side of an assembly and other combustible materials). The results of these tests are reported as protective membrane ratings.

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Annex H Informational References

H.1 Referenced Publications. The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

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