NFPA No.

251

FIRE TESTS— BUILDING CONSTRUCTION & MATERIALS 1969

Seventy-five Cents

NATIONAL FIRE PROTECTION ASSOCIATION
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Official NFPA Definitions

Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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SHOULD is intended to indicate recommendations or that which is advised but not required.

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Statement on NFPA Procedures

This material has been developed in the interest of safety to life and property under the published procedures of the National Fire Protection Association. These procedures are designed to assure the appointment of technically competent Committees having balanced representation from those vitally interested and active in the areas with which the Committees are concerned. These procedures provide that all Committee recommendations shall be published prior to action on them by the Association itself and that following this publication these recommendations shall be presented for adoption to the Annual Meeting of the Association where anyone in attendance, member or not, may present his views. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

Standard Methods of Fire Tests of Building Construction and Materials

NFPA No. 251 — 1969

1969 Edition of No. 251

The 1969 edition of Standard Methods of Fire Tests of Building Construction and Materials incorporates changes prepared by the Committee on Fire Tests and adopted by the National Fire Protection Association at its Annual Meeting on May 15, 1969.

The changes to the 1963 edition incorporated in this 1969 edition are in paragraphs 4(b) and 6(c). In addition, entire Section 9 was revised.

Origin and Development of No. 251

This standard had its origin in recommendations of the International Fire Prevention Congress, London, 1903. It was presented to the NFPA by the Committee on Fire-Resistive Construction in 1914. It was officially adopted in a revised form in 1918. Successive editions were published as a result of cooperative activity by the NFPA and other organizations in 1918, 1926, 1934, 1941, 1955, 1958, 1959, 1960, 1961 and 1963. It was handled in the NFPA successively by the Committee on Fire-Resistive Construction, the Committee on Building Construction, and now by the Committee on Fire Tests. The present Committee on Fire Tests has interlocking membership with the ASTM committee.

The text is similar to that published by the American Society for Testing and Materials, ASTM designation E-119, recommended by the ASTM Committee on Fire Tests. Previous editions of this standard have been adopted and published by Underwriters' Laboratories, Inc., as U.L. 263.

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SCOPE: Standards for fire testing procedures. Cooperates with other Committees dealing with special fire test procedures, including Flameproofing and Preservative Treatments and Wearing Apparel. Also cooperates with the American Society for Testing and Materials.

Contents

Standard Methods of Fire Tests of Building Construction and Materials

NFPA No. 251 — 1969

The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public. Recognition of this is registered in the codes of many authorities, municipal and other. It is important to secure balance of the many units in a single building, and of buildings of like character and use in a community; and also to promote uniformity in requirements of various authorities throughout the country. To do this it is necessary that the fire-resistive properties of materials and assemblies be measured and specified according to a common standard expressed in terms that are applicable alike to a wide variety of materials, situations, and conditions of exposure.

Such a standard is found in the methods that follow. They prescribe a standard exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure elapsing 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 may be cited as the "Standard Fire Tests," and the performance or exposure shall be expressed as "2-hr.," "6-hr.," "½-hr.," etc.

When a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified time-classification period.

Scope.

1 (a) These methods of fire tests are applicable 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. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.

(b) It is the intent that classifications shall register performance during the period of exposure and shall not be construed as having determined suitability for use after fire exposure.

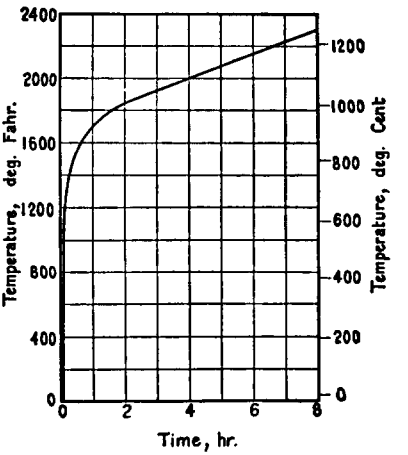
NOTE: A method of fire hazard classification based on rate of flame spread is covered in NFPA Standard No. 255, Method of Test of Surface Burning Characteristics of Building Materials.

CONTROL OF FIRE TESTS.

Time-Temperature Curve.

2. The conduct of fire tests of materials and construction shall be controlled by the standard time-temperature curve shown in Fig. 1. The points on the curve that determine its character are:

1000°F (538C.)	at 5 min.
1300°F (704C.)	at 10 min.
1550°F (843C.)	at 30 min.
1700°F (927C.)	at 1 hr.
1850°F (1010C.)	at 2 hr.
2000°F (1093C.)	at 4 hr.
2300°F (1260C.)	at 8 hr. or over



Time Temperature Curve
Fig. 1.

For a closer definition of the time-temperature curve, see Appendix A.

Furnace Temperatures.

3. (a) The temperature fixed by the curve shall be deemed to be the average temperature obtained from the readings of not less than nine thermocouples for a floor, roof, wall or partition and not less than eight thermocouples for a structural column, symmetrically disposed and distributed to show the temperature near all parts of the sample, the thermocouples being enclosed in sealed porcelain tubes ¾ in. in outside diameter and ⅛ inch in wall thickness, or, as an alternative in the case of base metal thermocouples, enclosed in sealed, standard-weight ½-in. black wrought steel or black wrought iron pipe. The exposed length of the pyrometer tube and thermocouple in the furnace chamber shall be not less than 12 in. Other types of protecting tubes or pyrometers may be used that, under test conditions, give the same indications as the above standard within the limit of accuracy that applies for furnace-temperature measurements. For floors and columns, the junction of the thermocouples shall be placed 12 in. 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. In the case of walls and partitions, the thermocouples shall be placed 6 in. 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.

(b) The temperatures shall be read at intervals not exceeding 5 min. during the first two hours, and thereafter the intervals may be increased to not more than 10 minutes.

(c) The accuracy of the furnace control shall be such that the area under the time-temperature curve, obtained by averaging the results from the pyrometer readings, is within 10 per cent of the corresponding area under the standard time-temperature curve shown in Fig. 1 for fire tests of 1 hr. or less duration, within 7.5 per cent for those over 1 hr. and not more than 2 hr., and within 5 per cent for tests exceeding 2 hr. in duration.

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

4. (a). Temperatures of unexposed surfaces shall be measured with thermocouples or thermometers* placed

*Under certain conditions it may be unsafe or impracticable to use thermometers.

under flexible, dry, felted asbestos pads. The properties of these pads shall meet the requirements listed in Appendix B. The wire leads of the thermocouple or the stem of the thermometer shall have an immersion under the pad and be in contact with the unexposed surface for not less than 3½ in. The hot junction of the thermocouple or the bulb of the thermometer shall be placed approximately under the center of the pad. The outside diameter of protecting or insulating tubes, and of thermometer stems, shall be not more than 5/16 in. The pad shall be held firmly against the surface, and shall fit closely about the thermocouples or thermometer stems. 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. The wires for the thermocouple in the length covered by the pad shall be not heavier than No. 18 B & S gage (0.04 in.) and shall be electrically insulated with heat-resistant and moisture-resistant coatings.

NOTE: For the purpose of testing roof assemblies, the unexposed surface shall be defined as the surface exposed to ambient air.

(b) Temperature readings shall be taken at not less than nine points on the surface. Five of these shall be symmetrically disposed, one to be approximately at the center of the specimen, and four at approximately the center of its quarter sections. The other four shall be located at the discretion of the testing authority to obtain representative information on the performance of the construction under test. None of the thermocouples shall be located nearer to the edges of the test specimen than 1½ times the thickness of the construction or 12 in. An exception can be made in those cases where there is an element of the construction which is not otherwise represented in the remainder of the test specimen. None of the thermocouples shall be located opposite or on top of beams, girders, pilasters, or other structural members if temperatures at such points will obviously be lower than at more representative locations.

(c) Temperature readings shall be taken at intervals not exceeding 15 min. until a reading exceeding 212°F (100°C) has been obtained at any one point. Thereafter the readings may be taken more frequently at the discretion of the testing body, but the intervals need not be less than 5 min.

(d) Where the conditions of acceptance place a limita-

tion on the rise of temperature of the unexposed surface, the temperature end point of the fire endurance period shall be determined by the average of the measurements taken at individual points; except that if a temperature rise 30 per cent in excess of the specified limit occurs at any one of these points, the remainder shall be ignored and the fire endurance period judged as ended.

CLASSIFICATION AS DETERMINED BY TEST.

Report of Results.

5. **(a)** Results shall be reported in accordance with the performance in the tests prescribed in these methods. They shall be expressed in time periods of resistance, to the nearest integral minute.

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 deformation, spalling, cracking, burning of the specimen or its component parts, continuance of flaming, and production of smoke.

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

(c) When the indicated resistance period is ½ hr. or over, determined by the average or maximum temperature rise on the unexposed surface or within the test specimen, or by failure under load, a correction shall be applied for variation of the furnace exposure from that prescribed, where it will affect the classification, by multiplying the indicated period by two thirds of the difference in area between the curve of average furnace temperature and the standard curve for the first three fourths of the period and dividing the product by the area between the standard curve and a base line of 68°F (20°C) for the same part of the indicated period, the latter area increased by 54° Fahr.-hr. or 30° Cent.-hr. (3240° Fahr.-min. or 1800° Cent.-min.), to compensate for the thermal lag of the furnace thermocouples during the first part of the test. For fire exposure in the test higher than standard, the indicated resistance period

shall be increased by the amount of the correction and be similarly decreased for fire exposure below standard (Note).

NOTE: The correction can be expressed by the following formula:

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

where:

C = correction in the same units as I.

I = indicated fire-resistance period,

A = area under the curve of indicated average furnace temperature for the first three fourths of the indicated period,

As = area under the standard furnace curve for the same part of the indicated period, and

L = lag correction in the same units as A and As (54° Fahr.-hr. or 30° Cent.-hr. (3240° Fahr.-min. or 1800° Cent.-min.)).

(d) Unless all of the materials used in the assembly classify as "noncombustible" as defined in NFPA No. 220, Standard Types of Building Construction, the term "combustible" shall be used after the assigned hourly classification, except that the roof covering in roof and ceiling assemblies shall not be considered in making this evaluation. No material shall be classed as noncombustible which, as used in the assembly, will be subject to a significant increase in combustibility or flame spread rating beyond the limits established by the definition of "noncombustibility" in NFPA No. 220 through the effects of age, moisture or other atmospheric conditions. Flame spread rating refers to the ratings obtained according to the Method of Test of Surface Burning Characteristics of Building Materials, NFPA No. 255.

TEST SPECIMEN.

Test Specimen.

6. (a) The test specimen shall be truly representative of the construction for which classification is desired, as to materials, workmanship, and details such as dimensions of parts, and shall be built under conditions representative of those obtaining as practically applied in building construction and operation. The physical properties of the materials and ingredients used in the test specimen shall be determined and recorded.

(b) The size and dimensions of the test specimen specified herein are intended to apply for rating constructions of dimensions within the usual general range employed in buildings. If the conditions of use limit the construction to smaller dimensions, a proportionate reduction may be made in the dimensions of the specimens for a test qualifying them for such restricted use.

(c) When it is desired to include a built-up roof covering, the test specimen shall have a roof covering of 3-ply, 15-lb. type felt and not in excess of 120 lbs. per square (100 sq. ft.) of hot mopping asphalt without gravel surfacing. Tests of assemblies with this covering do not preclude the field use of other built-up roof coverings.

CONDUCT OF FIRE TESTS.

Fire Endurance Test.

7. The fire endurance test on the specimen with 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.

Hose Stream Test.

8. (a) 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 hr., immediately after which 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, changes in direction being made slowly.

(b) Exemption: The hose stream test shall not be required in the case of constructions having a resistance period, indicated in the fire endurance test, of less than 1 hr.

(c) Optional Program: The submitter may elect, with the advice and consent of the testing body, to have the hose stream test made on the specimen subjected to the fire endurance test and immediately following the expiration of the fire endurance test.

(d) Stream Equipment and Details: The stream shall be delivered through 2½-in. hose discharging through a National Standard Playpipe of corresponding size equipped with a 1⅛-in. discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure and duration of application shall be as prescribed in Table I.

TABLE I.

Resistance Period	Water Pressure at Base of Nozzle, psi.	Duration of Application, min. per 100 sq. ft. exposed area.
8 hr. and over	45	6
4 hr. and over if less than 8 hr.	45	5
2 hr. and over if less than 4 hr.	30	2½
1½ hr. and over if less than 2 hr.	30	1½
1 hr. and over if less than 1½ hr.	30	1
Less than 1 hr., if desired	30	1

(e) Nozzle Distance: The nozzle orifice shall be 20 ft. 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. If otherwise located, its distance from the center shall be less than 20 ft. by an amount equal to 1 ft. for each 10 deg. of deviation from the normal.

Protection and Conditioning of Test Specimen.

9. The test specimen shall be protected during and after fabrication to assure normality of its quality and condition at the time of test. It shall not be tested until a large portion of its final strength has been attained, and, if it contains moisture, until the excess has been removed to achieve an air-dry condition in accordance with the requirements given in Paragraphs (a) through (c). 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. The ambient air temperature at the beginning of the test shall be within the range of 50° to 90°F (10° to 32°C). The velocity of air across the unexposed surface of the sample, measured just before the test begins, shall not exceed 4.4 ft. per sec., as determined by an anemometer placed at right angles to the unexposed surface. If mechanical ventilation is employed during the test, an air stream shall not be directed across the surface of the specimen.

(a) Prior to fire test, constructions shall be conditioned

with the objective of providing, within a reasonable time, a moisture condition within the specimen approximately representative of that likely to exist in similar construction in buildings. For purposes of standardization, this condition is to be considered as that which would be established at equilibrium resulting from drying in an ambient atmosphere of 50 per cent relative humidity at 73°F.[1] However, with some constructions, it may be difficult or impossible to achieve such uniformity within a reasonable period of time. Accordingly, where this is the case, specimens may be tested when the dampest portion of the structure, the portion at 6-in. depth below the surface of massive constructions, has achieved a moisture content corresponding to drying to equilibrium with air in the range of 50 to 75 per cent relative humidity at 73°±5°F. In the event that specimens dried in a heated building fail to meet these requirements 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 will be prevented by hermetic sealing, these requirements may be waived, except as to attainment of a large portion of final strength, and the specimen tested in the condition in which it then exists.

(b) If, during the conditioning of the specimen it appears desirable or is necessary to use accelerated drying techniques, it is the responsibility of the laboratory conducting the test to avoid procedures which will 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 given in Paragraph (a).

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[1]A recommended method for determining the relative humidity within a hardened concrete specimen with electric sensing elements is described in Appendix I of a paper by Carl A. Menzel, "A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity," Proceedings, American Society for Testing and Materials, Vol. 55, p. 1085 (1955). 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, when appropriate, as an alternate to the relative humidity method to indicate when wood has attained the proper moisture content. 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 given by the graphs in Fig. 23 on p. 327. They indicate that wood has a moisture content of 13 per cent at a relative

humidity of 70 per cent for a temperature of 70° to 80°F (21° to 27°C).

(c) Within 72 hrs. prior to the fire test[2] information on the actual moisture content and distribution within the specimen shall be obtained. The information should be included in the test report.

[2]If the moisture condition of the fire test assembly is likely to change drastically from the 72 hr. sampling time prior to test, the sampling should be made not later than 24 hrs. prior to the test.

TESTS OF BEARING WALLS AND PARTITIONS.

Size of Specimen.

10. The area exposed to fire shall be not less than 100 sq. ft., with neither dimension less than 9 ft. The test specimen shall not be restrained on its vertical edges.

Loading.

11. During the fire endurance and fire and hose stream tests a superimposed load shall be applied to the construction in a manner calculated to develop theoretically, as nearly as practicable, the working stresses contemplated by the design.

Conditions of Acceptance.

12. The test shall be regarded as successful if the following conditions are met:

(a) 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 for which classification is desired.

(b) The wall or partition shall have sustained the applied load during the fire and hose stream test as specified in Section 8, without passage of flame, of gases hot enough to ignite cotton waste, or of the hose stream, and after cooling but within 72 hr. after its completion shall sustain the dead load of the test construction plus twice the superimposed load specified above.

(c) Transmission of heat through the wall or partition during the fire endurance test shall not have been such as to raise the temperature on its unexposed surface more than 250°F (139°C) above its initial temperature.

TESTS OF NONBEARING WALLS AND PARTITIONS.

Size of Specimen.

13. The area exposed to fire shall be not less than 100 sq. ft., with neither dimension less than 9 ft. The test specimen shall be restrained on all four edges.

Conditions of Acceptance.

14. The test shall be regarded as successful if the following conditions are met.

(a) 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 for which classification is desired.

(b) The wall or partition shall have withstood the fire and hose stream test as specified in Section 8, without passage of flame, of gases hot enough to ignite cotton waste, or of the hose stream.

(c) Transmission of heat through the wall or partition during the fire endurance test shall not have been such as to raise the temperature on its unexposed surface more than 250°F (139°C) above its initial temperature.

TESTS OF COLUMNS.

Size of Specimen.

15. The length of the column exposed to fire shall, when practicable, approximate the maximum clear length contemplated by the design, and for building columns shall be not less than 9 ft. The contemplated details of connections, and their protection if any, shall be applied according to the methods of acceptable field practice.

Loading.

16. (a) During the fire endurance test the column shall be exposed to fire on all sides and shall be loaded in a manner calculated to develop theoretically, as nearly as practicable, the working stresses contemplated by the design. Provision shall be made for transmitting the load to the exposed portion of the column without unduly increasing the effective column length.

(b) If the submitter and the testing body jointly so decide, the column may be subjected to 1¾ times its designed working load before the fire endurance test is undertaken. The fact that such a test has been made shall not be construed as having had a deleterious effect on the fire endurance test performance.

Condition of Acceptance.

17. The test shall be regarded as successful if the column sustains the applied load during the fire endurance test for a period equal to that for which classification is desired.

ALTERNATE TEST OF PROTECTION FOR STRUCTURAL STEEL COLUMNS.

Application.

18. This test procedure does not require column loading at any time and may be used at the discretion of the testing laboratory to evaluate steel column protections that are not required by design to carry any of the column load.

Size and Character of Specimen.

19. (a) The size of the steel column used shall be such as to provide a test specimen that is truly representative of the design, materials, and workmanship for which classification is desired. The protection shall be applied according to the methods of acceptable field practice. The length of the protected column shall be at least 8 ft. The column shall be vertical during application of the protection and during the fire exposure.

(b) 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. The size of the plates or amount of concrete shall be adequate to provide direct bearing for the entire transverse area of the protection.

(c) The ends of the specimen, including the means for restraint, shall be given sufficient thermal insulation to prevent appreciable direct heat transfer from the furnace.

Temperature Measurement.

20. The temperature of the steel in the column shall be measured by at least three thermocouples located at each of four levels. The upper and lower levels shall be 2 ft. from the ends of the steel column, and the two intermediate levels shall be equally spaced. The thermocouples at each level shall be so placed as to measure significant temperatures of the component elements of the steel section.

Exposure to Fire.

21. During the fire endurance test the specimen shall be exposed to fire on all sides for its full length.

Conditions of Acceptance.

22. The test shall be regarded as successful if the transmission of heat through the protection during the period of fire exposure for which classification is desired does not raise the average (arithmetical) temperature of the steel at any one of the four levels above 1000°F, or does not raise the temperature above 1200°F at any one of the measured points.

TESTS OF FLOORS AND ROOFS.

(The following contemplates application of fire exposure to the underside of constructions.)

Size and Construction of Specimen.

23. **(a)** The area exposed to fire shall be not less than 180 sq. ft., with neither dimension less than 12 ft. Beams or girders, if a part of the construction under test, shall lie within the combustion chamber and have a clearance of not less than 8 in. from its walls.

(b) Beams or joists forming part of the assembly shall be supported in accordance with the recommended fabrication procedure for the type of construction. Assemblies representing forms of construction which restrain structural elements and top deck shall be supported by a restraining frame incorporated in the furnace structure simulating such restraint.

Loading.

24. During the fire endurance test a superimposed load shall be applied to the construction in a manner calculated to develop theoretically, as nearly as practicable, the working stresses in each member contemplated by the design.

Conditions of Acceptance.

25. The test shall be regarded as successful if the following conditions are met:

(a) The construction 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 for which classification is desired.

(b) Transmission of heat through the construction during the fire endurance test shall not have been such as to raise the temperature on its unexposed surface more than 250°F (139°C) above its initial temperature.

ALTERNATE TEST OF PROTECTION FOR SOLID STRUCTURAL STEEL BEAMS AND GIRDERS.

Application.

26. Where the loading required in Section 24 is not feasible this alternate test procedure may 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. The conditions of acceptance of this alternate test are not applicable to tests made under design loads as provided under tests for Floors and Roofs in Sections 23 to 25.

Size and Character of Specimen.

27. (a) The size of the steel beam or girder shall be such as to provide a test specimen that is truly representative of the design, materials and workmanship for which classification is desired. The protection shall be applied according to the methods of acceptable field practice and the projection below the ceiling, if any, shall be representative of the conditions of intended use. The length of beam or

girder exposed to the fire shall be not less than 12 ft. and the member shall be tested in a horizontal position. A section of a representative floor construction not less than 5 ft. 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. The rating of performance shall not be applicable to sizes smaller than those tested.

(b) 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 member before the protection is applied. The ends of the member, including the means for restraint, shall be given sufficient thermal insulation to prevent appreciable direct heat transfer from the furnace to the unexposed ends or from the ends of the member to the outside of the furnace.

Temperature Measurement.

28. The temperature of the steel in the beam or girder shall be measured with not less than four thermocouples at each of four sections equally spaced along the length of the beam and symmetrically disposed and not nearer than 2 ft. from the inside face of the furnace. The thermocouples at each section shall be symmetrically placed so as to measure significant temperatures of the component elements of the steel section.

Conditions of Acceptance.

29. The test shall be regarded as successful if the transmission of heat through the protection during the period of fire exposure for which classification is desired does not raise the average (arithmetical) temperature of the steel at any one of the four sections above 1000° F, or does not raise the temperature above 1200° F at any one of the measured points.

TESTS OF CEILING CONSTRUCTIONS.

Application.

30. This test procedure is to be used for classification of ceilings that are not an integral part of a floor construction and where thirty-six inches or more of space is provided above the top of the joists or beams supporting and protected by the ceiling.

Size of Specimen.

31. The area exposed to fire shall be not less than 180 sq. ft., with neither dimension less than 12 ft., and the ceiling surface at its edges shall be in contact with the test furnace structure.

Test Construction and Enclosure.

32. The test ceiling construction shall include all structural members and details including hangers, if any, but not walkways. Above the ceiling during the test, there shall be provided a tight flat-topped enclosure, the underside of the covering material of which shall be 36 in. above the top of the joists or beams supporting and protected by the ceiling. The top of the enclosure shall be made of cement-asbestos board ¼ in. in thickness under asbestos millboard ½ in. in thickness, and the side walls of 8-in. common brick, or it shall be of a construction having equivalent heat conductivity and heat capacity. Where use of the ceiling under a combustible construction is contemplated, at least five 15-in. square panels of 1-in. pine board shall be attached to the underside of the top of the enclosure. The temperatures on the bottom surface of these panels shall be measured.

Conditions of Acceptance.

33. The test shall be regarded as successful if the following conditions are met:

(a) The ceiling shall have withstood the fire endurance test without the passage of flame or ignition of combustible members or materials forming part of the construction above the ceiling as evidenced by glow or flame.

(b) Transmission of heat through the ceiling during the fire endurance test shall not have been such as to raise the average temperature above the test ceiling more than indicated in the following Items (1), (2), and (3). The limiting temperatures shall be the average of those taken at not less than five points, one of which shall be approximately at the center, and four at approximately the centers of the quarter sections.

(1) With combustible supports or other combustible material in contact with the ceiling, the temperature increase at the points of contact shall not exceed 250°F.

(2) With combustible supports or other combustible material not in contact with the ceiling, the temperature increase on the surface of any combustible members, pine panels, or combustible material adjacent to the ceiling shall not exceed 250°F. The temperature on the exposed surface of combustible members not in contact with the ceiling shall be measured under a sheet of mica approximately 0.002 in. in thickness.

(3) With no combustible material above the ceiling construction, the average temperature measured on the lower surface of the main structural supporting members (beams or slabs) shall not exceed 1200°F and the average temperature of the top and bottom of the beams, when used, shall not exceed 1000°F.