



# UL 1709

## STANDARD FOR SAFETY

### Rapid Rise Fire Tests of Protection Materials for Structural Steel



UL Standard for Safety for Rapid Rise Fire Tests of Protection Materials for Structural Steel, UL 1709  
Sixth Edition, Dated August 8, 2022

### **Summary of Topics**

***This revision of ANSI/UL 1709 dated July 8, 2024 includes the following changes in requirements:***

***– Fire Test Procedures for Passive Fire Protection Systems for Critical Process Control Equipment (CPCE); Part 3, Section [18](#) – [24](#), and Annex [C](#) – Annex [E](#)***

***– Fire Resistance Rating Procedures for Hollow Section Column Tests with Reactive Materials; [8.5](#) – [8.7](#), [16.5A](#), Section [A5](#)***

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The requirements are substantially in accordance with Proposal(s) on this subject dated February 23, 2024 and May 17, 2024.

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**ANSI/UL 1709-2024**

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## **UL 1709**

### **Standard for Rapid Rise Fire Tests of Protection Materials for Structural**

#### **Steel**

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#### **Sixth Edition**

**August 8, 2022**

This ANSI/UL Standard for Safety consists of the Sixth Edition including revisions through July 8, 2024.

The most recent designation of ANSI/UL 1709 as an American National Standard (ANSI) occurred on July 8, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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## PART 1 – GENERAL REQUIREMENTS

### INTRODUCTION

#### 1 Scope

1.1 This Standard describes a full-scale test method for measuring the thermal resistance of protective materials, systems, or constructions to rapid-temperature-rise fires.

1.2 Part 1 of this Standard describes the furnace calibration and furnace control requirements.

#### 2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

#### 3 Referenced Publications

3.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

3.2 The following publications are referenced in this Standard:

ISO 834-1, *Fire-Resistance Tests – Elements of Building Construction – Part 1: General Requirements*

UL 263, *Fire Tests of Building Construction and Materials*

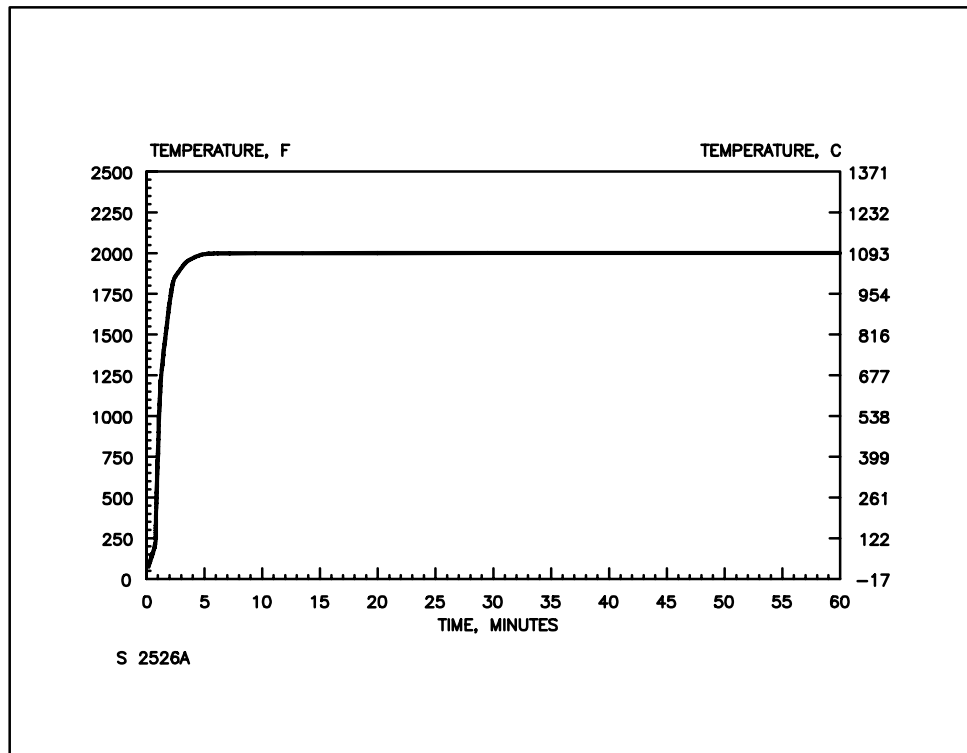
UL 2431, *Durability of Fire Resistive Coatings and Materials*

### FULL-SCALE TEST METHOD

#### 4 Furnace Control

4.1 The fire environment within the furnace is to develop a total heat flux of  $65,000 \pm 5000 \text{ Btu/h} \cdot \text{ft}^2$  ( $204 \pm 16 \text{ kW/m}^2$ ) and an average temperature of  $2000 \pm 100 \text{ }^\circ\text{F}$  ( $1093 \pm 56 \text{ }^\circ\text{C}$ ) within 5 min from the start of the test. The fire environment is to be controlled by reproducing the furnace temperatures recorded during the furnace calibration method specified in the Furnace Calibration section of the relevant Part of this Standard. This temperature is to be maintained throughout the remainder of the fire test as shown in [Figure 4.1](#).

**Figure 4.1**  
**Time-Temperature Curve**



4.2 The furnace is to be controlled to maintain the area under the time-temperature curve to within 10 % of the corresponding area under the standard time-temperature curve shown in [Figure 4.1](#) for fire tests of 60 min or less duration; to within 7.5 % for tests longer than 60 min but not longer than 120 min; and to within 5 % for tests exceeding 120 min in duration. The area under the time-temperature curve is to be obtained by averaging the results from the pyrometer or thermocouple readings.

4.3 A correction is to be applied for variation of the furnace exposure from the prescribed, where such variation will affect the test results, by multiplying the indicated time period by two-thirds of the value obtained by dividing the difference in area between the curve of average furnace temperature and the standard curve for the first three-fourths of the period by the area between the standard curve above a base line of 68 °F (20 °C) for the same part of the indicated period during the first part of the test. For fire exposure times longer than standard, the indicated rating period is to be increased by the amount of the correction and for fire exposure times less than standard, the indicated rating period is to be similarly decreased. The correction can be expressed by the following formula:

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

In which:

C is the correction in the same units as I

I is the indicated fire-resistance period

A is the area under the curve of indicated average furnace temperature for the first three-fourths of the indicated period

$A_s$  is area under the standard furnace curve for the same part of the indicated period

4.4 The temperature fixed by the requirements of the Furnace Calibration section of the relevant Part of this Standard, is to be the average temperature obtained from the readings of eight thermocouples symmetrically disposed and distributed within the test furnace to show the temperature near all parts of the assembly or assemblies.

4.5 The thermocouples are to be fabricated by fusion-welding the twisted ends of 0.064 in (1.6 mm) diameter (No. 14 B & S gauge) chromel-alumel wires having a time constant of 2 min or less, and mounting the wires in porcelain insulators. The thermocouple assembly is to be inserted through a standard weight, nominal 1/2-in iron, steel or inconel pipe, and the end of the pipe from which the welded junction protrudes is to be open. The thermocouple junction is to protrude 1/2 in (12.7 mm) from the open end of the pipe.

4.6 The junction of the thermocouples is to be placed 4 in (102 mm) away from the exposed face of the test specimen and located at the 1/3 and 2/3 heights of the test specimen. The junction of the thermocouples is not to touch the specimen during the test, as a result of specimen deflection.

4.7 Each thermocouple within the furnace shall be read at intervals not exceeding 1 min during the first 30 min of the test and at intervals not exceeding 5 min during the remainder of the test.

## 5 Furnace Calibration

5.1 A furnace calibration record is to be maintained and the furnace is to be recalibrated after completion of any repair that could alter the heat generation, retention or flow characteristics of the furnace. The calibration shall be conducted at a frequency not to exceed 10 years.

5.2 The exposure of the furnace is to be measured with thermocouples and calorimeters as described by the relevant subsequent Part of this Standard.

5.3 The measured values of all thermocouples and calorimeters are to be recorded at intervals not exceeding 1 min.

5.4 The thermocouples used to measure the temperatures within the furnace are to be constructed as described in [4.5](#).

5.5 Calorimeters are to have a minimum range of 100,000 Btu/h · ft<sup>2</sup> (315 kW/m<sup>2</sup>) and a 180° view angle

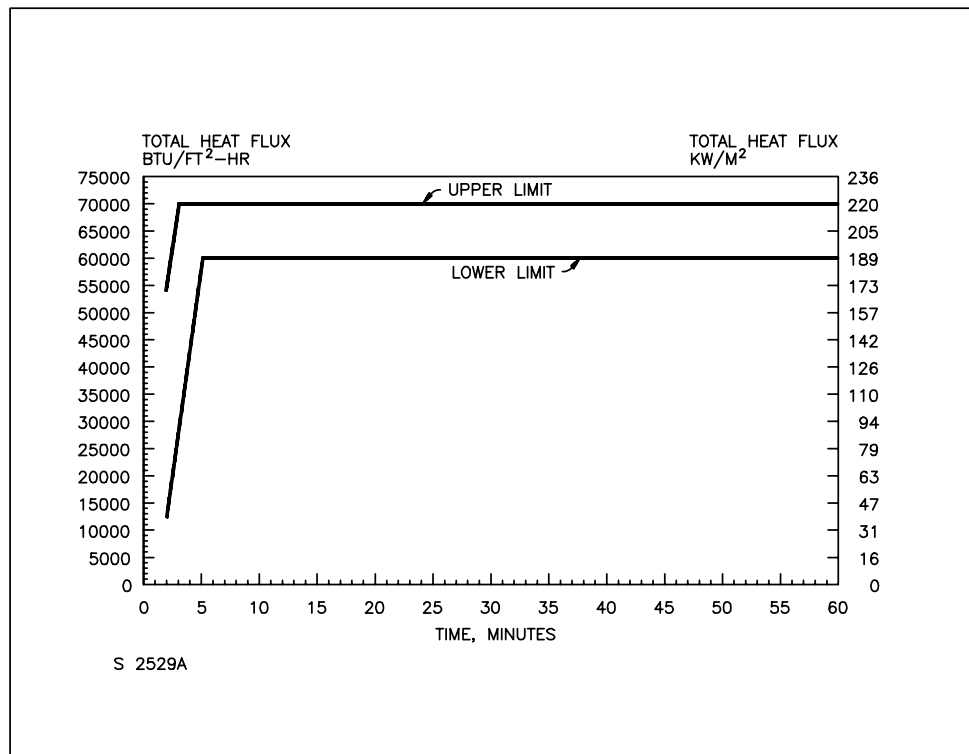
5.6 Combustion gas samples from within the furnace are to be obtained as described by the relevant subsequent Part of this Standard.

5.7 The combustion gas samples are to be obtained continuously by use of a vacuum pump and the oxygen content measured by an oxygen analyzer.

5.8 The fire environment during the calibration test is to comply with the requirements of [4.1](#). The length of the calibration test is to be 60 min.

5.9 Individual total heat flux measurements are to lie within the limits shown in [Figure 5.1](#).

**Figure 5.1**  
**Time-total Heat Flux Curve**



5.10 The average furnace temperature is to be determined by averaging the temperatures recorded by the furnace control thermocouples. The average shall be  $2000 \pm 100$  °F ( $1093 \pm 56$  °C) and individual temperatures are to be  $2000 \pm 200$  °F ( $1093 \pm 111$  °C) 5 min after the start of the test and until the end of the test.

## 6 Test Specimen

6.1 The size of the test specimen shall be representative of the design, materials, and workmanship for which classification is desired.

6.2 All thermocouples for the purpose of recording specimen temperature are to be fabricated from minimum 0.032 in (0.8 mm) diameter (No. 20 B & S gauge) chromel-alumel, inconel sheathed wires or equivalent having a time constant of 2 s or less.

## PART 2 – STRUCTURAL STEEL

### INTRODUCTION

## 7 General

7.1 Unless specifically stated otherwise, the requirements in Part 1 of this Standard are applicable.

7.2 Part 2 of this Standard covers additional procedures for use in conjunction with Part 1 of this Standard, intended to evaluate the thermal resistance of protective material applied to structural members and the ability of the protective material to withstand the fire exposure.

7.3 Part 2 of this Standard describes the minimum testing requirements for classification, the limits of applicability of test results and acceptable methodology to determine the classification achieved.

7.4 The test method includes a supplementary test method for beams, intended to evaluate the ability of protective materials to perform when subject to significant deflections, for use in conjunction with the full-scale exposure test and applicable for beams and other sections subject to bending. Information published in accordance with this test method may also include product design tables for beams and sections subject to bending derived from the supplementary test method and accompanying methodology.

7.5 Information published in accordance with this test method may also include product design tables for alternate limiting temperatures derived from a multi-temperature analysis. Such tables are provided to aid in conditions where a performance-based-design approach is implemented.

## 8 Glossary

8.1 For the purpose of the requirements in Part 2 of this Standard, the following definitions apply.

8.2 CONFIGURATION OF SECTION – The type of section, defined by reference to its shape and structural use. For example: open column, open beam, hollow column, hollow beam.

8.3 HOLLOW SECTION – A tube or pipe or similar shape that has a cross-section containing enclosed space.

8.4 OPEN SECTION – A wide flange or similar shape section that has a cross-section containing no enclosed space.

8.5 PASSIVE (Non-reactive) MATERIALS – Materials which do not change their physical form when exposed to high temperatures. Examples are gypsum board and Spray-Applied Fire Resistive Materials (SFRM), which passively insulate when exposed to high temperatures.

8.6 REACTIVE MATERIALS – Materials which undergo a chemical reaction and change their physical form when exposed to high temperatures. An example is Intumescent Fire-Resistive Materials (IFRM), which react, expand and insulate when exposed to high temperatures.

8.7 SECTION FACTOR – A ratio, such as  $W/D$  and  $A/P$ , that provides a means for sizing structural members for purposes of fire protection. The section factor is related to the slenderness or massiveness of the structural member and is indicative of the amount of heat energy that can enter the structural member and the rate at which it will heat up.

## 9 Terms of Abbreviation

9.1 For the purpose of the requirements in Part 2 of this Standard, the following terms of abbreviation are used.

$D$  or  $DFT$  thickness of fire protection material (in)

$D_{min}$  minimum thickness of fire protective coating (in)

$D_{max}$  maximum thickness of fire protection coating (in)

$D_{mid}$  an intermediate thickness of fire protection coating lying within the mid third between  $D_{min}$  and  $D_{max}$  (in)

$t$  the period or duration of classification (minutes)

$T$  the temperature (°F or °C) used as the criteria in an engineering assessment (engineering analysis or study) intended to provide supplementary information to the classification

$W/D$  where  $W$  is the weight of the open steel section per lineal foot and  $D$  is the perimeter of protection material at the interface between the open steel section and the protection material

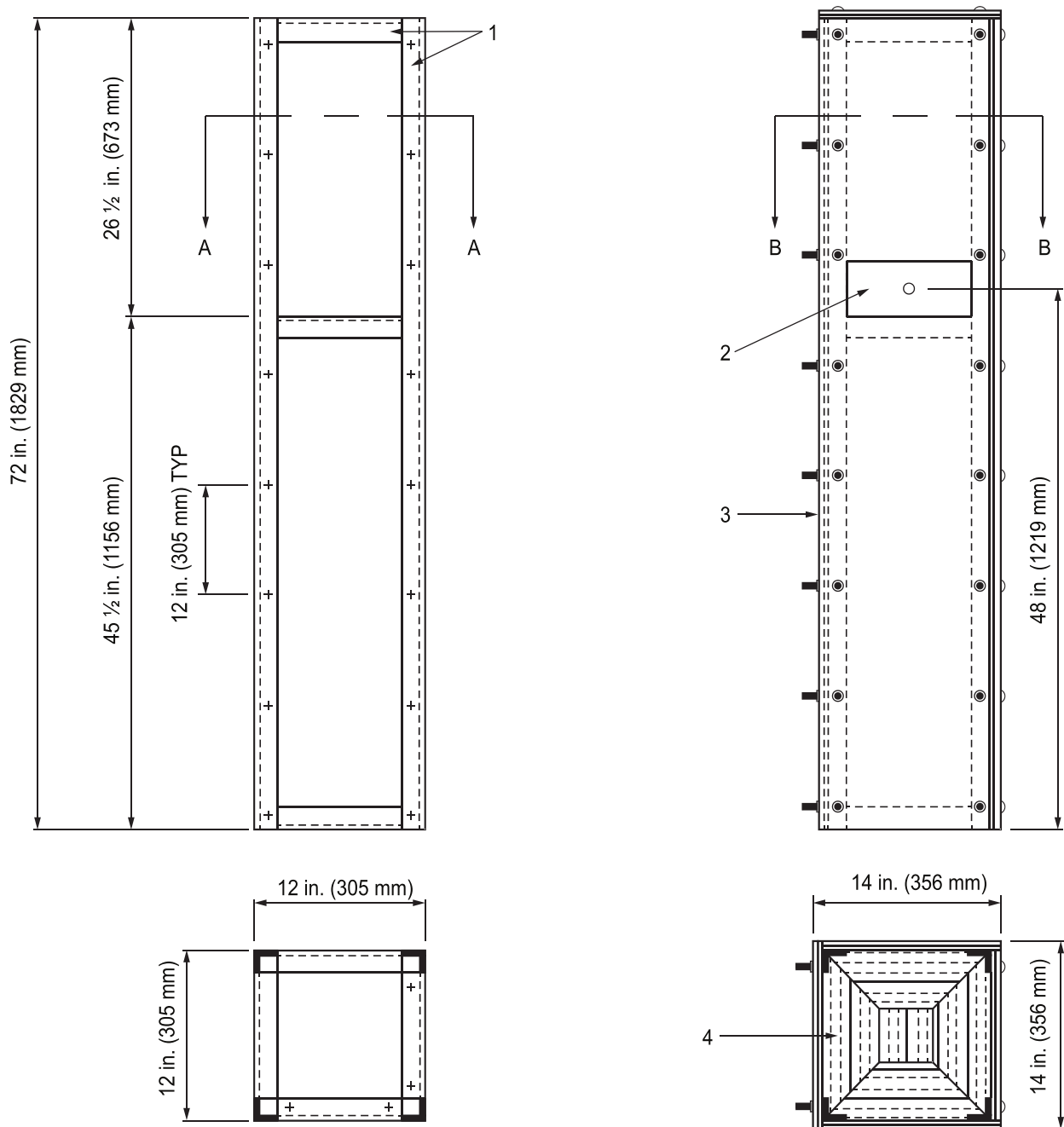
$A/P$  where  $A$  is the cross-sectional area of the hollow section and  $P$  is the perimeter of protection material at the interface between the hollow steel section and the protection material

## FULL-SCALE TEST METHOD

### 10 Furnace Calibration

10.1 The exposure of the furnace is to be measured with thermocouples and calorimeters mounted within a nominal 14 by 14 in by 6 ft high (357 by 357 by 1829 mm) vertical calibration column centered within the furnace chamber. The calibration column is to be fabricated from noncombustible materials, constructed and instrumented as shown in [Figure 10.1](#) and [Figure 10.2](#).

**Figure 10.1**  
**Calibration Column I**



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**KEY**

- 1 2" x 2" x 3/16" (51 x 51 x 4.8 mm) steel angles welded to form framework
- 2 Instrumentation block (2 required)
- 3 Two layers of nom. 1.2" (13 mm) Marinite or equivalent inorganic insulation boards installed on four sides and top of calibration column, secured to framework with No. 1/4 – 20 steel bolts with nuts and 1-1/4 (32 mm) diameter steel washers
- 4 Entire cavity of calibration column filled with nom. 6 lb/ft<sup>3</sup> (3484 kg/m<sup>3</sup>) density mineral wool batts