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289

Standard Method of Fire Test for Individual Fuel Packages

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ISBN: 978-145592076-1 (PDF)
ISBN: 978-145592077-8 (eBook)

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NFPA® 289

Standard

Method of Fire Test for Individual Fuel Packages

2019 Edition

This edition of NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, was prepared by the Technical Committee on Fire Tests. It was acted on by NFPA at its June Association Technical Meeting held June 11-14, 2018, in Las Vegas, NV. It was issued by the Standards Council on August 14, 2018, with an effective date of September 3, 2018, and supersedes all previous editions.

This edition of NFPA 289 was approved as an American National Standard on September 3, 2018.

Origin and Development of NFPA 289

The 2009 edition of NFPA 289 was the first for this standard. It established a fire test method for determining the contribution of individual fuel packages to heat and smoke release when exposed to various ignition sources. Testing protocols were provided for three types of individual fuel packages: single decorative objects such as signs, wall hangings, and mannequins; exhibit booths; and stage sets including backdrops and scenery. NFPA 289 is a standard test method for determining the extent to which these fuel packages contribute to fire growth and the potential for the spread of fire in a controlled environment.

The 2013 edition included updates to referenced publications, extracted definitions, and annex material. New requirements were added to Chapter 5 on ignition source power levels. Also, provisions for alternative probe locations were updated.

The 2019 edition has been updated to reflect the advancements in laboratory technology, including lighting and recording. New provisions for fire-retardant-treated natural Christmas trees were added, including conditioning requirements. Alternate provisions were added when testing for forensic fire reconstruction or research purposes.

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Standard

Method of Fire Test for Individual Fuel Packages

2019 Edition

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A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard describes a fire test method for determining the fire test response characteristics of individual fuel packages when exposed to various ignition sources.

1.1.2 This fire test method is applicable to individual fuel packages.

1.1.3 This fire test method is not intended to evaluate fire resistance.

1.1.4 This standard contains detailed descriptions of three types of individual fuel packages to be investigated, as follows:

(1)* Single decorative object
(2) Exhibit booth
(3) Stage setting

1.1.5* This test method shall not be used as an alternate compliance test for items for which there is an existing full-scale heat release test such as seating furniture, mattresses, stacking chairs, interior finish, textile wall coverings, or mattress sets.

1.1.6 When tests are conducted for the purpose of forensic fire reconstruction, or research, this test standard shall apply to any individual fuel package.

1.2 Purpose.

1.2.1 This method of test measures certain fire test response characteristics of individual fuel packages under specified fire exposure conditions.

1.2.2 The method of test provides the following data:

(1) Extent of fire growth
(2) Rate of heat release by the individual fuel package
(3) Total heat released by the individual fuel package
(4) Smoke obscuration, as determined in the exhaust duct
(5) Production of carbon monoxide, as determined in the exhaust duct
(6) Emissions of other combustion gases, as determined in the exhaust duct
(7) Gas temperatures at suitable locations
(8) Mass loss of single decorative objects

1.2.3* The performance observed in the test is based on the test conditions.

1.2.4 The method of test does not provide the following:

(1) Full information concerning toxicity of combustion gases
(2) Fire resistance of systems

1.3 Symbols.

The following symbols are used in this standard:

C	=	calibration factor for orifice plate or bidirectional probe ($kg^2\ m^2\ K^2$)
C_{est}	=	an approximate value of the calibration factor
C_{cor}	=	corrected calibration factor
dt	=	time (sec)
F_{mb}	=	mass of fuel burned (kg)
E	=	net heat released per unit mass of oxygen consumed (13.1 MJ/kg)
E_{CO}	=	net heat released per unit mass of oxygen consumed, for CO (17.6 MJ/kg)
Ht_{comb}	=	heat of combustion of the fuel used (46.5 MJ/kg for propane and 50.0 MJ/kg for methane)
I_0	=	light intensity for a beam of parallel light rays, measured in a smoke-free environment, with a detector having the same spectral sensitivity as the human eye and reaching the photodetector
I	=	light intensity for a parallel light beam having traversed a certain length of smoky environment and reaching photodetector
k	=	smoke extinction coefficient (l/m)

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L_p	=	light path length of beam through smoky environment, which is equal to the duct diameter (m)
$\dot{m}_e$	=	mass flow rate in exhaust duct (kg/sec)
$\dot{m}_{CO}$	=	release rate of CO (kg/sec)
$\dot{m}_x$	=	release rate of combustion product x (kg/sec)
M_a	=	molecular weight of incoming and exhaust air (29 kg/kmol)
M_{CO}	=	molecular weight of CO (28 kg/kmol)
M_{O_2}	=	molecular weight of oxygen (32 kg/kmol)
MW	=	fuel mass loss
OD	=	optical density per unit light path length (l/m)
ΔP	=	pressure drop across the orifice plate or bidirectional probe (Pa)
$\dot{q}$	=	rate of heat release (kW)
RSR	=	rate of smoke release (m^2/sec)
Δt	=	scan period (sec)
T_e	=	gas temperature at the orifice plate or bidirectional probe (K)
test period	=	duration of test (sec)
THR	=	total heat released (MJ)
TSR	=	total smoke released (m^2)
$\dot{V}_S$	=	volumetric flow rate at location of smoke meter (value adjusted for smoke measurement calculations) (m^3/sec)
X_{CO}	=	measured mole fraction of CO in exhaust flow (nondimensional)
X_{CO_2}	=	measured mole fraction of CO_2 in exhaust flow (nondimensional)
$X^0_{CO_2}$	=	measured mole fraction of CO_2 in incoming air (nondimensional)
X_{O_2}	=	measured mole fraction of O_2 in exhaust flow (nondimensional)
$X^0_{O_2}$	=	measured mole fraction of O_2 in incoming air (nondimensional)
X_x	=	measured mole fraction of combustion gas x in exhaust flow (nondimensional)
α	=	combustion expansion factor (nondimensional; use a value of 1.105, unless the value for the test specimen, and not the ignition gas, is known)
ϕ	=	oxygen depletion factor (nondimensional)
ρ_0	=	density of air at 273.15 K: 1.293 (kg/m^3)

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.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 270, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber,* 2018 edition.

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 defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.4 Shall. Indicates a mandatory requirement.

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

3.2.6 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Fuel Package. A grouping of one or more items whose proximity is sufficiently close that the ignition of one item can be expected to cause the spread of fire to the remaining items in the fuel package.

3.3.2 Individual Fuel Package. An item or a group of items for which the fire test response characteristics are to be measured.

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3.3.3 Heat of Combustion.

3.3.3.1 ***Effective Heat of Combustion.*** The measured heat release divided by the mass loss for a specified time period.

3.3.3.2 ***Net Heat of Combustion.*** The oxygen bomb calorimeter value for the heat of combustion, corrected for the gaseous state of product water.

3.3.4 Heat Release Rate. The heat evolved from the specimen, per unit of time.

3.3.5* Heating Flux. The rate of heat transferred per unit area to a surface, typically expressed in kW/m^2 or $Btu/s\text{-}ft^2$.

3.3.6* Initial Test Heat Flux. Amount of heat received by a specimen surface per unit area and unit time at the initiation of a test.

3.3.7 Oxygen Consumption Principle. The expression of the relationship between the mass of oxygen consumed during combustion and the heat released.

3.3.8 Smoke Obscuration. The reduction of light transmission by smoke, as measured by light attenuation. [**270,** 2018]

Chapter 4 Summary of Method

4.1 General.

4.1.1* The individual fuel package shall be tested by using one of the ignition sources as described in 4.1.7.

4.1.2* Decorative objects shall be tested as described in Section 5.1.

4.1.3 Exhibit booths shall be tested as described in Section 5.2.

4.1.4 Theater, motion picture, and television stage settings shall be tested as described in Section 5.3.

4.1.5 Individual fuel packages and decorative objects, other than those described in 4.1.2 through 4.1.4, shall be tested as described in Section 5.6.

4.1.6 The test methods described herein shall use a gas burner to produce a diffusion flame to expose the individual fuel package, except for forensic fire reconstruction, or research, as discussed in 4.1.8.

4.1.6.1 The burner shall produce a prescribed rate of heat output as described in 4.1.7.

4.1.6.2 The fire test response characteristics of the individual fuel package shall be measured by constant monitoring of heat release, smoke release, and the temperature of the gases in the exhaust duct connected to the hood.

4.1.6.3 The combustion products shall be collected in a hood that feeds into a plenum connected to an exhaust duct in which measurements of the gas velocity, temperature, smoke obscuration, and concentrations of selected gases are made.

4.1.7 The ignition source to be used shall be a gas burner as described in Section 7.1.

4.1.7.1* The ignition source shall be set at one of six power levels, namely, 20, 40, 70, 100, 160, or 300 kW, and shall be applied for an exposure period of 15 minutes.

4.1.7.2* The choice of power levels shall be based both on the type of individual fuel package to be tested and on its potential application.

4.1.8 Alternate Ignition Sources.

4.1.8.1 When tests are conducted for the purpose of forensic fire reconstruction, or research, the use of an alternate ignition source shall be permitted.

4.1.8.2 When an ignition source other than as described in 4.1.7 is used, the ignition source details shall be documented in sufficient detail in 11.1.2 of the report so that other laboratories will be able to replicate the experiments.

Chapter 5 Individual Fuel Packages

5.1 Decorative Objects.

5.1.1 Individual decorative objects of irregular shape such as, but not limited to, mannequins and other such objects used for display purposes shall be tested in the size and shape intended for use.

5.1.2 Materials intended for use in the manufacture of decorative objects comprising individual fuel packages that are planar such as, but not limited to, murals, wall hangings, and signs shall be permitted to be tested as a material in the thickness and size intended for use.

5.1.2.1 Objects intended to exceed width and height dimensions of 2.4 m (8 ft) shall be tested at maximum width and height dimensions not exceeding 2.4 m (8 ft).

5.1.2.2 The decorative object shall be mechanically supported in such a manner that the support system does not interfere with the fire test response characteristics of the decorative object.

5.1.3 The individual fuel package shall be placed on a protective barrier large enough to prevent melting or material from falling off the protective barrier as described in 5.1.4 and 7.5.2.1.

5.1.4 The protective barrier shall serve to catch falling material and to protect the load cell as described in Section 7.5.

5.1.5 For individual fuel packages of irregular shape, the ignition source shall be placed on the protective barrier *(see 5.1.3)* and in contact with the fuel package or located to optimize ignition and fire growth of the individual fuel package.

5.1.6 For murals, signs, wall hangings, and other objects that are planar, the vertical centerline of the ignition source shall be aligned with the vertical centerline of the decorative object ± 25 mm (± 1 in.) and located within 25 mm ± 2.5 mm (1 in. ± 0.1 in.) of the vertical face of the decorative object.

5.1.7* Decorative objects shall be tested using the ignition source at an initial power level of 20 kW.

5.2 Exhibit Booths.

5.2.1* Panels intended for exhibit booth construction shall be constructed into a 2.4 m ± 0.1 m × 2.4 m ± 0.1 m (8 ft ± 0.32 ft × 8 ft ± 0.32 ft) rear wall section and two 1.8 m ± 0.1 m long × 2.4 m ± 0.1 m high (6 ft ± 0.32 ft long × 8 ft ± 0.32 ft high) sidewall sections.

5.2.1.1 The booth shall be an open-top, open-front assembly.

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