

NFPA®

160

Standard for the
Use of Flame Effects
Before an Audience

2021



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NFPA® 160

Standard for the

Use of Flame Effects Before an Audience

2021 Edition

This edition of NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, was prepared by the Technical Committee on Special Effects. It was issued by the Standards Council on March 15, 2020, with an effective date of April 4, 2020, and supersedes all previous editions.

This edition of NFPA 160 was approved as an American National Standard on April 4, 2020.

Origin and Development of NFPA 160

NFPA 160, *Standard for Flame Effects Before an Audience*, was developed by the Technical Committee on Special Effects, which was established in 1994 in response to a recognized need for a document to provide guidance to public safety officials, designers, and operators of flame effects. The purpose of this standard is to provide requirements for reasonable protection for viewing audiences and performers of flame effects. The first edition of the standard was 1998.

For the 2001 edition, the Committee completed a partial revision of the standard. Revisions included amendments to standardized definitions, harmonization with the pyrotechnics special effects document, and editorial changes according to the *Manual of Style for NFPA Technical Committee Documents*.

The 2006 edition included a complete revision of the standard by the Committee. Key changes found in the 2006 edition included revisions to Chapter 3, Definitions; clarification of the document applicability by modifying the document title; definitions for temporary and permanent installations to correlate with the effect classifications based upon those terms; a new requirement for inspection intervals; and a new Annex C on inspection guidelines.

The 2006 edition of the standard also incorporated editorial changes according to the *Manual of Style for NFPA Technical Committee Documents*.

The 2011 edition of the standard incorporated amendments to the application section to clarify that NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*, applies to flame effect use when no audience is present. The Committee added definitions for the terms *performer* and *support personnel* extracted from NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, for consistency between the special effects documents. Requirements for development and approval of the flame effects plan were included. The Committee revised the separation distance requirements to eliminate the thermal flux provision and retain the skin surface temperature requirements. The skin surface temperature is based on a test method that can be more easily performed in the field.

The 2016 edition of NFPA 160 defined *hybrid flame effect* and added requirements for its use. The 2016 edition also indicated which portions of hybrid flame effects are covered by NFPA 160 and which are covered by NFPA 1126, since both documents apply, and added explanatory annex material to provide further guidance on the simultaneous application of NFPA 160 and NFPA 1126. In addition, the 2016 edition clarified that the use of ground-based effects utilizing explosives, liquid fuels, or other combustibles in air show environments is not covered by NFPA 160 and provided a reference for the use of such effects.



The 2021 edition of NFPA 160 significantly reorganizes the document to cover new advances in flame effect technology. Previously, NFPA 160 only contained requirements for flame effect technology using flammable gases, and it has now been revised to separate each flame effect technology by fuel source, which will now include solid, liquid, prepackaged single-use containers, and gels. Requirements that are common for all flame effect systems are now in Chapter 9, with the requirements specific to the fuel of the device located in Chapters 11 through 13. Fire performers now have requirements in Chapter 14 as well.

Dedication

The Technical Committee dedicates the 2021 edition of NFPA 160 to the memory of Tedward LeCouteur, a Committee member who worked tirelessly and passionately for the fire-performing community. It was his work that laid the foundation for Chapter 14 for fire performers.

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Committee Scope: This Committee shall have primary responsibility for documents on the controlled use of flame, pyrotechnics, or other means of special effects for entertainment, exhibition, demonstration, or simulation before a proximate audience; and the design, fabrication, installation, testing, control, operation, and maintenance of user equipment, fuel storage, and sources for special effects before a proximate audience.

This Committee does not have responsibility for documents on hazards other than those involving a proximate audience and the life safety considerations of the audience.

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NFPA 160

Standard for the

Use of Flame Effects Before an Audience

2021 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.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. 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 and extracted publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1* Scope. This standard shall provide requirements for the protection of the audience, support personnel, performers, the operator, assistants, and property where flame effects are used.

1.2 Purpose. The purpose of this standard shall be to provide minimum requirements for the design, manufacture, and operation of flame effects.

1.3 Application.

1.3.1* This standard shall apply to flame effects for entertainment, exhibition, demonstration, or simulation before an audience, including their design, fabrication, installation, testing, control, operation, and maintenance.

Δ 1.3.2 This standard shall apply to the following:

- (1) Use of flame effects before an audience (*see 3.3.13, Flame Effect*)
- (2) Design, fabrication, installation, testing, control, operation, and maintenance of equipment, materials, procedures, and systems used to produce flame effects

- (3) Rehearsal, videotaping, audiotaping, or filming of any television, radio, or movie production if such production is before an audience and includes the use of flame effects
- (4) Rehearsal of any production incorporating flame effects intended to be presented before an audience
- (5) Storage and holding at a venue where flammable and combustible materials are to be used to create flame effects
- (6) That portion or component of any hybrid flame effect that utilizes fuels, materials, devices, and methodologies governed by this standard

Δ 1.3.3 This standard shall not apply to the following:

- (1)* Flame effects produced solely by pyrotechnic special effects devices or pyrotechnic material
- (2)* Use of pyrotechnic special effects
- (3)* Storage of flammable solids, liquids, and gases not to be used to create flame effects
- (4) Nitrocellulose-based flame projectors
- (5) Manufacture, off-site storage, and transportation of materials and equipment used to produce flame effects
- (6) Use of flame effects in fire training, except where there is an audience that is not part of the training
- (7)* Manufacture, transportation, storage, sale, or use of model or high-power rocket motors
- (8) Traditional nontheatrical public display of flames such as the following:
 - (a) Use of lighted candles in restaurants or religious services
 - (b) Fireplaces in areas open to the public
 - (c) Restaurant cooking visible to the patrons
 - (d) Listed Group II flame effects
- (9) Use of consumer fireworks by the public
- (10) Use of motor vehicles in races or sanctioned competitive sporting events
- (11)* Use of ground-based effects utilizing explosives, liquid fuels, or other combustibles in air show environments
- (12) Use of pyrotechnic effect simulation equipment as defined in NFPA 1126

1.3.4* This standard shall not be used as a product standard.

Δ 1.3.5 When there is no audience present, NFPA 140 shall be used to regulate any flame effect use.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction.

tion, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

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

NFPA 1, *Fire Code*, 2021 edition.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2021 edition.

NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*, 2018 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, 2021 edition.

2.3 Other Publications.

2.3.1 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

Boiler Pressure Vessel Code, 2013.

N 2.3.2 European Commission Publications. European Commission, Rue de la Loi 130, 1049 Brussels, Belgium.

Pressure Equipment Directive, 2014.

2.3.3 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code*, 2018 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, 2016 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 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* 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.

3.2.5 Shall. Indicates a mandatory requirement.

N 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 Accumulator. A container or piping that holds a predetermined volume of fuel that is ready for use in a flame effect.

3.3.2 Area.

3.3.2.1 Hazard Area. The area made hazardous by the operation of the flame effect.

3.3.2.1.1 Accessible Hazard Area. That area made hazardous by the flame effect that is normally accessible to a person without the deliberate use of an additional means of access that is not normally in place.

3.3.2.2 Holding Area. An area where flame effect material or loaded flame effect devices are held prior to use.

3.3.2.3 Storage Area. An area where flame effect material or flame effect devices are stored prior to use or movement to a holding area.

3.3.3* Arm. That sequence of control system functions for the establishing of a source of ignition that must be complete and verified immediately before the firing of the flame effect.

3.3.4 Assistant. A person who works under the supervision of the flame effect operator.

3.3.5 Cast Members. Performers involved in a production involving the use of flame effects.

3.3.6 Direct Ignition. An automatic or manual ignition system that ignites fuel without a pilot.

3.3.7 Emergency Stop [Emergency Shutdown (ESD) System]. A circuit or other mechanism that, when actuated, results in the complete shutdown and extinguishment of all flame effects that are controlled by it.

3.3.8* Enable. The final set of control system functions that must be verified to be in a specific control mode immediately before the arming and firing of a flame effect **can** be implemented.

3.3.9 Enable Button. The control operator that is manually actuated by the operator prior to and during the arming and firing of the effect.

3.3.10 Fail-Safe. A state or an attribute of a system such that every single point failure in the system results in all controlling parts of the system with the ability to do harm to humans, animals, or equipment being disconnected from all sources of power and stored energy at the primary disconnect point.

3.3.11* Fire. The sequence of control system functions that result in the deliberate release of fuel for ignition.

N 3.3.12 Fire Watch. The assignment of a person or persons to an area for the express purpose of notifying the fire department, the building occupants, or both of an emergency; preventing a fire from occurring; extinguishing small fires; protecting the public from fire and life safety dangers. [1, 2018]

3.3.13 Flame Effect. The combustion of solids, liquids, or gases utilizing atmospheric oxygen to produce thermal, physical, visual, or audible phenomena before an audience.

3.3.13.1 Automatic Flame Effect. A flame effect that is supervised and fired by an automatic control system.

3.3.13.2* Hybrid Flame Effect. A flame effect that is used in combination with a pyrotechnic material or device.

3.3.13.3 Manual Flame Effect. A flame effect that is operated manually without the use of an automatic control system.

3.3.13.4 Portable Flame Effects. Flame effects that are designed and installed, either in a permanent or temporary installation, and that are designed to move or be moved in the course of operation or installation.

3.3.14* Flame Effect Appliance. The complete assembly of components and devices that controls and generates a flame effect, which are further defined by the type of fuel used for the primary flame.

N 3.3.14.1 Gaseous-Fuel Flame Effect Appliance. An appliance that uses gaseous fuel as the primary fuel.

N 3.3.14.2 Liquid-Fuel Flame Effect Appliance. An appliance that uses liquid fuel as the primary fuel.

N 3.3.14.3 Prepackaged Single-Use Container Fuel Flame Effect Appliance. An appliance that uses fuel from a prepackaged single-use container.

N 3.3.14.4 Solid-Fuel Flame Effect Appliance. An appliance that uses solid fuel as the primary fuel.

3.3.15 Flame Effect Burner. A burner designed to produce specific sizes and configurations of flames for flame effects.

3.3.16* Flame Effect Materials. Flammable or combustible materials used as fuel for flame effects and identified by their state of matter at standard temperature and pressure (STP).

N 3.3.16.1 Gaseous Fuel. A fuel that is a gas or vapor, or a liquefied flammable gas that has been vaporized.

N 3.3.16.2* Liquid Fuel. A fuel that is a liquid.

N 3.3.16.3* Solid Fuel. A fuel that is a solid.

3.3.17 Flame Effect Operator. The single person with overall responsibility for flame effect operations and safety.

3.3.18 Flame Effect Safety Controller. A control system that is part of a flame effect appliance that is used to prove that the source of ignition is present ("flame safeguard control").

3.3.19* Flame Effect System. The complete assembly of interconnected components, devices, and/or appliances that provides all of the functions necessary to fuel, monitor, supervise, generate, and control flame effects, including the emergency shutdown of the flame effects and, where necessary, the monitoring of external conditions that affect operation.

3.3.20* Flame Effect Systems, Classifications.

3.3.20.1 Group I Flame Effect. An attended, manually controlled flame effect.

3.3.20.2 Group II Flame Effect. An individual or group flame effect designed for unattended operation that is temporarily or permanently installed outside any structure.

3.3.20.3 Group III Flame Effect. An attended, temporarily installed flame effect for a specific production with limited operation and fixed time for removal.

3.3.20.4 Group IV Flame Effect. A large individual or group flame effect that is permanently installed inside or outside any structure designed for unattended operation without a main show supervisory control system.

3.3.20.5 Group V Flame Effect. A large individual or group flame effect that is temporarily or permanently installed inside or outside any structure and is designed for intermittent or continuous operation under the supervision of a main show control system but without full-time supervision by a technician.

3.3.20.6 Group VI Flame Effect. A large individual or group flame effect that is temporarily or permanently installed inside or outside any structure and is designed for intermittent operation under the supervision of a main show control system and a technical director, with cast members in close proximity to the effect at the time of operation.

3.3.20.7 Group VII Flame Effect. An individual flame effect that can be temporarily or permanently installed inside or outside any structure that, due to its unique operating requirements, does not fit into any other classification.

3.3.21 Hybrid Flame Effect. See 3.3.13.2.

3.3.22 Installation, Term of.

3.3.22.1 Permanent Installation. An installation of flame effects for which the governing use permit has a duration longer than 180 days.

3.3.22.2 Temporary Installation. An installation of flame effects for which the governing use permit has a duration of 180 days or less within a twelve-month period in a single venue.

N 3.3.23* Oxidizer. The source providing oxygen to a combustion reaction.

Δ 3.3.24* Performer. Any person active in a performance during which flame effects are used and who is not part of the audience or support personnel.

3.3.25 Permit. A document issued by the AHJ for the purpose of authorizing performance of a specified activity. Unless otherwise specified, the word *permit*, when used in this document, refers to a use permit.

3.3.25.1 Use Permit. A document issued by the AHJ for the purpose of authorizing the use of specific flame effects in a specific venue on a specified date and time or within a specified period.

3.3.26 Plan.

3.3.26.1 Design Plan. The plan for a flame effect appliance or design that presents the design criteria and/or assumptions used in the design, along with complete design information.

3.3.26.2 Flame Effect Plan. The document that is used to convey to the AHJ the information needed to evaluate the flame effect for the purpose of applying for a permit.

N 3.3.27 Prepackaged Single-Use Container. A container intended for single use and not to be refilled, approved for transportation, which has been factory filled with a pressurized fuel and is equipped with a prepackaged single-use container valve that allows connection to the container receiver of a prepackaged single-use container flame effect appliance.

N 3.3.27.1 Prepackaged Single-Use Container Receiver. A receiver installed on a prepackaged single-use container flame effect appliance with the receiver mating with the prepackaged single-use container, which when fully mated, allows for the operation of the prepackaged single-use container valve contained within the prepackaged single-use container and admits fuel to the appliance.

N 3.3.27.2 Prepackaged Single-Use Container Valve. A self-closing device internal to a prepackaged single-use container to allow dispensing of the fuel.

3.3.28* Primary Safety Control. A control with a sensor that is directly responsive to the ignition device attributes necessary for the safe operation of the effect.

3.3.29 Rated. A description of performance derived from testing or evaluation that guides appropriate selection, installation, and use of equipment that is not listed.

3.3.30 Safety-Critical. The failure of a device, component, system, or mechanism, which results in a situation that is immediately dangerous to life, health, or property.

3.3.31* Safety Shutdown (Lockout). The safe shutdown of the flame effect in the event of the actuation of any flame effect primary safety control or limit switch.

3.3.32* Supervisory Control System. A manual or automatic control system that supervises the operation of the flame effect.

3.3.33* Support Personnel. Any individual who is not a performer or member of the audience. [1126, 2016]

3.3.34 Valve.

3.3.34.1 Accumulator Charge Valve. A valve used to control the flow of fuel into an accumulator.

3.3.34.2 Effect Valve. The last fuel shutoff valve before the flame effect burner.

3.3.34.3 Safety Shutoff Valve. A fast-closing valve that automatically and completely shuts off the fuel supply in response to a normal or safety shutdown.

3.3.34.4 Vent Valve. A normally open, power-closed valve, normally located between the two safety shutoff valves.

3.3.35* Venue. The property, facility, building, or room within a building where flame effects are used, intended to be used, or are prohibited.

Chapter 4 Holding Areas for Flame Effect Materials and Devices

4.1* General. All flame effect materials and devices not connected for use shall be stored in accordance with applicable codes and standards and any state and local regulations.

4.2 Holding Areas. All flammable flame effect materials and loaded devices that have been removed from storage areas in anticipation of use shall be stored in a holding area acceptable to the AHJ.

4.2.1 Quantity Limitations.

4.2.1.1 The maximum quantity of flammable flame effect materials and loaded devices stored in a holding area shall be that quantity used in one day.

4.2.1.2 Quantities of flammable flame effect materials and devices in excess of those used in one day shall be permitted to be stored in holding areas with the approval of the AHJ.

4.2.2 Supervision. Flammable flame effect materials and loaded devices in holding areas shall be secured or supervised continuously by an attendant trained in emergency response procedures.

Chapter 5 Permit and Approval Requirements and Terms of Installation

5.1 Permit Requirements.

5.1.1* Permit Required. Except when otherwise required by the AHJ, a use permit shall be required for the use of flame effects before an audience.

5.1.2* Terms of Installation.

5.1.2.1 Permanent Installation. An installation of flame effects for which the governing use permit has a duration