

NFPA® 290

Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers

2023 Edition



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An International Codes and Standards Organization

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NFPA® 290

Standard for

Fire Testing of Passive Protection Materials for Use on LP-Gas Containers

2023 Edition

This edition of NFPA 290, *Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers*, was prepared by the Technical Committee on Fire Tests. It was issued by the Standards Council on April 28, 2022, with an effective date of May 18, 2022, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at www.nfpa.org for more information.

This edition of NFPA 290 was approved as an American National Standard on May 18, 2022.

Origin and Development of NFPA 290

Although the 2003 edition was the first edition of NFPA 290, *Fire Testing of Passive Protection Materials for Use on LP-Gas Containers*, a test procedure for torch fire and hose stream testing of thermal insulating systems for LP-Gas containers has been included as an annex to NFPA 58, *Liquefied Petroleum Gas Code*, since the 1986 edition of that code. That test method was developed by the Technical Committee on Fire Tests at the request of the Technical Committee on Liquefied Petroleum Gases as a result of numerous BLEVE incidents that had occurred in previous years. In the mid-1990s, the test procedure saw greater use, particularly outside the United States, and the two technical committees agreed that it should be developed and maintained as a fire test standard under the scope of the Fire Test Committee rather than as an annex to NFPA 58.

The 2003 edition of NFPA 290 represented a refinement of the test procedure that previously appeared as an appendix to NFPA 58, and it reorganized the procedure as a stand-alone fire test standard using mandatory language in accordance with the *Manual of Style for NFPA Technical Committee Documents*.

The 2009 edition contained revisions to clarify its scope and purpose and a revised definition of the term *passive fire protection material*.

No major changes were made in 2013.

The 2018 edition has been updated to reference the most up-to-date standards and terminology.

In 2023, clarification has been added to the annex related to NFPA 58 and NFPA 59.

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

Chapter 1 Administration

1.1* Scope. The test described in this procedure shall be used to determine the fire resistance of passive fire protection (PFP) materials applied to the exterior of LP-Gas containers.

1.2 Purpose. This test is designed to evaluate the fire resistance of passive fire protection (PFP) materials in a torch fire environment created by the rupture of a nearby storage vessel.

1.2.1* This test procedure subjects an insulated steel plate, simulating an LP-Gas storage vessel, to a torch fire exposure for 50 minutes. After 20 minutes of the torch fire exposure, the insulated steel plate is subjected simultaneously to the torch fire exposure and a hose stream for 10 minutes.

1.3 Application.

1.3.1 This procedure shall be a test of materials and not a test of assemblies. If necessary, additional testing shall be performed to determine the effectiveness of the material protecting a particular assembly or fabrication.

1.3.2* Although the test has been designed to reproduce conditions similar to those found in fires resulting from realistic releases of hydrocarbons, this test does not guarantee a specific degree of protection from the myriad of possible fires involving LP-Gas storage vessels or containers.

1.3.3 The test involves hazardous materials and operations.

1.3.3.1 The procedure does not address all of the safety problems associated with its use.

1.3.3.2 It shall be the responsibility of the user of the procedure to establish the safety and health practices and determine the applicability of regulatory limitations before use.

1.3.3.3 It shall be the responsibility of the supplier to inform the testing laboratory of any dangerous properties of the material to be tested, fumes given off during testing, and the residues after testing.

1.3.4 Although the test specified has been designed to simulate some of the conditions that occur in an actual LP-Gas-fueled torch fire, it does not reproduce them all exactly.

1.3.4.1 The results of this test do not guarantee safety but can be used as elements of a fire hazard or fire risk assessment for structures or plants.

1.3.4.2 The fire hazard or fire risk assessment shall also take into account all the other factors that are pertinent to an assessment of the fire hazard for a particular end use.

1.3.5 This test does not offer an assessment of other properties of the passive fire protection material such as weathering, aging, shock resistance, impact or explosion resistance, flame spread, or smoke production.

1.4 Units and Formulas.

1.4.1 SI Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.4.2 Primary Values. The SI value for a measurement and the equivalent inch-pound value given in parentheses 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 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 385, *Safety Play Pipes for Water Supply Testing in Fire Protection Service*, 2005, revised 2020.

2.3.2 Other Publications.

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

2.4 References for Extracts in Mandatory Sections. (Reserved)

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 Shall. Indicates a mandatory requirement.

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

3.2.3 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 phrases “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 Fire Resistance. The measure of the ability of a material, product, or assembly to withstand fire or give protection from it.

3.3.2* Passive Fire Protection (PFP) Material. A material that is applied to a substrate and designed to protect it from the thermal effects of a fire.

3.3.2.1 Passive Fire Protection — Coating Material. A material that is applied to a substrate and is designed to protect it from thermal effects.

3.3.2.2 Passive Fire Protection — Panel Material. A material in the form of a panel or sheet, including pre-formed components, that is designed to stand alone prior to application to a steel substrate.

3.3.3 Rear Box. A mild steel box, open at the front and back, that is designed to be attached to the rear of the test specimen to shield it from environmental influences.

3.3.4 Torch Fire. An ignited discharge of propane vapors under pressure.

Chapter 4 Test Specimens

4.1 Construction of Test Specimen.

4.1.1 Two test specimens shall be required to conduct this test.

4.1.2 One test specimen shall be an uninsulated steel plate used for calibration of the propane torch fire exposure.

4.1.3 A second test specimen shall be a steel plate thermally protected with the insulation material at the thickness, density, and installation techniques being evaluated.

4.1.4 The test specimen dimensions shall not be less than 1.2 m × 1.2 m (4 ft × 4 ft) by nominal 16 mm ($\frac{5}{8}$ in.) thick.

4.1.5 The test specimens shall be constructed using a steel plate with thermal properties equivalent to ASME pressure vessel steel.

4.1.6 Multiple insulated test specimens shall be permitted to be evaluated in a single test program, provided the test specimens are tested consecutively.

4.1.7 The test specimen shall be mounted on a steel-plate holder such that the exposed face of the test specimen is not shielded in any way by the test specimen fixture.

4.1.8 The steel-plate holder shall be constructed in such a manner that the only heat transfer to the backside of the plate is by heat conduction through the plate and not by any other heat paths.

4.1.9 The test specimen shall be mounted vertically.

4.1.10 The rear box shall be installed to the unexposed face of the test specimen in a manner such that all joints are gastight.

4.2 Construction of Rear Box.

4.2.1 All tests require fitting the rear box to the unexposed side of the test specimen to shield the unexposed face from environmental influences.

4.2.2 The rear box shall be constructed from mild steel a minimum of 10 mm ($\frac{3}{8}$ in.) thick.

4.2.3 The rear box shall be open at the front and back and flanged at the front to allow fitting to the rear of the test specimen with no significant air gaps.

4.2.4 The internal dimensions of the rear box shall match the dimensions of the test specimen and be a minimum of 1 m (3 ft) deep.

4.3 Passive Fire Protection (PFP) Material.

4.3.1 Documentation of the method of preparation of the test specimen and the application details of the PFP material shall be provided to the test laboratory in advance of the test.

4.3.2 The test laboratory shall include this information in the test report.

Chapter 5 Torch Fire

5.1 Torch Fire Nozzle. The propane vapor shall be issued from a nozzle capable of meeting the requirements of this test standard.

5.2 Torch Fire Exposure.

5.2.1 The flame temperature from the torch fire shall be 1200°C ± 60°C (2200°F ± 140°F) for the duration of the test.

5.2.2 The velocity of the torch fire at the exposed face of the test specimen shall be 64 km/hr ± 16 km/hr (40 mph ± 10 mph) for the duration of the test.

5.2.3 The tip of the discharge nozzle shall be aimed horizontally perpendicular and centered such that the apex of the flame shall be directed to impinge on the geometric center of the test specimen.

5.2.4 The tip of the discharge nozzle shall be positioned at a distance from the exposed face of the test specimen to achieve the temperature and velocity requirements specified in 5.2.1 and 5.2.2.

5.3 Fuel.

5.3.1 The fuel shall be a propane fuel delivered as a vapor, without a liquid fraction, at a steady flow rate such that the requirements of 5.2.1 and 5.2.2 are met.

5.3.2 There shall be a means of controlling and monitoring the fuel flow of the propane fuel during the torch test.

Chapter 6 Test Location

6.1 Environmental Effects. The test shall be carried out in a test location such that environmental effects are minimized.

6.2 Air Temperature. The ambient air temperature at the start of the test shall be between -10°C and 41°C (14°F and 105°F).

6.3 Wind Limitations. The wind conditions for tests conducted outdoors shall be less than 16 km/hr (10 mph) for the duration of the test.

6.4 Adverse Weather. Tests shall not be conducted outdoors during periods of rain or fog or other adverse weather conditions that could affect the outcome of the test.

Chapter 7 Conduct of Tests

7.1 Test Assembly.

7.1.1 The test specimen shall be adequately restrained in the test specimen fixture throughout the torch and hose stream tests.

7.1.2 The test duration shall be a minimum of 50 minutes.

7.2 Calibration Test.

7.2.1 Prior to evaluating the performance of the thermal insulation system, the torch impingement shall be calibrated as described in 7.2.2 through 7.2.7.

7.2.2 An uninsulated steel plate, as described in Section 4.1, shall be installed in the steel-plate holder.

7.2.3* The unexposed face of the uninsulated steel plate shall be instrumented with not fewer than nine thermocouples.

7.2.4 The thermocouples attached to the unexposed face of the test specimen shall be divided into nine equal squares with a thermocouple affixed to the center of each square.

7.2.5 Before exposure to the torch fire, none of the thermocouple readings on the unexposed side of the steel plate shall indicate a plate temperature in excess of 38°C (100°F) or less than 0°C (32°F).

7.2.6 Temperature measurements shall be monitored during the course of the calibration test and recorded at intervals not exceeding 30 seconds.

7.2.7 A calibration test shall be deemed successful when two of the nine thermocouples record unexposed face temperatures of 427°C (800°F) within 4 minutes \pm 0.5 minute from the start of the test.

7.3 Conduct of Torch Test.

7.3.1 A thermal insulation system shall be tested in the torch environment described in Section 7.2 in the manner described in 7.3.1.1 through 7.3.1.8.

7.3.1.1 The thermal insulation system shall be applied to the exposed side of a steel plate identical to that used during the calibration test described in Section 7.2.

7.3.1.2 The unexposed side of the steel plate shall be instrumented with a minimum of nine thermocouples placed as described in 7.2.3 to record the thermal response of the steel plate.

7.3.1.3 Before exposure to the torch fire, none of the thermocouple readings on the unexposed side of the insulated steel plate shall indicate a plate temperature in excess of 38°C (100°F) or less than 0°C (32°F).

7.3.1.4 The entire surface of the thermal insulation system shall be exposed to the torch fire environment.

7.3.1.5 The test specimen shall be exposed to the torch fire environment described in Section 7.2.

7.3.1.6 The insulated test specimen shall be exposed to the torch fire for 50 minutes.

7.3.1.7 Twenty minutes into the torch test, a hose stream test shall be conducted concurrently, as described in Section 7.4, for 10 minutes.

7.3.1.8 Subsequent to the application of the hose stream, the torch test shall continue until any thermocouple on the unexposed face of the steel plate indicates a plate temperature in excess of 427°C (800°F) or until a total test time of 50 minutes has elapsed.

7.4 Hose Stream Test.

7.4.1 During the torch test, the insulated test specimen shall be exposed to a hose stream test.

7.4.2 After 20 minutes of exposure to the torch test, the test specimen shall be exposed to a hose stream test.

7.4.3 The hose stream test shall be conducted concurrently with the torch test for a period of 10 minutes.

7.4.4 The hose stream shall be delivered through a 64 mm (2 in.) diameter hose discharging through a National Standard play pipe as specified in UL 385, *Safety Play Pipes for Water Supply Testing in Fire Protection Service*.

7.4.4.1 The play pipe shall have an overall length of 762 mm (30 in.) and shall be equipped with a 28 mm ($1\frac{1}{8}$ in.) diameter discharge tip of the standard-taper, smooth bore pattern without shoulder at the orifice.

7.4.4.2 The play pipe shall be fitted with a 64 mm (2 in.) inside diameter by 152 mm (6 in.) long nipple mounted between the hose and the base of the play pipe.

7.4.4.3 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.

7.4.4.4 The pressure tap shall not protrude into the water stream.

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

7.4.5 The gauge water pressure at the base of the nozzle and for the duration of the hose stream test shall be 207 kPa (30 psi).

7.4.5.1 The estimated delivery rate of water shall be 776 L/min (205 gpm) or 7760 L (2050 gal) over the 10-minute hose stream test.

7.4.6 Nozzle Distance. The nozzle orifice shall be located 6 m (20 ft) from and on a line normal to the center of the exposed surface of the test specimen.

7.4.6.1 If the nozzle cannot be located normal to the surface of the test specimen, the nozzle shall be on a line deviating not to exceed 30 degrees from the line normal to the center of the test specimen.

7.4.6.2 When so located, the distance from the center of the test specimen shall be less than 6 m (20 ft) by an amount equal to 0.3 m (1 ft) for each 10 degrees of deviation from the normal.

7.4.7 The hose stream shall be directed first at the middle of the test specimen and then at all parts of the exposed surface, making changes in direction slowly.

7.5 Conditions of Acceptance. None of the thermocouples on the unexposed side of the steel plate shall indicate a temperature in excess of 427°C (800°F) for a period of 50 minutes.

7.6 Environmental Conditions.

7.6.1 Environmental conditions shall be measured immediately before the test, and any significant changes during the test shall be noted.

7.6.2 The ambient temperature shall be measured. For tests conducted outdoors, wind speed and direction shall also be measured. Observations shall also be made of the weather, to indicate whether it is sunny or cloudy or whether there is any precipitation.

7.7 Measurements. A steady flow rate of propane vapor shall be required.

7.7.1 When the torch fire first impinges on the test specimen, a timer shall be started and the flow rate, temperatures, and pressures shall be monitored.

7.7.2 Readings of the instruments shall be taken at least once every 30 seconds.

7.7.3 The tests shall continue until either the time or temperature selected prior to the test is reached.

7.8 Observations.

7.8.1 Observations of significant details of the behavior and appearance of the test specimen during the test and after the torch fire is extinguished shall be recorded.

7.8.2 Information on deformation, spalling, cracking, and burning of the PFP material and continuance of flaming shall be noted.

7.9 Photographs.

7.9.1 Photographs of the test specimen shall be taken prior to and as soon as is practicable after the torch test has been extinguished.

7.9.2 The photographs described in 7.9.1 shall be included in the test report.

7.10 Video. A video record shall be made of the test.

Chapter 8 Presentation of Results

8.1 Test Report. A test report shall be produced and shall include the following information:

- (1) Name of the testing laboratory and the test date.
- (2) Names of the sponsor/customer, the manufacturer, and the product.
- (3) Documentation of how and when the test specimen was prepared, details of the application of the PFP material, and the name of the applicator company.
- (4) A description of the test specimen, including measurements of the thickness of passive fire protection material and the hardness, if measured. The mean, standard deviation, and range of measurements of thickness shall be given.
- (5) Record of test details, as follows:
 - (a) Ambient conditions.
 - (b) Record of the fuel pressure and temperature at least every 30 seconds throughout the test, where these are used to calculate mass flow rate, and the method of control and calculation.
 - (c) Record of fuel mass flow rate at least every 30 seconds throughout the test and total mass of fuel used.
 - (d) For reacting materials, the thickness of unreacted or partially reacted material left at the end of the test and the char thickness at the positions where the initial thickness was measured. The condition of the char and the strength of bonding to the underlying material shall be recorded.
 - (e) For materials restrained/supported by a reinforcing mesh, the condition of the mesh at the end of the test.
- (6) The test result, in the following format:
 - (a) The behavior and appearance of the test specimen during and after the test and photographs, as detailed in Section 7.8 and Section 7.9.
 - (b) Temperature/time plots and tables of temperatures at least every 30 seconds for each thermocouple.
 - (c) Record of the maximum temperature and the time it occurs for each thermocouple.
 - (d) Statement as to the material's performance with respect to the conditions of acceptance.

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.

- Δ **A.1.1** Thermal protection insulating systems are allowed for use on LP-Gas containers as a means of special protection in NFPA 58 and NFPA 59. These standards require that these materials undergo thermal performance testing as a precondition for acceptance. The intent of this testing procedure is to identify insulation systems that retard or prevent the release of the container's contents in a fire environment for 50 minutes and resist a concurrent hose stream for 10 minutes.

With the issuance of NFPA 290, this test method, with the acceptance criteria of Section 7.5, is now the test for thermal insulation of LP-gas containers required in Annex H of NFPA 58, and it is also required by NFPA 59 for the insulation in LP-gas-insulated containers.

A.1.2.1 The torch exposure simulates the high temperature and erosive effects of a high-pressure jet of burning fuel vapor issuing from a nearby ruptured LP-Gas storage vessel. The hose stream simulates a firefighter hose stream impingement on the insulated steel tank.

A.1.3.2 This test is an evaluation based on a “torching” type fire exposure. Other fire exposures such as a pool fire are a potential concern. It is believed, however, that the “torching” test is a worst-case fire scenario because of the high-temperature exposure coupled with the erosive effects of the high-velocity flame.

A.3.3.2 Passive Fire Protection (PFP) Material. Passive fire protection materials can be in the form of coatings or in the

form of panels or sheets, including preformed components, that are designed to stand alone prior to application to a substrate.

A.7.2.3 Thermocouples can be attached to the steel plate via several methods. One such method is to weld the individual thermocouple leads directly to the steel plate, with the individual leads separated by 6 mm (¼ in.) or less. Another method is to “peen” the thermocouples in place. This entails drilling a small diameter indentation into the steel plate. This indentation is less than the diameter of the thermocouple bead. The thermocouple bead is placed in the indentation, and the surrounding metal is “peened” over the thermocouple bead to secure it in place.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 58, *Liquefied Petroleum Gas Code*, 2020 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2021 edition.

B.1.2 Other Publications. (Reserved)

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections. (Reserved)