NFPA 290

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

2003 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
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

2003 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 and acted on by NFPA at its May Association Technical Meeting held May 18–21, 2003, in Dallas, TX. It was issued by the Standards Council on July 18, 2003, with an effective date of August 7, 2003.

This edition of NFPA 290 was approved as an American National Standard on July 18, 2003.

Origin and Development of NFPA 290

While this is the first edition of NFPA 290, 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. The test method first appearing in NFPA 58 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 occurred in previous years. In the mid-1990s, the test procedure saw greater use, particularly outside the United States, and it was agreed by the two technical committees 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.

This edition of NFPA 290 represents a refinement of the test procedure that appeared as Appendix H of NFPA 58, and reorganizes the procedure as a standalone fire test standard using mandatory language in accordance with the updated NFPA *Manual of Style*.

Technical Committee on Fire Tests

William E. Fitch, *Chair*
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April L. Berkol, Starwood Hotels & Resorts Worldwide, Inc., NY [U]
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Gordon E. Hartzell, Hartzell Consulting, Inc., TX [SE]
Marcelo M. Hirschler, GBH International, CA [SE]
Alfred J. Hogan, Reedy Creek Improvement District, FL [E]
Rep. International Fire Marshals Association
William E. Koffel, Koffel Associates, Inc., MD [SE]
James R. Lawson, U.S. National Institute of Standards & Technology, MD [RT]
Rodney A. McPhee, Canadian Wood Council, Canada, [M]
Frederick W. Mowrer, University of Maryland, MD [SE]
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Kuma Sumathipala, American Forest & Paper Association, DC [M]
T. Hugh Talley, Hugh Talley Company, TN [M]
Rep. Upholstered Furniture Action Council
Rick Thornberry, The Code Consortium, Inc., CA [SE]
William A. Webb, Performance Technology Consulting, Ltd., IL [SE]
Robert A. Wessel, Gypsum Association, DC [M]
Robert J. Wills, American Iron and Steel Institute, AL [M]
Peter J. Willse, GE Global Asset Protection Services, CT [I]

Alternates

Robert M. Berhinig, Underwriters Laboratories Inc., IL [RT]
(Alt. to P. D. Gandhi)
Delbert F. Boring, Jr., American Iron and Steel Institute, OH [M]
(Alt. to R. J. Wills)
Sam W. Francis, American Forest & Paper Association, PA [M]
(Alt. to K. Sumathipala)
Richard G. Gann, Ph.D., U.S. National Institute of Standards & Technology, MD [RT]
(Alt. to J. R. Lawson)
Peter L. Hunsberger, Armstrong World Industries, Inc., PA [M]
(Alt. to T. W. Fritz)
James K. Lathrop, Koffel Associates, Inc., CT [SE]
(Alt. to W. E. Koffel)
James A. Milke, University of Maryland, MD [SE]
(Alt. to F. W. Mowrer)
Arthur J. Parker, Hughes Associates, Inc., MD [SE]
(Alt. to J. J. Beitel)
David K. Tanaka, FM Global, MA [I]
(Alt. to R. G. Bill)
Ineke Van Zeeland, Canadian Wood Council, Canada [M]
(Alt. to R. A. McPhee)
Joe Ziolkowski, American Furniture Manufacturers Association, NC [M]
(Alt. to T. H. Talley)

Nonvoting

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(Alt. to T. L. Jilg)
Tod L. Jilg, Hoechst Celanese Corporation, NC [M]
Rep. American Fiber Manufacturers Association
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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on fire testing procedures, for reviewing existing fire test standards and recommending appropriate action to NFPA, for recommending the application of and advising on the interpretation of acceptable test standards for fire problems of concern to NFPA technical committees and members, and for acting in a liaison capacity between NFPA and the committees of other organizations writing fire test standards. This Committee does not cover fire tests that are used to evaluate extinguishing agents, devices, or systems.

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Standard for

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

2003 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Information on referenced 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 applicability of passive fire protection materials applied to the exterior of LP-Gas containers.

1.2 Purpose. This test is designed to give an evaluation of passive fire protection materials in an LP-fueled torch fire environment created by the rupture of a nearby storage vessel.

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 ANSI/UL Publication. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

ANSI/UL 385, *Standard for Safety Play Pipes for Water Supply Testing in Fire Protection Service,* 1994.

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 included, common usage of the terms shall apply.

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. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Fire Resistance. An indication of the length of time for which a structure will continue to resist the effect of a standard fire test before reaching thermal failure.

3.3.2 Passive Fire Protection (PFP) Materials. Two distinct types are coating materials and panel materials.

3.3.2.1 ***Passive Fire Protection — Coating Materials.*** 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 Materials.*** A material in the form of a panel or sheet, including pre-formed components, which are 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, which is designed to be attached to the rear of the test sample to shield it from environmental influences.

3.3.4 Test Specimen. A steel plate, thermally protected with an insulation material, exposed to the simulated LP-fueled gas impingement jet or torch fire.

3.3.5 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 samples shall be required to conduct this test.

4.1.2 One test sample shall be an uninsulated steel plate used for calibration of the gas-impinged fire exposure.

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

4.1.4 The test sample dimensions shall not be less than 1.2 m × 1.2 m (4 ft × 4 ft) by nominal 16 mm (⅝ in.) thick.

4.1.5 The test samples 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 samples are tested consecutively.

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

4.1.10 The rear box shall be installed to the unexposed face of the test sample 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 sample 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 (⅜ 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 sample with no significant air gaps.

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

4.3 Passive Fire Protection 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 sample 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 sample.

5.2.4 The tip of the discharge nozzle shall be positioned at a distance from the exposed face of the test sample 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 sample shall be adequately restrained in the sample 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 less than nine thermocouples to record the thermal response of the steel plate/PFP material.

7.2.4 The thermocouples attached to the unexposed face of the test sample 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 ± 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 7.3.1.7.

7.3.1.1 The thermal insulation system shall cover one 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 sample shall be exposed to the torch fire environment used in Section 7.2.

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

7.3.1.7 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 sample shall be exposed to a hose stream test.

7.4.2 After 20 minutes of exposure to the torch test, the test sample 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 ANSI/UL 385, *Standard for 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 (1⅛-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 psig to 50 psig)] graduated in no more than 13.8-kPa (2-psig) increments.

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

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 sample.

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

7.4.6.2 When so located, the distance from the center 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 sample and then at all parts of the exposed surface, making changes in direction slowly.

7.5 Conditions of Acceptance.

7.5.1 The thermal insulation system shall retard the heat flow to the steel plate so that 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 or greater.

7.5.2 The thermal insulation system shall be judged to be resistant to the action of the hose stream if the time from initiation of the torch test for any thermocouple on the unexposed side of the steel plate to reach in excess of 427°C (800°F) is 50 minutes or greater.

7.5.3 One successful combination of torch fire and hose stream test shall be required for qualification of the thermal insulation system.

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 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.

A.1.1 Thermal protection insulating systems are allowed for use on LP-Gas containers as a means of "Special Protection" in NFPA 58, *Liquefied Petroleum Gas Code*, and NFPA 59, *Utility LP-Gas Plant Code*. These standards have required 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 of 50 minutes' duration and that will resist a concurrent hose stream of 10 minutes' duration.

This test method provides a replacement for the test as described in Annex H of NFPA 58 and referenced in NFPA 59.

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.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 following documents or portions thereof are referenced within this standard for informational purposes only and are thus not part of the requirements of this document unless also listed in Chapter 2.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 58, *Liquefied Petroleum Gas Code*, 2001 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2001 edition.

B.1.2 Other Publications. (Reserved)

B.2 Informational References. (Reserved)

B.3 References for Extracts. (Reserved)

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Sequence of Events Leading to Publication of an NFPA Committee Document

Call goes out for proposals to amend existing document or for recommendations on new document.

▼

Committee meets to act on proposals, to develop its own proposals, and to prepare its report.

▼

Committee votes on proposals by letter ballot. If two-thirds approve, report goes forward. Lacking two-thirds approval, report returns to committee.

▼

Report — *Report on Proposals* (ROP) — is published for public review and comment.

▼

Committee meets to act on each public comment received.

▼

Committee votes on comments by letter ballot. If two-thirds approve, supplementary report goes forward. Lacking two-thirds approval, supplementary report returns to committee.

▼

Supplementary report — *Report on Comments* (ROC) — is published for public review.

▼

NFPA membership meets (Annual or Fall Meeting) and acts on committee report (ROP or ROC).

▼

Committee votes on any amendments to report approved at NFPA Annual or Fall Meeting.

▼

Appeals to Standards Council on Association action must be filed within 20 days of the NFPA Annual or Fall Meeting.

▼

Standards Council decides, based on all evidence, whether or not to issue standard or to take other action, including upholding any appeals.

Committee Membership Classifications

The following classifications apply to Technical Committee members and represent their principal interest in the activity of the committee.

M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.

U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.

I/M *Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.

L *Labor:* A labor representative or employee concerned with safety in the workplace.

R/T *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.

E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.

I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.

C *Consumer:* A person who is, or represents, the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in the *User* classification.

SE *Special Expert:* A person not representing any of the previous classifications, but who has a special expertise in the scope of the standard or portion thereof.

NOTES:

1. "Standard" connotes code, standard, recommended practice, or guide.
2. A representative includes an employee.
3. While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of members or unique interests need representation in order to foster the best possible committee deliberations on any project. In this connection, the Standards Council may make such appointments as it seems appropriate in the public interest, such as the classification of "Utilities" in the National Electrical Code Committee.
4. Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.