Designation: D5424 – 18

Standard Test Method for Smoke Obscuration of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration[1]

This standard is issued under the fixed designation D5424; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This is a fire-test-response standard.

1.2 This test method provides a means to measure the smoke obscuration resulting from burning electrical insulating materials contained in electrical or optical fiber cables when the cable specimens, excluding accessories, are subjected to a specified flaming ignition source and burn freely under well ventilated conditions.

1.3 This test method provides two different protocols for exposing the materials, when made into cable specimens, to an ignition source (approximately 20 kW), for a 20 min test duration. Use it to determine the flame propagation and smoke release characteristics of the materials contained in single and multiconductor electrical or optical fiber cables designed for use in cable trays.

1.4 This test method does not provide information on the fire performance of electrical or optical fiber cables in fire conditions other than the ones specifically used in this test method, nor does it measure the contribution of the cables to a developing fire condition.

1.5 Data describing the burning behavior from ignition to the end of the test are obtained.

1.6 The production of light obscuring smoke is measured.

1.7 The burning behavior is documented visually, by photographic or video recordings, or both.

1.8 The test equipment is suitable for making other, optional, measurements, including the rate of heat release of the burning specimen, by an oxygen consumption technique and weight loss.

1.9 Another set of optional measurements are the concentrations of certain toxic gas species in the combustion gases.

1.10 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard. (See IEEE/ASTM SI 10.)

1.11 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.12 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.13 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

1.14 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1711 Terminology Relating to Electrical Insulation

D5537 Test Method for Heat Release, Flame Spread, Smoke Obscuration, and Mass Loss Testing of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration

E84 Test Method for Surface Burning Characteristics of Building Materials

E176 Terminology of Fire Standards

E800 Guide for Measurement of Gases Present or Generated During Fires

[1] This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.17 on Fire and Thermal Properties.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

E1354 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System

2.2 *NFPA Standards:*[3]
NFPA 70 National Electrical Code
NFPA 289 Standard Method of Fire Test for Individual Fuel Packages

2.3 *Underwriters Laboratories Standards:*[4]
UL 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 1685 Standard Vertical Tray Fire Propagation and Smoke Release Test for Electrical and Optical Fiber Cables

2.4 *Canadian Standards Association Standards:*[5]
CSA Standard FT-4 Vertical Flame Tests: Cables in Cable Trays, Section 4.11.4 in C22.2 No. 0.3, Test Methods for Electrical Wires and Cables

2.5 *IEEE Standards:*[6]
IEEE 1202 Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies

2.6 *Other Standards:*
CA Technical Bulletin 133 Flammability Test Procedure for Seating Furniture for Use in Public Occupancies, January, 1991[7]
Nordtest Method NT Fire 032 Upholstered Furniture: Burning Behavior—Full Scale Test[8]
ISO 13943 Fire Safety–Vocabulary[9]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method and associated with fire issues, refer to Terminology E176 and ISO 13943. In case of conflict, the definitions given in Terminology E176 shall prevail. For definitions of terms used in this test method and associated with electrical insulation issues, refer to Terminology D1711.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *sample, n*—an amount of the cable type and construction to be tested, which is representative of the product for test.

3.2.2 *specimen, n*—the individual length of cable, or cable bundle, to be placed in the cable tray, which is representative of the product to be tested.

[3] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.
[4] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.
[5] Available from Canadian Standards Association (CSA), 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, http://www.csa.ca.
[6] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331, http://www.ieee.org.
[7] Available from Bureau of Home Furnishings and Thermal Insulation, State of California, Department of Consumer Affairs, 3485 Orange Grove Ave., North Highlands, CA 95660-5595.
[8] Available from Nordtest, P.O. Box 22, SF-00341, Helsingfore, Finland, 1987.
[9] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

4. Summary of Test Method

4.1 This fire-test-response standard determines a number of fire-test-response characteristics associated with smoke obscuration resulting from burning the materials insulating full-scale specimens of electrical or optical fiber cables located in a vertical cable tray and ignited with a propane gas burner. This test method is also suitable for making other, optional measurements, including rates of heat release, total amounts of heat released, rates and concentrations of carbon oxides released, and rates and amounts of mass of the specimen lost (see Appendix X2). Further optional measurements are also possible.

4.2 The vertical cable tray that holds the specimen is located in an enclosure of specified dimensions.

4.3 A hood, connected to a duct, is located above the fire enclosure. Smoke release instrumentation is placed in the duct. Heat and gas analysis release instrumentation (optional) is also placed in the duct.

4.4 Two different test procedures are specified, which differ in the burner used and in the electrical or optical fiber cable loading. These reflect details of three existing test methods: UL 1581 (protocol A) and CSA Standard FT-4 in C22.2 No. 0.3-M1985, or IEEE 1202 (protocol B) and UL 1685 (both protocols).

5. Significance and Use

5.1 This test method provides a means to measure a variety of fire-test-response characteristics associated with smoke obscuration and resulting from burning the electrical insulating materials contained in electrical or optical fiber cables. The specimens are allowed to burn freely under well ventilated conditions after ignition by means of a propane gas burner.

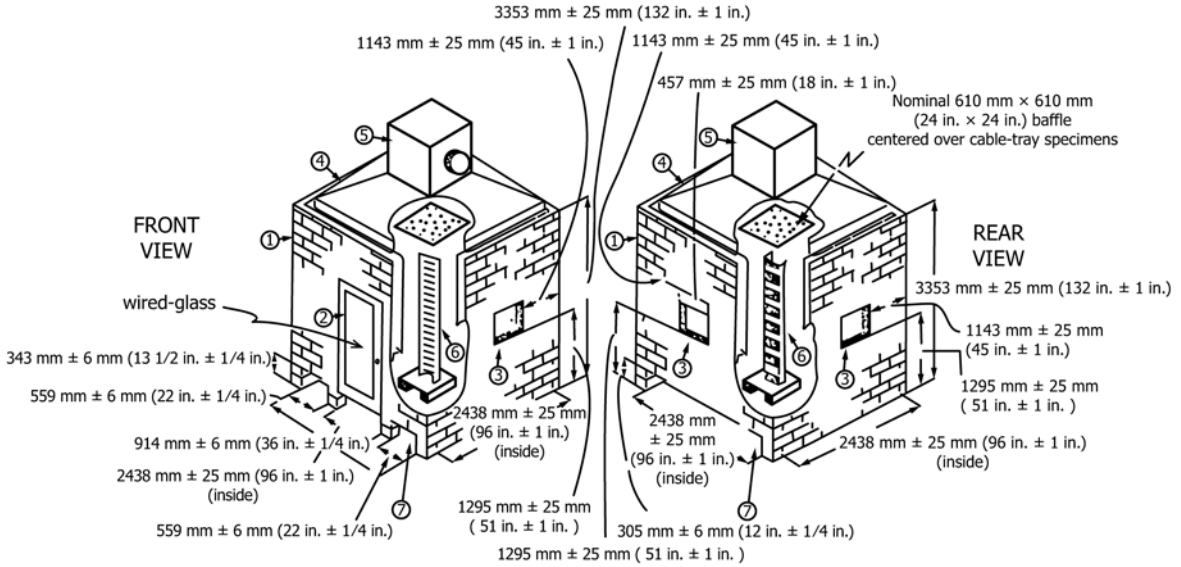
5.2 Smoke obscuration quantifies the visibility in fires.

5.3 This test method is also suitable for measuring the rate of heat release as an optional measurement. The rate of heat release often serves as an indication of the intensity of the fire generated. Test Method D5537 provides means for measuring heat release with the equipment used in this test method.

5.4 Other optional fire-test-response characteristics that are measurable by this test method are useful to make decisions on fire safety. The most important gaseous components of smoke are the carbon oxides, present in all fires. They are major indicators of the toxicity of the atmosphere and of the completeness of combustion, and are often used as part of fire hazard assessment calculations and to improve the accuracy of heat release measurements. Other toxic gases, which are specific to certain materials, are less crucial for determining combustion completeness.

5.5 *Test Limitations:*

5.5.1 The fire-test-response characteristics measured in this test method are a representation of the manner in which the specimens tested behave under certain specific conditions. Do not assume they are representative of a generic fire performance of the materials tested when made into cables of the construction under consideration.



1. Enclosure: an acceptable construction consists of concrete masonry blocks, laid up with mortar, nominally 203 mm high by 406 mm wide by 152 mm thick (8 by 16 by 6 in.).
2. Wired-glass door, for access and observation. The overall size of the door is 2.1 m high and 0.9 m wide (84 by 36 in.).
3. Steel-framed wired-glass observation windows, 457 mm (18 in.) per side (optional).
4. Truncated-pyramid stainless steel hood, with each side sloped 40°.
5. Cubical collection box, 914 mm (36 in.) per side, with exhaust duct centered on one side.
6. Cable tray, mounted vertically in the center of the enclosure. Tray base (stand) is optional.
7. Air intake openings.

FIG. 1 Cable Test Enclosure

5.5.2 In particular, it is unlikely that this test method is an adequate representation of the fire behavior of cables in confined spaces, without abundant circulation of air.

5.5.3 This is an intermediate-scale test, and the predictability of its results to large scale fires has not been determined. Some information exists to suggest that it has been validated against some large-scale scenarios.

6. Apparatus

6.1 *Enclosure:*

6.1.1 The enclosure in which the specimen is tested is shown in Fig. 1.

6.1.2 The enclosure has a floor area of 2.44 m ± 25 mm by 2.44 m ± 25 mm, with a height of 3.35 m ± 25 mm (8 ft ± 1 in. by 8 ft ± 1 in. by 11 ft ± 1 in. high). On top of the walls there is a pyramidal collection hood with a collection box.

6.1.2.1 Other enclosure sizes, such as 2.4 by 2.4 by 2.4 m (8 by 8 by 8 ft) or the 3 m cube are permitted, provided that the internal volume of the enclosure, exclusive of the pyramidal hood, ranges between 14.5 and 36 m^3 (512 and 1272 ft^3), the floor area ranges between 6 and 9 m^2 (97 and 64 ft^2), and the maximum air movement within the enclosure complies with 6.1.10 (Note 1).

NOTE 1—There is, as yet, not enough information as to the equivalence on smoke release between the various facilities. Further work needs to be done to confirm this.

6.1.2.2 In case of disputes, the referee method are the tests conducted using the enclosure in 6.1.2.

6.1.3 *Walls*—The maximum conductive heat flux loss of the walls of the structure is 6.8 W/(m^2K) (30 Btu/h-ft^2), based upon an inside wall temperature of 38°C (100°F) and an outside air temperature of 24°C (75°F). Paint the interior surface of the walls flat black. Any materials of construction that meet the preceding requirements are acceptable. Two examples of acceptable construction materials are nominally 152 mm (6 in.) thick concrete masonry blocks (density: 1700 kg/m^{-3} (106 lb/ft^{-3}) and thermal conductivity nominally k = 1.75 W/(m K), at 21°C; 12.13 Btu in./ft^2 h °F, at 70°F), or nominally 13 mm (0.5 in.) gypsum board, with 89 ± 6 mm (3.5 ± 0.25 in.) of standard fiberglass insulation, with an R value of 1.94 m^2 K/W (which corresponds in practical units to an R value of 11 h ft^2°F/Btu). Windows for observation of the fire test are allowed in the walls; ensure that the total area of the windows does not exceed 1.86 m^2 (20 ft^2).

6.1.3.1 Select materials of construction which can withstand the high temperatures and presence of open flame within the test enclosure and duct.

6.1.4 Provide air intakes at the base of two opposite walls, one of which contains the access door. Ensure that the total cross sectional area of the air intakes is 1.45 ± 0.03 m^4 (2250 ± 50 $in.^2$), and that the intake areas are divided approximately