

Finishes

By Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP

Cocoanut Grove Nightclub. Beverly Hills Supper Club. DuPont Hotel and Casino. Happy Land Social Club. The Station.

Some of you may have recognized the places listed above. The question is: what do these places have in common? Answer: Each was a site of a major fire that resulted in a significant number of deaths. Another connection between them is that the interior finishes and decorations at each location were contributing factors to loss of life and property (see table below).

Some people may not be aware of how important finishes are to the protection of life and property. This importance became all too apparent in 1942 when a fire broke out in the basement of the Cocoanut Grove Nightclub in Boston. The 15-minute fire claimed 492 lives in what has become the worst nightclub fire in US history. Many factors contributed to the devastating effects of the fire including inadequate exits and lack of sprinklers. However, the fire's rapid spread and the thick smoke were due to the nightclub's finishes and decorations.

Since that fire, building and fire codes have been revised to ensure that applied finishes, furnishings, and decorations aren't conducive to the spread of flames and smoke. However, the enforcement of such requirements has become another problem. In February of last year, a fire at another nightclub, The Station in Rhode Island, was a grim reminder of such a problem. Pyrotechnics ignited foam insulation that was used as a sound absorptive material. The foam, a type used as packing material, was not manufactured as an acoustical wall finish. Even with code requirements restricting the use of such finish materials, it is difficult to regulate the application of materials after construction. The only means to control improper application of finishes after occupancy is through periodic inspection, and even that isn't 100% effective.

Building codes set minimum requirements for materials applied as finish materials to walls, ceilings, and floors. The 2003 *International Building Code* even establishes requirements for decorations and trim such as curtains, draperies, and other materials suspended from walls and ceilings, while NFPA 101, *Life Safety Code*, provides requirements for contents and furnishings. Both of these codes exempt finishes having a thickness less than 0.036 inches (0.9mm) from their requirements. The minimum requirements are typically based on nationally recognized standards such as those developed by ASTM, UL, and NFPA. The IBC categorizes finish requirements into three groups: 1) wall and ceiling finishes, 2) interior floor finishes, and 3) decorations and trim.

Wall and Ceiling Finishes

There are two characteristics that concern the use of wall and ceiling finishes: flame spread and smoke development. These characteristics can be tested using ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*. This test method originated in 1922 by Underwriters Laboratory as a method to test fire-proofing paints and "white-wash," a common wood finishing technique at the time. The test method improved over time with ASTM adopting the method in 1961. The test method incorporates a tunnel-type furnace referred to as the "Steiner Tunnel" after the late Albert

J. Steiner, developer of this test method and many others. Other test methods incorporate the Steiner Tunnel such as NFPA 255 and UL 723.

ASTM E 84 uses a nominal 20-inch wide by 24-foot long sample of material mounted to the ceiling of the chamber. Burners in the tunnel are ignited and a draft is introduced to pull the flame along the length of the specimen. A flame spread index (FSI) is determined based on the distance the flame traveled along the test specimen compared to that of inorganic reinforced cement board, which has a rating of 0, and select grade red oak flooring, which has an arbitrary rating of 100. The smoke-developed index is determined by readings taken from a photoelectric cell in the exhaust end of the tunnel compared to the same materials for the flame spread. The IBC and NFPA 101 establish classification of finish materials using both the flame spread and smoke-developed indices. These classes are identified as A, B, or C, with A being the best rating. The IBC provides a table identifying minimum finish classifications for buildings based on occupancy, type of building component (i.e. exits, corridors, rooms, etc.), and fire protection (sprinklered and nonsprinklered). Generally, both the IBC and NFPA 101 allow a reduction by one classification (but not lower than Class C) if the building is sprinklered.

Textile wall and ceiling finishes pose additional hazards that require further control. Textiles include fabrics, carpet, and other similar materials. Textile wall and ceiling finishes must have a Class A rating per ASTM E 84 and be protected by an automatic fire sprinkler system. Textile wall finishes must be tested further using NFPA 265, *Standard Method of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings*. This test method is commonly referred to as the “Room/Corner Test.”

NFPA 265 involves applying a wall finish specimen to two walls. Then a 40kW flame is introduced for a period of 5 minutes and then increased to 150kW for 10 minutes. The specimen receives a pass/fail rating depending on whether or not flashover occurs. Flashover occurs when the majority of surfaces in a space are heated to the point at which they give off flammable gases that are hot enough to ignite themselves (i.e. they do not need to be touched by flame to start burning). Prior to flashover, flammable gases may be given off, but are not hot enough to ignite without a spark.

A test similar to NFPA 265 is NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth* (whew!). It was developed to test other wall finishes and is acceptable as an alternative to ASTM E 84 for both the IBC and NFPA 101. NFPA 101, however, permits the use of NFPA 286 as an alternative test method for textiles.

Acoustical and thermal insulating materials typically must have a Class A rating (flame spread index not greater than 25 and smoke-developed index not greater than 450) in accordance with ASTM E 84. It is important to note that if a material’s flame spread index or smoke-developed index increases beyond the limits indicated due to age, moisture, or other atmospheric conditions, then the material is not permitted.

Interior Floor Finishes

Combustible floor finishes have a history of not contributing to the early development of a fire. However, floor coverings could become involved in a fire when the room reaches, or is close to, flashover. Since 1971, the federal government has regulated carpet through 16 CFR 1630, *Standard for the Surface Flammability of Carpets and Rugs (FF 1-70)*. This standard, known as the “Pill Test,” is similar to ASTM D 2859. The test involves placing a tablet of methenamine (an antibacterial agent) on

the center of a 9-inch-square sample of carpet and igniting the tablet. The sample passes the test if the charred area is 1 inch or more from the edge of the 8-inch-diameter opening in the test frame. In order for the carpet to pass, 7 of 8 samples must pass this test. Since 16 CFR 1630 applies to all carpet sold in the U.S., the codes limit their reference to this standard for carpet. For example, the IBC requires that all floor coverings not used in exits and corridors must comply with the pill test as a minimum.

Floor finishes could, under certain conditions, propagate flames just on the basis of radiant heat, gases, and flames from an adjacent room through an opening such as a door. For exits and corridors, this is of great concern. To control such an occurrence, floor finishes in these spaces must be tested in accordance with NFPA 253, *Test for Critical Radiant Flux of Floor Coverings Using a Radiant Heat Energy Source*. This test places a sample in a chamber with a radiant panel above the sample at one end. The panel is heated to 500 deg C (932 deg F) and preheats the sample for 5 minutes. The end of the sample is then ignited by a burner for another 5 minutes and removed. When the flame goes out on the sample, the distance the flame front traveled is measured and the data is converted into watts per centimeter squared (W/cm^2) for a critical radiant flux. The higher the critical radiant flux, the more the material will resist flame propagation. Per NFPA 253, Class I materials have a critical radiant flux of greater than 0.45 W/cm^2 , while Class II materials are greater than 0.22 W/cm^2 .

Since floor finishes contribute little to a fire until the fire is fully involved, regulation of smoke-development is deemed unnecessary.

Decorations and Trim

In general, the IBC requires decorations such as draperies and curtains to pass either test 1 or 2 of NFPA 701, *Standard Methods of Fire Tests for Flame-Propagation of Textiles and Film*, or be noncombustible, in assembly, educational, industrial, and some residential occupancies. Which test to use is dependent upon the weight of the material being tested. NFPA 701 is also known as the “Vertical Ignition Test” and is similar to ASTM D 6413.

The use of flame-resistant materials is limited to 10% of the aggregate area of walls and ceilings, while the use of noncombustible materials is unlimited. In auditoriums, the limit can be increased to 50% if it is sprinklered throughout and the materials are installed in accordance with the code. Trim, such as handrails and guardrails, can’t exceed 10% of the aggregate wall and ceiling area, and must have a Class C rating per ASTM E 84.

Other Requirements

As previously mentioned, NFPA 101 regulates furnishings such as upholstered furniture and mattresses in addition to hanging furnishings and decorations. These requirements are based on occupancy and don’t apply to every use. Depending on occupancy requirements, upholstered furniture must comply with a cigarette ignition test per NFPA 260 for individual components and NFPA 261 for a complete mock-up with charred areas not exceeding those listed in NFPA 101. Regardless of code requirements, mattresses must comply with 16 CFR 1632.

New to the IBC is a requirement for buildings in flood hazard areas as defined by Chapter 16. The requirement stipulates that finishes below the design flood elevation must be flood-damage resistant. However, the IBC is silent on what constitutes flood-damage resistance.

Also in the IBC, but not related to fire resistance, are the requirements for toilets and bathing rooms. Floors of these spaces must be smooth (but still comply with the slip resistance requirements of the ADA), hard, and nonabsorbent. The floor surface must extend up the walls to a height no less than 6 inches. Walls shall also be smooth, hard and nonabsorbent within 2 feet of urinals and waterclosets to a height of 4 feet above the floor, and showers and bathtubs with shower heads shall have the same material to a height of 70 inches above the drain.

Finishes, if improperly installed or specified, can lead to tragic results during a fire. The goal is to reduce flame propagation and smoke development. Understanding the minimum requirements by the adopted code is essential to achieving this goal.

Fire Tragedies Propagated by Finishes

<u>Location</u>	<u>Deaths</u>	<u>Contributing Finish</u>
Cocoanut Grove Nightclub, Boston, Massachusetts, Nov. 28, 1942.	492	Paper decorations
Beverly Hills Supper Club, Southgate, Kentucky, May 28, 1977	164	Concealed, combustible ceiling tile
Dupont Hotel and Casino, San Juan, Puerto Rico, Dec. 31, 1986	96	Wall finishes
Happy Land Social Club, New York City, New York, Mar. 25, 1990	87	Wood paneling on wood studs
The Station, West Warwick, Rhode Island, Feb. 20, 2003	100	Foam insulation for sound absorption

To comment on this article, suggest other topics, or submit a question regarding codes, contact the author at ron@specsandcodes.com.

About the Author: Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP, is an ICC Certified Building Plans Examiner, and is the principal of RLGA Technical Services located in Scottsdale, Arizona, which provides specifications and code consulting services to architects, engineers, owners, and product manufacturers. A 1984 graduate of the University of Arizona, Ron has over 23 years of experience with military, public, and private agencies.