A BRIEF HISTORY OF CODE-REQUIRED "FIREBLOCKING" AT CONCEALED SPACES

By Lonnie Haughton, CDT, LEED AP

On January 28, 2015, a deadly four-alarm fire at a three-story, wood-framed, mixed-used building (*Figure 1*) located at the corner of Mission Street and 22nd Street in San Francisco, CA, destroyed the roof, attic, and upper floor apartments (*Figures 2* through *6*) and killed one resident. Constructed in 1907 after the great earthquake and fire that had ravaged San Francisco in 1906,[1] this historical building housed 47,000 square feet of commercial stores and shops (first floor), offices (second floor), and residential units at the third floor.

Following investigation, the San Francisco Fire Department reported:

- "This fire was most likely accidental and originated in the third floor south/west hallway within the west stud wall, with fire extension to and throughout the common attic space above.
- "Extreme fire damage throughout the common attic space indicated fire progression…throughout the attic space with initial fire presentation as 'drop down' of burning material to the [occupied apartments below].
- "Third floor occupants [were found] still in their rooms with smoke filling the units from the ceiling down. …The fire alarm in the building was silent and appears to have failed to activate."

Figures 7 and *8* show how the attic fire's rapid migration down into wall cavities below was facilitated by the absence of any form of closure at some floor-ceiling transitions. (Due to the failure of the alarm system, the third-floor tenants had no warning that their apartment walls were burning from the inside out, per *Figure 9*.) As reviewed below, our modern building codes fittingly describe such closures as "fireblocking."

- Section 718.2.3 of the 2013 San Francisco Building Code[2] requires the following: "Fireblocking shall be provided at interconnections between concealed vertical stud wall or partition spaces and concealed horizontal spaces created by an assembly of floor joists or trusses, and between concealed vertical and horizontal spaces such as occur at

Figure 1 – Dating to 1907, this fire-damaged structure reportedly was the first large building erected in San Francisco after the devastating Great Earthquake and Fire of 1906.

Photo 2 – The fire extended "to and throughout the common attic space above."

Photo 3 – The roofing system was destroyed by the fire and by the high volume of water deployed by the firefighters.

soffits, drop ceilings, cove ceilings, and similar locations."

- The *2012 International Building Code Handbook* by Douglas W. Thornburg, AIA, and John R. Henry, PE, advises: "Experience has shown that some of the greatest damage occurs to conventional wood-framed buildings during a fire when the fire travels unimpeded through concealed draft openings. This often occurs before the fire department has an opportunity to control the fire, and greater damage is created as a result of the lack of fireblocking. ...Virtually any concealed air space within a building will provide an open channel through which high-temperature air and gasses will spread. Fire and hot gasses will spread through concealed spaces between joists, between studs, within furred spaces, and through any other hidden channel that is not fireblocked."[3]

However, despite their aptness, the terms "fireblocking" and "fire blocking" are relative newcomers to North American building codes. Back when this building was constructed, Section 262 of the 1906 Building Law of the City and County of San Francisco simply required: "All stud walls... shall have one row of bridging for every seven feet in height over the first seven. Said bridging shall in all cases extend to the lathing or sheathing, so as to prevent the passage of fire and smoke, and shall be the same thickness as the studding."

RIGID BRIDGING TO PREVENT THE PASSAGE OF FIRE AND SMOKE

We see in Section 262 of the 1906 code that the key purpose for this solid bridging is the same as our modern-day fireblocking: "to prevent the passage of fire and smoke."

While such sparsely phrased instruction for closing off concealed spaces within wood-framed buildings remained virtually unchanged in San Francisco and the nearby City of Oakland until the end of World War II, many other cities and towns throughout the western United States already had begun to adopt various editions of the model Uniform Building Code (UBC), first published in 1927 by the International Conference of Building Officials (ICBO).

RIGID FIRE STOPPING AT CONCEALED SPACES AT WOOD-FRAMED BUILDINGS

Beginning with the 1927 UBC, the ICBO promulgated within the western United States the terms "fire stop" and "fire stopping" to define the rigid bridging required to prevent the passage of fire and smoke within concealed spaces at wood-framed buildings.

Section 2510(a) of the 1927 UBC mandated: "Fire stops shall be provided at all intersections of interior and exterior walls with floors, ceilings, and roof in such a manner as to effectively cut off communication by fire through hollow concealed spaces and prevent both vertical and horizontal drafts."

Section 2510(c) of the 1927 UBC confirmed that fire stopping had the same

meaning as the bridging called out in predecessor codes: "All stud walls or partitions shall have a continuous row of bridging or fire stopping which shall form a complete and effective separation in the entire width of partition at that point, placed in such a manner that there shall be no concealed air spaces greater than seven (7) feet in any dimension. Fire stops shall be the full width of the studding and sufficiently stiff to act as lateral bracing for the individual studs."

Further, Section 2205 of the 1927 UBC advised:

> All walls shall be effectively fire stopped at the floor and ceiling and at the *spring of cove in a coved ceiling.* [Italic emphasis added.] ...Fire stops shall also be placed between the floor and the ceiling in such a manner that there shall be no concealed air spaces with a dimension greater than seven (7) feet. Fire stopping shall consist of not less than two (2) inch material and shall be the full thickness of the stud wall. Where stories are not framed separately, fire stopping shall be placed behind the ribbon at the ceiling line and at the top of joist at the floor line. Such fire stopping shall be two (2) inches thick and the full width of the stud.

Photo 4 – The "top-down" attic fire dropped burning materials and smoke into occupied apartments below.

At the hallway depicted in *Photo 6*, we see examples of "the spring of cove in a coved ceiling" for which the 1927 UBC required the installation of fire stopping. Inspection at some of the most severely damaged rooms at the third floor confirmed the attic fire had stealthily dropped down

Photo 5 – The stealthy "top-down" fire dropped burning materials and smoke into occupied apartments below. (This lath and plaster ceiling exhibits stress cracking from the many thousands of gallons of water used to fight the fire.)

Photo 6 – The attic fire filled the third-floor hallways with smoke, closing off escape routes for the trapped tenants.

into similar stud bays that had not been firestopped.

These 1927 UBC "firestopping" requirements and terminology can be traced back to the first National Building Code (NBC), published in 1905 by the National Board of Fire Underwriters, an association formed by a group of major fire insurance carriers: "In all frame buildings which are to be lathed and plastered or otherwise sheathed on the inside...[t]he fire stop shall extend around all of the stud walls of the building, supporting the filling material where necessary on strips of wood nailed between studs, and in all stud partitions that rest directly over each other, and thus form a horizontal line of incombustible material to effectually cut off draft openings from story to story through floors, stud walls, and partitions."[4]

However, unlike the 1927 UBC, the fire stop being called out within the 1905 NBC was an "incombustible material" (e.g., masonry). In like manner, the fifth edition of the NBC, published in 1931, continued to require incombustible firestopping within wood-framed walls, per Section 1007.3. "In buildings of ordinary construction or frame construction where walls are studded-off, the space between the inside face of the wall and the studding directly over such space shall be firestopped with approved incombustible material, for a depth of not less than four inches, securely supported."

This pre-World War II difference of opinion (whether or not fire-resistive stoppings or bridgings that closed off concealed spaces in wood-framed buildings should be constructed with an "incombustible" material) was not fully resolved by the various regional code-writing authorities until their circa-2000 unification under the new International Code Council (ICC). Our modern authorities now better recognize that the simple key to limiting the spread of fire within such concealed spaces is to close off—with any type of approved material—all routes and openings for interstitial air flow. To that end, current codes even approve the use of ¾-in. particleboard as a fire-resistive bridging material.

FLEXIBLE PENETRATION FIRESTOPPING FOR FIRE-RATED WALLS

If all routes of unintended air movement into and/or through wall assemblies should be closed off to best protect a structure from the potentially calamitous effects of fire, then what should be done to close or seal the small gaps and open joints around various items, such as electrical boxes, that penetrate or "through-penetrate" a framed wall—in particular, a fire-rated wall assembly?

By the early-1970s, joint filler materials were being prescribed by code-writing authorities. An example is Section 705(c) of the 1973 Standard Building Code. "All openings around exposed pipes or power shafting shall be filled with approved noncombustible material or shall be closed off by close-fitting metal caps at the ceiling and floor line, and on each side of a wall or partition." By the late-1970s, the term "firestopping" was being used to describe such rigid and flexible fillers. Examples include:

Photo 7 – The attic fire readily dropped down into this third-floor wall due to the lack of "bridging" called out in the 1906 Building Law of the City and County of San Francisco.

Photo 8 – The attic fire readily dropped into the third-floor wall assemblies (lath and plaster) due to the lack of "bridging" – burning the walls from the inside out, per Photo 9.

- Section 4304(e) of the 1979 UBC: "Penetrations in walls requiring protected openings shall be fire-stopped. Firestopping shall be an approved material securely installed and capable of maintaining its integrity when subjected to test temperatures prescribed…for the specific wall or partition."
- Section 300-21 of the 1981 National Electrical Code (NEC): "Openings around electrical penetrations through fire-resistance-rated walls, partitions, floors, or ceilings shall be firestopped using approved methods to maintain the fire-resistance rating."

Beginning in 1982, the use of flexible penetration firestopping products soared with the issuance of industry standard ASTM E814, *Standard Test Method for Fire Tests of Penetration Firestop Systems*, published by the American Society of Testing and Materials (ASTM).[5] This new standard was fully incorporated (as UBC Standard 43-6) into the 1991 UBC, which also promulgated new terminology and requirements for the installation of "penetration fire stops" at all fire-resistance-rated walls.

In short, by the early-1990s, code-writing authorities were incorporating industry standard ASTM E814 and its terminology into the regional model codes. As a result, the term "firestopping" began being used to describe two highly distinct systems:

1. A rigid bridging material (which, in some codes, could be combustible) used to close off concealed spaces within wood-framed walls (and, for some authorities, also masonry walls), whether rated or nonrated
2. A flexible, noncombustible filler material used to seal gaps at penetrations of all fire-resistance-rated wall assemblies, whether framed with wood or steel studding

For example, consider the differing definitions and purposes of "firestopping" prescribed in the 1993 BOCA National Building Code:

- Section 720.6.2: "Firestopping shall be installed at all interconnections between vertical and horizontal spaces such as occur at soffits over cabinets, drop ceilings, cove ceilings, and similar locations."
- Section 709.6.5: "Openings to accommodate noncombustible conduits, pipes, and tubes through a single membrane that is an integral component of a fire-resistance rated wall assembly shall be permitted provided that…the openings are firestopped with approved noncombustible materials."

Clearly, this situation ("firestopped" and "firestopping" being used by code authorities to prescribe totally different means and methods for imparting improved fire-resistive characteristics to separate portions of the same building) is not tenable for busy construction professionals.

Photo 9 – Lath and plaster walls at occupied third-floor apartments burned from the inside out. (Note the burnt ends of the wooden lath at the right side of this fire-damaged wood stud.)

THE BIRTH OF OUR MODERN "FIRE BLOCKING" TERMINOLOGY

This problem of dueling definitions was resolved in all succeeding model code editions across the country by simply substituting new terminology (e.g., "fire blocks" and "fireblocking") for the "firestopping" (previously, "bridging") that had been required at concealed spaces in wood-framed buildings since the 1927 Uniform Building Code (UBC), and dating back to the 1905 NBC.

For example, the reformatted 1994 UBC prescribed at new Section 708.2: "Fireblocking shall be provided…(a)t all interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings, and cove ceilings."

As reported above, virtually the same "fireblocking" requirements and terminology are found in the current edition of the IBC (which, beginning in 2000, unified its predecessor regional model codes: the UBC, the Southern Standard Building Code,[6] and the BOCA National Building Code.[7]) While younger generations of construction professionals reasonably might assume that such aptly described terminology has existed for a very long period, such terms date back only to the early 1990s.[8]

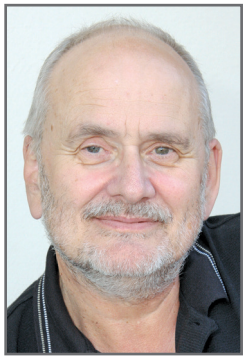
Still, even though our current "fireblocking" terminology is relatively new, the same concept of using bridging materials within wood-framed walls to prevent "the passage of fire and smoke" (per San Francisco's Building Laws of 1906) readily can be traced back more than a century, and very likely is far older.

REFERENCES

1. Harry Chase Brearley. *Fifty Years of a Civilizing Force – An Historical and a Critical Study of the Work of the National Board of Fire Underwriters.* Frederick A. Stokes Company, New York, 1916: "The afternoon papers of April 18, 1906 announced to a startled world that there had been an earthquake in San Francisco. …By the following morning, all thought of the earthquake was overshadowed by dispatches conveying the news that large sections of the city had become roaring furnaces of flame, whose progress it seemed impossible to stay. …When a drenching rain upon the fourth day extinguished the remaining embers, it was found that the flames had devastated 2,831 acres, five hundred and twenty blocks, containing twenty-five thousand buildings and including the finest portions of the city. A large part of the population was homeless; the loss of life had been heavy, and the property loss reached the staggering total of $350,000,000. Thus had occurred the greatest conflagra-

tion of history."

2. The 2013 San Francisco Building Code is an amended version of the 2013 California Building Code, which is modeled on the 2012 IBC.
3. Douglas W. Thornburg, AIA, and John R. Henry, PE. *2012 International Building Code Handbook*, McGraw Hill Education, LLC and International Code Council. Washington, DC, 2013.
4. Delbert F. Boring, PE; James C. Spence, PE; and Walter G. Wells. *Fire Protection Through Modern Building Codes, Fifth Edition.* American Iron and Steel Institute (AISI). Washington, DC, 1981: "The first model code in the United States was prepared by representatives of the fire insurance industry in response to the serious losses from conflagrations that occurred in cities throughout the country. ...The National Board of Fire Underwriters...deeply concerned by these enormous fire losses, developed a recommended building code... [c]alled the National Building Code... first published in 1905."
5. Copublished by Underwriters Laboratory, Inc. as industry standard UL 1479, *Fire Tests of Through-Penetration Firestops.*
6. *Fire Protection Through Modern Building Codes, Fifth Edition.* AISI, 1981: "The Southern Building Code Congress, Int. (SBCCI) was organized by building officials and inspectors from the southern part of the United States. The SBCCI first published the Southern Standard Building Code in 1946. Now known as the Standard Building Code, it is revised annually and new editions are published every three years."
7. Ibid. "The Building Officials and Code Administrators, International (BOCA), founded in 1915 as the Building Officials Conference of America, first published its model code, the Basic Building Code, in 1950." [Author's note: In the 1980s, as the insurance industry phased out of the model code-writing business, BOCA purchased all rights to the name National Building Code. The next edition of its model Basic Building Code was renamed the BOCA Basic National Building Code.]
8. Vickie J. Lovell. "Fireblocking and Firestopping: What's the Difference?" *PM Engineer*. August 2001. "A simple change in the terminology to more clearly define firestopping, fireblocking, and draftstopping has begun to clear up misunderstandings as to the intent of the code requirements in the more recent editions of the building codes. Unfortunately, there is still difficulty in interpreting the intent of older editions of the codes where the term 'firestop' is used interchangeably with the requirements for fireblocking and draftstopping, or where the requirements for the protection of penetrations are not carefully spelled out."



Lonnie Haughton, MCP, LEED AP, CDT

Lonnie Haughton, MCP, LEED AP, CDT, is a principal codes and construction consultant with Richard Avelar & Associates in Oakland, CA. He is one of about 900 individuals nationwide who have been certified by the International Code Council as a Master Code Professional. His additional ICC certifications include Fire Inspector I and Certified Building Code Official. Haughton's two-part history of San Francisco's Building Laws and Building Codes can be downloaded at http://www.RAvelar.com/company/articles.html.