TECHNICAL PRESERVATION GUIDELINES

Fire Safety Retrofitting

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Introduction

Ceremonial lobbies, open stairways, and generous corridors are among the charming attributes that distinguish historic public buildings but often fly in the face of modern egress requirements. Few pre-World War II buildings provide direct, protected discharge to the exterior. Most stairs discharge into lobbies or corridors. Ornamental stairways are enclosed by glazed door systems or have no doors at all. Smoke detection and fire suppression is usually inadequate. Fire suppression systems, although commercially available since the early 20th century, are rarely present.

Although fire safety improvements, particularly early warning detection and quick response suppression, help to reduce the risk of devastating historic building (and human) loss, their potential to compromise historic fabric often leads to wholesale resistance against egress code compliance. Fortunately, two important trends are converging to support flexible approaches to egress code compliance: 1) alternative codes for historic and non-historic existing buildings and 2) technological advances that compensate for fire safety deficiencies and offer less intrusive solutions for prescriptive code compliance.

This Guideline focuses on innovative design practices and recent advances in fire separation, detection and suppression technologies that are solving some of the greatest code compliance challenges affecting monumental buildings with ornamental interiors. Most of these illustrations show prescriptive compliance solutions that succeeded architecturally because of good design, product selection and execution. A few examples describe equivalent solutions that did not meet the prescriptive code to the letter but were determined to provide a close or equal level of protection.

Codes and Standards

The general intent of life safety codes is to ensure prompt escape of building occupants, in the event of a fire, to a safe area. The code addresses construction features such as the width, length, and fire resistance of exit paths; ability of construction materials to contain fire and prevent its spread; fire protection features such as smoke detection devices, alarms, and fire suppression systems; occupancy and operational features such as emergency evacuation planning; and fire precautions during construction.

Increasing recognition that compliance with prescriptive codes written principally to guide new construction can be onerous enough to discourage investment in older urban areas has lead states such as New Jersey and Maryland to adopt Smart Codes, or Rehabilitation codes that provide flexibility to achieve life safety goals without wholesale building reconfiguration.

The U.S. Department of Housing and Urban Development recently released an updated and expanded edition of it's invaluable Fire Ratings of Archaic Materials and Assemblies with the expressed goal of promoting the preservation and reuse of America's older housing and building stock.

This guide provides fire ratings for a wide variety of materials and assemblies found in buildings from the 19th to the mid-20th centuries, as well as methods for calculating the fire resistance of general classes of archaic materials and assemblies for which no documentation is available. It includes an array of details developed by English Heritage for upgrading the fire resistance of wood panel doors. The document has found widespread acceptance among code officials and has been incorporated into numerous state and local building codes, model code publications, and (U.S.) National Fire Protection Association (NFPA) standards.

In addition, *NFPA 914: Code for Fire Protection in Historic Structures* 2001 edition will provide jurisdictions a range of alternatives, including performance-based approaches and operational solutions, for meeting the intent of the *NFPA Life Safety Code* within the framework of the Secretary of Interior's Standards for Rehabilitation. The intent of *NFPA 914* is to ensure prompt escape of building occupants while minimizing the impact of fire and fire protection on the structure, contents and architectural features that give a building its historic character.

Early and frequent coordination between preservationists, the design team and GSA fire safety engineers ensures the best possible chance for productive collaboration to develop creative solutions and achieve consensus.

Fire Alarm Systems

One rehabilitation design strategy is to minimize new penetrations in stone, unpainted wood paneling, architectural concrete and other hard-to-patch materials. The aim is to minimize the need to repair these surfaces when the system is replaced.

Codes require that alarms remain in continuous operation while a building is occupied. Installing new systems side by side with existing ones can result in conspicuous holes left behind when the obsolete devices are removed. By carefully sequencing installation, existing mounting holes in stone and other decorative walls can be reused with minimal risk. This is done by isolating the zone where devices are mounted in an ornamental surface such as stone, so that a small area can be taken down without affecting the rest of the system. Work in these areas is done at night, when buildings are unoccupied, and under constant supervision to minimize safety risk.

Alarm bell locations can usually be reused for mounting audio-visual systems. Recessed bell pockets can be reused by surface mounting strobes on alarm bell grilles (Figs. 1, 2). Exposed hardware (excluding lamps) should be finished to blend with the wall or grille. Mounting a strobe on an ornamental grille requires adapting or custom fabricating the lamp device to appear integral with the grille.

Figs. 1 & 2: State Dept. building, Washington, DC.

Fig. 1: Original fire alarm box reused for new alarm and strobe.

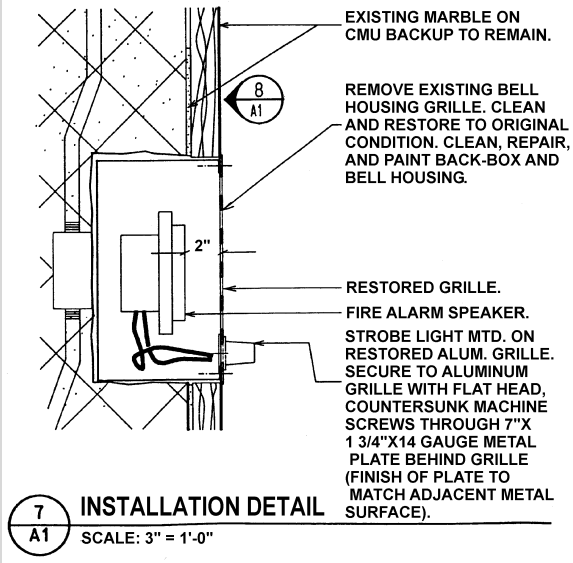


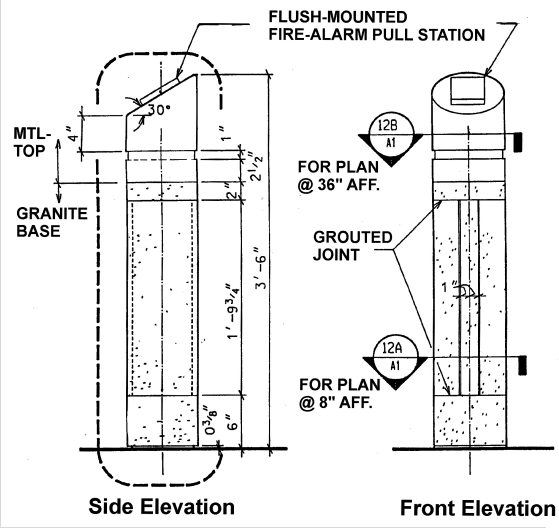
Fig. 2: Section detail; Audio-visual alarm reusing original alarm box and grille. (Design: Summer Consultants/Edward Sonnenschein, Architect)

Reusing existing manual station mounting boxes to avoid cutting new holes in decorative wall surfaces may require a waiver or modification of the Americans with Disabilities Act (ADA) height requirements. Existing manual stations are usually mounted lower than the 42 inches required under ADA. However, in historic buildings having sufficient floor clearance to allow wheelchairs to turn around, the authority having jurisdiction (AHJ) will often accept compliance with the ADA's side reach height limit of 54 inches.

Another fire alarm retrofitting design strategy is to avoid ornamental surfaces altogether by installing alarm bells in nearby flat plaster walls only (within audible range acceptable to the AHJ) and mounting alarm pulls on freestanding bollards (Figs. 3, 4). This solution is especially useful where reusing holes is not possible and where routing the electrical supply will be difficult or destructive.

Fig. 3: Alarm pull mounted on bollard fabricated to blend with marble and chrome of the State Dept. building's lobby eliminated need to penetrate marble walls.

Fig. 4: Alarm pull bollard. (Section drawing: Summer Consultants/Edward Sonnenschein, Architect)



Smoke Detection

Conventional photoelectric and ionization smoke detectors can be made less conspicuous by custom painting housings (the detector head must be disassembled to avoid damaging the intricate electronics) to match surrounding surfaces or by recessing housings so that only the detector head is exposed (Fig. 5). Housings must be removed for coating. It is advisable to have the manufacturer paint the housing, but at the very least the manufacturer's guidance should be sought to ensure the detector is not affected.

Fig. 5: Recessed smoke detector in ornamental plaster ceiling at the Commerce Dept., Washington, DC. All surfaces but the detector head were painted to match the ceiling.

Projected (light) beam detectors are useful where a surface mounted or partially recessed installation is undesirable and a ledge or cavity is available to conceal the beam projector and receiver. The increased cost of the projected beam detector may be offset by avoiding the need to restore disturbed decorative surfaces.

Air sampling detection enables the use of smaller components within historic spaces. The system's tiny PVC sampling tubes can be concealed in light fixtures, ledges and ornamental ceilings, allowing wider dispersal of the detection system with reduced architectural impact (Figs. 6, 7).

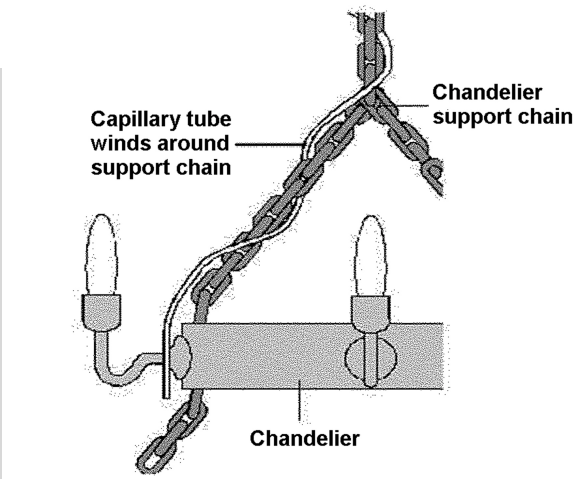
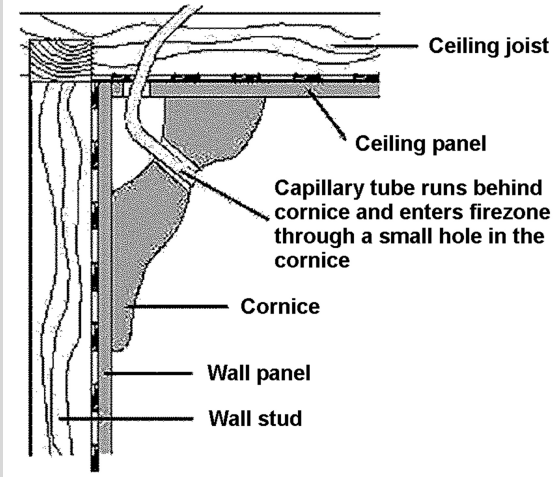


Fig. 6: Air sampling tubes concealed in chandelier.

Fig. 7: Air sampling tubes concealed in cornice.



(VESDA Aspirating Detection, Vision Systems)

Detection devices may be installed remotely. The system's early warning capacity makes it a particularly attractive option for large open areas such as atriums, open stairs, two-story spaces and spaces containing irreplaceable artwork, furnishings or other high-value contents.

Suppression

Sprinkler Systems

A basic rule of thumb for retrofitting sprinkler systems into historic buildings is to run piping in spaces of secondary importance, such as offices, to feed sprinkler heads in spaces of primary importance, such as public corridors. In buildings with double-loaded corridors, this requires routing piping along both sides of the corridor—an approach more costly than running pipes for office coverage through the corridor, but usually the only alternative for preserving original corridor ceilings.

In contiguous significant spaces, leaving piping exposed in spaces of lesser significance can be more discrete than constructing bulkheads to conceal piping where no chases exist. For best results with exposed piping in sensitive locations, specify copper to minimize pipe diameter (1 inch, as opposed to 1¼ inches for steel pipe); and recess piping on ledges and other projections. Piping should be aligned with other horizontal elements such as cornices and painted to match adjoining walls. Require installers to have successful experience installing piping in similar configurations (e.g., pipes conform to curved surfaces).

Specifying the right sprinkler head is also important in minimizing the visibility and physical intrusiveness of the system. Recessed heads offer discrete installation in very plain ceilings, but authorities responsible for building upkeep must take care to avoid allowing covers to be painted shut. Semi-recessed heads project less into the space, but the enlarged holes needed to accommodate semi-recessed heads give ceilings a pockmarked appearance.

Fig. 8: Detail showing exposed pipe tucked behind beam.
Old Post Office, Washington, DC.

Fig. 9: Only the sprinkler heads are visible from principle vantage points within the corridor.

Sidewall heads tend to be least visible and least destructive alternative in significant spaces with plaster walls and ornamental ceilings. Sidewall sprinkler heads fed from piping in adjoining offices are very inconspicuous if placed in flat wall surfaces (avoiding cornices and other ornament). Specify the smallest head that meets necessary performance requirements (e.g., extended throw) and color match heads to the wall or dominant original hardware material (Figs. 8, 9).

Pendant heads are usually the best choice for spaces having ornamental wall finishes (such as stained wood paneling, stone, or metal) and flat plaster ceilings. When ornamental ceilings must be penetrated, heads can be effectively camouflaged in rosettes and other repeating decorative motifs (Fig. 10). Heads such as Reliable F1FR are ideal for installation in decorative ceilings because they are very small, escutcheon plates can be omitted without violating their UL listing, and the entire head, excluding the activator, can be custom coated (under manufacturer's guidance) to match any finish.

Fig. 10: Glass bulb sprinkler head mimics ceiling rosettes in the GSA Central Office building Administrator's Suite. Washington, DC.

Water Mist

Originally developed for maritime use, water mist technology is now emerging commercially for fire suppression in buildings where high-value contents or limited water supply are a concern. Mist suppression works by creating a fog of very fine water droplets that extinguish fire without deluge, greatly reducing the risk of damage to artwork, decorative finishes, rare books or valuable furnishes. Since mist requires little water volume, systems can be installed using a stand alone water supply, reducing installation costs where water supplies are limited.

Two types of water mist systems have emerged:

1) Very low flow/high pressure system using high efficiency nozzles, 12-18 mm tubing, and a stand alone, dedicated water supply;
2) Low to intermediate pressure system which delivers higher quantities of water through slightly larger tubing sizes, using standard water supplies.

Both result in lower levels of water saturation when compared to standard sprinklers.

Some components await UL testing. Testing by other laboratories is also underway. The water mist system generally costs more than twice as much as sprinklers to install and requires more nozzles to ensure adequate coverage, but savings may result where water supplies for conventional sprinklers are inadequate. Design requires highly specialized expertise in the system. U.S. approvals for building installations so far have been limited to libraries and remote sites lacking adequate water for a sprinkler system. At this stage in the product's development, early and ongoing consultation between fire safety authorities, preservation review groups and the project design team is critical to consideration of mist as a suppression option. As demand increases and costs drop, the range of mist applications can be expected to broaden.

The water mist system's small components and flexibility will make it an increasingly attractive option where architectural constraints make concealed installation difficult

or undesirable. The mist system's ¼ inch steel tubes, optional flexible hoses, and tiny nozzles conform to curves much more easily than standard ¾ copper or 1½ inch steel sprinkler piping. A detailed profile of water mist technology is available in APT Bulletin 27:4, 1996.

Fire Separation

In older buildings lacking direct discharge, two-hour fire-rated egress paths to the outdoors are typically created by installing fire separations across the corridor (to isolate the egress path from the rest of the building) and replacing unrated materials, such as glazed doors, within the egress path.

Cross-Corridor Fire Separation

Careful placement and selection of cross-corridor separations can minimize the amount of historic material requiring replacement (Fig. 11).

Fig. 11: Standard drywall partition with 90 minute rated doors for cross corridor fire separation reduces height and width clearance. New products offer alternatives that maintain corridor clearance.

Hold Open Doors

Oversized hold open doors are the most economical alternative to cross-corridor fire separation. Custom fabricated doors detailed to match original paneled corridor doors can now be fabricated in sizes large enough that truncating the corridor is not necessary. Cross-corridor doors at the Federal Trade Commission building in Washington, DC, measure 10 feet high and 45½ inches wide, spanning all but 28 inches of the 10 foot wide corridor and 1 foot of the floor to ceiling height. A 12 inch high bulkhead and 14 inch wide jambs fill the gap and support the doors (Fig. 12).

Fig. 12: Cross-corridor doors at the Federal Trade Commission building in Washington, DC, span all but 28 inches of the 10 foot wide corridor and 1 foot of the floor to ceiling height. (National Capital Region)

Gel Glass Partitions

Gel glass, available in several varieties rated up to 90 minutes, provides complete transparency but is costly and requires thick dividing members to hold the heavy laminated glass (typically 1 1/8 inch thick for a 90 minute rated glass). Mullions can be customized by applying moldings to match original trim (Fig. 13).

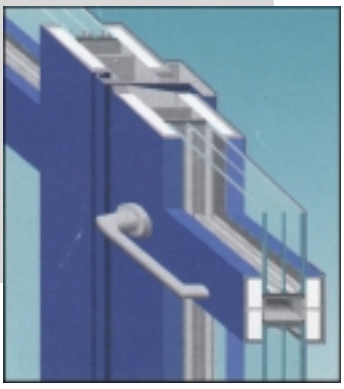


Fig. 13: Superlite II 90 minute laminated gel glass in steel door. (Section detail: O'Keefe)

Accordion Cross-Corridor Doors

Accordion fire doors are the only solution that offers complete transparency with no visible physical barrier. Because they are retractable, they require enough space alongside the corridor to create pockets (18 inches wide by 4 feet deep). Where walls and ceilings are flat plaster, they are fully reversible and nearly invisible because doors are completely retracted except during a fire. Only the ceiling track, receiving slot and door covering the pocket are visible (Fig.14). WON Door is the only product currently available.

Fig. 14: WON door accordion fire partition (partially retracted) allows ceiling and wall clearance to be maintained. Ariel Rios building, Washington, DC.

Fig. 15: Bulkhead installed below vaulted ceiling to accommodate track for WON door. If space above ceiling allows, entire door can be retracted to maintain vaulted ceiling clearance. Ariel Rios building, Washington, DC.

Even vaulted ceilings can be kept open if the space above the ceiling will accommodate a retracted door head. Unfortunately, this is rarely the case so a bulkhead must usually be constructed to square off the ceiling (Fig. 15).

Installing accordion fire separation doors at the Department of Commerce building in Washington, DC, required cutting into original stone walls and coffered ceiling but enabled the preservation of dozens of bronze and glass corridor doors that would otherwise have been absorbed into a larger egress path. Accordion door tracks, pocket and cover were painted to match the surrounding veined marble and elaborate ceiling (Figs. 16, 17). Smaller-than-standard hinges were also installed to minimize the visibility of the pocket cover door within the stone wall.

Fig. 16: Accordion door tracts, receiving slot and cover painted to match marble walls and coffered ceiling. Commerce Dept, Washington, DC.

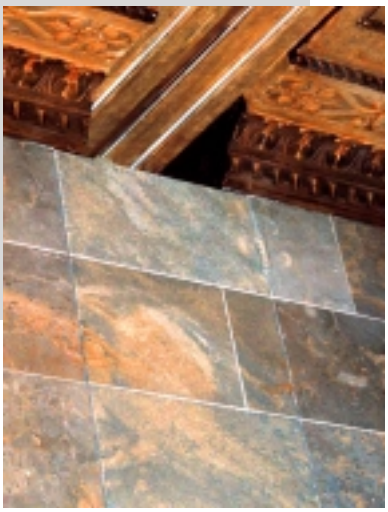


Fig. 17: Detail of faux marble painted door cover and ceiling tracks painted to match glazed bronze finish of coffers.

Air Curtain

High pressure air curtain technology has been used in Hollywood to contain fire in staged disasters for the film industry. European APT contacts advise us that similar technology is being used in the French Metro to provide fire separation in locations where a physical barrier is not practical. Such applications could hold promise in the future for creating unobtrusive enclosures in open areas and challenging ceremonial spaces.

Protected Passageways – Creating a Rated Path

Original stair and corridor doors(especially doors containing glass) are generally considered the weakest link in an egress enclosure and are the most common historic materials requiring replacement. However, in some cases, documentation of the fire resistance of archaic materials will support retaining historic doors.

Reusing Historic Doors

HUD Guideline: Fire Safety Ratings of Archaic Materials provides rating equivalencies developed from tests conducted on a variety of older door, wall and ceiling materials. The publication (currently pending revision which will increase the range of alternative solutions) also provides details showing how to upgrade the fire resistance of historic doors by applying intumescent coatings, adding backing materials behind glass and panels, and reinforcing connections between materials (Figs. 18, 19).

An economical solution for preserving historic glazed doors, where fire safety authorities will accept 60-80 minutes of fire resistance, is to retrofit historic doors with non-conductive rated glass such as Superlite XL by O'Keefe. Superlite XL is only ¼ inch thick and can be retrofitted into most historic doors. It is UL listed for 60 minutes but has resisted fire for 80 minutes in tests omitting the hose stream requirement (i.e., applicable to sprinklered buildings only).

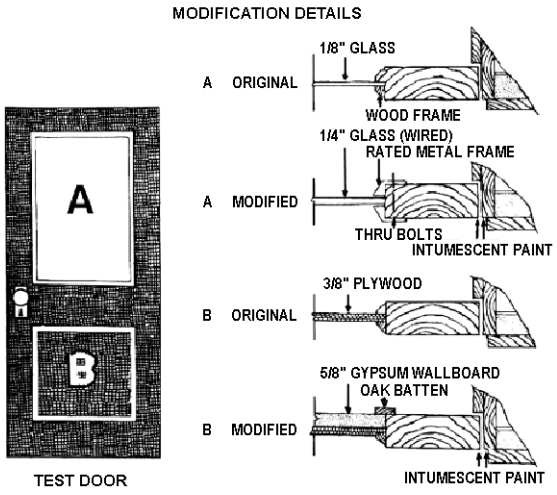


Fig. 18: Detail drawing showing upgrade of historic doors by applying backing materials and reinforcing connections. (HUD - *Fire Ratings of Archaic Materials and Assemblies*)

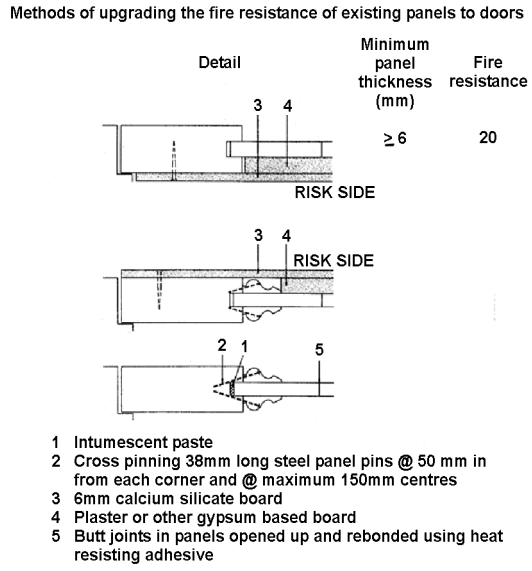


Fig. 19: Detail drawing showing upgrade of historic doors by applying backing materials and reinforcing connections. (English Heritage - *Timber Panelled Doors and Fire*.)

GSA fire safety officials approved retrofitting original steel and wireglass stair doors, in combination with water curtains, at the Department of Justice building in Washington, DC, with Superlite XL. Warnock-Hersey tested a fully glazed assembly matching the building's historic doors, sidelights, and transoms which withstood a 66 minutes fire test. Bronze and glass stair doors at the Department of Interior building will also be retrofitted with Superlite XL (Fig. 20).

Fig. 20: Bronze and glass stair doors at the Dept. of the Interior building will be retrofitted with Superlite XL rated glass.

Superlite provides low conductivity compared to other rated glass products and some shatter resistance. In replacement doors using rated glass, vision panels matching the width of the door's solid panels can now be used instead of standard oblong or 10 inch by 10 inch wireglass vision panels.

Replacement Doors

Where retrofitting existing doors with rated glass isn't an option, 90 minute custom paneled doors (solid or glazed) detailed to match original paneled doors are now commercially available. Maiman glazed doors, available in many wood varieties and virtually any panel configuration, use Superlite II laminated gel glass (formerly Contraflem) to provide transparency with a 90 minute rating. Thick (1 ½ inches), expensive, and beautiful, these doors offer an excellent rated alternative for highly significant buildings or projects limited in scale.

True paneled solid wood (Fig. 21), hollow metal, and kalamein (steel clad) (Fig. 22) are also available from Metalline, All Type and other fabricators. Metalline's kalamein door, produced since the early 1950s, has crisp moldings and well-concealed fasteners, mimicking original paneled doors well. A primary limitation with all manufacturers is a small selection of moldings – stock moldings tend to be smaller than originals. For the best possible match to original doors, moldings may need to be purchased from another source and supplied to the door manufacturer.

Fig. 21: Ariel Rios Building, Washington, DC. 90 minute true paneled wood door matching original corridor doors.

Fig. 22: 90 minute kalamein door closely matches original paneled stair doors at the Federal Trade Commission building, Washington, DC.

Conclusion

As the proportion of construction projects involving historic building rehabilitation continues to increase, so does the market for specialized fire safety compliance products designed to look good in older buildings or to blend with high quality finishes in contemporary buildings. You may be surprised at the willingness of manufacturers to adapt their systems. Maintain high expectations and don't hesitate to ask. Most importantly, make sure that you select a contractor with a proven track-record of successful fire protection projects in sensitive historic buildings.