Passive Fire Protection Inspection Gap Solved

- Why single-membrane penetrations, incomplete detailing, limited training and concealed vent/flow pathways can compromise fire-resistance-rated assemblies.
- A publication-ready perspective for architects, MEP engineers, specifiers, AHJs, fire marshals, special inspectors, contractors and building owners.

KEY FINDING — THE RATING BELONGS TO THE ASSEMBLY

UL Solutions reports that omitting required supplemental protection over a recessed troffer can cause significant heat transmission into the plenum and can potentially reduce a nominal two-hour floor/ceiling or roof/ceiling assembly to one hour or even less. [1]



Figure 1. Fire-rated floor/ceiling assembly with recessed light fixture: single-membrane penetration requiring a fire-protection solution. Conceptual CAD detail; project-specific UL design, listing, installation instructions and AHJ requirements govern.

THE PRODUCT-LISTING TRAP

The correct question is not simply "Is the fixture listed?" It is "Has this installed condition been evaluated or otherwise approved so the required fire resistance of this specific wall, floor or ceiling assembly is not reduced?"

EXECUTIVE SUMMARY

Passive Fire Protection Must Be Treated as a System of Verified Conditions

Fire-resistance-rated walls, floors and ceilings are not collections of individually rated products. Their hourly performance is established by testing the complete construction. When recessed luminaires, electrical boxes, exhaust fans, shower valves, plumbing boxes and similar devices interrupt one membrane of that construction, the opening becomes part of the fire-resistance problem and must be addressed by the applicable tested design, an approved tested/listed protection system, a code-permitted exception, or another method accepted by the Authority Having Jurisdiction (AHJ). [1][2]

The technical literature also identifies an implementation gap. Firestop and penetration protection can fail long before an inspector reaches the finished building: incomplete plans, generic notes, fragmented trade responsibility, incorrect product selection, inadequate installer knowledge, limited inspector training and concealment before verification can each undermine a compliant design. International Firestop Council (IFC) guidance specifically calls for clear system details in plans and specifications and recognizes that many jurisdictions have lacked enough personnel with the competence needed for knowledgeable special inspection. [3][4]

FRPS uses the term Vent Flow Pathway Management as an organizing framework for identifying and controlling openings and concealed pathways that can permit heat, flame and smoke to migrate beyond the intended compartment. This term should be understood as an FRPS explanatory framework, not as a defined IBC term. The underlying code obligation is the preservation of required fire resistance, opening protection, penetration protection and compartmentation.

The Paper's Central Conclusions:

- Passive fire protection is code-required life-safety construction; it is not an optional enhancement or a discretionary "best practice."
- Single-membrane penetrations can materially affect assembly performance even though they do not pass completely through the wall or ceiling.
- A device's electrical, mechanical or product-safety listing does not by itself demonstrate that the surrounding rated assembly retains its hourly fire-resistance rating.
- Clear construction details and system identification are prerequisites for meaningful plan review and field inspection.

- Specialized training matters because compliant firestop and membrane-protection systems are configuration-specific and cannot be verified by visual presence alone.
- Inspection must occur while critical conditions remain visible; concealment can turn a correctable defect into a hidden life-safety liability.

The Whole Assembly is the Fire-Resistance System

ASTM E119 and UL 263 fire-resistance ratings are developed from testing complete assemblies under prescribed fire exposure and performance criteria. UL emphasizes that recessed luminaires, like other individual components, are not assigned the assembly's hourly rating; the complete tested construction qualifies for the rating. [1]

This distinction is fundamental. A one- or two-hour wall does not retain that rating merely because most of its gypsum remains intact. The same is true for a rated floor/ceiling or roof/ceiling assembly after an opening is created for a fixture or service device. The resulting condition must remain within the tested or code-permitted boundaries of the assembly.

FRPS POSITION

A membrane penetration is not merely a hole in gypsum board. It is a modification to a tested life-safety assembly and should be designed, documented, installed and inspected with that level of importance.

Why Single-Membrane Penetrations Deserve Specific Attention

A through-penetration passes through the complete rated assembly. A membrane penetration interrupts only one face. Because the opening may appear localized or may be installed by a trade focused primarily on the equipment itself, the fire-resistance implications can be underestimated. UL identifies recessed fixtures and electrical boxes as conditions that require protection so the hourly rating is maintained. [2]

- Recessed troffer and lay-in luminaires that interrupt a rated ceiling membrane.
- Canless or wafer LED luminaires installed through gypsum or other rated ceiling membranes.
- Electrical, controls and communications boxes recessed into rated walls.
- Bathroom exhaust fans and other fan housings installed within rated floor/ceiling construction.
- Shower-valve bodies, plumbing connection boxes, washing-machine boxes and similar recessed plumbing devices.
- Medical-gas and specialty service boxes installed within fire-resistance-rated walls.

THE CENTRAL LIFE-SAFETY QUESTION

After every recessed fixture, device, penetration and concealed opening is installed, will the fire-resistance-rated assembly still perform as the tested and approved construction requires?

The Compliance Chain

DESIGN	DETAIL	INSTALL	INSPECT	MAINTAIN
Identify rated assemblies and recurring openings	Show tested/ listed protection conditions	Match the approved system and instructions	Verify before concealment	Protect the rating through future changes

UL Research Demonstrates the Consequence of Missing Protection

UL Solutions describes three principal paths for using recessed luminaires in fire-resistive ceilings: use of luminaires incorporated into a specific fire-resistance design with prescribed field protection, use of luminaires specifically certified for fire-resistance-rated assemblies, or use of another acceptable supplemental protection approach consistent with the applicable design and certification. [1]

UL's recent research is especially important because it moves the issue beyond theory. When required supplemental protection above troffer luminaires was omitted, heat transmission through the luminaire housing into the ceiling plenum increased substantially. UL reports that the condition could potentially reduce a two-hour assembly to approximately one hour or less. [1]

WHY THIS MATTERS TO DESIGN TEAMS

A localized recessed opening can govern the performance of a much larger assembly. Repeating the same unprotected detail across dozens or hundreds of units can multiply the same vulnerability throughout a building.

Code Framework: Preserving the Required Rating

IBC Chapter 7 establishes the core requirements for fire- and smoke-protection features. The membrane-penetration provisions require recessed fixtures in rated walls and floor/ceiling assemblies to be installed so that the required fire resistance is not reduced, subject to defined exceptions and approved tested/listed systems. [7][8]

IBC Chapter 17 adds a quality-assurance layer for specified building categories. The 2024 IBC special-inspection provisions address through-penetrations, membrane penetration firestops, fire-resistant joint systems and perimeter fire containment systems in high-rise buildings, Risk Category III and IV buildings, and qualifying Group R fire areas. Penetration-firestop inspections are tied to ASTM E2174. [6]

Code and Verification Hierarchy

QUESTION	EVIDENCE TO VERIFY	WHY IT MATTERS
What is the rated construction?	Approved assembly/design number, drawings, specifications.	The fire-resistance obligation belongs to the assembly.
What opening or recessed condition is being created?	Coordinated architectural/MEP details and device schedule.	Different devices and opening sizes create different conditions.
How is the opening protected?	Applicable tested/listed design, certification, code exception or approved evaluation.	Protection must match the actual field configuration.
Was it installed correctly?	Manufacturer instructions, listing limitations, field observations.	Small deviations can change system performance.
Was it verified before concealment?	Inspection records, photographs, deficiency closeout.	Hidden conditions are difficult and costly to verify later.

The Inspection Gap Begins in the Drawings

International Firestop Council inspection guidance states that firestop system details and materials should be included in the plans and specifications. If the documentation is insufficient to give clear direction to the general contractor and installer, IFC recommends that the submittal be treated as incomplete and returned for correction. IFC further notes that clear and complete plans and specifications can prevent many field problems. [3]

This is critical for recessed fixtures and devices because a generic note such as “maintain fire rating” does not identify the tested condition the installer must reproduce or the inspector must verify. Effective details should identify the rated assembly, the penetration or recessed-device condition, the required protection method, relevant listing/design references, limitations and any installation sequence that must be inspected before concealment.

A Recurring Coordination Failure

- The architect identifies rated walls or ceilings, but the MEP drawings show the device without a corresponding fire-resistance detail.
- The equipment specification requires a listed light, fan or valve but does not address the fire-resistance-rated construction receiving it.
- The firestop specification is written primarily around through-penetrations, while recessed-device conditions are left to trade coordination.
- The installer encounters the opening in the field and selects a familiar product without confirming the complete tested/listed system.
- The inspector sees firestop material or an enclosure but lacks a project-specific reference showing what the accepted condition should be.

Competent Inspection Requires More Than Recognizing Firestop Material

IFC guidance is direct about the training problem. It states that many jurisdictions adopting IBC special-inspection provisions have lacked enough personnel with the competence required to perform knowledgeable inspections to ASTM standards. IFC warns that a poor third-party inspection can pass installations that would not perform properly in a fire while incorrectly rejecting legitimate but unfamiliar systems. [4]

The same organization developed a comprehensive education and examination program because competent firestop special inspectors were not expected to appear automatically in sufficient numbers after the code requirement was adopted. The program combines technical study, examination and, at its premier level, multi-manufacturer product familiarization. [5]

Recent IFC guidance emphasizes that the firestop product itself does not possess the hourly rating. The rating belongs to the complete tested/listed system, including the assembly, penetrant or joint configuration, opening size, backing material, material depth, orientation, accessories and specified firestop products. Product-specific training helps inspectors determine whether the installation actually matches that documented system. [5]

TRAINING PRINCIPLE

The presence of a firestop product is not the same as verification of a firestop system. Competence means being able to compare the installed condition with the complete tested/listed configuration.

Inspection Timing is a Life-Safety Issue

IFC inspection guidance recommends that penetration and joint protection remain visible until inspected and approved. This is especially important where required material depth, backing orientation, accessories, enclosure configuration or annular-space conditions cannot be confirmed after finishes are installed. [3][5]

For recessed devices, concealment may occur behind gypsum board, suspended ceilings, tile, shower surrounds, cabinetry, mechanical equipment or architectural finishes. Once concealed, the project may face destructive verification, expensive rework or acceptance of an undocumented condition. The most reliable quality-control point is therefore before the assembly is closed.

PRE-CONCEALMENT HOLD POINT

For recurring membrane penetrations, the project team should establish a defined inspection hold point: approved detail available, first installation reviewed, deviations resolved, representative installations documented, and required inspection completed before concealment.

Vent Flow Pathway Management: A Practical Coordination Framework

Fire research has demonstrated the importance of flow paths in fire behavior. FSRI research shows that ventilation openings can create routes between a fire and areas of lower pressure, transporting heat and smoke and supplying oxygen that can increase fire growth. [9] Although this fire-service definition should not be applied indiscriminately to every construction penetration, it reinforces a basic building-safety principle: openings and connected concealed spaces matter.

FRPS uses Vent Flow Pathway Management to describe a broader design and coordination discipline for building construction: identify where rated membranes are interrupted, determine whether the resulting opening or cavity creates an unintended path for heat, flame or smoke, select an approved protection strategy, and verify the installed condition before concealment. This framework complements—not replaces—the requirements of the adopted building code, listed designs, project specifications and AHJ approval.

FRPS Vent Flow Pathway Management Framework

IDENTIFY	Map rated walls, floors, ceilings and recurring recessed-device conditions during design.
CONTROL	Use the applicable tested/listed protection system, code-permitted condition or approved evaluation.
VERIFY	Inspect the installation while critical components and interfaces remain visible.
DOCUMENT	Record the accepted condition so future renovations can preserve the compartmentation strategy.

Modern Fire Behavior Raises the Cost of Assuming Compartmentation

FSRI's research into legacy and contemporary residential construction documents how larger geometries, open floor plans, synthetic fuel loads and ventilation conditions affect fire development. Its work demonstrates that the amount and location of air supplied to a ventilation-limited fire can change how much energy the fire generates and how rapidly it generates it. Remote ventilation can create a flow path from the fire toward previously uninvolved portions of a building. [9]

The appropriate design conclusion is not that every penetration behaves like an open door or window. It is that modern buildings should not surrender intended compartmentation through undocumented or unverified openings. Rated construction is valuable precisely because it is intended to provide predictable separation when active systems, occupant actions and fire conditions are uncertain.

Where Compliance Can Break Down

Stage	Common Gap	Potential Consequence	Preferred Control
Design	Rated assembly shown; recessed condition not detailedand penetration	Field improvisation	Provide device-specific rated detail and listing reference
Plan Review	Generic "maintain rating" notefire-resistance-rated horizontal assemblies.	No objective acceptance criteria	Review recurring penetration conditions and approved systems
Procurement	Device listing confused with assembly fire resistance	False sense of compliance	Confirm fire-resistance application separately from product safety
Installation	Trade follows equipment instructions only	Assembly detail not reproduced	Coordinate manufacturer instructions with rated-system requirements

WHERE COMPLIANCE CAN BREAK DOWN continued

Stage	Common Gap	Potential Consequence	Preferred Control
Inspection	Inspector sees surface condition only	Hidden deficiency may be accepted	Use qualified personnel, documentation and required sampling/ destructive verification
Concealment	Finish work closes the cavity early	Condition becomes unverifiable	Establish pre-concealment hold points
Renovation	New services added later	Compartmentation slowly degrades	Maintain penetration records and re-verify alterations

Recommended Actions by Stakeholder

ARCHITECTS AND SPECIFIERS

- Identify fire-resistance-rated assemblies clearly and coordinate recurring membrane penetrations in the details.
- Avoid relying solely on generic notes. Reference the applicable tested/listed system or establish a submittal requirement that produces one before installation.
- Coordinate Division 07 requirements with Divisions 09, 22, 23, 26, 27 and 28 where recessed devices intersect rated construction.

MEP ENGINEERS AND EQUIPMENT SPECIFIERS

- Treat the device listing and the assembly fire-resistance condition as separate verification questions.
- Schedule recurring recessed devices that occur in rated walls or ceilings and identify required protection coordination.
- Require substitutions to demonstrate equivalent compliance with the rated assembly—not merely equivalent equipment performance.

AHJS, FIRE MARSHALS AND PLAN REVIEWERS

- Ask for clear system details when project documents do not identify how recurring membrane penetrations will maintain the rating.
- Require required special inspections and verify inspector qualifications where the adopted code applies.
- Support pre-concealment inspection processes for conditions that cannot be meaningfully verified after closure.

CONTRACTORS AND INSTALLERS

- Confirm the rated assembly and approved detail before cutting the membrane.
- Install every component of the tested/listed condition, including backing, fasteners, accessories, enclosure components and spacing requirements.
- Stop and request clarification when the field condition differs from the approved system rather than improvising a protection method.

The Role of Engineered, Repeatable Protection Solutions

Recurring recessed-device conditions create an opportunity for engineered protection to reduce field variability. A repeatable enclosure, gasket or other tested/listed protection approach can simplify coordination when it is appropriate for the specific rated assembly and device condition. The value is not the presence of a proprietary product alone; the value is a documented system that can be specified, recognized, installed consistently and inspected against objective criteria.

FRPS develops fire-rated engineered products and consulting solutions for defined recessed-device and penetration conditions, including applications involving shower valves, exhaust fans, recessed lighting and troffer/LED lay-in fixtures. Product use must remain subject to the exact applicable listing/design, compatible assembly and device, project specifications, manufacturer installation instructions and AHJ approval.

FRPS COMPLIANCE PRINCIPLE

Engineer the recurring condition. Verify the installation. Preserve the compartment. Protect what matters.

A Project-Level Verification Protocol

VERIFICATION STEP	PROJECT QUESTION	REQUIRED RECORD
Assembly	What rated wall, floor or ceiling is being modified?	Approved design/ assembly reference
Opening	What fixture/device creates the membrane penetration?	Device schedule and coordinated detail
Protection	What approved method preserves the required rating?	Listing, design, code exception or approved evaluation
Installation	Does the field condition match the documented system?	Installer QC record / first-install review
Inspection	Were critical conditions verified before concealment?	Inspection report, photos, deficiencies and closeout
Turnover	Can future work identify and preserve the accepted condition?	As-built detail and O&M/ firestop documentation

CONCLUSION

Passive Fire Protection Cannot Be an Assumed Condition

The code requirement is straightforward in principle: fire-resistance-rated construction must retain the required performance after penetrations, recessed fixtures and other building services are installed. The challenge is implementation. The evidence reviewed in this paper shows why successful compartmentation depends on more than selecting a firestop material. It requires coordinated design information, technically appropriate tested/listed systems, competent installation, qualified inspection and verification before concealment.

For modern construction, the safest question is also the simplest: after everything installed into and through the assembly is complete, is there objective evidence that the assembly remains the fire-resistance-rated construction the project requires?

THE FINAL PROJECT QUESTION

If a fire starts on one side of this assembly today, have we preserved the tested and code-required barriers intended to keep that event from becoming a larger building fire?

Selected Research, Code and Industry Guidance

1. **UL Solutions — The Influence of Recessed Luminaires in Fire Resistive Assemblies.** Recessed luminaire protection, whole-assembly rating and UL research on omitted troffer protection. Open Source
2. **UL Solutions — Membrane Penetrations in Fire Resistance Rated Walls: Key Considerations and Standards.** Membrane-penetration definitions, protection concepts and listing limitations. Open Source
3. **International Firestop Council — Inspection Guidelines for Penetration Firestop Systems and Fire Resistive Joint Systems**. Plan/specification review, preconstruction coordination and inspection before concealment. Open Source
4. **International Firestop Council — Special Inspector Qualifications.** Industry discussion of competence gaps and firestop special-inspector education. Open Source
5. **International Firestop Council — Why Firestop Special Inspectors Need Manufacturer Training.** Complete-system verification and product-specific training; published 2026. Open Source
6. **International Code Council — 2024 IBC Section 1705.18 — Fire-resistant penetrations and joints (code-change compilation reproducing current section text).** Special inspection scope and ASTM E2174 reference. Open Source
7. **International Code Council — 2024 IBC, Chapter 7 — Fire and Smoke Protection Features.** Membrane and through-penetration requirements; verify the edition and local amendments adopted for each project. Open Source
8. **International Code Council — 2021/Model IBC Section 714.4.2 and related membrane-penetration provisions.** Representative ICC code text confirming the long-standing requirement that recessed fixtures not reduce required fire resistance. Open Source
9. **Fire Safety Research Institute (FSRI) — Impact of Ventilation on Fire Behavior in Legacy and Contemporary Residential Construction.** Fire-dynamics research addressing ventilation, flow paths and contemporary residential fire behavior. Open Source
10. **ASTM International — ASTM E2174 — Standard Practice for On-Site Inspection of Installed Firestops.** Referenced by the IBC for qualifying penetration-firestop special inspections. Open Source