TECHNICAL WHITE PAPER | PROTECTING WHAT MATTERS MOST

Closing Passive Fire Vent Flow Pathways in High-Density, Multi-Family Housing

- Passive fire protection, compartmentation, penetration control, and engineered FRPS solutions for the next generation of multifamily, mixed-use and attainable housing.
- A code-informed perspective for architects, MEP engineers, developers, owners, contractors, AHJs, special inspectors and facility teams.

THE CENTRAL DESIGN QUESTION

As buildings become denser and more interconnected, how do we keep necessary MEP openings from weakening the fire-resistance strategy designed to protect occupants?



DENSER
More people and systems per building

MORE OPENINGS
More people and systems per building

LESS MARGIN
More people and systems per building

Density amplifies both opportunity and consequence.

The housing market is und er intense pressure to deliver more homes at attainable price points. Research from the Harvard Joint Center for Housing Studies documents persistent affordability challenges, while the Urban Land Institute points to housing strategies that connect residential development with transit, infrastructure and public resources. [1] [2]

The resulting development model is increasingly compact and system-intensive: multifamily housing stacked above retail, shared amenities and parking; senior or student living connected to services; and mixed-use communities with hundreds or thousands of occupants in a common structural environment.

THE CORE PRINCIPLE

The denser the community, the less tolerance there should be for unmanaged breaches in passive fire protection.

Why this matters

Fire safety is layered. Detection, suppression, egress and emergency response are essential; passive systems provide the built-in boundaries intended to help contain fire and smoke.

UL Solutions identifies compartmentation as an essential passive fire-protection feature and notes that firestopping penetrations through fire-resistance-rated construction is critical to maintaining that compartmentation. [3]

A new housing model

Affordable and attainable housing is increasingly being delivered through multifamily, mixed-use, infill and transit-oriented development. These projects can combine residences, retail, services, health-care, parking and community amenities within one integrated footprint.

That efficiency increases the number of building services crossing or recessing into fire-resistance-rated construction.

What changes with density?

A 300-unit project can repeat the same recessed lights, speakers, valves, electrical boxes, piping and mechanical equipment hundreds or thousands of times.

A small installation error therefore becomes a repeatable risk. Conversely, a clearly qualified and repeatable solution becomes a scalable quality-control strategy.

The life saftey response

The answer is not one product. It is disciplined compartmentation: tested assemblies, protected openings, approved penetration systems, inspection, documentation and lifecycle maintenance.

FRPS is positioned within that system as a family of engineered solutions for defined recessed and penetration conditions.

Five conclusions for project teams:

- Treat fire-resistance-rated walls, floors and ceilings as controlled building assets, not simply finished surfaces.
- Coordinate recessed devices and penetrations before construction instead of discovering conflicts at closeout.
- Use tested/listed systems or other code-acceptable solutions that match the actual field condition.
- Separate fire-dynamics "flow path" concepts from penetration-firestop terminology, while recognizing that unintended openings can undermine containment.
- Manage passive fire protection through design, installation, inspection, documentation, renovation and maintenance.

THE DEVELOPMENT TREND

The next affordable community is a systems-dense building.

High-density housing is not merely "more apartments." It is a concentration of people, services and infrastructure. Transit-oriented and mixed-use projects can place housing within walking distance of shops, work, healthcare and mobility, increasing social value while reducing land consumption. ULI's housing-policy research describes a shift toward connecting housing with transit and infrastructure as part of a broader systems approach. [2]

1 BUILDING	100s OF UNITS	1 STRATEGY
Multiple occupancies and uses	Repeated MEP conditions	Compartmentation must remain continuous

Typical Systems

- Electrical distribution and recessed lighting
- Low-voltage, communications and speakers
- Domestic water, waste and shower valves
- HVAC equipment, cassettes, fans and exhaust
- Fire protection, controls and life-safety devices

Typical Rated Boundaries

- Dwelling-unit separation walls
- Corridor and shaft enclosures
- Floor/ceiling and roof/ceiling assemblies
- Fire barriers and fire partitions
- Protected egress construction and other rated assemblies

Every interface requires a design decision. The correct solution depends on the rating, assembly construction, opening geometry, penetrating item, listing limitations and the applicable code provisions. The objective is not simply to “fill a hole;” it is to preserve the performance of the rated assembly as a system.

MAGAZINE TAKEAWAY

Affordable construction should remove waste, not required life-safety performance. Standardization can lower complexity without lowering the standard.

FIRE SCIENCE + COMPARTMENTATION

Control the pathways fire and smoke are allowed to take.

Modern residential fire research has shown the importance of ventilation to fire development. FSRI’s full-scale studies examined how ventilation locations and openings influence fire behavior in contemporary residential environments, including the effects of synthetic fuel loads and modern geometries. [4]

THE FLOW-PATH DISTINCTION

A construction penetration is not automatically an FSRI-defined fire flow path. But fire science reinforces a broader point: openings, pressure and air movement matter. Rated boundaries therefore have to remain intentional and controlled

Compartmentation is the structural defense.

Passive fire protection divides a building into zones intended to resist the spread of fire and products of combustion for the required duration. UL describes fire-resistance-rated walls and horizontal assemblies, fire doors, dampers and firestop systems as complementary elements of a balanced fire-safety strategy. [5]

1. CONTAIN
Rated walls and horizontal assemblies establish boundaries.

2. PROTECT
Openings and penetrations receive appropriate tested/ listed protection.

3. MAINTAIN
Inspection and lifecycle controls preserve the strategy after occupancy.

This is why the fire-resistance rating belongs to the complete construction, not to a single board, sealant or enclosure. When a device changes the membrane or creates a through-penetration, the protection method must be evaluated against the actual assembly and application.

CODE + QUALITY CONTROL

Compliance must survive the field condition.

The 2024 International Building Code addresses penetrations in fire-resistance-rated construction in Section 714. It also requires special inspection of specified penetration firestop systems in high-rise buildings, Risk Category III or IV buildings, and certain Group R fire areas with occupant loads greater than 250; penetration-firestop inspections under those provisions are conducted in accordance with ASTM E2174. [6] [7]

What Code Discipline Requires

- Identify the rated assembly and applicable opening condition.
- Select a tested/listed or otherwise code-acceptable protection method.
- Install within the conditions and limitations of the system.
- Verify substitutions and field changes before concealment.

What Quality Assurance Adds

- Preconstruction coordination among design, MEP, firestop and inspection teams.
- Penetration schedules and approved submittals.
- Photo documentation before closure.
- Lifecycle controls for renovations and future penetrations.

Why special inspection is a signal.

Special inspection exists because these details are consequential and can be difficult to verify after they are concealed. The code's inspection framework should be read as an industry lesson: penetration protection deserves controlled installation and documented verification, even where a particular project is not subject to Section 1705.18.

FIELD RULE

No unidentified opening. No undocumented penetration. No unverified repair.

The strongest compliance model moves the decision upstream: from "How do we fix this after the device is installed?" to "What qualified protection system are we designing into this condition?"

FRPS ENGINEERED SOLUTIONS

Productize recurring fire-protection conditions.

FRPS is built around a practical premise: recurring recessed and penetration conditions should have recurring, clearly defined protection strategies. The current FRPS product catalog includes composite and metal enclosures and a gasket solution addressing selected lighting, speaker, low-voltage, HVAC, exhaust-fan and shower-valve applications. [8]

FRPS FAMILY	TYPICAL PRODUCT ROLE	DESIGN INTENT
Composite / In-Ceiling	Downlighting & speaker enclosures	Repetitive ceiling recesses in qualifying rated assemblies
Composite / Low-Voltage	Low-voltage downlighting enclosures	Shallow-depth lighting conditions
Conposite / Plumbing	Shower valve gasket	Defined vertical-wall shower valve conditions
Composite / T-Grid	Lighting enclosures	Suspended ceiling / T-grid applications
Metal / Recessed	Lighting, HVAC, exhaust and shower-valve enclosures	Project-specific recessed equipment conditions

The exact fire-resistance rating, assembly type, dimensions, compatible device, penetrating item and installation method must always be confirmed in the applicable FRPS listing, design report and installation instructions. FRPS should not be treated as a universal solution for every penetration condition.

FRPS POSITIONING

Purpose-designed solutions for defined conditions - engineered to make repeatability, coordination and inspection easier.

FEATURES + BENEFITS

The value of repeatability in a 300-unit building

In repetitive multifamily construction, the same condition can occur hundreds of times. The best engineered solution is therefore not only one that performs in a fire test; it is one that can be specified, coordinated, installed and inspected consistently within the boundaries of its listing or approval.

Engineered Repeatability

A defined product geometry and installation sequence can reduce field improvisation across repeated units.

Constructability

Purpose-built products can simplify recurring conditions by reducing the number of field variables that trades must interpret.

Schedule Support

Standardized solutions can reduce late-stage redesign when predictable penetration conditions are identified early.

Design Integration

Applicable FRPS systems can be coordinated during architectural and MEP design instead of being treated only as a closeout issue.

Inspectability

Recognizable products and documented system conditions can make verification more straightforward for contractors, inspectors and AHJs.

Lifecycle Clarity

A documented product/system approach gives owners a clearer reference point when future repairs or renovations affect rated construction.

A standardized product does not eliminate the need for professional judgment, code review or inspection. Its value is that it can make the approved condition easier to repeat correctly.

THE SCALABILITY QUESTION

Would you rather solve the same life-safety condition 300 different ways - or qualify the right solution and repeat it correctly 300 times?

ENGINEERED PROJECT WORKFLOW

Move passive fire protection upstream.

1. Map

Identify every rated wall, floor, ceiling, shaft and barrier relevant to the project.

2. Schedule

Create a penetration and recessed-device schedule tied to architectural and MEP documents.

3. Match

Select tested/listed systems or other code-acceptable solutions that match actual field conditions.

4. Coordinate

Review device dimensions, clearances, substrates, supports and installation sequencing before procurement.

5. Install

Train affected trades and install exactly within the approved system requirements.

6. Verify

Inspect before concealment; resolve deviations before closing the assembly.

7. Document

Record system, location, installer, inspection result and supporting evidence.

8. Maintain

Control future penetrations, tenant improvements and equipment replacement throughout the building lifecycle.

BEST PRACTICE SHIFT

Passive fire protection should be designed - not discovered during inspection.

For projects using BIM or digital closeout platforms, the penetration schedule can become part of the building's permanent record. Over time, this creates a practical "digital twin" of rated barriers and their protected openings.

RESPONSIBILITY ACROSS THE BUILDING LIFECYCLE

Compliance is a team sport – and an ownership obligation.

STAKEHOLDER	PRIMARY PASSIVE-PROTECTION RESPONSIBILITY
Developer / Owner	Set the project standard, fund coordination and require closeout records.
Architect	Identify rated assemblies and resolve recurring membrane-penetration conditions in design.
MEP Engineer	Coordinate services with fire-rated construction and define equipment interfaces early.
General Contractor	Control field penetrations, substitutions and sequencing; prevent unapproved improvisation.
Installer / Firestop Team	Use the approved system and document deviations before proceeding.
Special Insoector / AHJ	Verify the installed condition against the approved system and code requirements.
Facility Team	Protect rated assemblies during maintenance, upgrades and tenant improvements.
FRPS / Manufacturer	Provide clear tested/listed system information, installation guidance and technical support for applicable conditions.

The building changes after occupancy

Internet cabling, plumbing repairs, lighting upgrades, HVAC replacement, technology changes and tenant improvements can all alter rated construction. A building that was compliant on opening day can accumulate risk if those changes are not managed. UL's fire-barrier guidance emphasizes ongoing barrier maintenance and inspection as part of building fire safety. [9]

CONCLUSION

Build more housing. Build less hidden risk.

The next generation of attainable housing will be judged on more than unit count. It will be judged on resilience: whether densely occupied buildings can continue protecting people when one room, one device or one system fails.

The appropriate response is not fear-based design. It is disciplined engineering. Understand fire behavior. Preserve compartmentation. Protect penetrations and recessed conditions. Inspect what is installed. Document what will later be concealed. Maintain the system after occupancy.

THE QUESTION TO ASK BEFORE CLOSING THE WALL OR CEILING

After everything we installed into and through this assembly, will it still perform as the fire-resistance-rated construction the project requires?

FRPS is positioned to support that discipline through purpose-designed fire-rated enclosures and gasket solutions for defined building conditions. The objective is straightforward: make important protection easier to specify, repeat, inspect and maintain - while respecting the limitations of each tested/listed system.

Let us help protect what matters most.

Selected sources & technical references

1. Harvard Joint Center for Housing Studies, The State of the Nation's Housing 2025, 2025.
2. Urban Land Institute, Building the Future 2025: Transformative Trends in State, Local, and Federal Housing Policy, 2025.
3. UL Solutions, "Code Authorities and the UL Master Audit Certificate of Compliance," 2020.
4. Fire Safety Research Institute, Impact of Ventilation on Fire Behavior in Legacy and Contemporary Residential Construction.
5. UL Solutions, "Firestop Systems: An Important Line of Defense for Fire Safety," 2022.
6. International Code Council, 2024 International Building Code, Section 714 - Penetrations.
7. International Code Council, 2024 International Building Code, Section 1705.18 - Fire-resistant penetrations and joints.
8. Fire Rated Product Specialties, FRPS Product Catalog, 2026.
9. UL Solutions, Fire Barrier Management guidance and services.

TECHNICAL NOTE: This white paper is educational and does not replace the adopted building code, project-specific design, an Authority Having Jurisdiction determination, or the current listing/design report and installation instructions for any FRPS product. Product ratings and compatibility must be confirmed for the exact field condition. Discussion of fire flow paths describes fire-dynamics principles and does not assert that every construction penetration is an FSRI-defined flow path.