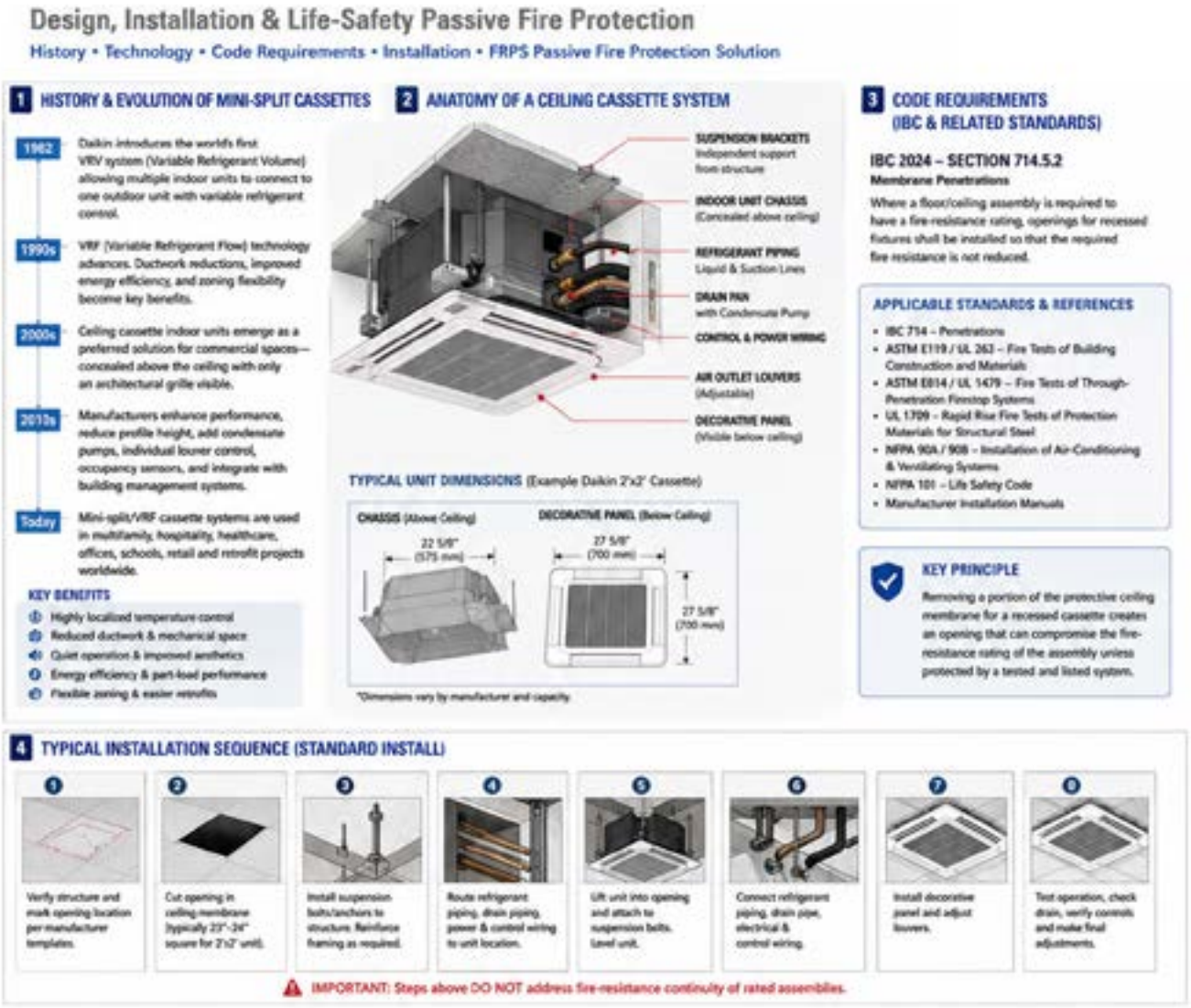
Mini-Split Cassettes in Fire-Rated Assemblies



THE CENTRAL DESIGN QUESTION

When a ceiling-recessed cassette removes a substantial portion of a rated ceiling membrane, what protects the opening so the required fire resistance is not reduced?

Executive Summary

Ceiling cassette mini-split and variable-refrigerant-flow (VRF) systems have become a mainstream way to deliver zoned heating and cooling with less ductwork, flexible indoor-unit placement and refined architectural integration. ASHRAE identifies recessed-ceiling cassettes as one of the standard VRF indoor-unit configurations and highlights the technology's variable capacity, individual zone control, part-load efficiency and, in heat-recovery systems, simultaneous heating and cooling.

The installation advantage that makes the cassette attractive can create a separate building-code coordination issue: most of the indoor unit is recessed above the finished ceiling. Where that ceiling membrane is part of a fire-resistance-rated floor/ceiling or roof/ceiling assembly, the unit opening is not merely an HVAC detail. It becomes an interruption of the protective membrane.

CORE PRINCIPLE

The equipment listing, normal operating temperature, or noncombustible housing of a cassette does not by itself establish that the cassette can replace the portion of a tested fire-resistance-rated ceiling membrane removed for installation.

IBC Chapter 7 requires membrane penetrations in rated horizontal assemblies to comply with the applicable penetration provisions and states that recessed fixtures in fire-resistance-rated floor/ceiling assemblies must be installed so the required fire resistance is not reduced. The appropriate compliance path depends on the exact adopted code, rated assembly, equipment configuration, penetrants, listing information and approval of the Authority Having Jurisdiction (AHJ).

This paper connects HVAC design practice with passive fire-protection coordination and proposes a repeatable project workflow: identify the rated assembly early, coordinate the cassette and its services, select an assembly-specific protective method, preserve service access, firestop qualifying service penetrations, and verify the completed work before concealment.

From Ductless Split Systems to Recessed Ceiling Cassettes

The modern cassette is the product of two parallel HVAC developments: ductless split-system air conditioning and variable-capacity multi-split/VRF technology. Ductless systems moved the indoor heat exchanger closer to the conditioned zone; VRF expanded that concept by networking multiple indoor units to variable-capacity outdoor equipment through refrigerant piping and integrated controls.

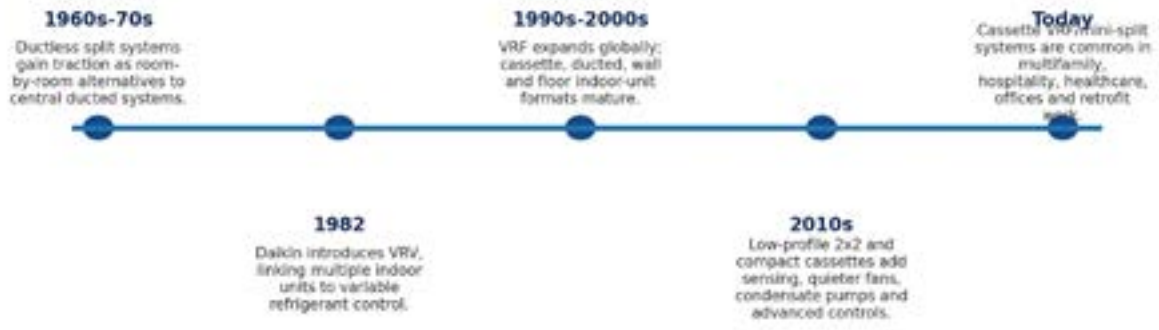


Figure 2. Simplified development timeline. Daikin identifies 1982 as the introduction of its VRV technology; VRV is a Daikin trademark and VRF is the generic industry term.

ASHRAE describes VRF as direct-expansion heat-pump technology using multiple indoor units connected to common outdoor equipment, with variable capacity and distributed control. Indoor-unit choices include wall-mounted, recessed-ceiling cassette, ceiling-suspended, floor-standing and ducted configurations. This diversity made VRF particularly adaptable to renovation work, buildings with limited shaft/duct space, and projects seeking room-by-room control.

Why Designers Choose Ceiling Cassettes

- Architectural integration: most of the indoor-unit chassis is above the ceiling, leaving only the grille or decorative panel visible.
- Zoned comfort: each indoor unit can respond to local heating and cooling loads through refrigerant-side control and variable-capacity outdoor equipment.
- Reduced ductwork: local fan-coil delivery can reduce large central duct distribution requirements, although ventilation air must still be addressed by the project design.
- Part-load performance: variable-capacity compressors and electronic expansion control allow the system to better match changing loads.
- Heat recovery: certain VRF configurations can simultaneously heat some zones and cool others while transferring energy within the refrigerant network.
- Application flexibility: cassette units are used in offices, hospitality, multifamily, healthcare, education, retail and other occupancies.

DESIGN TRADE-OFF

The same recessed configuration that improves aesthetics and reduces visible equipment also means the cassette occupies space that may otherwise have been part of a continuous ceiling membrane.

Anatomy and Operating Sequence of a Ceiling Cassette

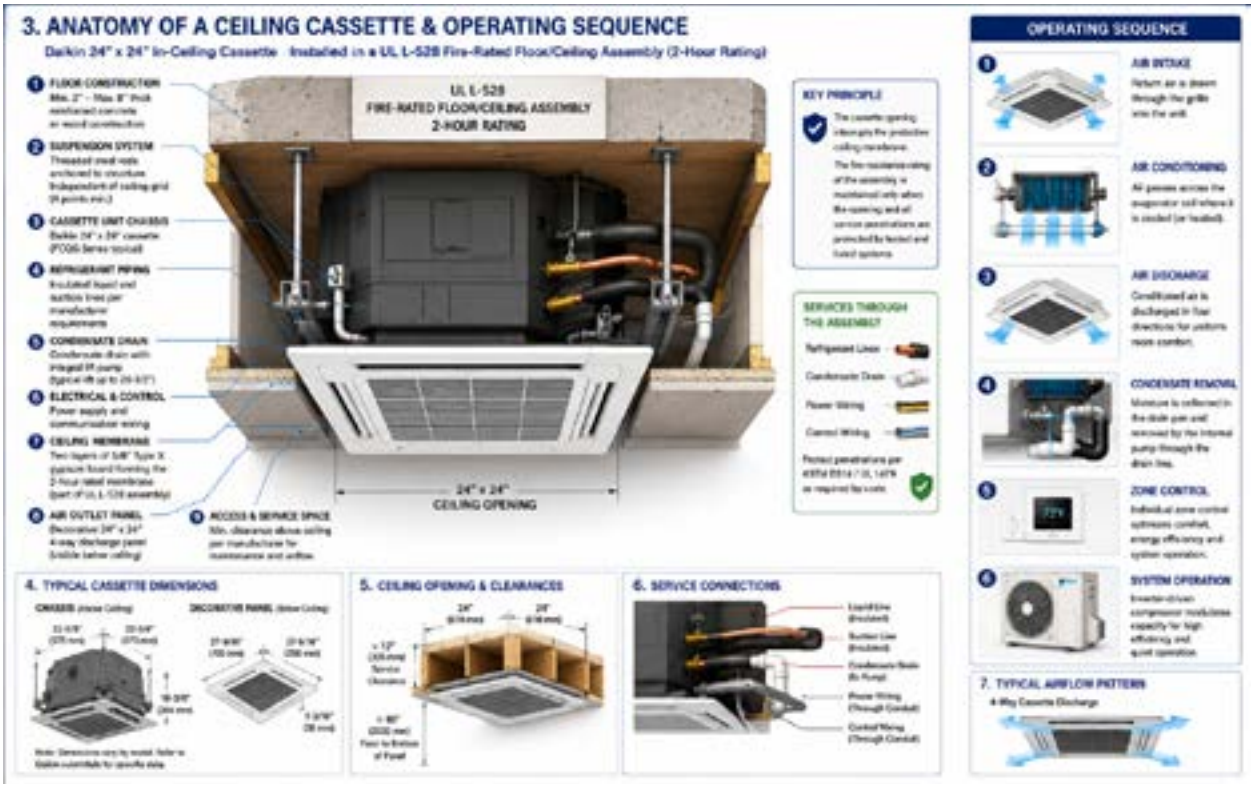


Figure 3. Anatomy and operating sequence of a Daikin 24 x 24 in-ceiling cassette coordinated with a UL L-528 fire-rated floor/ceiling assembly. Conceptual rendering; verify the exact UL design, cassette model, permitted opening, protective method, and current listing requirements for the project.

A cassette indoor unit generally contains a refrigerant coil, fan assembly, filter, drain pan, expansion/control components and electrical controls. Multi-directional discharge louvers distribute conditioned air into the room. Many current models incorporate condensate lift pumps, float switches, occupancy or temperature sensing, and local or building-level controls.

The cassette is normally suspended from structure rather than carried by the architectural ceiling grid. Refrigerant liquid/vapor lines, a condensate drain, power and control wiring, and sometimes outdoor-air or branch-duct connections enter the above-ceiling chassis. Those services create additional penetration conditions that must be coordinated independently from the large cassette opening itself.

Manufacturer Installation Direction: What the HVAC Instructions Solve

Manufacturer installation manuals typically focus on equipment performance, safety and serviceability. They address ceiling opening dimensions, structural suspension, leveling, piping, drainage, wiring, clearances, panel installation, pressure testing, evacuation, charging, controls and commissioning. These instructions are essential and must be followed.

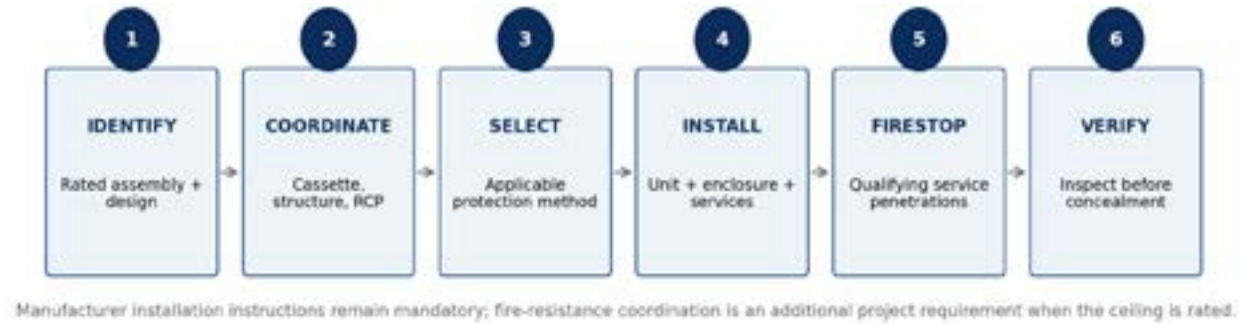


Figure 4. Recommended coordination sequence for a cassette in or near rated construction.

The critical coordination point is that manufacturer HVAC instructions do not automatically constitute a fire-resistance design for the building assembly. If the cassette interrupts a ceiling membrane that is part of a rated floor/ceiling or roof/ceiling construction, the project team must separately determine how the fire-resistance function of that membrane is preserved.

The Code Question: Is the Ceiling Actually Part of a Rated Assembly?

Not every suspended ceiling is fire-resistance rated. The first task is therefore to identify the exact assembly. A decorative acoustical ceiling below a rated structural slab may have a very different compliance condition from a gypsum membrane that is itself a required component of a listed floor/ceiling design.

REFERENCE	COORDINATION SIGNIFICANCE
IBC Chapter 7	Establishes fire-resistance and penetration protection requirements.
IBC 714.5	Addresses penetrations of fire-resistance-rated horizontal assemblies.
IBC 714.5.2	Addresses membrane penetrations and states that recessed fixtures in required rated floor/ceiling assemblies must not reduce the required fire resistance.
ASTM E119 / UL 263	Evaluates fire-resistance performance of complete building assemblies.
ASTM E814 / UL 1479	Evaluates through-penetration firestop systems; use must match the tested system and penetrant/assembly conditions.
ASHRAE 15 / 34	Refrigerant safety and classification considerations for VRF/mini-split systems.
NFPA 70 / NEC 440	Electrical requirements for air-conditioning and refrigerating equipment.
NFPA 13 / NFPA 72	Coordinate airflow and ceiling equipment with sprinkler and detection performance requirements.

Table 1. Key coordination references. Always verify the locally adopted code edition and amendments.

Membrane Penetration vs. Through-Penetration

A large recessed cassette opening and the service lines connected to the unit are not necessarily the same code condition. The cassette body can interrupt only one face of a rated horizontal assembly - a membrane-penetration/recessed-fixture condition - while a pipe, conduit or cable system may pass through the assembly and be addressed by a tested through-penetration firestop system.

IMPORTANT DISTINCTION

A bead of firestop sealant around the perimeter of a large cassette opening should not be assumed to restore the lost fire-resistive membrane. A tested/listed solution must address the actual assembly, opening, device and service configuration.

The International Firestop Council similarly distinguishes membrane penetrations, such as recessed boxes, from through-penetration firestop conditions. For designers, this means the large equipment recess should be resolved as an assembly problem, while qualifying line-set, drain, conduit and cable penetrations are coordinated with appropriate listed firestop systems.

What UL Research on Recessed Openings Teaches

UL Solutions has published research and guidance on recessed luminaires in rated floor/ceiling and roof/ceiling assemblies. The research is not a fire test of HVAC cassettes and should not be represented as one. It is nevertheless instructive because it demonstrates the assembly-level consequence of removing or inadequately protecting a portion of a rated ceiling membrane.

UL reports that, in research involving troffer luminaires, omitting required supplemental protection increased heat transmission into the concealed space and could substantially reduce the fire-resistance performance of the assembly. UL further emphasizes that recessed luminaires or other individual components are not independently assigned the assembly's hourly fire-resistance rating; the complete assembly earns the rating through testing.

ENGINEERING INFERENCE - NOT A CASSETTE FIRE TEST

The defensible conclusion for HVAC cassettes is not that a luminaire test proves a specific cassette rating. It is that large unprotected interruptions of a rated membrane cannot be presumed equivalent to the intact, tested assembly.

Standard Installation vs. Fire-Rated Coordinated Installation



Figures 5-7. UL L-528 1-hour fire-rated floor/ceiling cassette coordination: ceiling opening and clearances, FRPS metal enclosure detail FN-Z 26-50-10.5, service penetrations, and four-way airflow. Conceptual rendering; verify the exact UL design, FRPS listing, cassette manufacturer requirements, applicable firestop systems, and AHJ approval for the project condition.

In a non-rated ceiling, the standard manufacturer installation can generally focus on structural support, clearances, airflow, condensate control, refrigerant piping, electrical work and service access. In a rated membrane, those same requirements remain - but an additional passive fire-protection layer is needed to preserve the assembly's fire-resistance function.

This is why coordination must occur before procurement. A late fire-protection solution can conflict with required unit clearances, drain routing, line-set bends, access panels, ceiling depth, seismic bracing, lighting, sprinklers and detector placement.

FRPS Passive Fire-Protection Approach

FRPS applies an enclosure-based coordination strategy to recessed-device conditions in fire-resistance-rated construction. For mini-split cassette and fan-coil applications, the intent is to provide a factory-manufactured fire-resistant enclosure configuration around the recessed equipment where permitted by the applicable listing/design, while separately coordinating penetrations for refrigerant piping, condensate drainage, electrical power and controls.

- Identify the exact fire-resistance-rated floor/ceiling or roof/ceiling assembly and its hourly rating before selecting the protective configuration.
- Size and locate the enclosure to accommodate the cassette chassis, suspension system, required clearances and service access.
- Coordinate each service entry with the enclosure design and with listed firestop systems where the services penetrate rated construction.
- Do not modify the tested/listed assembly beyond the conditions permitted by the applicable design or certification documentation.
- Maintain access to filters, condensate pumps, electrical compartments, controls and other serviceable components.
- Require pre-concealment inspection and photographs so the installed protection can be verified before the ceiling cavity is closed.

FRPS POSITIONING

The objective is not to treat the cassette housing as a fire-rated membrane. It is to coordinate an engineered protective condition around a recessed HVAC opening while preserving the HVAC manufacturer's operating and maintenance requirements.

FRPS internal specification guidance currently calls for recessed cassette/FCU openings in rated floor/ceiling or roof/ceiling assemblies to receive protection equivalent to the required hourly rating and cautions that the cassette housing alone is not a substitute for the rated membrane. Project use must always be verified against current FRPS listing/design documents, compatible assemblies, device dimensions and AHJ requirements.

Recommended Design and Specification Workflow

1. Map the Rated Construction

Identify each rated floor/ceiling and roof/ceiling assembly on life-safety plans, architectural sections and reflected ceiling plans.

2. Schedule the Cassettes

List cassette model, dimensions, weight, access requirements, line-set entries, drain location and controls.

3. Verify the Assembly Condition

Determine whether the visible ceiling is the rated membrane or whether the rating is provided elsewhere in the assembly.

4. Select the Protective Method

Use a tested/listed assembly-specific method, listed enclosure or other approved solution appropriate to the exact condition.

5. Coordinate Services

Resolve refrigerant piping, drains, conduits, control wiring, penetrant materials, annular spaces and firestop systems.

6. Coordinate Life-Safety Devices

Check sprinklers, smoke detection, dampers, access panels and ceiling obstructions against applicable standards.

7. Install and Document

Install to manufacturer and listing instructions; photograph enclosure and penetrations before concealment.

8. Verify and Close Out

Include listing/design documents, inspection records and as-built locations in the project closeout package.

Specification Language – Suggested Editorial Basis

DIVISION 23 / DIVISION 07 COORDINATION

Where ceiling-recessed cassette units or associated services interrupt a fire-resistance-rated floor/ceiling or roof/ceiling assembly, provide protection using systems or enclosures specifically approved for the assembly and field condition. Maintain the required hourly rating; coordinate equipment support, service clearances and all pipe, conduit, cable and drain penetrations. Do not rely on the cassette housing or unlisted field-built materials as replacement for the required fire-resistive membrane.

The specification should also require the HVAC submittal package to identify the rated assembly at each cassette location and include the protective enclosure/firestop data, installation instructions, coordinated sections, service-access clearances and pre-concealment inspection requirements.

Roles and Responsibilities

DISCIPLINE	PRIMARY COORDINATION RESPONSIBILITY
Architect	Identify rated horizontal assemblies and coordinate reflected ceiling plans, access and architectural membrane continuity.
Mechanical Engineer	Select cassette systems, coordinate piping/drainage/controls, and flag locations where equipment intersects rated construction.
Fire Protection / Code Consultant	Confirm code path and compatibility of the proposed protective method with the rated assembly.
Electrical Engineer	Coordinate power, disconnects, raceways and control penetrations.
General Contractor	Assign scope ownership and sequencing; prevent concealment before inspection.
HVAC Contractor	Install cassette and services per manufacturer requirements; coordinate openings and access.
Firestop / Passive Fire Contractor	Install listed firestop systems and enclosure-related protection within the limits of the approved design.
AHJ / Special Inspector	Verify the approved condition, documentation and installation where required.

Table 2. Suggested responsibility matrix. Project contracts govern actual scope.

Conclusion: Treat the Recess as Part of the Assembly

Mini-split and VRF ceiling cassettes are a mature, highly effective HVAC technology. Their benefits - zoning, reduced ductwork, architectural integration and variable-capacity operation - are well established. The life-safety coordination issue arises only when a recessed cassette intersects construction that is required to provide an hourly fire-resistance rating.

At that point, the design question changes. It is no longer enough to ask whether the cassette is properly supported, drained, wired and commissioned. The project team must also ask whether the fire-resistance-rated assembly, after the opening and all related services are installed, still matches an approved tested/listed condition.

THE FINAL PROJECT QUESTION

After the cassette, line set, drain, electrical feed, controls and access provisions are installed, will the horizontal assembly still perform as the fire-resistance-rated construction the project requires?

FRPS advocates making that question part of standard MEP and life-safety coordination - before rough-in, before ceiling closure and before an inspection failure exposes the gap. Preserve the rating. Control the opening. Verify the installation.

Selected Technical References

1. ASHRAE Handbook - HVAC Systems and Equipment, Chapter 18, Variable Refrigerant Flow. Describes VRF operating principles, indoor-unit configurations, applications, controls, design and refrigerant-safety considerations.
2. Daikin Industries - corporate history materials identifying the 1982 introduction of VRV technology and subsequent development of variable refrigerant systems.
3. International Building Code, Chapter 7, particularly Section 714.5 and 714.5.2 for horizontal assemblies and membrane penetrations. Verify locally adopted edition and amendments.
4. UL Solutions / IAEI, technical guidance on recessed luminaires in fire-resistance-rated floor-ceiling and roof-ceiling assemblies (2024), including the principle that the complete assembly - not an individual component - establishes the hourly fire-resistance rating.
5. International Firestop Council, guidance distinguishing membrane penetrations from through-penetration firestop systems and explaining the role of listed systems.
6. ASTM E119 / UL 263, Fire Tests of Building Construction and Materials; ASTM E814 / UL 1479, Fire Tests of Penetration Firestop Systems.
7. ASHRAE Standards 15 and 34; NFPA 70 (NEC) Article 440; NFPA 13; NFPA 72, as applicable to the project.
8. FRPS Mini-Split Cassette / FCU Fire-Rated Penetration Coordination, CSI 3-Part Format, internal technical guidance. Verify current revision and current third-party listing/design documentation before specification or publication.

Technical and Editorial Notice

This white paper is educational and is not project-specific engineering, legal or code advice. Codes and local amendments vary by jurisdiction. Product ratings, design numbers, compatible assemblies, device dimensions, clearances, penetration limits, installation conditions and listing requirements must be verified against current manufacturer and third-party certification documents and accepted by the Authority Having Jurisdiction. Discussion of UL luminaire research illustrates assembly-level fire-resistance principles and is not represented as a fire test of HVAC mini-split cassettes.