HIGH-RISE BUILDINGS

Table of Contents

Page

List of Figures

List of Tables

1.0 SCOPE

This data sheet provides recommendations concerning the unique hazards associated with high-rise buildings (see Appendix A for definition).

1.1 Hazards

High-rise buildings pose distinct challenges compared to low-rise buildings. Fire, smoke, and water can propagate vertically via the building exterior, through penetrations and other openings that carry utility services and HVAC ducts from floor to floor. These hazards can cause extensive damage across a large area.

Firefighting efforts can also be hindered due to the height of high-rise buildings and limited reach of equipment (in most cases, a maximum of seven stories). This means fires within high-rise buildings often must be fought from the inside. Each additional story increases the difficulty of getting firefighters, equipment and water to upper floors, especially when occupants are trying to exit the building at the same time.

1.2 Changes

April 2026. This document has been completely revised. Significant changes include the following:

A. Recommendations were reviewed and clarified.

B. Updated loss history.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Construction and Location

2.1.1 Structural Fire Resistance

2.1.1.1 Ensure the fire resistance of structural and other building elements is in accordance with the minimums in Table 2.1.1.1. Refer to Data Sheet 1-21, *Fire Resistance of Building Assemblies*, for further information.

Table 2.1.1.1. Fire-Resistance Rating Requirements for Building Elements

Building Element	*Minimum Fire-Resistance Rating (hours)*
Primary structural frame	3
Bearing walls	3
Floor construction and secondary members	2
Shafts and chases	2
Stairwell and elevator enclosures	2
Enclosures where manual firefighting equipment (standpipes, fire extinguishers, etc.) is located	2
Fire-rated, normally closed or automatic closing fire doors for openings in stairwells and enclosures	1½

2.1.1.2 Repair spalled or missing fireproofing. Ensure that building employees, tenants, maintenance workers and contractors restore any fireproofing removed during repair or renovation of the building.

Pay particular attention to new construction, areas that have been renovated, and areas in which the fireproofing is exposed (such as basement storage areas and mechanical rooms). Inspect these areas for possible spalling prior to the installation or replacement of ceiling tiles or sheathing.

2.1.1.3 Include the fire resistance and performance of the concrete in the design of structural elements where high strength concrete (HSC) is proposed. Consider in the design the behavior of HSC at elevated temperatures and the relationship between concrete temperature and mechanical properties. The designer is responsible for verifying that the fire resistance meets the requirements of Section 2.1.1.1.

2.1.2 Interior Vertical Fire Spread

2.1.2.1 Limit the potential for interior vertical fire spread by limiting the number of floors connected by non-enclosed vertical floor openings, such as escalators and tenant staircases. Where such openings are unavoidable, provide protection per Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers,* Section 2.5.1.7.

2.1.2.2 Separate atria and other open areas that extend between multiple floors from adjacent occupied areas with a smoke-tight fire partition having a fire resistance rating of at least one hour. Protect openings with FM Approved and labeled fire doors (normally closed or automatically operated by smoke detection) with a minimum 3/4-hour fire rating. If windows are provided in the fire partition, ensure the glazing is fire-resistant by providing one of the following:

1. Listed fire-rated glass with a minimum 3/4-hour fire-resistance rating
2. Minimum 1/4 in. (6 mm) thick wired glass
3. Glass block

Window frames must be fire-rated and equipped with gasketing to allow for glass expansion.

2.1.2.3 Protect openings into fire-rated chases, shafts and stairwells with FM Approved fire doors having FM Approved closers and/or release devices. Ensure these doors are normally closed or are automatic-closing fire doors with a fire rating of at least 1-1/2 hours (unless otherwise noted).

2.1.2.4 Protect penetrations for electrical, mechanical, plumbing and communications systems that pass through a wall, floor or floor/ceiling assembly constructed as a fire barrier, with an FM Approved fire-stop system.

2.1.2.4.1 Ensure that fire-stopping is performed by an FM Approved Fire-Stop Contractor.

2.1.2.5 Seal all voids created at the intersection of the exterior curtain wall and the floor assembly with a listed, 2-hour assembly to prevent interior fire spread. Ensure exterior wall panels and frames are tightly secured at each floor to prevent outward buckling under fire exposure.

2.1.2.5.1 Ensure the fire-stopping is securely held in place and installed in accordance with its listing. Z-clips may be used to support (or to pierce) the underside of the fire-stopping and hold it in place (see Figure 2.1.2.5).

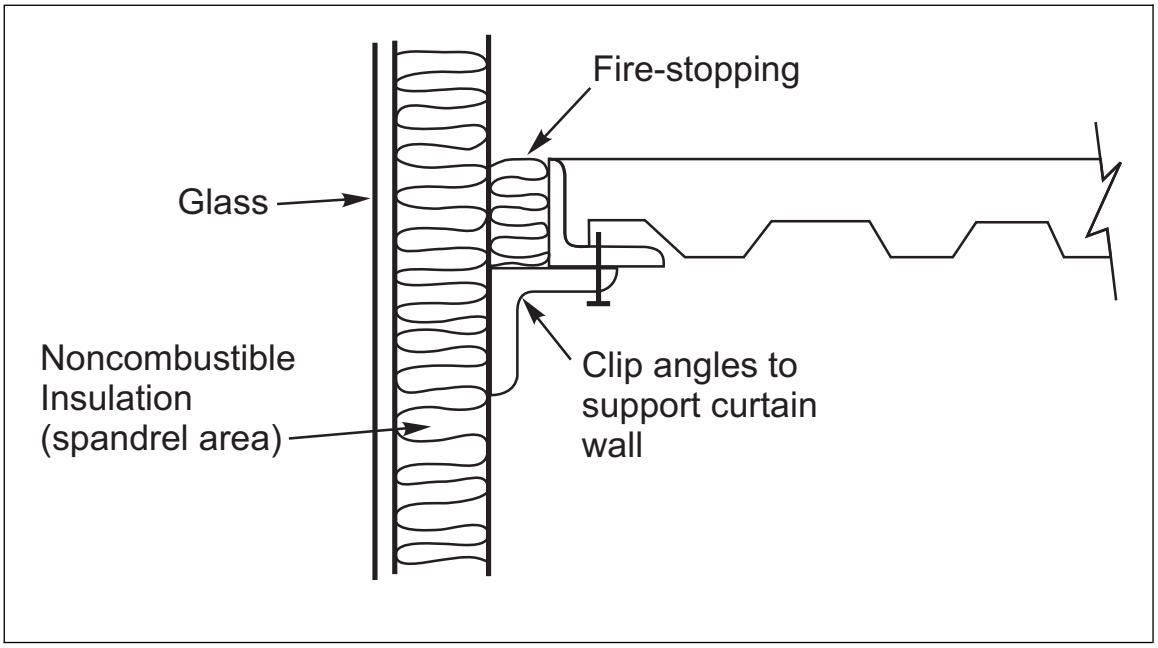

Fig. 2.1.2.5. Exterior glass curtain wall in metal frame; Fire-stopping friction fit in space and supported by clip angle

2.1.2.6 Provide expansion joints between floor sections with a minimum 2-hour rated, FM Approved firestop assembly.

2.1.3 Exterior Construction

2.1.3.1 Provide either FM Approved insulated curtain wall assemblies (e.g., metal composite material (MCM) systems) or noncombustible exterior wall assemblies. Examples include concrete, masonry and glass fiber insulated steel sandwich panels.

2.1.3.2 Ensure the glass in curtain walls or windows is one of the following:

1. Laminated glass
2. Tempered glass
3. Double-pane glass
4. Wired glass
5. Glass block
6. Special glass that has passed a recognized fire test for integrity

In locations prone to tropical storms, provide windows rated for potential windborne debris (see Data Sheet 1-28, *Wind Design*.)

2.1.4 Other Hazards

2.1.4.1 Arrange protection against natural hazards in accordance with Data Sheet 1-2, *Earthquakes*; Data Sheet 1-28, *Wind Design*; Data Sheet 1-29, *Roof Deck Securement and Above-Deck Roof Components*; Data Sheet 1-40, *Flood*; Data Sheet 9-18, *Freeze*, and other applicable Data Sheets.

2.1.4.2 Use noncombustible or FM Approved pipe and duct insulation on all pipes and ducts with exposed insulation.

2.1.4.3 Protect against liquid damage in light hazard occupancies in accordance with FM Data Sheet 1-24.

2.1.4.4 Arrange and protect emergency and standby power systems in accordance with FM Data Sheet 5-23, *Design and Protection for Emergency and Standby Power Systems.*

2.1.4.5 Design and protect high rises constructed with mass engineered timber in accordance with FM Data Sheet 1-36, *Mass Engineered Timber.*

2.1.4.6 Arrange battery energy storage systems in accordance with FM Data Sheet 5-33, *Lithium-Ion Battery Energy Storage Systems*, or other applicable data sheets.

2.1.4.7 Protect against exterior fire exposures in accordance with FM Data Sheet 1-20, *Protection Against Exterior Fire Exposure.*

2.1.4.8 Arrange vegetative roof systems and other occupied roof areas and decks in accordance with FM Data Sheet 1-35, *Vegetative Roof Systems, Occupied Roof Areas and Decks.*

2.1.4.9 Arrange roof-mounted solar photovoltaic panels in accordance with FM Data Sheet 1-15, *Roof-Mounted Solar Photovoltaic Panels.*

2.1.4.10 Arrange parking garages in high-rise buildings in accordance with FM Data Sheet 7-15, *Garages.*

2.1.4.11 Manage the hazards of construction, alterations and demolition operations in accordance with FM Data Sheet 1-0, *Safeguards During Construction.*

2.2 Protection

2.2.1 Provide sprinkler protection for all high-rise buildings wherever combustibles or combustible construction is present. Design sprinkler systems in accordance with FM Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*, or other applicable data sheets.

2.2.2 Provide an adequate water supply for fire protection in accordance with FM Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*, and FM Data Sheet 3-7, *Fire Protection Pumps.*

2.2.3 Design water supply and fire protection systems to avoid the need for pressure reducing valves and do not install automatic breach containment valves, in accordance with FM Data Sheet 3-11, *Flow and Pressure Regulating Devices for Fire Protection Service.*

2.2.4 In buildings that are more than 420 ft (128 m) in height, provide a minimum of two risers for each sprinkler system zone. Feed alternate floors within a sprinkler system zone from different risers, such that adjacent floors are not supplied from the same riser. The risers should be remote from each other.

2.2.5 Provide standpipes for fire service use.

2.2.6 Provide an FM Approved fire alarm system connected to a constantly attended location or listed central station in accordance with FM Data Sheets 5-40, *Fire Alarm Systems,* and 5-48, *Automatic Fire Detection.* Arrange the alarm system to monitor water flow alarms for each sprinklered floor, and all smoke and heat detectors. Provide supervision for fire pumps, tanks and reservoirs in accordance with FM Data Sheet 9-1, *Supervision of Property.*

2.2.7 Arrange the ventilation system to limit smoke spread. This result can be accomplished by ventilation shutdown, dampers, etc., upon activation of automatic fire protection alarms (i.e., smoke detection, water flow alarm).

2.2.8 Depending on the size and complexity of the building, consider providing an emergency communication center equipped for emergency operation of all the building electro-mechanical systems, such as fans, elevators, smoke control, fire protection, etc.

2.3 Human Element

2.3.1 Develop pre-incident plans for applicable perils in accordance with FM Data Sheet 10-1, *Pre-incident and Emergency Response Planning.*

2.3.2 Ensure all fire protection systems and equipment are inspected, tested and maintained in accordance with Data Sheet 2-81, *Fire Protection System Inspection, Testing and Maintenance,* and see Data Sheet 3-11 for inspection, testing and maintenance recommendations pertaining to pressure reducing valves.

2.3.3 Ensure the fire alarm system is thoroughly inspected and tested by adequately trained personnel in accordance with FM Data Sheet 5-48, *Automatic Fire Detection.*

2.3.4 Maintain an up-to-date list of control valves, by type and location, for all building services liquid piping systems. Label the main domestic water shutoff valve for each floor. Train staff to be able to quickly locate and close control valves. See FM Data Sheet 1-24, *Protection Against Liquid Damage*, for more information.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Curtain Walls

A curtain wall is an exterior, non-load-bearing wall of metal, metal sandwich panel, composite (e.g., MCM), glass or stone veneer attached to the structure by a sub-frame of metal. Many curtain walls are sandwich panels that may or may not have an insulated core.

A common tendency has been to fill the opening between the curtain wall and the floor slab with polyurethane and other foam materials that are combustible. Consequently, determining how these openings are sealed is important, as fire can spread through the space between the edge of the floor slab and the curtain wall. This opening has been identified as a key element in vertical fire spread if:

1. It is not filled.
2. It is inadequately filled with fire-stopping material.
3. The metal curtain exterior wall buckles under fire exposure, allowing the fire-stopping to drop out of place.

3.2 Loss History

Over a recent 10-year period, FM clients have reported 28 losses over US$10 million in buildings with five stories or more for a total gross loss of US$554 million (2025 values). Fourteen of these losses were caused by escaped liquids (sprinkler/fire protection, domestic or freeze), totaling US$260.5 million. Seven were

caused by fires or explosions, totaling US$155.2 million. The remaining losses were caused by other miscellaneous perils, including electrical breakdown, impact, collapse, tornado damage, earthquake and mechanical breakdown of an elevator.

4.0 REFERENCES

4.1 FM

Data Sheet 1-0, *Safeguards During Construction*
Data Sheet 1-2, *Earthquakes*
Data Sheet 1-15, *Roof-Mounted Solar Photovoltaic Panels*
Data Sheet 1-20, *Protection Against Exterior Fire Exposure*
Data Sheet 1-21, *Fire Resistance of Building Assemblies*
Data Sheet 1-22, *Maximum Foreseeable Loss*
Data Sheet 1-24, *Protection Against Liquid Damage in Light-Hazard Occupancies*
Data Sheet 1-28, *Wind Design*
Data Sheet 1-29, *Roof Deck Securement and Above-Deck Roof Components*
Data Sheet 1-35, *Vegetative Roof Systems, Occupied Roof Areas and Decks*
Data Sheet 1-36, *Mass Engineered Timber*
Data Sheet 1-40, *Flood*
Data Sheet 1-42, *MFL Limiting Factor*
Data Sheet 1-57, *Plastics in Construction*
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 3-7, *Fire Protection Pumps*
Data Sheet 3-11, *Flow and Pressure Regulating Devices for Fire Protection Service*
Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*
Data Sheet 5-23, *Design and Protection for Emergency and Standby Power Systems*
Data Sheet 5-33, *Lithium-Ion Battery Energy Storage Systems*
Data Sheet 5-40, *Fire Alarm Systems*
Data Sheet 7-15, *Garages*
Data Sheet 9-1, *Supervision of Property*
Data Sheet 9-18, *Prevention of Freeze-ups*
Data Sheet 10-1, *Pre-Incident and Emergency Response Planning*

APPENDIX A GLOSSARY OF TERMS

Compartmentation: The subdivision of a floor area by fire-rated walls and/or partitions into smaller spaces. Walls must be continuous from floor slab to the underside of the slab or deck above and built with noncombustible materials. Compartmentation is not a substitute for automatic sprinklers.

However, in conjunction with sprinkler protection, it can be particularly important to help limit interior fire spread.

Fire barrier: A continuous, fire-resistance-rated assembly designed to restrict the spread of fire and the movement of smoke. Fire barriers are continuous fire separations with terminations at exterior walls, fire walls, another fire barrier or the roof, which constitute a complete fire separation. Fire barriers shall be continuous through concealed spaces, such as the space above a suspended ceiling. Openings are protected with fire doors having a minimum fire protection rating of 20 minutes.

Fire compartment: The space bounded by exterior walls or fire barriers, fire partitions or horizontal fire-rated assemblies (floors or floor-ceiling assemblies). Penetrations are sealed with fire stops, and openings are protected with self-closing or normally closed fire doors having the appropriate fire resistance rating. When a floor/ceiling is used to provide compartmentation or segregation of hazardous occupancies, it should have a minimum one-hour fire-resistance rating.

Fire-stopping: An assembly to prevent interior fire spread. Fire-stopping installed between the exterior curtain wall and the edge of the floor slab is typically compressible, fire-resistant insulation, which should be mechanically secured or friction-fit with only minor voids, ensuring the effective prevention of upward fire spread. Note the fire-stopping material must be fire-resistant. Ordinary fiberglass thermal insulation does not qualify as fire-stopping.

FM Approved: Products and services that have satisfied the criteria for FM Approval. Refer to the Approval Guide and RoofNav for a complete listing of products and services that are FM Approved. .

High-rise building: Any building with an occupied floor located more than 75 ft (23 m) above the lowest level of fire service vehicle access with the following exceptions:

- Airport traffic control towers
- Open parking garages
- Amusement park structures
- Bleachers
- Grandstands
- Stadiums
- Special industrial buildings (i.e., BLRB)
- Buildings with high-hazard occupancies

High-strength concrete: Any concrete with a 28-day compressive strength of at least 6,000 psi (41 MPa). Strengths can reach a maximum of 20,000 psi (138 MPa).

Interconnected floors: Two or more floors connected by an unprotected (non-fire rated), open stairway or equivalent (escalators, atria, shafts, etc.) “N” is the number of interconnected floors.

Listed: Listed by a reputable testing laboratory, according to a widely recognized testing standard and adopted by model building codes.

Perimeter flue space: The space that exists between the edge of the floor slab and the inside surface of the curtain wall panel in modern construction. This space can be several inches to more than 1 ft (30 cm) wide and will allow the passage of fire, heat, smoke and water between floors. This space is usually filled with a noncombustible or fire-resistive material called “fire-stopping.”

APPENDIX B DOCUMENT REVISION HISTORY

April 2026. This document has been completely revised. Significant changes include the following:

A. Recommendations were reviewed and clarified.

B. Updated loss history.

October 2013. The following changes were made:

- This document has been revised to use the occupancy hazard categories as defined in Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies.*
- Added a new definition for concrete on protected steel.

July 2012. This document has been revised. The following is a list of major changes:

- An editorial review was completed. The term ″fire-safing″ was replaced with ″fire-stopping.″
- Recommendations have been added to reduce leak-related damage.
- Appendix A, Glossary of Terms, was updated

May 2008. A reference to Data Sheet 5-23, *Design and Protection for Emergency and Standby Power Systems*, was added. An editorial review was completed.

September 2000. This revision of the document has been reorganized to provide a consistent format.

January 1999. Information on fire performance of high-strength concrete was added.

March 1990. Major revision was made.

APPENDIX C BIBLIOGRAPHY

American Concrete Institute (ACI). *Report on High-Strength Concrete.* ACI 363R-10, March 2010.

NFPA 1006 Standard for Rescue Technician Professional Qualifications. 2003 Edition. National Fire Protection Association.

NFPA 1670 Standard on Operations and Training for Technical Search and Rescue Incidents. 2004 Edition. National Fire Protection Association.

Underwriter's Laboratories Fire Resistance Directory, 2009.

Visiiri 2/2006, pp. 6-7, on the heavy rescue unit of VR Railway Company in Helsinki, Finland, Liitin Oy, retrieved May 9, 2007. (Finnish)

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