WORKPLACE SOLUTIONS

From the National Institute for Occupational Safety and Health

Preventing Deaths and Injuries to Firefighters Working at Strip Mall Fires

Summary

Firefighters are at significant risk of injury or death when fighting fires in strip malls. Strip mall fires are low-frequency, high-risk incidents due to a variety of construction features, including limited entry and egress, high heat release rate (the rate at which fire releases energy) fuel loading, maze-like conditions, and high entanglement potential. Fire departments should ensure first-arriving resources conduct a complete 360-degree size-up, locate the fire, identify probable avenues for fire extension, knock down any visible fire from the exterior, and reassess fire conditions before initiating firefighting operations in the hazard zone.

Strip malls present challenges that may cause firefighters to become disoriented while conducting interior search and firefighting operations. The first arriving resource's ability to conduct a 360-degree might not occur due to the size (length and width) of the building. This information needs to be communicated to the dispatcher and other responding units by the first arriving resource. If the initial size-up doesn't include Side Charlie, resources should be assigned to the rear of the building (Side Charlie) [NVERS 2013].

Description of Risk

Strip malls have various physical features, dimensions and construction features based on the era of construction, renovations, or alternations. Many of these structures are Type II (noncombustible construction), Type III (ordinary construction), Type V (wood frame), and can contain both conventional wood framing and engineered structural systems [Weinschenk and Zevotek 2020]. In the United States, strip malls are typically one-story and contain a wide range of occupancy types under one roof with a sidewalk in front. Restaurants, discount stores, automotive parts retailers, dry cleaners, clothing stores, medical and dental offices, and banks are just a few of the businesses that can be found in a strip mall. In urban settings, an occupancy might have illegal housing or contain a living space. While the individual occupancies may be separated by a wall, they may have a common attic space [NVERS 2013; NFPA 2021b].

Fire departments should understand that these structures may not have fire protection systems in place and construction features may contribute to rapid horizontal spread of fire. In buildings with fire protection systems, system integrity, operability and functionality based on current occupancy use must be considered when fighting fires in strip malls [Weinschenk and Zevotek 2020].

Firefighting and occupancy hazards include the following:

- Firefighting hazard
  - High entanglement potential, including drop ceiling assemblies
  - High heat release rate fuel loading
  - Maze-like conditions
  - Void spaces such as the plenum space (the space between a dropped ceiling and the structural ceiling) accumulate fire gas which allows rapid fire growth and smoke explosions

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- Possible basement or other below-grade areas, even if the fire appears to be on the ground or higher level
- Hazardous materials storage such as propane/compressed natural gas on Side Charlie
- Challenging roof top ventilation, including construction, solar panels, dead loads, and compartmentalized rooms below the roof
- Collapsing roofs and walls
- Falling facades

- Occupancy hazards
  - Limited access and egress
  - Complicated security measures, such as window bars, reinforced locks, and roll down gate(s) [NVERS 2013; NFPA 2021b]

Firefighting Strategy and Tactics for Strip Mall Fires

Critical factors that can't be changed when fighting structure fires include building design and construction, type of occupancy, age, size, entrances/exits, and roof type. However, incident commanders (IC) should consider the initial arrival factors, such as the life safety profile (survivability of occupants); location and travel of the fire, fire and smoke conditions of exposures, wind direction, and smoke conditions; available staffing and resources; and water supply to develop the correct strategy and incident action plan (IAP) [FIRESCOPE 2015].

The next step is to identify the appropriate strategy. The development of the IAP for a strip mall incident should be designed around the tactical priorities of:

- Completing search and rescue operations
- Managing fire control by knocking down the main body of fire and preventing it from extending into exposures by using the reach of the stream from a protected position
- Basing the salvage profile on the building's contents and firefighters' exposure to the products of combustion and suppression activities to preserve property efficiently and safely [FIRESCOPE 2015]

Many of today's command posts are equipped with an internet connected computer, tablet, cell phone or the use of a drone that can provide the incident commander with overhead pictures of the building. This aerial footprint/map can provide the IC with the following:

- Access to and around the building
- Hydrant locations
- Apparatus placement for responding companies
- Firewalls
- Heavy objects (e.g., heating, ventilation, air conditioning (HVAC) units on the roof), solar panels, skylights, smoke and vent hatches, potential translucent panels on the roof
- Location and extent of overhangs, facades, perimeter wall parapets and large drop-offs, including setbacks and additions
- Exposures (when the fire extends beyond the main fire occupancy or unit, e.g., Bravo 1, Delta 1) (**See Diagram 1**)
- Utility shut off locations [NVERS 2013; FIRESCOPE 2015]

Heavily packed occupancies present safety challenges for firefighters. When advancing hoselines, friction points such as shelving, merchandise, display and checkout counters can hamper the stretch, causing delays in reaching the seat of the fire. Stock can fall from shelves, causing firefighters to become entangled in racks of clothing and merchandise. Operating in occupancies with a high volume of merchandise and furnishings in zero visibility creates additional hazards for firefighters. Firefighters can become disoriented and lose directional awareness.

Most roof construction in strip malls consists of lightweight construction elements (such as wooden trusses or steel bar joists), which can result in early roof failure when exposed to fire conditions. Steel bar joists are common on the east coast, and wooden beams or trusses are more common in the western part of the country. [Weinschenk and Zevotek 2020].

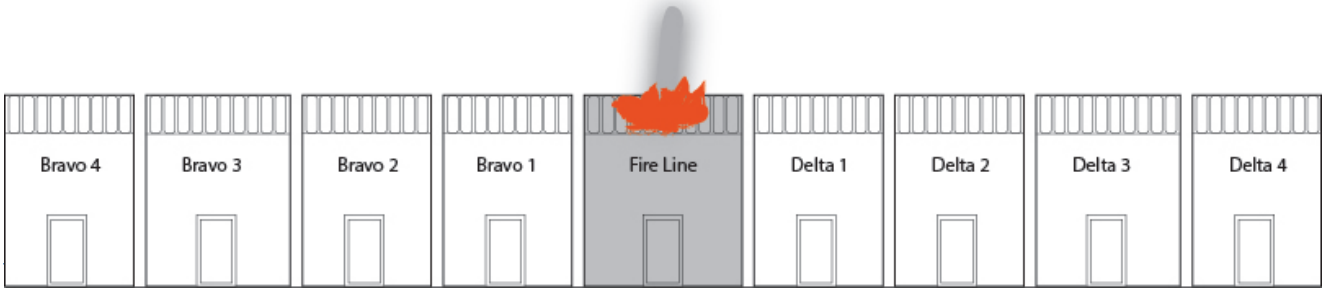

Diagram 1. Exposures can be indicated by the identifier for the side of the Extension (e.g., Bravo 1) followed by a number that starts adjacent to the unit on fire.

Side Charlie of most strip malls units do not have windows, only doors. The IC should assign an engine company and truck company to Side Charlie for hoseline deployment and forcible entry. The rear door should be opened early in the incident to provide egress for occupants and enable an assessment of fire and building conditions by firefighters. Then the door should be controlled so that ventilation can be coordinated with suppression operations [NVERS 2013; NFPA 2021b]. Fire attack should be coordinated with ventilation and forcible entry, which should be communicated to the IC. The doors on Side Charlie of strip mall occupancies are typically well secured, requiring a higher level of forcible entry. Crews spotting apparatus and operating on Side Charlie also need to be aware of overhead power lines. Side Charlie often has tight access for apparatus. Officers should ensure that engineers or chauffeurs avoid parking or spotting apparatus in potential collapse zones [NVERS 2013].

Case Study

On April 30, 2016, a 20-year-old volunteer firefighter (identified as FF2) died while fighting a fire in a strip mall. The fire occurred in a 7,037-square-foot retail golf store that was approximately 50 feet wide and 140 feet in depth. The front of the building (Side Alpha) was constructed entirely of plate-glass windows with a center entrance doorway protected by a metal security gate. Side Bravo (left side) and Side Delta (right side) were constructed of concrete block fire walls which were approximately 12 feet high and reached to the roof deck. A storage room, offices, and restrooms were located at the rear of the structure. A closed fire door was located on Side Charlie near the Side Charlie/Side Delta corner. The front door on Side Alpha provided the only means of normal entry and exit to the store. The flat roof consisted of a metal roof deck covered by three layers of asphalt, foam, and waterproof membrane covered by asphalt and gravel. The one-story building was built on a concrete pad. The building did not contain a sprinkler system.

Engine 3 crew observed a light haze of smoke when they arrived in the strip mall parking lot. The Engine 3 senior captain, lieutenant, and firefighter 2 (FF2) approached the golf store door. Another fire department member arrived and joined the Engine 3 crew. They quickly forced open the outer sliding plate-glass door and were confronted with an inner security gate door. The lieutenant and senior captain from Department 7 were able to force open the security gate. The captain directed the Engine 3 firefighters to pull a 200-foot 1¾-inch hoseline to the front door. The lieutenant entered the structure a short distance and used a thermal imager to scan the interior.

Engine 3 (a lieutenant and two firefighters) advanced toward the Side Charlie/Side Delta corner and began to flow water toward the fire. The Engine 3 lieutenant used the thermal imager to direct the firefighter (FF1) working the nozzle where to flow water. FF1 on the nozzle ran low on air, became fatigued, and passed the nozzle to FF2. FF1 began to follow the hoseline to the outside after telling the lieutenant that he had to leave. FF2 continued to work the nozzle with the lieutenant directing him.

The ladder company had difficulty cutting through the flat metal roof due to the composition of the roof. They unsuccessfully tried to ventilate the roof using a chainsaw and had to switch to a circular saw with a metal cutting blade. (**See Photo 1**).

Photo by NIOSH

Photo 1. Construction of flat metal roof covered with asphalt foam insulation, and gravel. Chain saws were initially used to open the roof for vertical ventilation but would not cut through the metal deck. A circular saw with metal cutting blade had to be used.

Conditions continued to deteriorate inside the structure with increasing smoke and heat, plus no visibility (**See Photo 2**). Due to the deteriorating conditions and trying to get FF2 out of the building, the Engine 3 lieutenant followed the hoseline until he came to a coupling. He looked back for FF2 and saw that he was standing. The lieutenant turned around and grabbed FF2. They fell over a display of golf bags and became separated from the hoseline.

The lieutenant turned in the direction that he thought was Side Alpha and began pulling FF2 with him. They were both walking in near-zero visibility and ran into another display of golf clubs. FF2 stated that he was completely out of air and had to get out of the building. FF2 disappeared into the thick smoke, moving away from the lieutenant toward the Side Charlie of the store. The lieutenant also ran out of air. His facepiece fogged up, so he removed his helmet and facepiece. The lieutenant activated his personal alert safety system (PASS) device as he continued to crawl through a series

Photo by County Fire Marshal's Office.

Photo 2. The photo shows the interior conditions.

of golf club displays. The lieutenant did not have a portable radio so he could not call for assistance. He heard a voice in front of him, which was Engine 16 and began to yell for help. A Mayday was transmitted by the captain of Engine 20 at the front door for a missing firefighter as the lieutenant exited the building. FF2 was located about two minutes later and transported to the hospital where he was pronounced deceased. The lieutenant was transported to the hospital for treatment of smoke inhalation and was released later that day [NIOSH 2016].

Additional challenges with fighting fires in strip malls are highlighted in the following NIOSH investigation reports:

- F1996-17: **Sudden Roof Collapse of a Burning Auto Parts Store Claims the Lives of Two Fire Fighters—Virginia**
- F2013-14: **Career Probationary Fire Fighter Runs Out of Air and Dies in Commercial Structure Fire—Michigan**
- F2017-14: **Career Fire Fighter Dies and Another is Seriously Burned Fighting Arson Fire at a Commercial Strip Mall—Texas**

Controls

To minimize the risks of fighting fires in strip mall occupancies, NIOSH recommends that fire departments take the following precautions:

Pre-Incident:

- Develop, implement, and enforce standard operating procedures/standard operating guidelines (SOPs/SOGs) for firefighting operations in strip malls.
- Ensure that an incident management system is used at all incidents, including a personnel accountability system [FIRESCOPE 2019; NFPA 2020b; NFPA 2021a].
- Integrate risk management into the regular functions of incident command [NFPA 2020b; NFPA 2021a].
- Understand how horizontal and vertical ventilation affects fire behavior and coordinate ventilation with firefighting operations so that the flow path is appropriately identified and controlled [Weinschenk and Zevotek 2020].
- Conduct pre-incident planning, building familiarization, and develop defined tactical objectives to ensure effective fireground decision-making at strip mall fires [NFPA 2024]. Identify hanging facades that create a collapse hazard.
- Conduct practical training on strip mall fires, focusing on the IAP, crew integrity, hoseline placement, ventilation, air management, and safe exterior and interior firefighting operations [NFPA 2021a].

Incident:

- ***Size-up:***
  - Ensure the first arriving officer provides a complete and accurate initial radio report including a 360-degree report, plus an initial rescue profile and risk assessment [FIRESCOPE 2015; NFPA 2020b].
  - Use a thermal imager as part of the size-up to assist in determining the fire location [NFPA 2021b].
  - Assign a company to Side Charlie and a company to the roof to complete size-up. Send the initial truck company to the roof to report on roof stability, heavy dead loads, fire extension in the attic, fire wall locations, and unusual configuration of the structure [NVERS 2013].
- ***Incident Management:***
  - Ensure the strategy and IAP are communicated to all on-scene and responding members before entry is made into the fire building [FIRESCOPE 2015; NFPA 2020b].
  - Ensure incident commanders forecast the direction of the incident based upon the initial strategy and IAP. Forecasting is done early in the incident in order to build an effective incident organization [FIRESCOPE 2015; NFPA 2020b].
  - Establish divisions and groups to ensure manageable span of control and to maintain personnel accountability [FIRESCOPE 2014; NFPA 2020b].
  - Initiate a defensive strategy when risk outweighs gain, especially for property only [NFPA 2020b; NFPA 2021a].
- ***Fireground Operations:***
  - Ensure crew integrity and personnel accountability. Firefighters should stay in physical contact with the attack hoseline and/or search rope, use a thermal imager, and use proper air management to ensure they can exit the structure safely [NFPA 2021a].

- Remember that air management is critical to firefighter safety, and it will take just as long, if not longer, to get out of the structure as it did to get inside [NIOSH 2016].
- Assign and stage rapid intervention crews at strategic locations [NFPA 2021a].
- Establish collapse zones if external fire damage is evident [NFPA 2021a; NFPA 2021b].
- Secure an uninterrupted water supply that will provide an adequate water before initiating interior firefighting operations [NVERS 2013].
- Apply water from a safe distance to achieve knockdown when fire has extended out of the building.
- Use a 2½-inch hoseline with a solid bore nozzle to provide necessary extinguishment and penetration capability [NVERS 2013].
- Consider mobile portable masters and blitz attack devices in combination with attack lines [NVERS 2013].
- Deploy attack lines as back-up to the first handline into Bravo 1 Exposure and Delta 1 Exposure to check for fire extension [FIRESCOPE 2015].

- ***Critical Benchmarks:***
  - Check the facade for smoke or fire before entering structure [NVERS 2013; NFPA 2021b].
  - Inspect the plenum space to check for fire extension at the entrance doorway before moving into the building and continue as the crew advances [NVERS 2013; NFPA 2021b].
  - Deploy an interior crew to check the cockloft or concealed attic space for fire extension into exposures. Horizontal fire spread is a critical factor and must be addressed early [Weinschenk and Zevotek 2020].
  - Secure all electrical service panels and natural gas or propane meters. If this is not feasible, contact the appropriate utility company for assistance [NVERS 2013].

Post-Incident:

- Conduct a post-incident analysis [FIRESCOPE 2015; NFPA 2021a].
- Provide an action plan and lessons learned to identify the need for revisions to SOPs/SOGs, additional mandatory training, or other necessary changes.
- Update your community risk assessment program and pre-incident planning process based on recommendations from post-incident analysis reports [NFPA 2021a; FIRESCOPE 2019].

Suggested Citation

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Information about the International Association of Firefighters is available at iaff.org

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