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Best Practices Guide for Wildfire—Commercial Properties

IDENTIFYING HAZARDS FOR A SPECIFIC SITE

Wildfire criteria may apply anywhere in the country where a building is located in proximity to wildfire-prone areas. Applicability is determined by a site-specific fire hazard severity zone (FHSZ) assessment of vegetation, topography, fire history and other factors. Businesses can request their FHSZ rating and other relevant information from local building or fire officials in their area. Such assessments may also be conducted using the RECOMMENDATIONS sections below, which contain descriptions of “moderate,” “high,” and “extreme” (sometimes also referred to as “very high”) wildfire hazard zones. If it is determined that a building is in one of these zones, the building should be built or maintained in accordance with the program recommendations associated with that hazard zone. (Note: The guidance in this document does not apply in downtown urban areas.)

WILDFIRE-SPECIFIC DESIGN GUIDANCE

Because many designers are not as familiar with wildfire hazards, as compared to other perils, this guide provides background information and describes a coupled approach to addressing wildfire hazards which deals with both the building and surrounding vegetation. Specific design recommendations for various wildfire hazard levels are provided following the Background and Definitions section below.

BACKGROUND AND DEFINITIONS

Building ignitions during wildfires occur when a component of a building is exposed to one or more of the three basic wildfire exposures: burning embers (also called firebrands), direct flame contact, and radiant heat.

Since the roof is a large surface that may be either almost horizontal or have a relatively low slope, burning embers frequently accumulate on its surface. In addition, it is not uncommon for dry plant debris to accumulate in valleys, along gutters and at intersections of the roof with a wall. Large firebrands, accumulating embers, and ignition of debris

on the roof can result in fire that ignites the roof cover or penetrates through the roof cover, resulting in loss of the entire building. This is a particularly critical issue if the roof cover is combustible or an adjacent wall is covered with combustible siding. Wildfire researchers typically consider the roof to be the most vulnerable component. If the roof is combustible, its replacement with a fire-rated roof cover is considered the most important mitigation measure to be taken.

FIRE RATINGS FOR ROOFS

Fire ratings for roof coverings are either Class A, B or C (or, in the case of a non-fire-retardant-treated wood shake covering, not rated). IBHS recommends a Class A covering. For low-slope roofs, a Class A-rated roof cover includes testing and rating of the entire roof system assembly, which includes the roof cover, insulation, vapor or air barriers, and the type of deck. Examples of roof systems considered to be Class A regardless of the deck type include built-up roofing and ballasted single-ply membranes. There are a number of Class A-rated steep-slope roof coverings, including asphalt composition shingles, clay tile and steel. Some Class A tile designs provide for an opening at the eave-end and ridge. These openings should be plugged with a noncombustible material to minimize entry of embers in the area under the roof covering.

EXTERIOR WALL IGNITION

Noncombustible siding materials such as concrete and brick will provide the greatest fire protection from flames, embers, and radiant heat. The distance between the ground and the bottom of the siding on the exterior wall affects a building’s vulnerability, particularly when walls are made of materials that can ignite. The building code generally calls for 6 inches of clearance between the ground and the start of the siding. Ignition of a combustible siding material, or component of the wall assembly, can result in either fire entering the building through the stud cavity of a framed wall assembly, or spreading vertically up the wall and impinging on or possibly breaking the window glass. The fire can also enter the attic through the eave or eave vent. Once the glass in a window breaks, embers can readily enter the building and ignite interior furnishings or flames can enter and ignite window treatments.

RISKS ASSOCIATED WITH BURNING EMBERS

Burning embers are the most frequent cause of building ignitions. They can ignite nearby vegetation or accumulated debris, or enter the building through openings, such as an open window or attic vent. Once inside, embers can ignite furnishings or other combustible materials and accumulated debris stored in unoccupied spaces, such as an attic. Nearby ignitions can subject some portion of the building to either a direct flame contact exposure, where the flames touch the building, or a radiant heat exposure—the heat you feel when standing near a campfire or fireplace.

RISKS ASSOCIATED WITH RADIANT HEAT

The vulnerability of a building to radiant heat depends on the intensity and duration of the exposure. If the radiant heat level is high enough, and duration long enough, it can result in the ignition of a combustible product (e.g., wood siding), or it can break the glass in a window. Exposures to lower levels of radiant heat can pre-heat materials, making them easier to ignite from a direct flame contact exposure.

IGNITION POTENTIAL ASSOCIATED WITH EMBER TRANSPORT

Burning embers can travel for a mile or more before landing on or near a building. Because of the ability of wind-blown burning embers to travel long distances, this guidance document includes recommendations to (1) make buildings less vulnerable to direct ember exposures, (2) reduce the opportunity for the flames from spot fires caused by wind-blown embers, to reach the building, and (3) minimize the opportunity for radiant heat exposures caused by ember ignition of landscaping vegetation, outbuildings or other combustible items on the property to threaten the business.

Recommendations addressing the vulnerability of a building to embers are provided for all fire hazard severity zones and the near-building (0 to 5 ft) defensible space. The near-building zone is very important since any ember ignitions in this zone would very likely result in a direct flame contact exposure to the side of the building. Recommendations addressing direct flame contact and radiant heat exposures are included in the Defensible Space Zones section below.

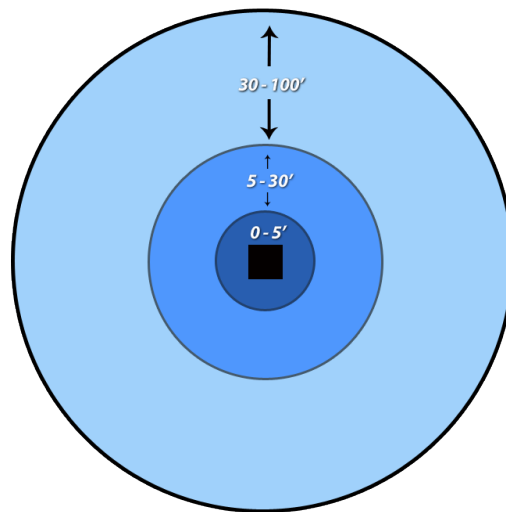
TERMS USED IN, OR APPLICABLE TO, THIS SECTION:

Authority Having Jurisdiction (AHJ): From NFPA 1144 (2009), “an organization, office, or individual responsible for enforcing the requirements of a code or standard, for approving equipment, materials, or installation and a procedure.”

Bird-Stop/Bird-Stopping: Used to describe the application of a material to fill the space between the roof covering and roof deck to minimize the accumulation of fine debris in that area. These materials can also limit the intrusion of embers during wildfires.

Defensible Space: The area between a building and an approaching wildfire, where vegetation has been managed to reduce the wildfire threat and improve the likelihood of a building surviving without assistance from firefighters, as described in “Fire Adapted Communities: The Next Step in Wildfire Preparedness,” University of Nevada Cooperative Extension, Publication SP-10-10.

Defensible Space Zones: Each of the three zones in a defensible space plan acts as a layer of protection between your business and the approaching wildfire.



Defensible Space Zones

Zone 1: 0–5 Feet (also referred to as near-building, noncombustible or low-combustible zone)

The objective of this zone is to reduce the chance that ignition will result during a direct flame contact exposure to the building. Because this zone is closest to the building, it requires the most careful selection and intensive management of vegetation and materials.

1. Install hard surfaces in this zone (e.g., concrete walkway), or use noncombustible mulch products (e.g., rock mulch).
2. Landscape vegetation recommended for this zone includes irrigated lawn and low-growing herbaceous (non-woody) plants. Shrubs and trees, particularly conifers, are not recommended for use in this zone.
3. Remove dead plant material from plants. Plants adjacent to combustible siding and foundation vents, as well as plants under or next to windows and soffit vents or interior corners, present the greatest hazard.

Zone 2: 5–30 Feet (or to the property line)

The objective of vegetation management in this zone is to prevent the fire from climbing into the crown or upper portions of trees or shrubs, and to stop the fire from burning directly to the building. Trees and shrubs in this zone should be in well-spaced

groupings and well maintained. Eliminating ladder fuels and creating separation between plants, or plant groupings, are techniques used to fulfill this objective.

1. Dead plant material and tree branches should be removed from vegetation on a regular schedule.
2. Create islands or groupings of vegetation that will result in a discontinuous path of vegetation, thereby making it difficult for the fire to burn directly to the building. Embers may still be able to ignite individual islands of plants in this zone, which is why plant selection and maintenance is so critical in the 0–5 ft zone.
3. Lower tree branches and nearby shrubs (the ladder fuels) should be removed so that a surface fire cannot reach the tree crown. Trees located within this area should be maintained with a minimum horizontal spacing of 10 ft between crowns. Branch removal should not exceed $\frac{1}{3}$ of the tree height.
4. Locate outbuildings (e.g., for storage) at least 30 ft away from the building, or create a 5-ft Zone 1–type defensible space within 5 ft of the outbuilding.
5. Paved parking areas surrounding commercial developments can serve as fire breaks, stopping the fire front from burning directly to buildings.

Zone 3: 30–100 Feet (or to the property line)

1. The goal of this zone is to slow down and reduce the energy of the wildfire. Tree and brush spacing should force fire in tree (or shrub) crowns to drop to the ground. Dead trees and shrubs should be removed.
2. The rate of fire spread and flame length is affected by slope. A steeper slope will result in a faster-moving fire with longer flame lengths. Determine the slope of the land around the building:
 - At the top of a slope, the building should be set back a minimum of 15 ft for a single-story structure and 30 ft for a two-story structure.
 - Buildings located mid-slope, or with inadequate set-back at the top of slope, should utilize an enhanced fuel modification zone up to 150 or 200 ft for slopes greater than 40%. Trees located within this area should be maintained with a minimum horizontal spacing of 10 ft between crowns.

Fire Hazard Severity Zone (FHSZ): The Fire Hazard Severity Zone represents an evaluation of the wildfire hazard (not risk) in a particular area. The fire hazard severity zones are often determined and mapped by a given authority having jurisdiction (AHJ) in wildfire prone areas. For the purpose of this document, the fire hazard severity zones have been classified as moderate, high, or extreme (sometimes also referred to as very high).

Guidance regarding general characteristics associated with each severity zone is provided in each section. However, the first step in determining a given FHSZ rating should be to contact your local AHJ and request any information that has already been developed, including the FHSZ rating.

Ignition-Resistant Building Material (IRM): As defined in the International Wildland Urban Interface Code (IWUIC 2009), an ignition-resistant building material is one that resists ignition or sustained flaming combustion as determined by testing in accordance with provisions outlined in Section 503.2 of the IWUIC or Section 3.3.13, NFPA 1144, 2008 Edition. An ignition-resistant building material has been tested for an extended 30-minute flame spread test according to procedures provided in ASTM E 2768, Test for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test).

Materials with this designation have typically been subjected to an accelerated weathering procedure (IWUIC Section 503.2.1.1.3) prior to testing to the extended 30-minute flame spread test. A list of compliant materials is maintained by the California Office of the State Fire Marshal Building Listing Program at osfm.fire.ca.gov/strucfireengineer/strucfireengineer_bml.php.

Noncombustible: A noncombustible material is one that complies with the provisions given in ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.

Combustible Material: Combustible materials will ignite and burn when subjected to fire or elevated temperatures. Two properties are helpful in characterizing and comparing the relative combustibility of different materials. These include the flame spread index (ASTM E 84) and heat release rate.

Vegetation: Vegetation consists of naturally occurring plant materials, as well as species introduced into the area. Vegetation is often a primary source of wildfire fuel and has a profound influence on fire behavior.

Attributes that contribute to vegetation’s fire hazard rating include:

- Plant age
- Moisture content
- Amount and distribution of dead materials (i.e., ratio of live to dead material)
- The ratio of the surface area of the vegetation components to volume of the same vegetation (i.e., the size of leaves, twigs and branches)
- Geometry and arrangement of the plant
- Chemical content (i.e., the amount of volatiles or extractives in the component)

Plant characteristics associated with higher combustibility include:

- Narrow leaves or needles (often evergreen)
- Volatile resins and oils, as indicated by leaves that have an aromatic odor when crushed
- Accumulation of fine, twiggy, dry, or dead material on the plant or on the ground under the plant
- Loose or papery bark that often falls off and accumulates on the ground (e.g., palms and eucalyptus)

Plant characteristics associated with lower combustibility include:

- High moisture content in leaves
- Low oil or resin content (little or no aromatic odor when leaves are crushed)
- Drought tolerance or drought resistance (deeply rooted plants with thick, heavy leaves)
- Minimal seasonal accumulation of dead vegetation (foliage, twigs, small branches, etc.)
- Open or loose branching habit
- **Plant is short enough to enable easy** maintenance and pruning

Vegetation Management Plan (VMP): A Vegetation Management Plan provides information (narrative and figures) about topography (slope and aspect), location of building(s) on the parcel, proposed fuel treatment details and location, presence of noxious weeds on site and in the vicinity, environmentally sensitive concerns (e.g., threatened and endangered species, as well as state-listed sensitive species and wetlands), vegetation maintenance and monitoring programs. The VMP should provide information on how the three defensible space zones will be developed and maintained.

A local AHJ (e.g., fire marshal, urban forester, or fuels management officer) should be consulted regarding vegetation options beyond the information provided in this document.

A landscape professional should be consulted when developing the VMP. Depending on the site, a forester, range manager, or natural resource specialist could be consulted.

Fuel Modification Zone: There are a number of kinds of fuel modification zones, including defensible space around a home or building, community fuel breaks, fuels treatment along an access road, and a community safe area. For the purpose of this document, the fuel modification zone is related to the defensible space zones surrounding a building. Fuel

modification includes actions taken in terms of selecting, locating and maintaining vegetation, and decisions regarding storage of combustible items to reduce or otherwise modify fuel loading. It is a critical component in making and maintaining effective defensible space. For these FORTIFIED standards, the principal objective of fuel modification and reducing fuel loading is to minimize the ability of the flame front of a wildfire to burn to the building, and reduce the opportunity for vegetation ignited by embers to create a flame contact and/or radiant exposure to the building.

The VMP should address all vegetation on the property, both naturally occurring and landscape, and not just that associated with the defensible space. This applies to developments within large tracts of land.

A summary of the building and vegetation management recommendations are given in Table 1.

Table 1. Summary of the hierarchical structure for building and vegetation management recommendations for this guide as a function of the Fire Hazard Severity Zone (FHSZ).

Designated FHSZ	Recommended for All Zones	High	Extreme (Very High)
Moderate	Yes	No	No
High	Yes	Yes	No
Extreme (Very High)	Yes	Yes	Yes

RECOMMENDATIONS: ALL FIRE HAZARD SEVERITY ZONE AREAS

- 1. Vegetation Management Plan:** A Vegetation Management Plan should be submitted for review and approval.
- 2. Building-Related Properties and Recommendations:** Building finishes and components should meet the following:
 - a. Roof coverings** should have a Class A fire rating based on testing to ASTM E 108, UL 790 or FM 4470.
 - b. Any openings between the roof covering and roof deck** at the roof edge and/or ridge should be plugged using a noncombustible material (i.e., bird-stopped).

- c. **Projections from sloped or flat roofs** (e.g., a dormer or a wall of a taller portion of the building) should be clad with a noncombustible or ignition-resistant material.
 - d. **Exposed roof valley flashings** should be corrosion-resistant metal and installed over a minimum 36-in. wide underlayment consisting of one layer of No. 72 ASTM cap sheet running the full length of the valley.
 - e. **Gutters and downspouts** should be of noncombustible materials. Typical aluminum gutters and downspouts are acceptable. The gutter should incorporate an integral metal flashing at the roof edge, or a separate angle flashing should be used at the roof edge. Clearing debris from gutters should be incorporated into a routine maintenance and upkeep plan for the building(s) in the development.
 - f. **Eave construction** should incorporate a soffit design using a horizontal return from roof edge to the exterior wall.
 - g. **Soffit vent openings:** Noncombustible, corrosion-resistant screening with a mesh size no greater than 1/8 in. should be used to cover the attic, sub-floor and other vent openings on the wall. When vent openings are integrated within the soffit material, an individual vent opening should not exceed 1/8-in. diameter or 0.05 sq in. Vents designed for use in wildland urban interface areas that have been accepted for use by the AHJ should be allowed for use.
 - h. **Operational windows** should have screens covering those sections that can open.
 - i. **Vehicle access (garage) doors** should be weather-sealed around the perimeter to minimize entry of embers.
 - j. **Storage of combustible materials:** Combustible materials should not be stored under attached decks.
 - k. **Deck boards:** Solid wood, plastic, or wood-plastic composite deck boards (all are combustible products) should comply with the requirements of Chapter 7A, California Building Code. A listing of compliant products can be found at the California Office of the State Fire Marshal Building Materials Listing Program website at osfm.fire.ca.gov/licensinglistings/licenseslisting_bml_searchcotest.php. Select category option "8110 – Decking for Wildland Urban Interface (W.U.I.)."
 - l. **Spark arrestors** with 1/2 in. mesh screening should be installed at the outlet of all chimneys.
 - m. **Interior fire protection system** should include monitored fire sprinkler system (preferred), or monitored smoke and/or heat detectors.
3. **Parcel/Surroundings Recommendations:** The following relate to control of combustible materials on the parcel/surrounding area:
- a. **Defensible space** should be created and maintained as previously outlined and as provided in the Vegetation Management Plan.
 - b. **Signage** should be made from a noncombustible material. Street numbers should be at least 4-in. high, reflective, applied on a contrasting background, at each driveway entrance, and be visible from both directions of travel.
 - c. **Firewood storage and liquefied propane (LP) gas containers** should be at least 30 ft from the building. The firewood should not serve as ladder fuel into nearby vegetation. LP gas containers should have a 10-ft noncombustible zone extending out from the outside edge of the container. Alternatively, the container can be surrounded by a CMU block wall, with wall height equaling the container height. The wall should provide ventilation at the bottom to reduce the accumulation of LP gas should a leak occur.
 - d. **Entrances and driveways** should be at least 12-ft wide with at least 13.5 ft of vertical clearance. The angle of approach and departure should be designed to allow for emergency vehicle access without damaging the equipment when entering or leaving the driveway.
 - e. **If property is gated**, the gate should open inward and have an entrance at least 2 ft wider than the driveway. Any gate should be located at least 30 ft from a roadway intersection. If secured, the gate should have a key box or lock of a type approved by the local AHJ
 - f. **Flammable liquids:** Small quantities of combustible and flammable liquids stored outside should be located in UL or FM Approved fire rated cabinets and labeled with appropriate signage.
 - g. **Fire hydrants** should be located within 250-500 ft, or as approved by the fire authority having jurisdiction (FAHJ), of the building connected to a reliable public or private water supply.
 - h. **Setback of buildings and structures:** Buildings and structures should be set back a minimum of 30 ft from any property line adjacent to a national forest, state park, open space preserve or other protected wildland.

- i. **Planned landscaping** planted adjacent to the building(s) should be irrigated.

RECOMMENDATIONS: MODERATE FIRE HAZARD SEVERITY ZONE AREAS

Moderate Fire Hazard Severity Zones have the following conditions:

- The area has been designated as a moderate (or lower) hazard area by local or state authorities
 - Flat terrain with no grades greater than 9%
 - Limited wildland or conservation area exposure
 - No known history of wildfires in the area
1. **Additional Building Recommendations** beyond those required for all zones:
 - The exterior siding is not restricted in this fire hazard severity zone
 - No additional recommendations
 2. **Additional Parcel/Surroundings Recommendations** beyond those required for all zones:
 - No additional recommendations.

RECOMMENDATIONS: HIGH FIRE HAZARD SEVERITY ZONE AREAS

High Fire Hazard Severity Zones have the following conditions:

- The area has been designated as a High or Significant hazard area by local or state authorities
 - Hilly terrain with grades that average 10%–20%
 - Has a shared border with a wildland or conservation area consisting of forested, shrub or chaparral vegetation within 100 ft of the site
 - A history of wildfires in the area
1. **Additional Building Recommendations** beyond those required for all zones and the Moderate Fire Hazard Severity Zone:
 - a. **Exterior windows, window walls, glazed doors, and glazed openings within exterior doors** should be insulating-glass units with a minimum of one tempered pane, or glass block units, or

have a fire resistance rating of not less than 20 minutes when tested according to UL 9 or NFPA 252. Glazing frames made of vinyl materials should have welded corners, metal reinforcement in the interlock area (i.e., at the horizontal meeting rail in a hung window, vertical member in a casement windows), and be certified to ANSI/AAMA/NWDA 101/I.S.2-97 structural requirements.

- b. **Gutters** should incorporate a noncombustible gutter cover device. If the roof slope allows, the gutter cover device should be installed so that it is parallel to the plane of the roof slope (with steeper sloped roofs this may not be possible).
 - c. **Exterior wall coverings** should meet one of the following:
 - Combustible siding with an integral horizontal lap joint (tongue and groove, ship-lap, rabbeted bevel) is acceptable. The chinking in chinked-style log wall constructions should be fire rated. Panelized siding with a vertical ship-lap joint is also acceptable.
 - Ignition-resistant materials as defined in this document.
 - Noncombustible material in accordance with ASTM E 136.
 - d. **Exterior personnel doors** should be of noncombustible construction, or solid core having stiles and rails not less than 13/8-in. thick with interior field panel thickness no less than 1¼-in. thick, or should have a fire resistance of no less than 20 minutes when tested in accordance with NFPA 252 or UL 10.
2. **Additional Parcel/Surroundings Recommendations** beyond those required for all zones and the Moderate Fire Hazard Severity Zone:
 - a. **Outdoor Storage**
 - High-piled storage of combustible material should not exceed 10 ft in height and should be located a minimum of 50 ft from the building.
 - Outdoor storage of large quantities of combustible and flammable liquids should be located greater than 50 ft away from the building or stored in detached noncombustible buildings.

- Liquefied propane (LP) tanks should be located at least 50 ft from the building and other structures on the property. Acceptable alternatives include the following: (1) create a 10 ft noncombustible (rock, gravel, mulch or irrigated lawn) zone around the tank, (2) enclose the tank using noncombustible materials, or (3) unless otherwise prevented by the local AHJ, bury the tank following requirement in NFPA 58 or FM Global Property Loss Prevention Datasheet 7-55.
- b. Buildings and structures** should be set back a minimum of 30 ft from any property line adjacent to a national forest, state park, open space preserve or other protected wildland.
- c. Any fire hydrants** should be located within 250 ft of the building connected to a reliable public or private water supply.
- c. Attached decks**, such as a balcony or porch, should meet one of the following criteria:
 - Should consist of a noncombustible solid surface decking (e.g., lightweight concrete with noncombustible top surface), and enclosed on the underside of the deck with the enclosure material being attached to the underside of the deck support structure.
 - Should consist of a combustible decking product that complies with the requirements of Chapter 7A of the California Building Code.
 - For slopes greater than 20%, a 6 ft tall noncombustible wall (e.g., concrete block, or stone) should be located on the downslope side of each attached deck, located between 20 ft and 30 ft from the outer edge of the deck and extending along the side of the building to which the deck is attached.

- d. Exterior windows, window walls, glazed doors, and glazed openings** within exterior doors should be insulating-glass units with tempered glass, have glass block units, or have a fire resistance rating of not less than 20 minutes, when tested according to UL 9 or NFPA 80.

2. Additional Parcel/Surroundings Recommendations beyond those required for all zones and the Moderate and High Fire Hazard Severity Zones:

- a. For buildings built mid-slope and the slope is greater than 20%:**
 - i. For slopes between 21% and 40%**, the defensible space recommendations should be increased to 150 ft in the downslope direction, following the recommendations established for the 30- to 100-ft zone.
 - ii. For slopes greater than 40%**, the defensible space recommendations should be increased to 200 ft in the down slope direction, following the recommendations established for the 30- to 100-ft zone.

RECOMMENDATIONS: EXTREME (VERY HIGH) FIRE HAZARD SEVERITY ZONE AREAS

Extreme Fire Hazard Severity Zones have the following conditions:

- The area has been designated as an extreme, severe or very high hazard area by local or state authorities.
- Steep-sloped terrain with grades that average more than 20%.
- Has a shared border with a wildland or conservation area consisting of forested, shrub or chaparral vegetation within 100 ft of the site.
- A history of wildfires in the area.

Recommendations and those specified for the Moderate and High Fire Hazard Severity Zones should also be incorporated with those specified for this hazard zone.

- 1. Additional Building Recommendations** beyond those required for all zones and the Moderate and High Fire Hazard Severity Zones:
 - a. Exterior wall assemblies** should be clad with a noncombustible material in accordance with ASTM E 136, or with the exception of exterior-rated, pressure-impregnated fire-retardant-treated shakes or shingles, rated as an ignition-resistant material.
 - b. Floor projections** should maintain the fire resistance of the exterior walls, or the projections should be enclosed to the grade.