Building Code

Source: Clarion Associates

Hazards Addressed

How it Works

The regulation of building and structure design, construction, compliance, and occupancy has existed since the early 1900s, intended to protect the public health, safety, and general welfare. From the early 20th Century until 1994, three separate non-profit organizations (Building Officials and Code Administrators International, Inc. (BOCA); International Conference of Building Officials (ICBO); and Southern Building Code Congress International, Inc. (SBCCI)) developed model codes used by the building community.

Although these separate organizations were effective and responsive to the nation's needs, they recognized the value of having a single set of codes. They responded by creating the International Code Council (ICC), a group that develops and makes available a comprehensive and coordinated set of International Codes, including:

- International Building Code (IBC)
- International Energy Conservation Code (IECC)
- International Existing Building Code (IEBC)
- International Fire Code (IFC)
- International Fuel Gas Code (IFGC)
- International Green Construction Code (IGCC)
- International Mechanical Code (IMC)
- ICC Performance Code (ICC PC)

- International Plumbing Code (IPC)
- International Private Sewage Disposal Code (IPSDC)
- International Property Maintenance Code (IPMC)
- International Residential Code (IRC)
- International Swimming Pool and Spa Code (ISPSC)
- International Wildland Urban Interface Code (IWUIC or WUI)
- International Zoning Code (IZC)

The International Codes provide safeguards and ensure uniformity in the construction industry. One or more of these International Codes becomes the law of a particular state or jurisdiction when formally adopted (and often amended) by the appropriate state or local governmental authority.

Statewide building codes—and adequate enforcement of codes—play a vital role in public safety and loss prevention. They can reduce the need for public disaster aid and increase a community's resilience. While the state does not have a mandatory code, most local governments in Colorado have adopted all or most of the International Codes listed above. If a county or municipality does not have a building code, factory-built structures and buildings constructed on site intended for multiple occupancy are subject to building standards set forth by the state Division of Housing. According to the *Natural Hazard Mitigation Saves: 2017 Interim Report*, released by the National Institute of Building Sciences, implementing mitigation measures in new construction to exceed select provisions in the 2015 IBC and the 2015 IRC and the implementation of the WUI Code saves society an average of $4 for every $1 spent on mitigation.

If a county has enacted a building code, it is also required to adopt and enforce a building energy code that meets or exceeds the standards in the 2003 International Energy Conservation Code (IECC). The relatively new International Green Construction Code (IGCC) was released by the ICC in 2010 and was created to aid in the construction of sustainable buildings in the business and residential sectors.

In addition to the IGCC, there are other International Codes designed to address specific hazards such as the Wildland-Urban Interface Code (IWUIC or WUI Code). See separate tool profile on the WUI Code.

Implementation

Formal adoption by the local governing body is required to enact or modify a building code. Revised versions of the International Codes are released by the ICC on a three-year cycle, allowing states and jurisdictions the opportunity to adopt the most up-to-date standards. It is common for state and local jurisdictions to adopt revised codes every other cycle so they can maintain a uniform set of standards for longer than a three-year period. This also provides a level of predictability to those using and administering the codes.

To administer the code, most local governments employ a code official (building official) and/or a department overseen by the building official who conducts inspections to ensure structures are constructed in compliance with the local building code. Sometimes small or rural jurisdictions contract with the county or a private firm to provide building inspection services. In many communities there is a person on the building department staff who is familiar with local hazards and how they are mitigated through local code provisions and other ordinances (for example, a certified floodplain manager).

Where It's Been Done

Boulder County has a long history of utilizing building code regulations to address wildfire hazard in their wildland-urban interface. Building code regulations were first implemented in the late 1980s when two local fires (including the Black Tiger fire that destroyed 46 structures) prompted increased awareness of wildfires and home loss, and have continued to evolve since then. Original regulations focused on roof requirements but have expanded through a series of local amendments to include defensible space (vegetation management) and ignition-resistant materials and construction. Currently, any development that goes through the planning process is required to have a wildfire mitigation plan. Prior to the building permit being issued, the plan needs to be reviewed and approved. While this regulatory approach covers new construction (including new homes, additions, and remodels), Boulder County complements this regulatory process with its Wildfire Partners program—a voluntary approach that enables existing homeowners to request an on-site property assessment and receive mitigation guidance about their home and landscape. Together, the regulatory and voluntary/educational approaches are reaching out to help both new and current residents mitigate their property against wildfire risk (*Planning Building & Zoning*, 2016).

Larimer County adopted its first building code in 1972, and today continues to adopt the most current editions of the International Building Code with local amendments. A recent amendment to the code requires wildfire hazard mitigation standards for new construction. This section establishes minimum standards for the design and construction of new or substantially improved buildings in wildfire hazard areas for the protection of life and property. Requirements include specifications for fire-resistant construction practices in addition to the provision and maintenance of defensible space in compliance with the guidelines prescribed

Development in Fort Collins, Larimer County, CO.

Source: Marek Uliasz

by the Colorado State Forest Service. They also address standards for liquid propane gas facilities, containers, and tanks and requirements for the installation of spark arrestors for chimneys. These amendments apply to all locations within the wildfire hazard area as defined in the Larimer County Wildfire Mitigation Area Map. They are enforced by the Building Official who has the authority to approve alternate materials and methods of compliance not specifically prescribed by the code so long as they are equivalent in terms of suitability, effectiveness, fire resistance, durability, and safety. These code amendments are a critical component to the County's broader Wildfire Safety Program (*Building*, n.d.a).

Boulder, Larimer, and Weld Counties (Flood Mitigation). While most communities in Colorado have adopted building codes based on international standards that include minimum flood-resistant design standards, the State of Colorado requires each to adopt an amendment to these provisions in compliance with its own "Rules and Regulations For Regulatory Floodplains In Colorado" (2011) as established by the Colorado Water Conservation Board (CWCB). These rules include higher regulatory standards that exceed most codes and minimum standards of the National Flood Insurance Program (NFIP), and communities have the option to adopt even higher standards through their own local ordinances and building code amendment process.

One common approach to higher regulatory standards is the adoption of **freeboard**: an additional margin of safety expressed in feet above a predicted water surface elevation, typically defined as the Base Flood Elevation (BFE) on a FEMA Flood Insurance Rate Map (FIRM). In 2011, CWCB amended its rules to require one foot of freeboard for all new or substantially changed structures in floodplains. A number of communities in Colorado had already amended their local building codes and relevant ordinances to meet or exceed this standard, and the risk reduction benefits of doing so were realized following the September 2013 floods. For example most communities in the hard hit counties of Boulder, Larimer, and Weld had amended their codes to include a freeboard requirement – and many include a two foot freeboard. A 2015 FEMA study determined that $183 million in losses were avoided in these three counties during the 2013 flood event through these more stringent regulatory practices (*Reducing Losses*, 2015).

Advantages and Key Talking Points

Benefits of implementing a building code include:

- Protecting the public health and safety and the safety, protection, and sanitation of new structures.
- Protecting financial investments and property values. If construction does not comply with current recommended codes the structure may be at greater risk for damage and loss.
- Property insurers may not cover work done without permits and inspections.
- Ensuring that structures have the physical integrity to endure hazard conditions.

Challenges

The biggest challenge for a community considering adoption of a building code for the first time (or adding additional requirements to address hazards like wildfire) is gaining public support—especially for communities with a lower risk to hazards or a short history of hazard events. Another challenge includes proper administration and enforcement of the building code, which requires someone with training, preferably ICC certification.

Key Facts

Administrative capacity	Building officials with requisite training and certification
Mapping	Not required
Regulatory requirements	Local Building Code
Maintenance	Yes
Adoption required	Yes
Statutory reference	Counties C.R.S. § 30-28-201; Municipalities C.R.S. § 31-15-601
Associated costs	Staff time, generally offset by building permit fees. Cost of training workshops sponsored by the Colorado Chapter of ICC

Examples

Boulder County Building Department	https://www.bouldercounty.org/property-and-land/land-use/building/building-safety-inspection-services/
Larimer County Building Department	larimer.org/building
Colorado Energy Code	colorado.gov/pacific/dola/colorado-energy-codes-0

For More Information

International Construction Code

iccsafe.org

Colorado Chapter of the International Code Council

coloradochaptericc.org

International Fire Code

https://www.iccsafe.org/products-and-services/i-codes/2018-i-codes/ifc/

International Green Construction Code

https://www.iccsafe.org/products-and-services/i-codes/2018-i-codes/igcc/

Insurance Institute for Business and Home Safety
disastersafety.org

Federal Alliance for Safe Homes (FLASH)
flash.org

International Wildland-Urban Interface Code
https://shop.iccsafe.org/media/wysiwyg/material/3850X12-toc.pdf

ICC 600-2014: Standard for Residential Construction in High-Wind Regions
https://codes.iccsafe.org/content/ICC6002014?site_type=public

National Fire Protection Association
Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas: https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1141

Model Code and Commentary

Commentary

The International Code is developed by the International Code Council (ICC) establish standard building safety and engineering regulations and help protect critical infrastructure, which is the lifeline of a community during and after a major hazard event. Jurisdictions have the option of adopting local amendments to the International Codes that are tailored to address risks associated with hazard areas. While it is not required, adopting more stringent standards to mitigate hazards leads to safer, stronger, and more resilient communities.

The types and associated levels of risk can vary widely among communities. Amendments to the local building code depend largely on area-specific conditions and/or mitigation objectives that the community has defined relative to one or more hazards. This model has been prepared from a planner's perspective and presents several examples where tailored building code standards, specifically related to hazard mitigation, can be implemented into local building codes. Local building officials and other hazard mitigation staff are the administrators of building codes and should take the lead role in tailoring language for your jurisdiction and selecting appropriate methodologies.

Land development and zoning codes address mostly site conditions and exterior building treatment, but rarely address what happens within the building itself before, during, or following construction. Building code standards are most effective when paired with other hazard mitigation strategies that are identified in this guide, specifically: Community Wildfire Protection Plan; Hazard Mitigation Plan; Resilience

Planning; Conservation Easement; Stream Buffers and Setbacks; Stormwater Ordinance; Site-Specific Hazard Assessment; Subdivision and Site Design Standards; and Wildland-Urban Interface Code.

Text in blue shading provides model language while commentary is located in *italics* in the column at the right. The model language used in this document is based on existing building codes from communities around the state and nation. The language is illustrative only; consult local building officials and legal counsel to tailor language for your jurisdiction.

Organization of this Model

Following some introductory material on applicability and submittal requirements, the remainder of this model is organized by hazard. Some hazards include more building-code related information than others, whereas others are either not included at all or are better addressed through site development standards.

Cost-Benefit Considerations

In 2017, the National Institute of Building Sciences released an Interim Report, *Natural Hazard Mitigation Saves*, that is intended to inform future code changes to make communities more resilient, help jurisdictions make decisions on what codes to adopt and enforce, and assist policymakers in developing effective federal programs that support pre-disaster mitigation. The report also includes research that helps quantify the benefits of exceeding the baseline standards found in the 2015 International Building Code (IBC) and 2015 International Residential Code (IRC). The report suggests that implementing measures in new construction to exceed select provisions in the 2015 IRC and 2015 IBC and implementation of the IWUIC saves society approximately $4 for every $1 spent on mitigation. The benefit-cost ratio increased further to $6 for every $1 spent on mitigation provided by federal mitigation grants through the Federal Emergency Management Association (FEMA), the U.S. Economic Development Administration (EDA), and the U.S. Department of Housing and Urban Development (HUD).

New Construction Versus Existing Structures

Applying standards to new construction is a conventional approach to ensuring life safety is protected. However, retrofitting existing structures to today's modern standards is less straightforward. Older structures can be at a higher risk of sustaining damage during a natural hazard event if they are not upgraded through renovation and repair projects over time. The

Code-Specific Applicability Standards: *Separate applicability statements and exceptions can be adopted specific to each building code category that is adopted by the community (i.e., residential, gas, mechanical, plumbing, property maintenance, fire prevention, energy, existing building, electrical, green construction, performance, etc.). This provides the community with the flexibility to exempt specific building code requirements for specific projects or improvements for both new and existing structures.*

For example, loafing sheds and similar detached accessory structures within the wildfire hazard area of Larimer County are not required to meet the wildfire hazard mitigation requirements.

International Existing Building Code (IEBC) establishes standards for when existing buildings are required to be made compliant with seismic design provisions, flood design requirements, and other International Codes as a result of alterations, repairs, additions, changes of occupancy, and relocations (IEBC 2015 Chapter 1, Section 101; Chapter 3, Section 301; and Chapter 4).

Applicability Thresholds

To ensure that a community's building stock (both old and new) is resilient, local governments should identify thresholds for when new and existing projects are required to comply with the adopted building code standards. Such thresholds are often included in the applicability section of the building code.

Note: This language can be added to Section 104 of Chapter 1 of the IBC:

Duties and Powers of Building Official

For applications for reconstruction, rehabilitation, repair, alteration, addition or other improvement of existing buildings or structures located in [*insert jurisdiction name here*] and [*insert hazard area here*], the building official shall determine if the proposed work constitutes substantial improvement or repair of substantial damage.

Where the building official determines that the proposed work constitutes substantial improvement or repair of substantial damage, and where required by this code, the building official shall require the building to meet the requirements of IBC Section 1612, Flood Loads; IRC Section R322, Flood Resistant Construction; and [*insert code reference here*], as applicable.

Duties and Powers of Building Official: *Chapter 16, of the International Building Code includes general structural design standards as well as specific standards for snow loads, wind loads, soil lateral loads, rain loads, flood loads, and earthquake loads. If the building official determines that substantial improvement or repair is being conducted, the IEBC requires compliance with only the flood loads in Section 1612. Communities could elect to require compliance with more structural design standards found in Chapter 1612, or other standards of the International Codes.*

Application Submittal Requirements

It is critical that staff reviewing a building permit request is provided with the necessary information to help them identify the level of risk associated with that project. Depending on the nature of the request, it is common for communities to require that all building permit applications (depending on the request) be accompanied by a site plan. In cases where improvements are proposed in highly sensitive areas, a Site-Specific Hazard Assessment may be required by the building official. The jurisdiction's building code can establish what type of information is required to be on the site plan.

Note: This language can be added to Section 107 in Chapter 1 of the IBC:

Site Plan

The construction documents submitted with the application for permit shall be accompanied by a site plan drawn in accordance with an accurate boundary line survey showing to scale the:

1. Topographic contours
2. Flood hazard areas;
3. Floodways;
4. Design flood elevations;
5. Fire hazard areas;
6. Existing vegetation;
7. Rock formations;
8. Fault lines; and
9. [*Any other hazard specific features identified or required by the building official*].

The building official is authorized to waive or modify the requirement for a site plan where the application for permit is for alteration or repair or where otherwise warranted.

Floods

The best way to mitigate risks associated with flooding is to avoid constructing in areas that are at risk for flooding. The Stream Buffers and Setbacks section and Stormwater Ordinance section of this guide provides guidance for preventing development near flood risk areas and management of on-site stormwater.

Many communities have adopted floodplain regulations as part of their land development codes that are separate from the community's building codes. Colorado has minimum requirements for floodplain regulations that are established by the Colorado Water Conservation Board. Some Colorado standards for certain floodplain management activities exceed those required by the

Submittal Requirements: *The submittal requirements for each community should be tailored to address the specific hazard concerns in the area. The application materials should include all of the pertinent information needed by staff to determine if the proposed project complies, or does not comply, with all of the jurisdiction's adopted codes and amendments.*

More sophisticated standards may require applicants to provide additional information. Each community should consider their level of staff resources and training when crafting standards; some may consider hiring a third party to review specialized or technical plans associated with natural hazards.

National Flood Insurance Program (NFIP). In those cases, the stricter of the State standards take precedence. Addressing existing structures located in flood-prone areas is particularly challenging. Existing structures can use flood mitigation techniques (aside from avoidance of floodplain areas) including:

- Dry flood-proofing (making the building watertight to prevent water entry);
- Wet flood-proofing (making uninhabited or non-critical parts of the building resistant to water damage);
- Relocation of the building; and
- Incorporating floodwalls into site design to keep water away from the building.

In addition to the techniques above, a relatively simple approach to preventing water damage to structures is requiring gutters and downspouts on all buildings to direct water away from the foundation to prevent damage from trapped moisture. For this reason, Boulder County has adopted amendments to the IBC requiring all buildings (with exception to a few) to provide gutters or downspouts.

Note: This language can be added as a new Section 1805 in Chapter 18 of the IBC:

Dampproofing and Waterproofing

Gutters, downspouts, and downspout extensions are required on all buildings.

Exceptions:

1. Post framed buildings.
2. Buildings where, in the opinion of the building official, the gutters will become damaged by sliding snow.
3. Roofs with eaves or overhangs of six feet or greater.
4. Roofs that are constructed with internal roof drains.
5. Buildings where an approved alternate means of drainage is designed by a soils engineer or other qualified registered design professional.

Flood Mitigation Examples: *The following jurisdictions have adopted standards related to flood mitigation in their respective land development codes:*

Weld County: Chapter 29, Article II, Sec. 29-2-120

Sliding Snow and Damage to Gutters and Downspouts: *Sliding snow and ice accumulations on rooftops can cause serious damage to gutters and other roof components. Projects at risk of damage from sliding snow and ice should consider alternative gutter and downspout designs to ensure proper drainage and functionality during all seasons. Adjusting architectural design and gutter position so that sliding snow and ice will not impact the gutter systems is one way to prevent such damage. Additionally, a wide variety of "snow guards" are available that can eliminate sliding snow problems and thus ensure proper drainage and localized flood prevention.*

Larimer County: Land Use Code 4.2.2

Boulder County: Land Use Code Article 4, 4-400

Another strategy for minimizing the risk of flood through building design is by installing a vegetated roof or green roof. A green roof refers to roof surfaces that have been designed to incorporate large areas of vegetation. Green roofs provide several benefits to the community including improved aesthetics, reduced heat island effect, and retaining and reducing peak stormwater runoff during rain events. While it is common for communities to incentivize the construction of green roofs, some cities including Denver, Toronto, Washington D.C., and San Francisco, require their construction.

Drought

Drought originates from a lack of precipitation over an extended period of time, resulting in a water shortage. The demand that people place on a water supply can exacerbate the impacts of drought. Local government can establish policies and implement strategies to manage and protect water resources so that impacts are minimized during times of drought. Some communities have adopted amendments to the International Plumbing Code (IPC) and the IRC to reduce flow rates through water fixtures to conserve limited water resources. In addition to adopting local building code amendments, upgrading water supply and delivery systems to eliminate breaks and leaks will help conserve water. The model code language below provides additional guidance on how drought impacts can be minimized.

Note: This language, which was taken from the City of Westminster Building Code, can replace the figures in Table P2903.2 found in Section P2903 in Chapter 29 of the IRC:

Maximum Flow Rates and Consumption for Plumbing Fixtures and Fixture Fittings

Lavatory faucet: 1.5 gpm at 60psi

Shower head: 2.0 gpm at 60 psi

Sink faucet: 2.2 gpm at 60 psi

Water closet: 1.28 gallons per flushing cycle

Colorado Legislation: *In 2016, the Colorado Legislature passed a law (Colo. Rev. Stat. § 6-7.5-102) banning the sale of new plumbing fixtures that have not been certified by the EPA's WaterSense Program or successor program.*

Note: This language, which was taken from the City of Westminster Building Code, can be added to Section 601 in Chapter 6 of the IPC:

Water Conservation

1. Water recycling systems shall be mandatory for all automatic full- service commercial car wash facilities constructed after [*insert effective date here*].
2. Water recycling systems shall not be mandatory for manual self-service commercial car wash facilities.

Note: This language, which was taken from the City of Denver Building Code, can be added to Section 401 in Chapter 4 of the IPC:

Rain Sensing

An approved rain sensing system shall be installed on all new automatic lawn sprinkler systems. Said rain sensing system shall be capable of turning the lawn sprinkler system off in the event adequate rain has fallen.

Note: This language, which was taken from the City of Westminster Building Code, can replace the figures in Table 604.4 found in Section 604 in Chapter 6 of the IPC:

Lavatory, private: 1.5 gpm at 60 psi

Lavatory, public (metering): 0.25 gallons per metering cycle

Lavatory, public (other than metering): 0.5 gpm at 60 psi

Shower head: 2.0 gpm at 60 psi

Sink faucet: 2.2 gpm at 60 psi

Urinal: 0.5 gallons per flushing cycle

Water closet: 1.28 gallons per flushing cycle

Wildfire

As residential developments expand into wildland areas, people and property are increasingly at risk from wildland fire. Several preventative measures can be taken to minimize the spread of fire on the site as well as to make the building more fire-resistant. In addition to adopting local building code amendments to protect structures, the Wildland-Urban Interface Code and the Community Wildfire Protection Plan sections of this guide provide guidance for how wildfire hazards can be minimized through other measures.

Note: This language, which was taken from the Boulder County Building Code, can be added to Section 723 in Chapter 7 of the IBC:

Generally

Unless more restrictive requirements apply, the ignition-resistant construction and defensible space requirements of Section [R327] of the amendments to the IRC shall be applicable to all new buildings, additions, and repairs.

Note: This language, which was taken from the Larimer County Building Code and the Boulder County Building Code, can be added as a new Section 327 in Chapter 3 of the IRC:

Defensible Space

1. Defensible space in compliance with current Colorado State Forest Service guidelines shall be required on all new construction in the [*hazard area*].
2. Any landscaping materials or natural ground cover within three feet of the exterior walls of the building shall be a non-combustible surface – no landscaping– over a weed barrier within five feet of exterior walls. The noncombustible surface should extend underneath and two feet past the dripline of decks.
3. For additions equal to or greater than [*insert percentage of the total square footage of the original structure here*], the defensible space shall be provided around the entire structure.

Evaluation of the defensible space will be based upon:

1. Current Colorado State Forest Service standards and guidelines; and

Wildfire Building Code Amendment Examples: *To review all of the amendments to the Boulder County and Larimer County building code, please use the following links:*

Boulder County:
Boulder County Building Code Amendments

Larimer County:
Larimer County Building Code Amendments

Improvements that Trigger Defensible Space Requirement: *Larimer County requires that any additions that are equal to or greater than 50 percent of the original square footage of the structure trigger the need to comply with the defensible space requirements. This percentage should be tailored to each community and may align with thresholds for nonconforming structures to comply with other site features.*

2. Site specific vegetation and topographical characteristics

The Building Official may allow alternatives to the Colorado State Forest Service standards and guidelines based on specific site conditions.

1. Defensible space areas created as required by this code or other referenced documents within the [*community hazard mitigation plan*] are to be maintained by the property owner.
2. No re-planting or new planting of trees, shrubs, or other vegetation that would violate the defensible space requirements of this section shall be permitted.

Exterior Walls

1. Exterior walls of buildings or structures shall be constructed with one of the following methods extending from the top of the foundation to the underside of the roof sheathing:
    a. Noncombustible materials approved for a minimum of one-hour fire-resistance-rated construction on the exterior side.
    b. Approved noncombustible materials.
    c. Heavy timber or log wall construction.
    d. Fire-retardant-treated wood labeled for exterior use on the exterior side.
    e. Ignition-resistant materials on the exterior side.

Exterior Windows and Glazing

1. Exterior windows, window walls, glazed doors, windows within exterior doors, and skylights shall be tempered glass, multi-layered glazing, glass block, or have a fire protection rating of not less than 20 minutes.
2. Unless they are part of a fire-rated assembly, window frames and sashes may be constructed using any material permitted by this code. Windows with unreinforced vinyl frames or sashes are not permitted.

Exterior Doors

1. Exterior doors and garage doors shall be approved noncombustible construction, metal clad, solid core wood not less than 1 3/4 inches in thickness, or have a fire protection rating of not less than 20 minutes.
2. Windows within doors and glazed doors shall comply with exterior window and glazing standards.

Vents

1. Attic ventilation openings, foundation or under-floor vents, or other ventilation openings in vertical exterior walls and vents through roofs shall not exceed 144 square inches each.
2. Such vents shall be covered with noncombustible corrosion-resistant mesh with openings not to exceed 1/8 inches or shall be designed and approved to prevent flame or ember penetration into the structure.
3. Gable end and dormer vents shall be located at least 15 feet from property lines and shall be designed and approved to prevent flame or ember penetration into the structure.
4. Under-floor ventilation openings shall be located as close to grade as practical.

Roof Covering

Roof covering materials shall be listed Class A roof covering materials or be constructed as a Class A roof assembly. For roof coverings where the profile allows a space between the roof covering and roof decking, the space at the eave ends shall be fire stopped to preclude entry of flames or embers, or have one layer of 72-pound (32.4 kg) mineral-surfaced, non-perforated cap sheet complying with ASTM D 3909 installed over the combustible decking.

Roof Valleys

When provided, valley flashings shall be not less than 0.019 inch (No. 26 galvanized sheet gage) corrosion-resistant metal installed over a minimum 36-inch-wide underlayment consisting of one layer of 72-pound mineral-surfaced, non-perforated cap sheet complying with ASTM D 3909 running the full length of the valley.

Protection of Eaves

1. The leading edge of the roof at the fascia shall be finished with a metal drip edge so that no wood sheathing is exposed.
2. Eaves, fascias, soffits, covered decks, and covered porch ceilings shall be protected on the enclosed underside by any one of the following materials or methods:
    1. Noncombustible materials;
    2. Ignition-resistant materials;
    3. Materials approved for a minimum of 1-hour fire-resistance-rated construction;
    4. 2-inch-thick nominal dimension lumber;
    5. 1-inch-thick nominal fire-retardant-treated wood;
    6. 3/4-inch-thick nominal fire retardant-treated plywood labeled for exterior use; or
    7. Any materials permitted by this code.

Gutters and Downspouts

1. Gutters, downspouts, and gutter covering devices shall be constructed of noncombustible material.
2. Gutters shall be provided with an approved means to prevent the accumulation of leaves, pine needles and debris in the gutter.

Liquid Propane Gas

Liquid propane gas containers and tanks installed in the [*hazard area*] shall be located within the defensible space in accordance with the International Fire Code.

Spark Arrestors

Chimneys serving fireplaces, woodstoves, barbecues, incinerators, or decorative heating appliances in which solid fuel or liquid fuel is used, shall be provided with a spark arrestor.

1. Spark arrestors shall be constructed of woven or welded wire screening of 12 USA standard gage wire (0.1046 inch) (2.66 mm) having openings not exceeding one-half inch.
2. The net free area of the spark arrestor shall not be less than four times the net free area of the outlet of the chimney.

Definitions

Defensible Space: An area either natural or manmade, where material capable of allowing a fire to spread unchecked has been treated, cleared or modified to slow the rate and intensity of an advancing wildfire and to create an area for fire suppression operations to occur.

Fire-Retardant-Treated Wood: Wood meeting the requirements of Section R802.1.5 of the IRC or Section 2303.2 of the IBC.

Heavy Timber Construction (Type IV, HT): Construction with wood framing members, columns, flooring and roof decks sized in accordance with IBC Section 602.4.

Ignition-Resistant Building Material: Ignition-resistant building materials shall comply with any one of the following:

- Material that complies with the requirements for noncombustible materials in this section.
- Fire-retardant-treated wood labeled for exterior use.
- Roof assemblies containing fire-retardant-treated wood shingles and shakes and classified as Class A roof assemblies.

- Materials currently approved by the California Department of Forestry and Fire Protection, Office of the State Fire Marshal (search categories include 8110-Decking Materials, 8120-Exterior Windows, 8140-Exterior Sidings and Sheathings, 8150-Exterior Doors and 8160-Under Eave).

Log Wall Construction: A type of construction in which exterior walls are constructed of solid wood members and where the smallest horizontal dimension of each solid wood member is at least 6 inches (152 mm).

Noncombustible: As applied to building construction material, a material that, in the form in which it is used, is either one of the following:

1. Material of which no part will ignite and burn when subjected to fire. Any material conforming to ASTM E 136 shall be considered noncombustible within the meaning of this Section.
2. Material having a structural base of noncombustible material as defined in Item A above, with a surfacing material not over 1/8 inch (3.2 mm) thick, which has a flame spread index of 50 or less. Flame spread index as used herein refers to a flame spread index obtained according to tests conducted as specified in ASTM E 84 or UL723.
3. “Noncombustible” does not apply to surface finish materials. Material required to be noncombustible for reduced clearances to flues, heating appliances or other sources of high temperature shall refer to material conforming to Item A.
4. No material shall be classified as noncombustible that is subject to increase in combustibility or flame spread index, beyond the limits herein established, through the effects of age, moisture or other atmospheric condition.

Some communities address wildfire concerns through a separate set of code standards specific to the Wildland-Urban Interface by adopting a standalone WUI Code –

which is available as part of the International Code family but can also be integrated into the community's land development code for site development issues aside from structural requirements. For more information, see the WUI Code section of this guide.

Extreme Heat

Extreme heat is a weather condition that results in temperatures that are much warmer than average for a particular time and place. According to the Centers for Disease Control and Prevention, extreme heat causes more deaths than any other weather-related hazard. More than 65,000 Americans visit emergency rooms each summer for acute heat illness. To respond to the growing challenges related extreme heat, some communities are implementing strategies to minimize the impacts of extreme heat through building design.

Power outages are commonly associated with extreme heat events because of increased demand on electric grids to run air conditioning systems. When demand threatens to exceed the grid's capacity to supply electricity, utility providers take precautions to reduce strain on the system. Designing building infrastructure to withstand extreme heat events will help alleviate stress on utility infrastructure and avoid electric service interruption.

One cost effective approach is the use of cool surfaces on building roofs. Cool surfaces are measured by how much light they reflect (solar reflectance or "SR") and how efficiently they radiate heat (thermal emittance or "TE"). A cool roofing surface is both highly reflective and highly emissive to reduce the amount of light that is converted into heat and to maximize the amount of heat that is radiated away. High solar reflectance is the most important property of a cool surface. Increasing the reflectance of buildings through white surfaces or other reflective colored surfaces can reduce the temperature of buildings, thereby reducing the demand for cooling the building through mechanical systems. White roofs are typically 30 to 65 degrees Fahrenheit cooler than dark roofs in afternoon sunshine.

Cool Surfaces: *The Cool Roofs and Cool Pavements Toolkit (2012) Developed by the Global Cool Cities Alliance is a valuable resource aimed at helping homeowners and city officials transition to cool roofs and pavements. This toolkit includes technical information about design, costs, and benefits. coolrooftoolkit.org*

Design-Day Values: *The ASHRAE recommends using design-day temperatures that do not exceed, or lower than, 1 percent of the hours in the historical record. If an HVAC system is designed for the most extreme annual conditions on record, the system could be grossly oversized, may not function efficiently, and could have higher initial costs than is necessary. Many facilities can accept the possibility of not maintaining design indoor conditions for a few hours a year to avoid these impacts; however, some facilities, such as hospitals, may elect to use more extreme design-day values due to the critical nature of the spaces and functions occurring in the facility.*

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) developed procedures for calculating building heating and cooling loads (commonly referred to as design-day values) that are referenced by the International Energy Conservation Code (IECC). Design-day describes a period of time with maximum conditions that an HVAC system is designed to accommodate and maintain a desired indoor temperature and humidity. In an extreme heat event, the outside temperature may exceed the design-day value, thereby rending the mechanical systems undersized. Improperly sized cooling equipment may place additional stress on mechanical, electrical, and plumbing systems, resulting in increased stress and demand on public utility infrastructure.

To prepare for extreme heat events, mechanical equipment can be evaluated using elevated design-day criteria. Supplemental systems can also be added to fill the gap of the de-rating due to temperature. Another approach is ensuring there are redundant systems in place that are de-rated for their design intent at operating temperatures.

Note: This language, which was taken from the City of Philadelphia Building Code, can be added to Section 1504 in Chapter 15 of the IBC and Section R905 in Chapter 9 of the IRC:

Roof Reflectance

Roof coverings over conditioned spaces on low-slope roofs (roof slope < 2:12) on newly constructed buildings and additions to existing buildings shall be Energy Star rated as highly reflective.

Exceptions

1. An addition to a roof that supports living vegetation and includes a synthetic, high quality waterproof membrane, drainage layer, soil layer, and light weight medium plants shall be permitted to comprise part or all of the roof area.

Cool Roof Criteria: *There are several entities that have criteria for measuring Solar Reflectance (SR) and Thermal Emissivity (TE). The City of Philadelphia uses the Energy Star rating system while the City of Chicago accepts compliance with either the CRRC standards or labeled as Energy Star qualified.*

- *U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE) Energy Star Program*
- *ASTM International*
- *American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)*
- *US Green Building Council's Leadership in Energy and Environmental Design (LEED)*
- *Cool Roof Rating Council (CRRC)*

2. Roof areas used as outdoor recreation space by the occupants of the building.
3. An area including and adjacent to rooftop photovoltaic and solar thermal equipment, totaling not more than three times the area that is covered with such equipment.
4. Any roof, if the amount of rooftop space not subject to exceptions A through C is in the aggregate less than 100 square feet.

Landslide, Mud/Debris Flow, Rockfall

Designing buildings and structures for the direct effects of a landslide, debris flow, or rockfall is not typically cost-effective. However, many improvements can be made to a site to reduce the structural risk to debris flow and/or rockfall. The most effective ways to prevent damages from a gravity-driven movement of earth is to:

- Select non-hillside or stable slope sites for development; (avoidance)
- Construct channels, drainage systems, retention structures, and deflection walls;
- Plant groundcover to stabilize soils;
- Reinforce soils using geo-synthetic materials; and
- Avoid cut and fill building sites.

Most of these can be addressed by land development codes and engineering standards, rather than building codes. The Landslide, Mud/Debris Flow, and Rockfall section of this guide provides guidance for how land movement related hazards can be avoided.

Soil Hazards

As with landslide and other gravitational hazards, mitigating soil hazards can best be achieved through careful site selection, including geotechnical study of the site. In subsidence-prone areas, foundations must be appropriately constructed, and utility lines and connections must be stress-resistant. When retrofitting structures to be more subsidence-resistant, engineering best management practices such as shear walls, geo-fabrics, and earth reinforcement techniques such as dynamic compaction can be used to increase resistance to subsidence damage and to stabilize collapsible soils.

Note: This language, which was taken from Weld County's adopted building code, can be added as a new Section 1805 in Chapter 18 of the IBC:

Foundation Design and Inspection

1. All foundations shall be designed by an architect or engineer licensed by the State of Colorado.

    1. If a site-specific soils report is not provided, an 'open hole' inspection shall be conducted by an architect or engineer licensed by the State of Colorado.
    2. Subsequent to that inspection, a written letter bearing the architect's or engineer's stamp shall be presented to, and approved by, the [*insert jurisdiction name and department*] prior to backfilling around the foundation.

1. An architect or engineer licensed by the State of Colorado may perform all foundation, perimeter drain, dampproof and concrete encased electrode inspections.
    1. Setback and offset distances must first be approved by [*insert jurisdiction name here*] building inspectors, and a stamped letter from the architect or engineer must be received and approved by the [*insert jurisdiction name and department*] prior to any structural inspections on the building.
    2. A stamped letter must state that the architect or engineer did perform the inspections and that the work is consistent with the design drawings for the foundation.

Foundation Requirements to Mitigate Soil Hazards: *To ensure sufficient foundation strength and construction, Weld County requires all foundations to be designed by an architect or engineer licensed by the State of Colorado. If a site specific soils report is not provided, then an 'open hole' inspection conducted by a licensed architect or engineer is required together with a written letter bearing the architect's or engineer's stamp. Prior to backfilling around the foundation, this letter needs to be approved by the Weld County Building Inspection Department.*

Weld County Building Regulations: Section 29-2-20M

Wind Hazards

The key strategy for protecting a building from wind damage is to maintain the structural integrity of the building envelope, including roofs and windows. Bracing roof trusses and gables and using hurricane straps to strengthen the connection between the roof and walls and walls and foundation will help the structure withstand lateral and uplift forces. Chapter 16, Section 1609 of the IBC and Chapter 3, Section 301 of the IRC establishes general standards based on regional climactic data for the appropriate design of buildings and structures to withstand wind loads.

Winds blowing over mountain ranges or through gorges or river valleys in some regions can develop speeds that are substantially higher than the values indicated on the map. The basic design windspeed map provided in the IBC (Figure 1609.3(1)) and IRC (Figure R301.2(4)A) identifies the Front Range Area as a “special wind region” requiring further examination for unusual wind conditions.

In 2006 the Structural Engineers Association of Colorado (SEAC) prepared a Colorado Front Range Gust Map that several communities have adopted to supplement the basic wind design criteria found in the IBC and IRC. This map is intended provide local communities with area-specific windspeed data to inform the design of buildings and structures in the Front Range area. It is important to note, when selecting basic wind speeds in regions with a diversity of terrain, use of regional climatic data and consultation with a wind engineer or meteorologist is advised.

Site-Specific Windspeed Data: The Applied Technology Council (ATC) has user-friendly engineering resources and applications available to those seeking windspeed data for a specific site. ATC is a nonprofit corporation that was established in 1973 through the efforts of the Structural Engineers Association of California.
http://windspeed.atcouncil.org

Larimer and Boulder counties have adopted area-specific windspeed maps depicting wind exposure categories for anticipated wind events.

Note: This language, (similar to those found in Boulder and Larimer Counties), can be used to amend Section 1609.3 in Chapter 16 of the IBC or Section R301.2.1 in Chapter 3 of the IRC:

Basic Windspeed

1. The project engineer may designate exposure based on site specific conditions.
2. The required Wind Design Speed for a project area shall comply with the [*insert name of local windspeed map here*], as amended.

Severe Winter Storm

Chapter 16, Section 1608 of the IBC and Chapter 3, Section 301 of the IRC establishes general standards based on regional climactic data for the appropriate design of buildings and structures to withstand snow loads. Due to extreme variations for local snowfall amounts throughout most of the mountainous regions of Colorado, The IBC (Figure 1608.2) and IRC (Figure 301.2(4)B) require that site-specific case studies be established to calculate ground snow loads.

In 2016 the Structural Engineers Association of Colorado (SEAC) prepared a Colorado Design Snow Loads study that several communities have adopted to replace the basic snow load design criteria found in the IBC and IRC. This study provides detailed statistical analysis that aims to achieve uniform resistance against snow loads throughout the entire state of Colorado.

Note: This language can replace Section 1608.2 in Chapter 16 of the IBC:

Ground Snow Loads

Snow loads shall be determined by the building official using the [*insert jurisdiction snow load map name here*], as amended. Snow loads are based upon the report, "2016 Colorado Design Snow Loads," prepared by the Structural Engineers Association of Colorado (SEAC) Snow Load Committee, April 2016.

Power outages are also associated with severe winter storms. Heat sources and other critical building infrastructure may be compromised during these events. Elevating building insulation standards helps to prevent heat loss during extreme cold, but in order to maintain comfortable temperatures for extended periods of time, primary or supplemental heating systems need to be operational in some capacity. In 2014, FEMA released a report (FEMA P-1019) outlining best practices for improving reliability of emergency power systems during severe natural hazard events. While the report primarily focuses on critical facilities (hospitals, rescue stations, emergency shelters, communications facilities, etc.), these concepts and principles could be modified to apply to other facilities and buildings.

Snow and Ice on Rooftops: *The article, "Minimizing the Adverse Effects of Snow and Ice on Roofs" released by research engineers with the Cold Regions Research and Engineering Laboratory (CRREL) provides additional information for how building design can minimize adverse effects of snow drifting, sliding snow, ice damming, and snow ingestion. Serving the Corps of Engineers team, CRREL is known for its multi-disciplinary research to help solve scientific and engineering challenges in cold and complex environments.*
erdc.usace.army.mil

Earthquake

There are several ways in which building codes can improve a building's resistance to seismic events. The primary focus of earthquake design is ensuring that people can safely exit a building following an earthquake. While implementing additional design measures may allow buildings to better withstand the effects of an earthquake, they are not always intended to ensure full functionality of a building following an event.

Implementing earthquake resilient construction practices can be accomplished through a variety of structural engineering measures or structural components (e.g., shear walls, braced frames, moment resisting frames, diaphragms, base isolation, energy dissipating devices such as visco-elastic dampers, elastomeric dampers, and hysteretic-loop dampers, and bracing of nonstructural components). More simple building techniques can also be used including avoiding soft stories (a multi-story building in which one or more floors have windows, wide doors, large unobstructed commercial spaces, or other openings in places where a shear wall would normally be required for stability) and bolting the sill plate of houses to the foundation.

The IBC establishes "seismic design categories" based on the spectral accelerations as mapped by the USGS and the site soils classification as determined by a geotechnical engineer. The seismic design category increases in seismic resistance as a function of a letter, seismic design category "A" is the least seismic resistant while category "F" is the highest. The most common mitigation technique used by communities to address seismic events is to require the minimum seismic design category for all types of buildings to exceed that required by the IBC. Benefits and costs of designing to exceed International Code requirements for earthquake depend on several factors including added cost of construction, building economic design life, building replacement cost, and other variables.

Exceeding Seismic Design Standards: *The City and County of Denver has adopted amendments to the IBC requiring all types of buildings to satisfy the requirements of Design Category B as a minimum (See Section 1613). denvergov.org*

Note: This language can be added to Section 1613 in Chapter 16 of the IBC:

Minimum Seismic Design Category

All buildings and structures in [*insert jurisdiction name, specific hazard area, or other identifier here*] shall satisfy the requirements of Seismic Design Category [*insert appropriate category here (A through F)*], as a minimum.