High Performance Building Requirements for Sustainability

Summary of Significant Modifications to the 2009 International Building Code

The discussion below describes the HPBRS, provides substantiation for functional resilience in code provisions, and suggests possible strategies for use of the HPBRS. This discussion is intended as a primer for the substantiations of groups of key modifications presented here in tabular format.

There are several national efforts intended to establish criteria for the design and construction of sustainable or green buildings. Each of these raise the bar on design and construction to address the economic, environmental, and societal aspects of sustainability as related to buildings. Each of these accomplishes their respective goals through provisions that are more stringent than the minimum building codes. Building energy conservation criteria in these efforts enhance the criteria in the International Code Council (ICC) *International Energy Conservation Code.* Indoor air quality criteria enhance the ICC *International Mechanical Code*. Water resource conservation features enhance the minimum requirements of the ICC *International Plumbing Code*. Measures addressing site selection and development enhance the minimum requirements in the ICC *International Zoning Code*. These national efforts have an emphasis on energy, water, and resource conservation; indoor air quality; and site selection and development. Unfortunately, the significant environmental benefits that result from providing functional resilience through the design and construction of better buildings has not been a priority. Enhancements for improved life safety, public health, general welfare and property protection above the minimum building design and construction criteria provided in the ICC *International Building Code* provide the basis for functional resilience. The *High Performance Building Requirements for Sustainability* (HPBRS) uniquely addresses the necessary enhancements, combining energy, water, and resource conservation; indoor environmental quality, and site development with provisions for enhanced functional resilience. The HPBRS is concisely presented in a comprehensive compilation of modifications that may serve as an overlay to the *International Building Code*. Further, criteria outside the purview of the typical building code department have been either intentionally excluded or included only as appendices for consideration of adoption by the authority having jurisdiction.

Functional resilience is about maintaining building serviceability and sustaining communities. The approach in the HPBRS is intended to achieve functional resilience through provisions that provide longer lasting and more durable buildings. With increased frequency of severe events where minimum design loads are exceeded, such buildings should be more resistant to damage. This philosophy is an alternative to buildings or building components designed and constructed to only satisfy the minimum requirements of current building codes and thus require:

- excessive routine maintenance or repair;
- disassembly, disposal, and replacement due to short service life of buildings or building components; and
- repair or disposal and replacement when disasters occur.

Minimum building requirements whether through energy codes, plumbing codes, mechanical codes, zoning codes, or basic building codes, do not encourage truly sustainable buildings. The HPBRS is an attempt to integrate the concepts of the *Whole Building Design Guide* (WBDG) into the minimum design and construction criteria for "high performance," "sustainable," or "green" buildings. The WBDG, developed in partnership between the National Institute of Building Sciences (NIBS) and the Sustainable Building Industries Council (SBIC), has as its key concepts: accessible, aesthetics, cost-effective, functional/operational, historic preservation, productive, secure/safe, and sustainable.

Often advancements in building codes are based on subjective information or intuition. There are numerous references about the economic, societal, and environmental benefits that result when enhanced functional resilience are integrated into building design and construction. A few of these are:

Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities
National Institute of Building Sciences Multi-Hazard Mitigation Council - 2005

One of the findings in this report is "The analysis of the statistically representative sample of FEMA grants awarded during the study period indicates that a dollar spent on disaster mitigation saves society an average of $4." The programs studied often addressed issues and strategies other than enhanced disaster resistance of buildings and other structures. However, more disaster-resistant buildings enhance life safety; reduce costs and environmental impacts associated with repair, removal, disposal, and replacement; and reduce the time and resources required for community recovery.

Five Years Later – Are we better prepared?
Institute for Business and Home Safety - 2010

This IBHS report states: "When Hurricane Katrina made landfall on Aug. 29, 2005, it caused an estimated $41.1 billion in insured losses across six states, and took an incalculable economic and social toll on many communities. Five years later, the recovery continues and some residents in the most severely affected states of Alabama, Louisiana and Mississippi are still struggling. There is no question that no one wants a repeat performance of this devastating event that left at least 1,300 people dead. Yet, the steps taken to improve the quality of the building stock, whether through rebuilding or new construction, call into question the commitment of some key stakeholders to ensuring that past mistakes are not repeated." This report indicates that there is a need to implement provisions to make buildings more disaster-resistant. Clearly this suggests that functional resilience should at least be integrated into the design and construction of sustainable buildings.

National Weather Service Office of Climate, Water and Weather Services
National Oceanic and Atmospheric Administration (NOAA) - 2010

Data provided on the NOAA website [www.weather.gov/os/hazstats.shtml] indicates that the average annual direct property loss due to natural disasters in the United States exceeds of $35,000,000,000. This does not include indirect costs associated with loss of residences,

business closures, and resources expended for emergency response and management. These direct property losses also do not reflect the direct environmental impact due to reconstruction after the disasters. Functional resilience will help alleviate the environmental impact and minimize both direct and indirect losses from natural disasters.

Global Climate Change Impacts in the United States

U.S. Global Change Research Program (USGCRP) - 2009

The USGCRP includes the departments of Agriculture, Commerce, Defense, Energy, Health and Human Services, Interior, State and Transportation; National Aeronautic and Space Administration; Environmental Protection Agency, USA International Development, National Science Foundation and Smithsonian Institution

The report identifies that: “Climate changes are underway in the United States and are projected to grow. Climate-related changes are already observed in the United States and its coastal waters. These include increases in heavy downpours, rising temperature and sea level, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the ocean and on lakes and rivers, earlier snowmelt, and alterations in river flows. These changes are projected to grow.” The report further identifies that the: “Threats to human health will increase. Health impacts of climate change are related to heat stress, waterborne diseases, poor air quality, extreme weather events, and diseases transmitted by insects and rodents. Robust public health infrastructure can reduce the potential for negative impacts.” Key messages in the report on societal impacts include:

- “City residents and city infrastructure have unique vulnerabilities to climate change. “
- “Climate change affects communities through changes in climate-sensitive resources that occur both locally and at great distances.”
- “Insurance is one of the industries particularly vulnerable to increasing extreme weather events such as severe storms, but it can also help society manage the risks.”

Sustainable building design and construction cannot be about protecting the natural environment without consideration of the projected growth in severe weather. Minimum codes primarily based on past natural events are not appropriate for truly sustainable buildings. Buildings expected to have long term positive impacts on the environment must be protected from these extreme changes in the natural environment. The provisions for improved disaster resistance are just another way the HPBRS enhance minimum building codes.

Sustainable Stewardship - Historic preservation plays an essential role in fighting climate change

Traditional Building, National Trust for Historic Preservation - 2008

In the article Richard Moe summarizes the results of a study by the Brookings Institution which projects that by 2030 we will have demolished and replaced 82 billion square feet of our current building stock, or nearly 1/3 of our existing buildings, largely because the vast majority of them weren't designed and built to last any longer. Durability, as a component of functional resilience, can reduce these losses.

Opportunities for Integrating Disaster Mitigation and Energy Retrofit Programs
Senate Environment and Public Works Committee Room, Dirksen Senate Office Building, Washington, D.C. - 2010

During this panel discussion a representative of the National Conference of State Historic Preservation Officers noted that more robust buildings erected prior to 1950 tend to be more adaptable for reuse and renovation. Prior to the mid-1950s most local jurisdictions developed their own building code requirements that uniquely addressed the community's needs, issues and concerns. Pre-1950 building codes typically resulted in more durable and robust construction that lasts longer.

Even though there is a perceived high degree of confidence that building codes or other criteria for designs will result in the anticipated performance, this is not always the case. There are reports of buildings, certified by the Green Building Certification Institute, as compliant with the *Leadership for Energy and Environmental Design* that did not reach their targeted energy conservation performance. Similarly, there is no guarantee that the provisions in any building code, including those addressing functional resilience, are not subjective or intuitive. However, many of the provisions for functional resilience addressed in the HPBRS provide a basis for buildings to comply with the Institute for Business and Home Safety (IBHS) "Fortified" programs. Insurance companies participating in the IBHS "Fortified" program are willing to offer lower premiums for projects that qualify. Providing this level of benefit for functional resilience is far more quantifiable than compliance with many other provisions in building codes or other sustainability initiatives.

Further, what is the total environmental impact of insulation, high efficiency equipment, components, and appliances, low-flow plumbing fixtures, and other building materials and contents which are incorporated into sustainable buildings but become irreparable or contaminated and are disposed of in landfills after disasters? The US Army Corps of Engineers estimated that after Hurricane Katrina nearly 1.2 billion cubic feet of building materials and contents ended up in landfills. This is analogous to stacking enough refrigerators a fifth of the way to the moon or placing them end to end around the equator of the Earth twice.

The modifications to the *International Building Code* presented in the HPBRS enhance the provisions of several of the ICC 2009 series of model codes: *International Building Code, International Electrical Code, International Energy Conservation Code, International Mechanical Code, International Plumbing Code, and International Zoning Code.* The resulting code that combines the HPBRS with the *International Building Code* may not be applicable to all buildings in all jurisdictions. However every jurisdiction is encouraged to consider: (1) adoption for all government owned or financed buildings; (2) adoption for buildings within the jurisdiction that qualify for a high performance "—HP" designation; or (3) in disaster-prone areas or more forward-thinking jurisdictions, adoption for all new buildings.

1) **Government owned or financed buildings -** As increases in tax revenues are becoming more difficult to obtain, jurisdictions need to consider efforts that use tax revenues more wisely. Such revenue should be invested in functionally resilient new buildings rather than continuing to pay high replacement and repair costs for less durable, less disaster-resistant buildings with shorter service lives**.**

2) **Buildings with a high performance (HP) designation -** Government owned or financed buildings and buildings designated HP can serve as exemplary and education buildings within communities. Communities may also be able to identify to their residents that these buildings may be areas of refuge when disasters occur. Reduced expenditures for emergency management, disaster relief and disaster recovery can also be of significant benefits to communities**.**

3) **All new buildings -** In disaster prone areas, the need for sustainable buildings with enhanced functional resilience is becoming more important due to the increasing frequency of extreme weather conditions and more significant losses related to natural disasters. Functionally resilient buildings are not only about landfill avoidance, but they also contribute to better living and working environments and more sustainable communities. Functionally resilient buildings will attract and retain investors, allow businesses to function with a reduced rate of interruption when disasters occur and facilitate disaster recovery. These benefits are not only for the businesses, but also for the residents employed at or relying on the products and services from those businesses.

Where the *High Performance Building Requirements for Sustainability* (HPBRS) are adopted some modifications to the 2009 *International Building Code* would result. The significant modifications are identified, grouped and summarized using a brief description of the intent related to design and construction practices for sustainability. Many of these modifications accomplish much more than positively influencing environmental impact or sustainability. The substantiations however, are intentionally focused on the contributions for improved sustainability.

Concepts and Substantiations	***Modifications***	***IBC Sections***	***HPBRS Sections***
Administration High Performance Building Requirements for Sustainability (HPBRS) uniquely integrates functional resilience with energy, water, and material resource conservation; indoor air quality; and site selection and development as the key components to the design and construction of "green," "sustainable" or "high performance" buildings. A designation is established to identify buildings compliant with the HPBRS. The scope is limited, directing the HPBRS to be applicable to building occupancies where the most significant positive environmental impacts will result.	• Adds high performance requirements	101.1	101.1
	• Excludes Group U occupancies	101.2	101.2
	• Adds sustainability	101.3	101.3
	• Requires peer review for building heights over 75' or spans greater than 150'		107.2.7
	• Adds high performance designation to occupancy classification	111.2 302.1	111.2 302.1
	• Sets criteria to verify conformance	1704.15	1704.15

Air Barriers High performance buildings are designed with energy conserving features like air barrier systems to reduce air infiltration into the interior of the building. The addition of appropriate air barriers criteria contributes to enhanced sustainability by reducing heating and cooling loads. This results in less demand on the utility delivery systems in a community. This also requires less expenditure of materials and resources for construction of utility systems to meet increased utility demand to serve new buildings and using fewer natural resources to generate power thus helping to reduce the negative environmental impacts of non-renewable power generation. Related substantiations: *Energy Conservation, Energy Conservation – Appliances, Energy Conservation – Fenestration, Energy Conservation – Lighting, Heat Island Mitigation, Indoor Environmental Quality – Thermal Comfort.*	• Adds criteria for air barriers		1403.7 1403.7.1 1403.7.1.1 1403.7.1.2 1403.7.1.3 1403.7.1.3.1 1403.7.1.3.2 1403.7.1.3.3 1403.7.2
Automatic Sprinkler Systems Robustness of the building is enhanced by requiring most buildings to be provided with sprinkler protection. Sprinkler protection combined with established fire compartments can reduce damage to the building and its contents from a fire event which in turn enhances sustainability by minimizing how much building materials will be required to restore the building and reduces the amount of materials entering landfills. Appropriate levels of combined containment with automatic fire sprinkler systems minimize damage from fire, smoke, steam and water used for suppression and control, Further, the combination reduces that amount of toxic smoke that may be generated by some building materials and building contents when fires occur. Additional benefits are enhanced life safety, potentially less demand on community resources required for emergency response and allowing facilities to be more readily adapted for re-use if there is a change of occupancy in the future. Related substantiations: *Automatic Sprinkler Systems NFPA 13R, Automatic Sprinkler Systems Trade-Offs, Egress, Electrical , Fire and Smoke Detection, Robust Construction through Strengthened Fire Resistance, Robust Construction through Height and Area Restrictions, Wildland Fire Hazard Mitigation*	• Removes unnecessary language related to the presence of automatic sprinkler systems	505.4 507.6 507.9 507.10 708.2 708.14.1 716.5.2 716.5.4 806.1.2 907.4.3.1 1007.4 1020.1 1021.1 1027.1 2603.3 2609.1	505.4 507.5 507.8 507.9 708.2 708.14.1 716.5.2 716.5.4 806.1.2 907.4.3.1 1007.4 1020.1 1021.1 1027.1 2603.3 2609.1
	• Requires automatic sprinkler systems for all occupancies except F-2 and some S-2	903.2	903.2

Automatic Sprinkler Systems NFPA 13R Robustness of the building is enhanced by requiring most buildings to be provided with sprinkler protection. This includes requiring sprinkler protection throughout all parts of the building including concealed floor and attic spaces of combustible materials. Sprinkler protection in concealed floor and attic spaces can reduce damage to the building and its contents from a fire event which in turn enhances sustainability by minimizing how much building materials will be required to restore the building and reducing the amount of materials entering landfills. Consistent with the discussion under automatic sprinkler systems, this concept supports enhanced life safety, reduced demand on community resources for emergency response and reduced risk to emergency responders. Related substantiations: *Automatic Sprinkler Systems, Automatic Sprinkler Systems Trade-Offs, Egress, Electrical , Fire and Smoke Detection, Robust Construction through Strengthened Fire Resistance, Robust Construction through Height and Area Restrictions, Wildland Fire Hazard Mitigation*	• Prohibits residential combination automatic sprinkler systems	903.3.5.1	903.3.5.1
	• Prohibits the use of NFPA 13R automatic sprinkler systems	903.3.1.2 903.3.5.1.1 903.4 907.2 1021.2T 1026.6	903.3.1.2 903.3.5.1.1 903.4 907.2 1021.2T 1026.6
Automatic Sprinkler Systems Trade-Offs Sprinkler protection combined with compartmentation enhances sustainability by minimizing how much building material will be required to restore the building after a fire event and reducing the amount of materials entering landfills. An added gain from this increased robustness is achieved by eliminating any reductions in other fire safety features that minimum building codes allow due to the presence of sprinkler protection. Consistent with the discussion under automatic sprinkler systems enhance life safety and reduced the demand on community resources for emergency response and risk to emergency responders. Related substantiations: *Automatic Sprinkler Systems, Automatic Sprinkler Systems NFPA 13R, Egress, Electrical , Fire and Smoke Detection, Robust Construction through Strengthened Fire Resistance, Robust Construction through Height and Area Restrictions, Wildland Fire Hazard Mitigation*	• Eliminates increase in volume of stored materials	414.2.5(1)T	414.2.5(1)T
	• Eliminates increases in maximum temperature rise for doors	715.4.4 715.4.4.1	715.4.4 715.4.4.1
	• Eliminates reductions in draftstopping	717.3.2 717.3.3 717.4.3	717.3.2 717.3.3 717.4.3
	• Prohibits relaxation in standpipe criteria	905.3.4	905.3.4
	• Prohibits use of Class I in lieu of Class III standpipes	905.3.1	905.3.1
	• Eliminates provisions that allow for increased glazing	2608.2 2609.4	2608.2 2609.4
	• Eliminates provisions that allow for increased spacing of panels	2608.2 2609.4	2608.2 2609.4
	• Eliminates option for hoistways to be unvented	3004.1	3004.1

Definitions Several definitions are provided to assure proper understanding and appropriate implementation of the provisions related to sustainability.	• Adds definitions for bio-based products, bio-based wood products, classrooms, cross aisles, design resource, development, effective shade coverage expressway, heat capacity, post-consumer recycled content, pre-consumer recycled content, solar reflectance index, and traffic aisles	1202 1402.1	1202 1402.1 L102.1 M102.1 O102.1
Design Service Life Plan High performance building designs use a design service life plan to insure critical features such as choice of materials and building systems that incorporated into the building minimize long term costs for repair, maintenance and replacement of components. This encourages more robust buildings that enhance the sustainable environment through long lasting structures. The primer discussion identifies that the more robust buildings designed and constructed prior to the 1950s are typically more adapted for reuse and renovation. Also in the primer discussion the Brookings Institution report suggests that more recently constructed buildings tend to be more disposable and are being replaced rather than renovated or reused.	• Mandates and sets minimum criteria for design service life plans and retention thereof.	107.2.6 107.2.6.1 107.2.6.2 107.2.6.3 107.2.6.4	107.2.6 107.2.6.1 107.2.6.2 107.2.6.3 107.2.6.4
Earthquake Hazard Mitigation Increasing the stringency of the design criteria of high performance buildings for earthquakes enhances a buildings ability to respond to a ground motion event. This results in more durable buildings which reduces damage to the building and its contents from seismic events which in turn enhances sustainability by minimizing how much building materials will be required to restore the building and reducing the amount of materials entering landfills. Additional benefits are enhanced life safety, potentially less demand on community resources required for emergency response and allowing facilities to be more readily adapted for re-use if there is a change of occupancy in the future. Related substantiations: *Materials Resource Conservation and Efficiency, Security, Wind Hazard Mitigation.*	•Sets criteria for enhanced resistance to earthquake damage	1613.1 1613.5.1	1613.1 1613.1.1 1613.5.1 1613.6.1

Egress Requiring sprinkler protection, fire and smoke detection, and added fire resistance increases the time for occupants to safely egress the building. Life safety is further enhanced by eliminating relaxation of means of egress requirements that minimum building codes allow due to the presence of sprinkler protection. Provisions for enhanced egress directly improve occupant comfort and productivity by providing a safer and more secure environment. These provisions also minimize how much building materials will be required to restore the building after a fire event and reducing the amount of materials entering landfills. Related substantiations: *Automatic Sprinkler Systems Automatic Sprinkler Systems NFPA 13R, Automatic Sprinkler Systems Trade-Offs, Electrical, Fire and Smoke Detection Robust Construction through Strengthened Fire Resistance, Robust Construction through Height and Area Restrictions, Wildland Fire Hazard Mitigation.*	• Requires at least one occupant evacuation elevator even where automatic sprinkler systems are present	1007.2.1	1007.2
	• Mandates minimum clearance for all stairways	1007.3	1007.3
	• Prohibits elimination of areas of refuge	1007.3	1007.3
	• Prohibits increases in common path of travel distances	1014.3	1014.3
	• Prohibits increase in occupant load for single exits in Group R-2 occupancies	1015.1	1015.1
	• Prohibits decreases in the separation distance between exits	1015.2.1	1015.2.1
	• Prohibits increases in travel distance to exits	1016.1T	1016.1T
	• Prohibits increases in the length of dead ends in corridors	1018.4	1018.4
Electrical High performance buildings are designed with added features to the electrical system such as only using screw-wired type connectors for electrical conductors and surge protectors for the electrical services. These design features enhance the sustainable environment by reducing risk of electrical fires that can damage buildings thus minimizing how much building materials will be required to restore the building and reducing the amount of materials entering landfills.	• Enhances electrical safety	2703.1 2703.2 2704.1	2703.1 2703.2 2704.1
Energy Conservation High performance buildings must be designed with more energy conserving features add to the sustainable environment of a community by reducing demand on and adding complexity to required utility delivery systems. Building operation and space conditioning equates to nearly 1/3 of all energy use in the United States. The significant contribution of reduced energy consumption and shifted peak demand is less environmental impact from non-	• Sets criteria for enhances energy conservation	1301.1	1301.1
	• Adds definitions for building thermal envelope, fenestration, visible transmittance		1302.1
	• Sets criteria for peak load reduction		1303.5
	• Sets criteria for energy monitoring		1303.8

renewable resources used to generate power. This also requires less expenditure of materials and resources for construction of utility infrastructure to meet increased utility demand to serve new buildings. Related substantiations: *Air Barriers, Energy Conservation – Appliances, Energy Conservation – Fenestration, Energy Conservation – Lighting, Heat Island Mitigation, Indoor Environmental Quality – Thermal Comfort,*	• Sets minimum criteria for energy conservation		1304.1 1304.1.1 1304.1.2 1304.1.3 1304.1.4
	• Sets maximum baseline building criteria for energy conservation		1304.1.4T
	• Sets criteria for solar reflectance of exterior walls		1409.1 1409.2
	• Modifies criteria for landscaped roofs	1507.16	1507.16
	• Sets criteria for solar reflectance of roofs		1507.17. 1507.17.1 1507.17.2
	• Adds criteria to better ensure integrity of foundation insulation		1805.2.1.1
	• Requires escalators and moving walkways to slow down or stop when not in use		3005.2.3
Energy Conservation – Appliances High performance buildings need to be designed with energy efficient appliances and equipment such as those labeled Energy Star. These add to the sustainable environment of a community by reducing energy loads for the building. The significant contribution of reduced energy consumption is less environmental impact from non-renewable resources used to generate power. This also requires less expenditure of materials and resources for construction of utility infrastructure to meet increased utility demand to serve new buildings. Related substantiations: *Air Barriers, Energy Conservation, Energy Conservation – Fenestration, Energy Conservation – Lighting, Heat Island Mitigation, IEQ – Thermal Comfort,*	• Sets criteria for appliances and equipment		1303.7

Energy Conservation – Fenestration High performance buildings need to be designed with more energy conserving windows, doors and glazed wall systems. These add to the sustainable environment of a community by reducing heating and cooling loads for the building. The significant contribution of reduced energy consumption is less environmental impact from non-renewable resources used to generate power. This also requires less expenditure of materials and resources for construction of utility infrastructure to meet increased utility demand to serve new buildings. Related substantiations: *Air Barriers, Energy Conservation, Energy Conservation – Appliances, Energy Conservation – Lighting, Heat Island Mitigation, Indoor Environmental Quality – Thermal Comfort,*	• Sets criteria for fenestrations		1303.4 1303.4.1 1303.4.2 1303.4T 1303.4.3
Energy Conservation – Lighting High performance buildings need to be designed with appropriate consideration of daylighting and the use of energy efficient light fixtures. These add to the sustainable environment of a community by reducing energy loads for the building. The significant contribution of reduced energy consumption is less environmental impact from non-renewable resources used to generate power. This also requires less expenditure of materials and resources for construction of utility infrastructure to meet increased utility demand to serve new buildings. Related substantiations: *Air Barriers, Energy Conservation, Energy Conservation – Appliances, Energy Conservation – Fenestration, Heat Island Mitigation, Indoor Environmental Quality – Thermal Comfort,*	• Sets criteria for light pollution reduction		1205.3.1
	• Sets criteria for daylighting		1303.1
	• Sets criteria for lighting controls		1303.2 1303.3
	• Sets criteria for exterior lighting		M109.1 M109.1.1 M109.1.2 M109.1.3
Fire and Smoke Detection Provisions for enhanced detection alert occupants and emergency responders to the hazard. Early response will help minimize the amount of damage. This is achieved by eliminating reductions in other fire safety features such as manual activation of fire alarms that minimum building codes allow due to the presence of sprinkler protection. Provisions for enhanced notification systems directly improve occupant comfort and productivity by providing a safer and more secure environment.	• Requires manual fire alarm boxes	907.2.1 907.2.2 907.2.3 907.2.4 907.2.7 907.2.8.1 907.2.9	907.2.1 907.2.2 907.2.3 907.2.4 907.2.7 907.2.8.1 907.2.9
	• Requires smoke detection in Group I occupancies	907.2.6.1 907.2.6.3.3	907.2.6.1 907.2.6.3.3

Related substantiations: *Automatic Sprinkler Systems Automatic Sprinkler Systems NFPA 13R, Automatic Sprinkler Systems Trade-Offs, Egress, Electrical, Robust Construction through Strengthened Fire Resistance, Robust Construction through Height and Area Restrictions, Wildland Fire Hazard Mitigation*	• Require smoke detection system in buildings located in wildland urban fire areas	907.2.24	907.2.24
Flood Hazard Mitigation Increasing the stringency of the design criteria for flood hazards enhances the ability to resist damage to the building and reduce loss of contents. This enhances sustainability by minimizing how much building materials will be required to restore the building and reducing the amount of materials entering landfills. Additional benefits are enhanced life safety, potentially less demand on community resources required for emergency response and allowing facilities to be more readily adapted for re-use if there is a change of occupancy in the future. When organic materials and most building contents are damaged by flood waters, contamination prevents reuse and they must be disposed.	• Sets criteria for enhanced resistance to flood damage	1612.4	1612.4 1811.1
	• Mandates provisions for enhances resistance to damage due to flooding	Appendix G	Appendix G
	• Prohibits development in floodplains		O101.1.2
Habitat Protection High performance building design need to include proper site selection and placement of the building to reduce the negative impact to the natural environment. This includes avoiding wetlands and land adjacent to sensitive bodies of water or the natural habitat of endangered species. Other provisions retain open spaces and provide restrictions on lighting to minimize the negative impact of the building on habitats.	• Sets criteria for light pollution reduction		1205.3.1
	• Adds criteria for properly harvested wood		2309.1
	• Sets criteria for exterior lighting		M109.1T M109.2
	• Prohibits development in endangered or threatened species habitats		O101.1.3
	• Prohibits development near wetlands		O101.1.4 O101.1.5
	• Prohibits development near bodies of water		O101.1.6 O101.1.7
Related substantiations: *Materials Resource Conservation and Efficiency, Heat Island Mitigation, Site Selection and Development, Site Selection and Development*	• Restricts site development		O103.1 O103.1T O103.2 104.1

Hail Impact Resistance Increasing the robustness for the exterior of buildings located in areas subject to hail damage reduces the likelihood the building will be damaged from a hail storm event. This reduces the amount materials needed to repair or replace damaged materials which in turn enhances sustainability. This also reduces the amount of materials entering landfills. Related substantiations: *Wildland Fire Hazard Mitigation, Wind Hazard Mitigation*	• Sets criteria to enhance hail damage resistance for exterior building elements		1408.3.1 1507.1.1 1507.1.1.1 1507.1F
Heat Island Mitigation High performance building design needs to include appropriate development of the site, driveways and parking areas, selection of site vegetation and selection of materials for the exterior of the building to reduce the absorption of heat from the sun. Heat generated from the sun increases the demand for cooling the inside of buildings which is inconsistent with efforts to conserve energy in a sustainable environment. Cooler surfaces also help preserve habitats, especially by reducing the temperature of stormwater runoff on sites located near wetlands and bodies of water. The energy savings provide benefits discussed in the section energy conservation. Related substantiations: *Air Barriers, Energy Conservation, Energy Conservation – Appliances, Energy Conservation – Fenestration, Energy Conservation – Lighting, Indoor Environmental Quality – Thermal Comfort,*	• Sets criteria to minimize heat island effects		M107.1 M107.2 M107.3 M107.3.1 M107.3.1.1 M107.3.1.2 M107.3.2 M107.3.3
	• Restricts site development		O104.1
Interior Environmental Quality – Air Quality Maintaining a healthy indoor environment is necessary to provide productive and comfortable places to work and live. Enhancing air quality is accomplished by using materials less hazardous to people's health and improving ventilation and filtering of indoor air. The benefits include improved comfort, worker moral and reduced expenditures for health related effects on personnel.	• Adds criteria to limit volatile organic compound (VOC) concentrations		804.5
	• Limits off-gassing of building materials, adhesives, sealants, paints, and coatings		807.1 808.1 809.1
	• Sets minimum ventilation requirements	1203.1	1203.1
	• Sets criteria for removal of particulate matter		1203.6 1203.6.1 1203.6.2
	• Sets criteria for carbon dioxide detection		1203.7

	• Provides restrictions for recreational smoking areas		1203.8 1203.8.1 1203.8.1.1 1203.8.1.2 1203.8.1.3 1203.8.1.4 1203.8.2 1203.8.2.1 1203.8.2.2 1203.8.2.3
	• Adds criteria for particulate matter removal		2802.1
Related substantiations: *IEQ– Debris, IEQ – Moisture, IEQ – Noise, IEQ – Radon Mitigation, IEQ – Rodentproofing, IEQ – Thermal Comfort, Security, Water Conservation and Resource Management and Protection*	• Sets criteria for cleanliness of HVAC systems during and after construction		3314.1 3314.1.1 3314.1.2 3314.1.2T
Interior Environmental Quality – Debris Reductions in the amount of outside debris being brought into the building improve indoor environmental quality. New provisions include special building mats located at major entries into the building. In addition to a cleaner and healthier environment key sustainability issues resulting from less debris being distributed throughout the building are less manpower, cleaning agents, cleaning equipment and HVAC equipment filter replacements. Related substantiations: *IEQ – Air Quality, IEQ – Moisture, IEQ – Noise, IEQ – Radon Mitigation, IEQ – Rodentproofing, IEQ – Thermal Comfort, Security, Water Conservation and Resource Management and Protection*	• Sets criteria to limit distribution of debris in buildings		1211.1
Interior Environmental Quality – Moisture Enhanced indoor environment through the control of moisture being introduced into building improves the quality of the work and living spaces and reduces damage to the built environment. This is accomplished with features such as using durable, non-absorbent floor and wall finishes, providing extra protection to piping subject to freezing and protecting building materials on construction sites from exposure to high moisture prior	• Sets criteria for enhanced moisture protection	1210.1 1210.2	1210.1 1210.2
	• Adds criteria for spray from lawn sprinklers		1403.8
	• Sets criteria for secondary water protection for high wind regions		1503.1
	• Enhances floor drains to limit water		2903.4

to incorporation into the structure. This results in more robust building with reduced risk of damage to the building and its contents from moisture or water which in turn enhances sustainability by minimizing how much building materials will be required to restore the building and reducing the amount of materials entering landfills. Several of these modifications will also help minimize the potential for the growth of mold and mildew. This reduces the risk to occupant health and requires less resources to remove, dry, and clean affected building components. Related substantiations: *IEQ – Air Quality, IEQ – Debris, IEQ – Noise, IEQ – Radon Mitigation, IEQ – Rodentproofing, IEQ – Thermal Comfort, Security, Water Conservation and Resource Management and Protection*	damage		
	• Enhances water pipe requirements to limit water damage		2903.5
	• Sets requirements for construction materials subject to damage from moisture		3313.1 3313.1.1 3313.1.2
Interior Environmental Quality – Noise Noise control is a crucial quality for interior environment of high performance buildings. Extra attention to noise control in the building through enhancements for walls and floors separating spaces from each other and from the exterior of the building improve the work environment, worker morale and occupant comfort. Through good planning and sustainable site development proximity to other buildings and structures and occupant densities within buildings tend to increase. Noise control is necessary for healthy, safe, comfortable and productive interior environments in these more densely populated areas and buildings. The desire for sustainable buildings to be located near the transportation infrastructure combined with infrastructure changes to meet increasing populations and density requires the audibility of exterior sounds in the interior environments to be reduced. Related substantiations: *IEQ – Air Quality, IEQ – Debris, IEQ – Moisture, IEQ – Radon Mitigation, IEQ – Rodentproofing, IEQ – Thermal Comfort, Security, Water Conservation and Resource Management and Protection*	• Sets criteria for enhanced noise control	1207.1	1207.1
	• Sets criteria for enhanced noise control - air-borne sound	1207.2 1207.2.1	1207.2 1207.2.1 1207.2.1.1 1207.2.1.1.1 1207.2.1.1.2 1207.2.1.1.3 1207.1.2 1207.1.3 1207.2.2
	• Deletes unnecessary language for noise control	1207.2.1	
	• Sets criteria for enhanced noise control - structure-borne sound	1207.2.3	1207.2.3
Interior Environmental Quality – Radon Mitigation Where high levels of radon are present in soils, foundations must be designed to minimize infiltration into the interior environment. The result is improved occupant health, comfort and morale and can reduce expenditures for health related effects.	• Mandates design and construction for radon mitigation		Appendix N
	• Sets criteria for radon mitigation techniques		N101.1 N101.1.1 N101.1.1.1 N101.1.1.2 N101.1.1.3

Related substantiations: *IEQ – Air Quality, IEQ – Debris, IEQ – Moisture, IEQ – Noise, IEQ – Rodentproofing, IEQ – Thermal Comfort, Security, Water Conservation and Resource Management and Protection*			N101.1.1.4 N101.1.1.5 N101.3
Interior Environmental Quality – Rodentproofing Building elements enclosing habitable spaces in high performance buildings need to be designed to minimize infestation by rodents. The result is improved occupant health, comfort and morale and can reduce expenditures for health related effects. Rodentproofing also reduces the potential for destruction of building components due to infestations and the negative environmental impacts due to extermination. Damaged materials need to be repaired or replaced and infestations tend to lead to openings in the exterior enveloped impacting energy conservation and moisture penetration resistance. Related substantiations: *IEQ – Air Quality, IEQ – Debris, IEQ – Moisture, IEQ – Noise, IEQ – Radon Mitigation, IEQ – Thermal Comfort, Security, Water Conservation and Resource Management and Protection*	• Mandates rodentproofing		Appendix F
Interior Environmental Quality – Thermal Comfort Energy conserving features like programmable thermal controls are provided in high performance buildings to regulate the comfort of the interior environment. These add to the sustainable environment of a community by reducing energy loads for the building and enhancing the occupants work and living spaces. This results in less demand on the utility delivery systems in a community and improved occupant morale and comfort. Related substantiations: *Air Barriers, Energy Conservation, Energy Conservation – Appliances, Energy Conservation – Fenestration, Energy Conservation – Lighting, Heat Island Mitigation, IEQ – Air Quality, IEQ – Debris, IEQ – Moisture, IEQ – Noise, IEQ – Radon Mitigation, IEQ – Rodentproofing, Security, Water Conservation and Resource Management and Protection*	• Provides criteria for controlling the thermal environment		1204.2 1204.2.1 1204.2.2 1204.2.3 1212.1

Materials Resource Conservation and Efficiency Building material selection needs to consider the environmental impacts of mining, harvesting, processing and manufacturing. This includes using regional materials to reduce transportation to the site, the use of materials with some recyclable content or material that can be recycled when removed from the building. Incorporating features into the building design that encourage recycling by building occupants is also encouraged. The use of quality materials with demonstrated long service life potential, especially those that are recyclable, are important sustainability features with regard to long-term waste management. Consideration is also given to building systems that satisfy multiple performance criteria for the building project. Related substantiations: *Automatic Sprinkler Systems Design Service Life Plan, Earthquake Hazard Mitigation, Flood Hazard Mitigation, Hail Impact Resistance, IEQ – Moisture, IEQ – Rodentproofing, Pavement Serviceability and Durability, Robust Construction through Strengthened Fire Resistance, Robust Construction through Height and Area Restrictions, Snow and Ice Damage Mitigation, Waste Management, Water Conservation and Resource Management and Protection, Wildland Fire Hazard Mitigation, Wind Hazard Mitigation*	• Sets sustainability criteria for building materials		Appendix L L101.1 L101.2 L101.3 L101.4
	• Sets minimum criteria for recycled content, reused materials, and resource minimizations		L105.1 L105.1.1 L105.1.2 L105.1.3 L105.1.4 L105.1.5 L105.1.6 L105.2
	• Sets criteria for maximum fuel consumption for materials transport		L106.1
	• Sets criteria for environmental stewardship at points of extraction, harvesting, manufacture and assembly		L107.1 L107.1.1 L107.1.2 L107.1.3 L107.1.4 L107.2
Parking Area Design Parking areas need to accommodate occupancy and use without being oversized. This enhances sustainability by minimizing the amount of the natural environment that must be disturbed, the frequency and amount of material used in parking areas, and the resources required for maintenance. Related substantiations: *Design Service Life Plan, Heat Island Mitigation, Materials Resource Conservation and Efficiency, Pavement Serviceability and Durability*	• Mandates sustainability practices for the design and construction of parking areas and drives		Appendix M M101.1
	• Sets criteria for parking area design including parking spaces and traffic aisles		M103.1 M103.1T M103.2 M104.1 M104.2 M104.3 M104.4 M105.1 M105.2 M105.3

Pavement Serviceability and Durability Careful development of the site, drives and parking areas includes providing durable pavements which have long life expectancy and require little maintenance. This enhances sustainability by minimizing the frequency and amount of material and manpower resources that will be required for maintenance, repair and replacement. Related substantiations: *Design Service Life Plan, Materials Resource Conservation and Efficiency*	• Sets minimum serviceability criteria for pavements		M106.1 M106.1.1 M106.1.2 M106.1.3 M106.1.4
Robust Construction through Strengthened Fire Resistance Increased fire resistance of building elements reduces the amount of damage to the building and its contents. This enhances sustainability by minimizing how much building materials will be required to restore the building and reduces the amount of materials entering landfills. Additional benefits are enhanced life safety, potentially less demand on community resources required for emergency response, and allowing facilities to be more readily adapted for re-use if there is a change of occupancy in the future. Robustness is a predominant component for functional resilience as discussed in the primer to this table. The substantiation for functional resilience is not repeated here.	• Eliminates reduction in fire resistance rating for building elements	404.6 413.2 403.2.1.2 508.2.5 508.2.5.2 508.2.5.3 508.2.5T 601T 602.4.3 705.8T 706.4T 709.3 712.3 803.11.2 804.4.1 905.4.1 1018.1T	404.6 413.2 403.2.1.2 508.2.5 508.2.5.2 508.2.5.3 508.2.5T 601T 602.4.3 705.8T 706.4T 709.3 712.3 803.11.2 804.4.1 905.4.1 1018.1T
	• Limits mixed occupancy buildings in Groups A-1 and A-2 to Type I or Type II construction	507.3.1	507.3.1
	• Strengthens the fire resistance criteria for building elements	503T 507.3 508.3.3 508.4T 706.3 709.1 1406.2.1.1	503T 507.3 508.3.3 508.4T 706.3 707.3.10 709.1 1406.2.1.1

		1505.1T 1505.5	1408.3.1 1505.1T 1505.5 1505.8
	• Strengthens the requirement for protection of openings	705.8.2 705.12 706.8 707.6	705.8.2 705.12 706.8 707.6
	• Eliminates reductions in provisions intended to resist fire spread	705.8.5 705.11 706.5 709.4	705.8.5 705.11 706.5 709.4 2803.1
Related substantiations: *Automatic Sprinkler Systems Automatic Sprinkler Systems NFPA 13R, Automatic Sprinkler Systems Trade-Offs, Egress Electrical, Fire and Smoke Detection, Robust Construction through Height and Area Restrictions, Wildland Fire Hazard Mitigation*	• Eliminates reductions in fire performance and smoke development for interior finishes	803.5T	803.5T
Robust Construction through Height and Area Restrictions Requiring increased fire resistance for building elements, as buildings increase in size, reduces the amount of damage to the building and its contents. This enhances sustainability by minimizing how much building materials will be required to restore the building. This also reduces the amount of materials entering landfills, positively impacts the demand on community resources required for emergency response, and allows facilities to be more readily adapted for re-use if there is a change of occupancy in the future. Robustness is a predominant component to functional resilience as discussed in the primer to this table. The substantiation for functional resilience is not repeated here. Related substantiations: *Automatic Sprinkler Systems Automatic Sprinkler Systems NFPA 13R, Automatic Sprinkler Systems Trade-Offs, Egress, Electrical, Fire and Smoke Detection, Robust Construction through Strengthened Fire Resistance, Wildland Fire Hazard Mitigation*	• Eliminates height and/or areas increases	406.3.5T 503T 504.2 506.3 506.4.1 507.4	406.3.5T 503T 504.2 506.3 506.4.1
	• Clarifies that only one story Group F-2 and S-2 buildings can be unlimited in area	507.2	507.2
	• Limits unlimited area in Group B, F, M and S occupancy classifications to Type I and Type II construction	507.3	507.3
	• Removes unnecessary language for Group H occupancies	507.7	507.6
Security Enhanced resistance to forced entry provides additional safety and security.	• Sets minimum criteria for forced entry resistance		Appendix P P101.1 P101.2

The benefits are improved occupancy comfort and elevated security which may provide for more continuous operation of businesses. The enhanced security features also assist in making the building more robust and resistant to damage from impacts and wind. More secure buildings tend to keep communities safer and thereby attract and retain businesses and residents.	• Sets minimum criteria for forced entry resistance for exterior doors and door frames		P102.1 P102.1.1 P102.1.2 P102.1.3 P102.2 P102.2.1 P103.1 P103.2
	• Sets minimum criteria for forced entry resistance for windows		P104.1
	• Sets minimum criteria for alarms and monitoring		P105.1 P105.2 P105.3 P105.4
	• Sets minimum criteria for exterior lighting for security		P105.5
Related substantiations: *Energy Conservation – Lighting, Hail Impact Resistance, IEQ – Noise, IEQ – Rodentproofing, Wind Hazard Mitigation*	• Sets special security criteria for Group M occupancies		P106.1 P106.1.1 P106.1.2 P106.2
Site Selection and Development Careful site selection and placement of the building reduces the negative impact to the natural environment. To accomplish this development in or near wetlands and land adjacent to sensitive bodies of water or the natural habitat of endangered species is prohibited.	• Sets restrictions on land use		O101.1
	• Prohibits use of prime farmland for buildings		O101.1.1
	• Prohibits development near bodies of water		O101.1.2 O101.1.6
	• Prohibits development identified as a habitat for endangered species		O101.1.3
	• Prohibits development near bodies of water		O101.1.2 O101.1.6
	• Prohibits development in wetlands		O101.1.4 O101.1.5
Related substantiations: *Habitat Protection, Heat Island Mitigation, Parking Area Design, Water Conservation and Resource Management and Protection*	• Prohibits development on parkland and preserves		O101.1.7 O101.1.7.1 O101.1.7.2

Snow and Ice Damage Mitigation Increasing the stringency of the design criteria for snow and ice hazards results in more robust buildings with less risk of damage to the building and its contents. Enhances sustainability is achieved by minimizing the amount of both replacement materials required to restore the building and damaged materials entering landfills.	• Sets criteria for heat strips to prevent ice dams		1503.4.4
	• Sets criteria for enhanced resistance to snow damage	1608.2	1608.2
Waste Management Building design and material selection need to consider the environmental impacts of waste generated during construction. This includes using materials with some recyclable content or material that can be recycled or reused when removed from the building. Limits for maximum amounts of waste during construction are established. An additional set of provisions allow for adequate recyclable and reusable waste collection and storage areas. Many recyclables are combustible, and when sorted and collected in mass can become a fire hazard, thus frequency, location, health and safety of these areas are addressed. Related substantiations: *Materials Resource Conservation and Efficiency*	• Sets criteria for the design and construction of storage and collection areas		L103.1 L103.1.1 L103.1.2 L103.1.3 L103.1.4 L103.1.5 L103.2 L103.2.1 L103.2.2 L103.2.3 L103.3 L103.3T
	• Sets criteria to minimize the amount of construction waste		L104.1 L104.2 L104.3
Water Conservation and Resource Management and Protection There are several water resource concepts applicable to high performance buildings. Building design and site development should allow for collection and storage of rainwater for reuse in irrigation. Water saving fixtures also are available. Both of these concepts support preservation of water as a natural resource and add to the sustainable environment of the community. Reducing quantities of water needed at the site results in less demand on natural water resources, less demand on water treatment plants, and reduces expenditure of materials and resources for expansion of water utility systems.	• Adds provisions for rainwater management		1511.1
	• Sets criteria for plumbing fixtures, and other water using devices		2904.1
	• Sets criteria for water metering		2905.1
	• Sets criteria for runoff management		M108.1 M108.1.1 M108.1.2 M108.1.3 M108.1.3.1 M108.1.3.2
	• Prohibits development in or near wetlands and near bodies of water		O101.1.4 O101.1.5

Related substantiations: *Indoor Environmental Quality – Moisture*			O101.1.6
Wildland Fire Hazard Mitigation When buildings are built in areas subject to wildfires they are at risk to damage that may occur. To reduce the likelihood of damage, sites for high performance buildings will be reviewed for characteristics of the surrounding environment to see if they may contribute to wildfires. If found, the building design will incorporate features to enhance the robustness of the building to reduce risk of fire damage and production of toxic emissions. In turn this enhances sustainability by minimizing how much building materials will be required to restore the building and reduce the amount of materials entering landfills. Additional benefits are enhanced life safety and potentially less demand on community resources required for emergency response. Related substantiations: *Automatic Sprinkler Systems Automatic Sprinkler Systems NFPA 13R, Automatic Sprinkler Systems Trade-Offs, Egress, Electrical , Fire and Smoke Detection Robust Construction through Strengthened Fire Resistance, Robust Construction through Height and Area Restrictions*	• Mandates compliance with the IWUIC	101.4 705.1	101.4 101.4.7 705.1
Wind Hazard Mitigation Incorporating storm shelters and community shelters into the design of buildings located in high wind regions enhances the living environment for the occupants. These shelters become havens for protecting people from injury or death due to structural collapse and windborne debris. The use of shelters reduces the demand on community resources required for emergency response and healthcare. Increasing the stringency of the design criteria of high performance buildings for wind hazards results in more robust buildings. The sustainability benefit from reduced damage minimizes how much building materials will be required to restore the building. A further benefit is a reduction in the amount of damaged building materials and content entering landfills. The community also benefits because there is less demand on community resources required for emergency response and relief. Facilities that can more quickly be reoccupied or adapted for re-use support community continuity.	• Mandates storm shelters	423.1	423.1 423.3
	• Sets criteria for high wind event prone areas		423.3.1 423.3.2 423.3.3
	• Enhances the wind resistance criteria for exterior walls	1405.14	1405.14 1408.3.1
	• Sets criteria for gutters in high wind regions	1503.4.3	1503.4.3
	• Enhances wind resistance of roof coverings	1504.3 1504.3.1 1504.4 1504.5 1504.8 2304.7.2	1504.1.1 1504.3 1504.3.1 1504.4 1504.5 1504.8 2304.7.2

			2304.7.2.1 2304.9.1 2304.9.1.1
Related substantiations: *Earthquake Hazard Mitigation, Materials Resource Conservation and Efficiency, Security*	• Sets criteria for enhanced resistance to wind damage	1609.1.1 1609.1.2 1609.1.3	1609.1.1 1609.1.2 1609.1.3