Code Requirements and Sustainable Design

Project stakeholders should collaborate early in the design process to ensure building- and fire-code requirements are met

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A societal shift to become better stewards of our environment is taking place all around us. As part of this "greening" shift, practitioners and stakeholders at all levels of the built-environment community quickly are realizing that innovative building-design solutions are outpacing the language/concepts that have been the foundation of model building and fire codes.

Sustainable-design-project teams often are confronted with "roadblocks" when it comes to strictly meeting traditional building/fire-code requirements. These teams need to invoke provisions of codes that address alternate designs, materials, and methods of construction. For example, many sustainable-design projects include elements such as underfloor-air-distribution (UFAD) systems, exterior sunshades/light shelves, light wells, and atria. During a project's permit process, design elements often are met with questions and concerns from local building and fire authorities because they do not address the traditional prescriptive requirements of model building and fire codes, as well as the traditional process of schematic design, design development, and construction-document development.

As outlined in the International Building Code (IBC) and other model codes, an alternative design, method of construction, or material may be approved when a building official finds that it is satisfactory and complies with the intent of the code provisions, fulfills its intended purpose, and has at least the equivalent quality, strength, effectiveness, fire resistance, durability, and safety of what is prescribed by code.[1] This "alternative method and materials" section of most building codes is from what a collaborative, integrated design process needs to evolve for a sustainable-design project. To meet a building code's threshold criteria, project teams need to provide supporting evidence of their proposed alternative approach, design method, and/or materials. Data supporting assemblies and comprehensive design packages and/or test reports often are needed to substantiate requests for alternative materials or methods and must be presented to a project's building/fire officials for approval. Without supporting data, evidence, tests, or research reports, implementation of sustainable-design elements may be delayed.

The effective incorporation of sustainable-design elements requires an integrated, collaborative design process. This process requires the "blending" of all stakeholders involved in a project. These stakeholders range from the building owner to the architect, mechanical engineer, electrical engineer, structural engineer, fire-protection engineer, interior designer, and local building and fire

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authorities. Rather than each design practitioner working mostly in a semi-autonomous environment to provide design solutions within his or her area of expertise, an integrated design approach draws on a group's collective expertise to develop comprehensive design solutions likely to be approved by local building/fire officials.

This integrated design process is critical for sustainable-design projects and often is managed during periodic meetings conducted by project-team members. Through these meetings, team members' strengths are combined in identifying areas of overlap and synergy and addressing water usage, energy usage, occupant comfort/usage, daylighting, environmental impact, and other issues.

To achieve energy efficiency, a project team not only needs to utilize the expertise of a mechanical engineer for the design of a building's heating and cooling systems, but to collaborate with others on a building's sun-exposure orientation, natural lighting, and landscaping. Each of these elements can play a role in whether code requirements are met.

To "bridge the gap" between the implementation of sustainable design elements and building/fire-code requirements, code intent, and firefighting tactics, it is important that a project team understand that building codes are based on the minimum requirements for safeguarding public health, safety, and general welfare. Building-official approval of innovative materials, systems, and assemblies is a critical part of the design process that often is overlooked. Limiting the possibility of a redesign requires expertise regarding building-code and fire-protection requirements.

HVAC SYSTEMS

UFAD systems have become a common element in green-building design. The concept is to use the area under a floor as a plenum space for supply-air distribution and the space above a ceiling as the return plenum in a noncombustible building. Several code issues may need to be addressed when a UFAD system is proposed. The area under a floor often is used for power- and data-cable distribution. In a plenum space, a power cable needs to conform to electrical-code requirements, while a data cable must be plenum-rated. There can be issues regarding connections between power and data cables under and above a floor. As a result, some jurisdictions require smoke detection beneath floors, which creates access and maintenance issues. Some jurisdictions see this plenum space as being similar to a computer room's raised floor, which requires sprinkler protection. This yields problems for underfloor-duct installations or fire stops under floors, which further disrupts airflow.

Some mechanical inspectors have fought the use of UFAD systems, viewing them as a possible violation of mechanical-code restrictions against unducted heating air distribution under floors. Regardless, when proposed, such systems need to be cleared with code authorities. If a system is allowed, any necessary special requirements must be established.

In green buildings, atria are a common method of allowing natural light and air distribution, sometimes in conjunction with natural ventilation, to assist the stack effect in the air-distribution process. Smoke control often is required when an atrium is planned. Also, atria generally are required to be served by sprinkler systems that are separate from the remainder of the floors. Other fire-protection issues, such as an atrium's size and arrangement, including the location of walking surfaces and exit paths, need to be discussed early in a design process. These issues, in conjunction with design-fire size, will affect a smoke-control ventilation system. (Model building codes, such as the IBC, have requirements regarding the size of design fires.[2])

Supply- and exhaust-air requirements also need to be established. These determine the amount of equipment required and the size of the air shaft serving a space. Supply-air velocity is important in smoke-control systems, and it affects grille sizing and location. These issues are better determined early in a design process for space requirements and power consumption (normal and emergency) to be established for smoke-control-system equipment.

Natural ventilation sometimes is used to supplement or provide supply air to an atrium, both normally and in smoke-control mode. In the event natural ventilation is used, the wind effect may need to be modeled and accounted for in the design of a smoke-exhaust system. In some cases, natural ventilation and the stack effect may be suitable to ventilate an atrium normally and during a fire.

Natural-ventilation designs require a performance-based design approach. In this approach, it is likely that modeling would be performed to prove the adequacy of an atrium's ventilation for a variety of fire scenarios. Mechanical-exhaust capacity also can be modeled in an attempt to reduce the required exhaust quantity. Modeling also can allow the adjustment of fan capacity determine the location of fan intakes and exhaust. Regardless, the general concept and approach to dealing with an atrium needs to be established early in a project and discussed with all of the stakeholders, including the authority having jurisdiction (AHJ).

EXTERIOR SHADING

Sunshades, sun shelves, or sunscreens are a common means of reducing heat load in green-building design. Some of the more unusual designs include movable screens. A fire department may have concerns about sunscreens and sun shelves because of the materials proposed or operation and building-access issues. There also may be concern over the use of any green-roof systems. These present operational issues regarding how firefighters ladder a building for rescue purposes. Green buildings need to work for fire departments, with unusual design features discussed early in a project and the local fire department's input obtained. A fire department is a stakeholder that often is overlooked in the design process.

An AHJ may have an issue with a proposed sunshade or sunscreen material. Initially, this may be an architectural issue, but ultimately, if the AHJ does not accept the proposed material, it may affect the heat load and mechanical systems. Some proposed materials are combustible or, at the very least, have not been fire tested in the proposed configuration. As such, full-scale testing at an approved fire-test laboratory may be necessary or required to establish whether a material burns and, if it does, at what rate. If the sunshade or sunscreen material used in a system is going to be an issue, it needs to be established early in a project.

FIRE SUPPRESSION

Rainwater cisterns and reclaimed water are being used to supply not only irrigation systems, but fire-sprinkler systems. Industrial sites often have non-potable-water supplies contributing to a fire-water-supply system, but for the most part, residential and commercial urban developments have potable-fire-water supplies. When reclaimed water is interfacing with potable systems and is proposed as part of a fire-water-supply system, backflow requirements need to be reviewed carefully. In addition, there may be sprinkler-drop requirements that need to be taken into account to protect sprinklers against sediment buildup in their pipes. Finally, pipe-corrosion potential needs to be evaluated. Microbiologically influenced corrosion (MIC) may be an issue with the use of reclaimed-water supplies. Where present, MIC can reduce a sprinkler pipe's life significantly and require chemical treatment to remediate. It may not make sense to use reclaimed water as part of a fire-suppression system if chemicals must be added to the system or if a premature failure of the sprinkler system could occur because of poor water quality.

Water-mist systems have been used in green-building designs as an element of fire suppression. In some cases, water-mist use is not the result of a desire to conserve water, but of working with the available water supply, especially in adaptive-reuse buildings. Water mist can be used to deal with issues associated with an available water supply's inability to support pressure and flow for new sprinkler systems. For example, an old high-rise warehouse was converted to mixed-use occupancy with residential and commercial components. Because parking was needed in the building, the owner proposed a multiple-level car-stacker system. The fire department indi-

Green Benefits of Copper in Sprinkler Systems

With the rapid growth of the green-building movement, mechanical-systems engineers increasingly are being tasked to develop more efficient and environmentally friendlier HVAC systems. One critical component of a building's overall design is the fire-sprinkler system. Copper, a material recommended and specified for all types of water-supply systems, also is recognized for its green attributes. These include:

• *Recyclability*. Copper tubing is 100-percent recyclable and typically contains pre- and post-consumer scrap. Copper tube and fittings can contain a high amount of recycled copper with no loss of purity.

• *Fire resistance*. Although fire temperatures can reach 1,500°F, copper has a melting point of nearly 2,000°F. It will not transport fire through floors, walls, and ceilings, and it maintains constant water pressure when subjected to flames. In the event of a fire, copper does not burn, support combustion, or give off toxic fumes.

• *Flow*. Preventing capacity loss to maximize a system's effectiveness is critical. With copper, there is no excessive corrosion buildup that might impede water flow or dislodge and clog system components. The thin protective oxide film that forms naturally on the inner surface of copper tubes does not flake off.

• *Versatility*. Copper piping systems can be designed and installed easily. Thin-wall copper tubing offers superior flow rates in comparison to other similar-size piping materials, and, because smaller diameters can be used, installation often requires less labor and results in less damage to building interiors.

• *Sustainability and cost*. The ease of installation, longevity, durability, and dependability of copper systems often make them competitive and even lower in cost over the long run. Because copper is recyclable, additional cost is recovered when a building is demolished or a system is removed.

• *Longevity and low maintenance*. Copper has an extended life span and requires little maintenance. With its clean-installation procedures, space occupancy is not interrupted.

cated that a car stacker in the proposed configuration constituted "high-hazard occupancy." The available water supply could support a sprinkler system for the residential and commercial spaces, but there was insufficient flow and pressure for protection of a car-stacker system. As a result, a water-mist system was proposed for the stacker enclosure. This was accepted by the AHJ based on design and testing data provided by the equipment manufacturer.

NATURAL LIGHTING

A popular approach in sustainable design is the integration of natural light. Natural light may be brought to a building's interior through the use of skylights, light wells, and atria. One common exterior application is a light court. These design elements may impose building-, fire-, and life-safety-code issues if not coordinated with fire-protection engineers during the early stages of design.

In building construction, a roof may be required to have a fire-resistance rating. If skylights are used in a roof's design, there may be building-code requirements for the skylights to be protected or limited in size to maintain the fire-resistance rating of the roof assembly.

Light wells present unique building-code requirements. A light well is a shaft located in an interior area of a building. Windows located in this shaft allow light to filter from roof level to interior areas. A light well can be used to bring natural light through a building to lower levels. Even though a light well is surrounded by one building, building codes may require that an assumed property line be created and that window-opening protection be provided, depending on building type, occupancy classification, and separation distance (light-well size).

As previously discussed, the size and location of a light well can have significant code implications. In situations in which a building is located in close proximity to its property line and natural light is brought in from exterior light courts, building codes require the light courts to have specific dimensions, depending on the building's height and configuration. The size of light courts, and the size, location, and protection of window openings must be considered early in a design process.

CONCLUSION

In summary, the sustainable-design concept will continue to grow in the built environment. Many of its aspects will come into conflict with existing building and fire codes. To maintain the highest-possible level of life safety for building occupants while taking full advantage of sustainable-design benefits, it is imperative that all project stakeholders be involved as early as possible in discussions designed to achieve desired results and move a project expeditiously through the AHJ-approval process.

REFERENCES

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2) ICC. (2003). *Design fire*. International Building Code Section 909.9. Clifton Park, NY: Thomson Delmar Learning.

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