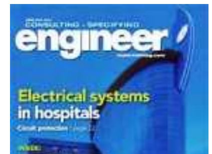

Office Design: Raising The Standard

Office Buildings Present A Range Of Challenges As Diverse As The Tenants That Occupy The Structures. To Succeed, Engineers Need To Stay On Top Of Owners' Needs, Environmental Concerns, Sustainability, And A Range Of Other Issues.

By Jenni Spinner, Contributing Editor

06/29/2011

SHARE

   

Participants

- Jessie Jones, LEED AP, Director of Sustainable Services, the RMH Group, Lakewood, Colo.
- Charles B. Kensky, PE, LEED AP, Executive Vice President/Project Manager, Bala Consulting Engineers Inc., King of Prussia, Pa.
- Keith Lane, PE, RCDD/NTS, LC, LEED AP, President, Lane Coburn and Associates LLC, Bothell, Wash.
- Andrew Thompson, PE, LEED AP, CxA, HBDP, Principal/Vice President, M.E. Group, Lincoln, Neb.

CSE: What engineering challenges do office buildings pose that are different from other structures?

Jessie Jones: Predicting actual office building operations following construction can be challenging. Although we design buildings based on available usage information for our clients and on certain assumptions, it's up to owners and tenants to operate the facilities as designed for them to perform as intended. Changes in occupancy, program, and tenant schedules made throughout the design process and beyond can create cascading consequences with respect to construction scheduling/costs and building operational performance.

Charles B. Kensky: Design loads are based on occupancy and equipment usages and often differ across the floor plans and as well as from floor to floor. Meeting the outside air ventilation requirements on older high-rise buildings is a challenge due to the lack of outside air access. Varying occupancy demands, due to telecommuting, and increased power and cooling requirements for critical IT loads also add to the challenges. Varying occupancy in large training rooms and the increased ventilation requirements for open office spaces are a particular challenge, especially in older high-rise buildings. Other issues are personal comfort, proper temperature control and zoning, after-hours cooling, and how the tenant pays for this service.

Keith Lane: The electrical engineer needs to ensure there is the flexibility within the electrical infrastructure to provide the required load densities for today and tomorrow while still providing a cost-effective design. Additionally, on the telecommunication side, the electrical engineer must understand the client's bandwidth requirements and ensure future proofing.

Andrew Thompson: Typically office buildings have fairly dense occupancy; ideally each occupant would be able to control its own environment. The individual environment is critical to productivity and ultimately the success of the project. Engineering systems that are able to adapt to the human element of a building is especially a challenge within an office environment.

CSE: How have the needs and characteristics of office buildings changed in recent years?

Thompson: Quality indoor environments with daylight and high ventilation air quantities have become more of a focus. Providing these elements within a high-performance building challenges designers to be creative in utilizing energy effectively without waste.

Lane: Offices are required to have much more flexibility on both the power and telecommunications side. Additionally, there are many more LEED-certified buildings, so design innovation that provides for energy efficiency and cost effectiveness requires a higher level of engineering. Efficient lighting systems continue to evolve; we are seeing the implementation of LED lighting systems within office buildings. In large cities where square footage comes at a premium, we are seeing the implementation of car stackers within parking garages. Some of these stackers are completely automated.

Kensky: The higher outside air ventilation requirements are a challenge for older buildings, particularly with older high-rise buildings. The need for 24x7 cooling for critical spaces requires dedicated systems within the building infrastructure to properly handle these loads. Lower lighting loads and improved building envelopes have reduced cooling and heating capacities.

Jones: More stringent energy codes and standards are being established and enforced. To meet these enhanced requirements, design teams must collaborate early in the design process to develop "out-of-the-box" solutions. In addition to delivering more energy-efficient buildings, this integrated design approach delivers a more fluent design and construction process and leads to fewer errors and omissions.

CSE: Discuss re- and retro-commissioning of office buildings: What are owners and office managers requesting? What energy management tools are you suggesting?

Thompson: The reduction in profit margins has put an emphasis on operating costs. Owners recognize that cutting energy use costs is a good opportunity to ultimately increase profit margins. Re- and retro-commissioning have proven to be effective avenues to reduce these costs with a great return on investment. You can't fix what you can't measure. Measurement and verification within buildings is critical to high performance. We suggest building management systems with measurement capabilities and operated by educated and trained staff that can measure and analyze performance.

Jones: Office building owners and managers are requesting commissioning services much more frequently because of the cost savings they deliver. The recommissioning process allows facility engineers to fine-tune their energy systems, implement energy-conserving measures, and realize cost savings.

Kensky: Successful retrocommissioning and recommissioning is a collaborative effort of the independent commissioning agent, MEP engineer, facilities engineer, and selected contractor. First, the commissioning agent develops commissioning protocols to test as built conditions. Second, testing is accomplished with assistance of contractors and facilities personnel. Finally, the results of commissioning are reviewed by the MEP engineer and the rest of the project team so as to assure code compliance and to determine the best course of corrective actions, including replacing defective equipment, optimizing systems operation, and scheduling other building improvements and maintenance.

CSE: Please describe a recent existing building project you've worked on—share problems you've encountered, how you've solved them, and aspects of the project you're especially proud of.

Jones: I'm currently working on a project to renovate the Byron G. Rogers Federal Office Building (in Denver, Colo.), which is a mid-1960s-era, 18-story, 500,000-sq-ft office tower. Ambitious energy goals set by the General Services Administration (GSA) exceed those of most newly constructed buildings. The most significant design hurdles involve the building's fixed north-south orientation and the building's architecturally significant façade. The north-south orientation inherently creates thermal heat gain and limits daylighting opportunities, while the 45-year-old façade is not well-insulated and cannot be replaced due to its historic status. We have used the north-south orientation to our advantage by storing the thermal heat gain and transferring it to other portions of the building as needed. To enhance the building envelope while preserving the existing façade, an exterior wall is being reconstructed from within the building to allow continuous insulation to be added.

Kensky: A recent project was a 120,000-sq-ft tenant fit out of an existing building. A data center, call center, and training rooms were added to this 20-year-old building. The existing mechanical units did not have enough cooling or ventilation capacity to properly satisfy the space loads and ventilation requirements. The control system was an older pneumatic system. The data center required 24x7 redundant cooling and power, as well as specialized fire detection and protection systems. We added a dedicated generator and 2N UPS system for the data center, repurposed the existing UPS and generator system to serve the call center, and added a dedicated HVAC unit to serve the call center. The building automation system (BAS) was upgraded with a new network-based system that not only increased the overall efficiency of the building systems but also provided alarm logging and reporting, increased monitoring of the critical infrastructure systems, and provided easy access to flexible scheduling. This was challenging because of the aggressive completion schedule and necessitated prepurchase equipment packages. There were issues with reutilizing the existing VAV boxes, as their internal condition had deteriorated, causing some to leak and compromising others' damper operation, thus control and space comfort was compromised. The data center and call center portion of the project was independently commissioned and worked as designed. Since the office portion was not independently commissioned, there were a lot of contractor and construction issues that had to be resolved after the tenant moved in. Once the project was completed, the successful response of critical systems to a loss of power event assured that the 24x7 operation continued uninterrupted and underscored that these efforts were worthwhile.

Thompson: We provided commissioning for more than 30 million sq ft in the last few years. Many of these projects were retrocommissioning projects for the GSA. There are a few particular projects of large scale that offered the potential for significant energy and operational cost savings. The challenges with these facilities is to educate and convince the building engineers to embrace well-developed energy-efficient sequences of operation in lieu of “in-hand” operation. Through these retrocommision efforts we were able to reduce energy operational costs by 30% or more, which in some cases resulted in energy cost reductions exceeding $1 million.

CSE: When working on office buildings in other countries, what differences or innovations have you witnessed? What can engineers working on American buildings learn from this?

Kensky: Other countries may have more adverse conditions, such as higher summer temperatures, lower winter temperatures, or sand- or salt-laden air conditions. All of these require different types of design approaches to allow the equipment to function properly. While working on a 24x7 data center project in Toronto, condenser water quality and particulates became an issue, thus full flow water filter systems had to be employed. For some projects in Latin America, workers required and welcomed extra training and mentoring so as to improve the quality of workmanship.

CSE: What factors do you need to take into account when designing building automation and controls for an office building?

Thompson: The building management system needs to be effective in controlling the high-performance systems and technologies in today’s market, but at the same time must be simple and straightforward in order for the owner and staff to gain value from the system. The best system has no value if the owner can’t use it effectively.

Kensky: Proprietary parts and labor are always an issue. A control system that utilizes open protocol such as BACnet or LonWorks allows easier integration and potentially multiple service companies to work on the system. Establishing the proper sequences and operations of the spaces and building, needs to be coordinated with the capabilities of the HVAC equipment. Many energy-saving features that can be designed into the controls system may not be possible due to limitations of the controllers provided with the main HVAC equipment.

Jones: Control systems must meet the office building owner's and users' needs with respect to comfort, adjustability, and energy savings, among other factors. Although these systems may be complex, they should be simple to operate. Well-designed "dashboards" with meaningful building performance metrics allow operators to view how their facilities are performing in real time.

CSE: When re- or retrocommissioning office building control systems, what challenges do you encounter, and how do you overcome these challenges?

Jones: When commissioning an office building, the goal is usually limited to maintaining or returning operations to "as-designed" conditions. When this occurs, other simple opportunities to improve comfort and energy savings may be overlooked since they were not included in the original design. We take a holistic approach that tries to identify other enhancement opportunities when simplifying or otherwise improving control operations. Since calibration or replacement of field devices is essential to this process, we also endeavor to provide building operators and owners with requisite training to maintain their facilities in peak condition.

Kensky: The original design sequences may not be available or no longer apply. To overcome this, we review the currently programmed sequences and schedules and develop protocols based on these. We review the sequences with the building engineer and verify that they are appropriate for the current systems and space usage. We then modify the sequences, schedules, and protocols accordingly and then retrocommission the systems and equipment.

CSE: How have changing HVAC, fire protection, and/or electrical codes and standards affected your work on office buildings?

Kensky: Older buildings were designed around older codes. The newer increased ventilation rates, reduced lighting power density, and complex lighting control systems relative to occupancy and exterior exposure require added consideration in our designs. Changes to fire and smoke ratings of storage and file rooms and smoke/fire damper requirements at duct penetrations and at shafts have also caused us to modify our designs.

Jones: On the whole, upgraded codes and standards have yielded office building designs that are more energy efficient, increase safety levels for occupants, and provide additional marketability for the buildings themselves.

CSE: How do such codes/standards vary from region to region? Discuss any international projects you’ve worked on.

Jones: Every authority having jurisdiction (AHJ) has its own code amendments and interpretations. Some are based on unique regional requirements; others are based more on tradition. Identifying deviations from the international codes early in the design process simplifies our work. Enforcement of compliance with energy codes is, unfortunately, highly variable; some AHJs exceed the requirements of the International Energy Conservation Code, while others do not check for compliance. Fortunately, more and more attention is being paid to the energy codes both by consultants and code officials.

Kensky: Codes and standards in other countries are a little less stringent than in the States. Local inspection officials often do not enforce the codes to the letter of the law. There are also fewer oversight organizations such as UL to provide for a basic level of quality in equipment specified overseas. It is incumbent upon the engineer to ensure a level of construction quality and safety remains throughout the project.

CSE: Which codes and standards prove to be most challenging in office building work?

Jones: Since applicable codes define the minimum standard of performance for an office building, they usually set the bar low for optimizing building performance. Energy and resource conservation requirements/goals as developed in the LEED program, ASHRAE Standard 189.1, and others are forcing us to rethink how to design office building envelopes and mechanical/electrical systems.

CSE: What's the one factor most commonly overlooked in electrical systems in office buildings?

Jones: Power quality is most often overlooked. It can be affected by poor electrical distribution system design, concentrated harmonic loads, and inadequate compensation of transient contribution due to dirty loads. Diminished power quality can easily occur if a large 120/208-V transformer feeds a large portion of an office building. In these instances, power quality problems affect the entire distribution fed by the transformer. Our company's standard is to specify smaller transformers that only feed one branch circuit transformer each. We also separate dirty power loads from clean power loads by directing them onto different transformers. This allows for the application of harmonic mitigation and surge protection at the source of the problem rather than having to treat the entire system.

Lane: Space planning for the required electrical and telecommunication systems. If space planning is not developed as a team effort between the electrical engineer, architect, and mechanical engineer during the early stages of the schematic design, significant problems and redesign may be required near the completion of the design.

Kensky: Wiring of workstation systems furniture and the types of wiring systems within the furniture. Integration of the mechanical and fire alarm systems. What is required by code, and which discipline provides which component and who provides the wiring.

CSE: What types of products do you most commonly specify in an office building, and why? Describe the UPS system, generators, etc.

Kensky: We specify all the components from the incoming service gear to the distribution systems down to the light fixtures, devices, receptacles, and switches. The UPS typically is a single- or multimodule, double conversion unit with external maintenance bypass and a minimum of 15 minute battery backup. Generators are typically diesel engine driven units, although we have designed systems around bi-fuel (natural gas + diesel fuel) generators. Generators can be located inside the building or more typically outside in either a reach-in or walk-in sound attenuated enclosure.

Lane: Many of our clients are including small data centers within their office building; these require both generator and UPS backup. Provisions for this equipment including the UPS batteries need to be programmed in the initial phases of the design. High-rise office building require a life-safety generator to feed loads such as elevators, fire pumps, pressurization fans, fire alarm systems, and egress lighting. As energy codes tighten, we are implementing the most cost-effective and energy-efficient lighting systems. For some applications, the increased cost for LED fixtures is validated through energy efficiency and life of the light source.

Jones: Modern offices are almost universally specified with high-efficiency fluorescent lighting systems and more sophisticated lighting controls. Occupancy sensors and daylight harvesting also are commonly specified to further increase energy efficiency. Dedicated diesel engine generator sets are frequently specified for larger or mission-critical office buildings. The life safety and standby systems connected to these generators must be separated. Recent code changes also require that life safety systems be selectively coordinated; to address this issue, we have standardized use of fused overcurrent protection for life safety systems. UPS systems are often requested and provided; these systems are either centralized or provided as point-of-use at each computer workstation and in the telecom server rooms. UPS systems have backup capacities ranging from 15 minutes to as much as an hour. VRLA-type batteries are the most common type used for UPS systems. To achieve rated battery life for UPS systems, it is essential to maintain the ambient temperature around the batteries at 77 F even during times when these buildings are typically unoccupied, such as holidays and weekends; during these periods, most building cooling systems are shut down to save on energy use and operating costs.

CSE: How have sustainability requirements affected how you approach electrical systems?

Kensky: Lower lighting densities in the designs, higher efficiency equipment, more automatic lighting controls such as schedule controlled systems and occupancy sensors, day lighting controls, and integration with external shade controls and daylight dimming controls. More indirect lighting with task lighting is becoming the design norm. Solar and wind power are becoming more popular as are combined heat and power (CHP) systems and purchasing of renewable energy from the green grid.

Jones: Lighting power densities have been reduced dramatically in the last few years. Lighting design professionals frequently are required to work with extremely low power densities, making it difficult for them to deliver the minimum recommended illumination levels. With recent energy reduction goals calling for a 70% reduction in energy use below ASHRAE 90.1, lighting professionals are given few options to deliver functional illumination levels and to be creative with their lighting designs. Sustainability requirements for daylight harvesting have resulted in more sophisticated lighting control systems. Such systems are more costly and require commissioning to ensure proper operation. Lighting power density reductions directly affect office buildings' heating loads since lower power densities produce less residual heat. Such reductions are helpful in cooling-dominated climates where building operators are often looking to shed heating loads wherever possible to save on cooling costs. However, for heating-dominated climates, the heating systems must make up for the heat usually generated by higher lighting densities.

CSE: Describe your experience with energy audits, specifically tax incentives or rebates for electrical / power use.

Lane: There can be significant rebates for retrofit projects, such as lighting. The key is to work closely with the utility to coordinate the maximum potential incentives early in the design process as the incentives programs change based on many factors including the actual funds that remain in the rebate programs.

Jones: Many local power utilities have initiated programs to reduce energy load and reduce peak demand. Utilities frequently contract with firms that specialize in providing facility energy audits and identifying feasible energy conservation opportunities. Other programs involve demand-side management for which third-party firms finance energy-reducing retrofits for utilities' customers; in exchange, the firms receive a portion of the cost savings achieved by the energy reductions directly related to their efforts. Owners can take advantage of tax incentives and energy rebates in existing buildings by replacing inefficient lighting systems with energy-efficient light fixtures and lighting control devices, by replacing inefficient motors with those controlled by variable-frequency drives, and by installing renewable energy systems such as photovoltaics or wind turbines. In many instances, the installation of such systems without these incentives or rebates would not be cost feasible.

Kensky: Energy audits can range from a simple one-day walk-through with a follow-up letter report, or they can be a detailed analysis with energy models and ROI evaluations. The utility rebates related to ACT 129 can be simple $/item such as $1.00/CFL or $/sq ft based on proven energy savings determined by acceptable modeling software. These grants and rebates are provided by the utility company and/or the state and federal government level. The tax incentives are typically a rebate or deduction on your tax statement. The deduction then becomes a percentage value based on your tax rate.

CSE: What types of lighting retrofits are existing building owners requesting?

Jones: Several office building owners we've recently worked with are requesting lighting retrofits using LED-type lighting systems. While these light sources have certain operational benefits, a well-designed fluorescent lighting system can be more energy efficient than a current state-of-the-art LED system. The initial capital costs for fluorescent lighting systems are also less than equivalent LED lighting systems. Office building owners also frequently replace standard light switches with those utilizing occupancy sensors and daylight harvest photocells. Occupancy sensors turn the lights on when personnel are detected in a space, while photocells turn lights on when daylight entering a space is below a certain set threshold.

Kensky: Higher efficiency lamps and fixtures such as CFL, T5, and LED lights and fixtures; electronic ballasts; and indirect lighting. They are also requiring more intelligent controls and operation of the lighting.

CSE: What trends, systems, or office products have effected changes in fire detection / suppression systems in office buildings?

Kensky: Open office plans without ceilings or only “clouds” of ceilings make the detection and extinguishing of fires more difficult. The installation of the smoke/heat detectors becomes more problematic due to heights, access, testing, and service. Sprinklers have to be located at the highest open structure but also under all objects that are 48 in. or wider such as ductwork. Sprinklers must be installed in all cloud ceilings and in lower private office ceilings. Thus the overall complexity and quantity of devices and piping can tend to increase.

Jones: More and more properties are being sprinklered even when not mandated by code. Passive fire protection measures such as firewalls, smoke partitions, and associated dampering provided in the International Building Code are becoming more widely accepted by the design and construction communities. Laser and video detection are becoming more popular.

CSE: What changes in suppression systems have you seen in office buildings recently? What do you see changing in the near future?

Jones: Many office building computer rooms are being fitted with preaction fire suppression and clean-agent systems as owners have become increasingly focused on protecting their expensive and critical physical assets. Environmentally friendly agents are increasingly being specified for such applications.

CSE: What are some important factors to consider when designing a fire and life safety system in an office building? What things often get overlooked?

Kensky: Integration of the mechanical and fire alarm systems, what is required by code, which discipline provides which component, and who provides the wiring. Elevator shaft detection and protection, elevator machine room equipment shunt trip requirements, and fireman command center–voice evacuation systems.

Jones: Passive systems, including firewalls, smoke barriers, and egress, need to be understood by the entire design team, as each discipline can affect the life safety systems of the other disciplines. For example, our mechanical engineers cannot situate ducts and piping in spaces allocated for egress. We must specify rated dampers in the fire and smoke barriers. Coordination among all design disciplines is necessary to prevent surprises during plan review and construction. Adding a fire protection engineer to the team provides a centralized authority to coordinate life safety issues.

Lane: There are a number of codes that affect the design of the life safety system; additionally, there are interpretations of the code from the AHJ. It is critical to understand all of the applicable codes and AHJ interpretations prior to completing the design of a life safety system. For emergency generators, you need to ensure the required run time and the required amount of fuel all fall within the applicable codes in reference to the maximum allowable fuel storage. There is also new code language in the 2008 NEC that provides for additional separation of life safety and legally required or standby loads.

CSE: What unique requirements do HVAC systems in office buildings have that you might not encounter on other structures?

Jones: Office buildings need to provide occupants with a comfortable environment. Studies reveal that worker productivity, as well as lease rates, are directly affected by levels of occupancy comfort. Providing a comfortable environment while keeping construction and energy costs in check has been a challenge for the industry.

Kensky: For high-rise office buildings, you will need to deal with pressure breaks in the piping systems. This can require significant equipment to be located at multiple levels within the facility. Office buildings with atriums may also require a smoke evaluation system. This is often incorporated with the HVAC system design, but it complicates the overall controls and must be controlled by listed control systems.

CSE: How can automated features and remote HVAC system control benefit office building clients?

Jones: Implementing remote HVAC control systems is generally not recommended as network connections can easily be lost. Building control should be contained within the facility. However, using remote monitoring via the Internet or dedicated networks provides many benefits, including the ability to track energy usage and building performance.

Kensky: Automated features such as sequences, sensors, and schedules can provide higher energy efficiencies for the building as a whole. This can be due to free cooling, scheduling of system operation, set back temperatures, demand control ventilation, occupancy and vacancy sensors, etc. Remote HVAC control can enable a building manager or service technician to diagnose a problem and dispatch the proper part and service technician for the repair. Remote monitoring can enable the building manager to schedule a system as requested by a tenant for after-hours usage and also enable the building manager to turn off lights and components that a tenant may have left on after hours.

CSE: What types of water pumps, valves, etc. do you have to specify to ensure water is adequately moved around the structure? What issues are involved?

Jones: No magic here—we specify pumps that operate at peak efficiency and variable-speed drives on most equipment and controls to minimize pumping horsepower. Pressure-independent control valves are being used on more of our projects.

Kensky: The issue is proper system design for dynamic balancing and reduced water velocity noise. The system must also have controls, sensors, and automatic valves that will allow the pump speed to vary based on load conditions. Once the pump speed varies, the water flow changes and thus dynamic balancing is more critical. These are typically not required features in constant flow systems, but constant flow systems use more energy over the life of the system. Pumps are generally selected with non-overloading motors, and pipe velocities are maintained at a maximum to avoid water noise in pipes and to avoid large pump/motor sizes. Phased office construction is another problem which can further complicate an office hydronic design.

CSE: Have you considered rainwater or grey water use in your office building projects? If no, why not? If yes, please describe the systems and any challenges you've encountered.

Kensky: We have utilized rainwater harvesting for irrigation on several projects. We have not utilized rainwater or grey water for building sanitary system use. The systems required for rainwater or grey water building sanitary system (pumps, tanks, filters, UV systems, separate supply and sanitary piping systems, oil water separators, etc.) use tend to be extensive and costly without a reasonable payback or ROI.

Jones: Most of our projects are located in Colorado, which is a water-producing state and can't own water by federal water compacts. Therefore, we are, unfortunately, unable to use grey water for most of our projects other than for communities that have reclaimed "purple pipe" water systems. Grey water has tremendous potential, and we encourage its use whenever possible.

Related News:

- Developing a detailed test, balance plan - 30.06.2011 00:00
- Designing smart restrooms - 09.06.2011 00:00
- Tall order for super high-rises - 23.05.2011 00:00

<- Back to: Home

About Us | Contact Us | Advertise | Subscribe to Magazine | Site Map | Privacy Policy
Home | Channels | New Products | Media Library | Connect | Industry News | Events and Awards | Newsletters | Blogs | Magazine