Prescription for hospital, health care facility success

Hospital and health care facility projects are especially important due to their sensitive nature. Engineers charged with designing these buildings must take special care when working in these mission critical facilities.

**CSE: What sorts of challenges do hospitals and health care facilities pose that you don’t encounter on other projects?**

**Michael Chow:** Remodeling existing health care facilities and hospitals can be challenging due to the existing conditions and keeping the facility running 24/7 during construction. There may be a lack of record engineering drawings, labeling of HVAC systems, or electrical panelboard schedules. Also, there may be tight above-suspended ceiling space for new engineering systems (e.g., ductwork).

**George Isherwood:** The people who go to health care facilities are under stress. Whether they are the patient or a family member, they are often overcome by worry and concern. I believe this is important to keep in mind when designing systems in health care facilities. Making things easy and comfortable should be our highest priority.

**Michael Lentz:** The biggest challenges that I see in health care facilities are energy savings, maintenance, pressurization, and operational redundancy. With the current economic situation, health care, just like any other industry, has had to cut corners. New projects are demanding tighter budgets, and health care facilities are reducing their maintenance staff. This is a more serious concern in health care due to the nature of the facilities to care for patients. It is very difficult to meet the energy savings that are required by U.S. Green Building Council LEED, or even requested by the owner, and sometimes still meet the need of the patients and the facility. Tighter budgets also restrict what types of energy-saving measures the project can support. Budgets have also pushed for more maintenance-friendly equipment while trying not to lose quality or redundancy capabilities.

**CSE: Looking into the future 2 to 5 years, how will the needs and characteristics of hospitals and health care facilities change?**

**Lentz:** More and more health care facilities are outsourcing maintenance, which then requires a more maintenance-friendly design. This can greatly increase the cost of the project. Mechanical equipment needs to be more advanced in order to reduce maintenance. The mechanical equipment needs to communicate with the building management system (BMS) more so fewer staff members can monitor a larger number of pieces of equipment. The equipment needs more alarm points in order to troubleshoot problems quicker and easier. Also, more and more of the mechanical equipment is either being required to be or requested to be on emergency power. All of this affects the project budget and contributes to the rising cost of health care.

**Isherwood:** In my experience, I believe the health care industry is making great strides at changing the public’s perception on what to expect when visiting medical and health care facilities. Health care facilities have always been a place you go when you’re sick or injured. In the near future, that will continue to
I first noticed this when we went to visit my mother-in-law at our local hospital. She commented that her room was like a nice hotel. My oldest daughter attended a healthy cooking class, and my younger children wanted to go back for dinner after my mother-in-law was discharged. Looking at the design of hospitals, sometimes we become immune to the effects they have on the general public. My children’s experience going to the hospital was one of excitement and learning, which is day and night to my memory in visiting hospitals as a child and a young adult.

Chow: We anticipate there will be more renovations to existing hospitals and health care facilities. The challenge will be to meet the future codes such as the number of receptacles in critical patient rooms increasing due to changes in NFPA 70: National Electrical Code (NEC). The existing electrical infrastructure may not be able to accommodate these changes without significant additions that many times are not accounted for in the initial construction budget by the owner of the facility.

Isherwood: In our experience, commissioning services are being purchased for new construction in hospitals, but the demand for retro-commissioning services is not as high. We believe this is because of the high monitoring of existing systems from outside review agencies. Even though these reviews are being completed, we believe most health care systems do not fully realize the benefits of retro-commissioning.

CSE: Since the Affordable Care Act passed, what shift in the types of hospitals and health care facilities work have you experienced? For example, a bigger workload, more retro work on existing facilities vs. new construction, etc.

Isherwood: I think health care networks are still figuring out how the Affordable Care Act is going to benefit them and they are holding back resources until the government uncertainty is clarified. We have experienced a shift toward smaller renovations and infrastructure projects.

CSE: I think health care networks are still figuring out how the Affordable Care Act is going to benefit them and they are holding back resources until the government uncertainty is clarified. We have experienced a shift toward smaller renovations and infrastructure projects.

Isherwood: I believe the economy has not had a significant impact on the largely privatized health care design industry. I believe the implementation and shifting of resources from the adoption of the Affordable Care Act has overpowered any positive effects from the rising economy.

CSE: How often are you called on to retro-commission hospitals and health care facilities, as opposed to new construction of a building? What are some key differences between the two?

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CSE: How has the economy impacted your work in this area? Have you seen the number of projects decline with the recession, and improve now that the economy is on the uptick?
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—Michael Chow

due to the critical nature of the systems to function 24/7, the systems cannot shut down, and if the controls are not on emergency when power is lost, the units will not automatically restart after the 10-second delay.

Isherwood: Ease of service and the ability to understand the systems is crucial. Building controls are becoming more complex and maintenance staffs are being asked to do more with fewer resources. We need to make sure we design building control systems that will not become a burden on the staff, but a benefit.

CSE: What’s the one factor most commonly overlooked in electrical systems in hospitals?

Chow: Understanding and incorporating the applicable codes and standards for a hospital is commonly overlooked. A hospital may be certified by The Joint Commission and an engineer designing

small hospitals, from both a solution and a cost standpoint.

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Lentz: All major building equipment needs to be tied into the BAS and alarmed for malfunctions. This is due to the critical nature of the systems to function 24/7 and also due to most health care facilities reducing maintenance staff. Emergency power for the automated control system and local panels also needs to be accomplished. Again, a remodel may inadvertently overlook their standards and requirements.

CSE: How does implementing BAS in an existing building differ from designing controls for a new building?

Isherwood: There are a significant number of small hospital systems that have been using the same BAS for years. Some of these networks will no longer be supported by basic operating computer systems, let alone the BAS system. Also, different manufacturers have opened different control protocols for tying into a BACnet or similar common language. These challenges are huge for

CSE: Describe a recent project in which you had a complex standby, back-up, or emergency power design.

Lentz: Inova Women’s Hospital has three 2 MW 5 kV generators paralleled with the utility system and four distribution sub-stations. Three 2 MW, 4.16 kV enclosed diesel engine electric generators (EGs) and auxiliary systems were provided in a designated outdoor yard, remote from the hospital central plant. The 2 MW emergency generators were paralleled through the emergency generator 5 kV paralleling switchgear (EGPS). The EGPS was configured with two outgoing main breakers to the normal 5 kV switchgear, one bus tie breaker, two emergency generator auxiliary load breakers, existing plant breaker, and three generator breakers. Although the generators were intended to be used as standby generators only, the use of a selective catalyst reduction (SCR) system was provided in the design. The SCR system reduces engine emissions, specifically NOx up to 90%, and has become a required component in most new generator installations to meet state/U.S. Environmental Protection Agency emissions requirements. The SCR system consists of an injection/mixing pipe, catalyst housing, solution storage tanks, solution transfer pumps, and associated control panels. The generator assemblies were contained in pre-engineered sound attenuated enclosures. The enclosures achieve a 40 dB(A) reduction of the generator set source noise, as measured at 1 meter from the enclosure.

CSE: What unique NFPA 99: Health Care Facilities Code issues have you encountered, and how have you resolved them?

Chow: The 2014 NEC has a proposed change to increase the minimum number of receptacles for a patient bed in a critical care area from 6 to 14 receptacles. This would coordinate the requirements between the NEC and NFPA 99.

CSE: How might the complexity and scale of fire/life safety systems in hospitals and health care facilities vary from other types of structures?

Lentz: Due to the fact that most health care facilities cannot be evacuated and have to be designed to defend a fire, in-place smoke control systems can become very complex. Smoke zones need to be designed so that when a zone
is alarmed, that specific zone can be kept at a negative pressure to the adjacent smoke zones in order to contain all of the smoke in the zone under alarm. We have found that the best way to accomplish this is under the smoke control sequence of operation, we convert the air-handling unit (AHU) that serves the smoke zone under alarm to 100% outside air. We are using the return fan now as a smoke exhaust fan. A modulating smoke control damper is installed on the supply air duct serving the zone, and it modulates to maintain the zone at a negative pressure. The supply air smoke control damper is controlled by a differential pressure sensor located at the doorways between the zone under alarm and all adjacent smoke zones.

**CSE: What are some important factors to consider when designing a fire and life safety system in hospitals and health care facilities? What things often get overlooked?**

**Lentz:** Smoke control systems are often overlooked, which can require a hospital to shut down critical AHUs during a fire/smoke alarm. Atrium evacuation systems and stair pressurization systems are also often overlooked, which can be very difficult to install and engineer after construction or even during the design process without a lot of redesign. When designing smoke control systems or atrium smoke evacuation systems within the building’s normal HVAC system, what is generally overlooked is the fact that the components of the HVAC system now have to be UL listed for that use and now have activation or communication with the fire alarm system.

**CSE: What unique requirements do hospitals and health care facilities’ HVAC systems have that you wouldn’t encounter on other structures?**

**Isherwood:** Equipment redundancy is more common in health care facilities than in other structures. This is due to the failure events that may occur and endanger patients if redundant systems are not properly designed, installed, and commissioned.

**Lentz:** Redundancy and reliability are the largest requirements that I see. Most health care facilities require some means of redundancy in their HVAC systems so they can still adequately serve patient and critical spaces during an equipment malfunction or failure. The amount of redundancy is always something that has to be weighed and measured against the project budget and the type of program space that is being built. For example, 100% redundancy for the HVAC system is more suitable for operating rooms and patient spaces than material holding or administrative offices. How you achieve this type of redundancy is also something that is unique to each facility. Is the redundancy a standby air handling unit, a standby supply fan, a fan wall assembly, or a manifold system that can withstand the loss of partial supply air?

**CSE: What HVAC techniques or tools have you used to reduce the possibility of hospital-acquired infections (HAIs)?**

**Lentz:** Strict pressurization requirements between different program areas within the hospital, and filtration and separation of different program areas within the hospital. For example, applying 100% exhaust to the emergency

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**eQUEST**

**eQUEST** is designed to allow engineers to perform detailed analysis of today’s state-of-the-art building design technologies using today’s most sophisticated building energy use simulation techniques but without requiring extensive experience in the “art” of building performance modeling. **CSE:** What HVAC techniques or tools have you used to reduce the possibility of hospital-acquired infections (HAIs)?
department waiting rooms. Any airborne infection isolation room exhaust is treated with high-efficiency particulate air (HEPA) filtration. All critical spaces, such as operating rooms, recovery areas, and sterile processing departments, are equipped with return or exhaust air terminal units in order to maintain correct pressurization within the program area, even if there is a loss of supply air to the space.

**Lentz:** The two programs that we most commonly use are Carrier Hourly Analysis Program (HAP) and the Dept. of Energy’s eQUEST. These programs allow us to model the exterior of the building and evaluate several different HVAC systems throughout the building at the same time. We can see which system will have the most energy savings, and then evaluate that system from a maintenance perspective as well as evaluate if the system is a practical application for the building.

**CSE:** What software or systems do you use to model the energy consumption of the building?

**Chow:** Engineers need to know that a net-zero energy hospital project should incorporate integrated project delivery (IPD). Also, extensive energy modeling analysis will need to be performed as well as integrating innovative design strategies and including both on-site and off-site renewable energy sources.