Dallas, Texas, is the site of the largest hospital construction project currently under way in the United States. Parkland Memorial Hospital, built in 1954, when the facility served around half as many patients as it does today, will soon be replaced by a new $1.27 billion Dallas County health care campus. With the region’s population expected to double by 2025 – and Parkland caring for more patients with nowhere else to turn than all other Dallas hospitals combined – the project is designed to meet the county’s public health care needs well into the future.

Construction of the new 2.5 million-sq-ft Parkland campus was overwhelmingly approved by Dallas County voters: Eighty-two percent said yes to partially funding the project through bond proceeds. When it opens in 2015, the new 862-bed acute care hospital will represent a 38 percent increase in bed space. It will be the largest public hospital building in the nation constructed in one phase and one of only two Level 1 trauma centers in Dallas. In addition to the acute care facility, the Parkland campus will include a separate outpatient clinic, medical/surgical building, parking structure, logistics building and new central utility plant (CUP).

The $74 million, state-of-the-art CUP has been built to provide essential thermal, electric, water and emergency utilities to the campus buildings. Resiliency, sustainability and long-term operational flexibility became the driving forces that shaped the design of the plant, which has been in operation for nearly a year now, supporting the ongoing hospital construction.

**HARDENED RESILIENCY**

The 81,146-sq-ft CUP can supply the hospital and surrounding buildings with up to 192,000 lb/hr of steam and 98,400 MBtu/hr of hot water. The steam is used inside the hospital to generate domestic hot water and to operate several steam-to-steam generators for sterilization and humidification purposes. The hot water is used for space heating. Up to 13,750 tons of chilled water are also produced and supplied to campus buildings for air conditioning.

While most health care facilities require emergency backup power and redundancy for all major equipment, Parkland’s crucial role as the public’s safe haven during natural disasters prompted extreme measures to ensure stable and uninterrupted operations. For example, in addition to the thermal utilities produced at the plant, the domestic water, softened water, fire water and electricity are fed through the CUP and distributed to the campus in redundant utility corridors that are connected in a looped configuration within the hospital basement. Each leg of the loop can carry the entire hospital’s load. Without this redundant piping, a single rogue backhoe operator could disrupt utilities and shut down the facility. Applying this level of preparedness to the production equipment, the CUP has emergency connections to the chilled-water, heating hot water and steam/condensate systems, in addition to the N+1 equipment redundancy requirement designed into all systems.

Further, electrical service to the campus comes via four redundant feeds served from two independent utility substations. In the unlikely event that all four feeds are lost, the CUP houses 17.5 MW of diesel generator capacity able to maintain essential hospital functions and CUP utility services. Parkland’s robust electrical system is designed to maintain service to the hospital under multiple failure and disaster scenarios. Vulnerable overhead lines and rolling brownouts in the region make a single utility failure almost inevitable. By requiring two independent electrical services from separate substations, the design eliminates a significant single point of failure upstream from the utility plant. Once this investment in reliability was committed, the cost to run an addi-
Variable-speed chiller lineup and associated piping at the new Central Utility Plant

In the case of natural disaster, the CUP can operate in island mode – completely disconnected from grid electrical and gas utilities. More than 40,000 gal of diesel and 850,000 gal of water are stored on-site. This emergency reserve capacity allows the CUP to maintain the hospital’s critical services and most normal services, under worst-case conditions, for a minimum of 36 hours independent of off-site utilities.

**SUSTAINABILITY**

Stewardship is one of Parkland’s strategic goals. To the CUP team, this meant minimizing environmental impact as well as responsibly using county tax dollars. Sustainable design measures implemented within the CUP were analyzed through a lifecycle cost analysis to demonstrate a strong return on investment. Based on limited funding, each measure was required to pay back within a mere five-year term. To identify and evaluate sustainable measures, the CUP design team initiated an upfront energy programming phase to precede detailed design.
During this planning phase, the CUP and hospital designers coordinated to establish the most effective and efficient system criteria for the campus utilities. The collective teams were able to take a unique full-campus approach. For example, the hospital’s heating design temperatures were reconfigured to match the capabilities of the equipment proposed within the CUP – namely a 1,000-ton heat pump chiller (fig.1). The early collaborative discussions established compatibility between the two systems, created operational flexibility by allowing the heat pump to operate in parallel or series, and boosted overall system efficiency.

The CUP generates utility services for the campus with reliability and efficiency as top priorities. The highest-impact equipment in the CUP is the heat pump chiller, with a net efficiency (coefficient of performance of 5.97) far greater than that of separate heating and cooling equipment. This is possible since the heat returned from the chilled-water system is “moved” to the heating system and boosted to 150 degrees F via a dual-stage vapor compression cycle. While the heat pump marginally impacts cooling efficiency, the net savings are substantial for a campus with year-round heating requirements.

To further reduce electrical use, the plant employs variable-frequency drives on all large motors, enabling pumps, fans and compressors to operate at improved efficiencies at off-peak conditions. Parkland has committed to sharing energy consumption data with the U.S. Green Building Council (USGBC) to enrich its growing database of operational data. Additionally, chilled-water optimization software will be employed through the controls vendor, which transmits performance data continuously to a remote monitoring facility, allowing any reductions in performance to be rapidly identified and rectified.

By maximizing heat pump chiller use, the CUP is projected to save 15 million gal of water annually – a dramatic savings in an arid region.

The heat pump chiller generates chilled water by transferring the heat to the heating hot water system rather than rejecting and wasting it to the environment through a conventional cooling tower, which, by nature, experiences significant evaporation losses. For instance, the five cooling tower cells can consume (evaporation plus blowdown) up to 500 gpm of water under worst-case conditions. The CUP’s ability to produce 1,000 tons of cooling capacity without use of a tower represents a key advantage moving into a future where water availability may be a challenge and prices are projected to spike.

**BY MAXIMIZING HEAT PUMP CHILLER USE, THE PLANT IS PROJECTED TO SAVE 15 MILLION GAL OF WATER ANNUALLY – A DRAMATIC SAVINGS IN AN ARID REGION.**

The Parkland campus, including the CUP, is designed using the USGBC’s LEED (Leadership in Energy and Environmental Design) green building rating system guidelines. Currently, the CUP is preparing to apply for LEED certification under the 2009 New Construction rating system. Based on its energy-efficient performance and judicious use of sustainable construction materials, the CUP is anticipated to achieve a LEED Silver rating and contribute to the hospital building’s energy performance – projected to be more than 26 percent higher than the ASHRAE 90.1 baseline.

The selection of steam boilers with low-nitrogen oxide burners (9 ppm) was another design decision that significantly decreases the CUP’s environmental impact (fig 2). While this level of emission control was not required, it streamlined the air permitting process and, most importantly, was the right choice to make.

A combined heat and power system was evaluated via a Level I screening process and found to have a reasonable lifecycle cost despite Parkland’s electricity price being relatively low. However, the publicly funded budget, complex construction schedule and limited physical space dictated a classic chiller/boiler plant with energy conservation measures applied strategically, which assured a near-term payback on the investment.

Other alternatives to enhance sustainability, such as thermal energy storage, were evaluated in the early energy programming stages. Peak shaving, load leveling and capacity offset opportunities were explored. However, the demand component within the current rate structure is not significant enough to generate the savings required to offset the initial cost of a thermal energy storage system. The limited footprint available also created challenges for implementing such a system, especially a larger stratified water system that would be preferred for its simplicity and resiliency.

**OPERATIONAL FLEXIBILITY**

The new Parkland hospital Central Utility Plant (fig. 3) was designed with the total lifecycle in mind. The CUP facility itself was built to last for 80 to 100 years, matching the expected lifespan of the new hospital. Consistent with that vision, the systems were also designed to be expandable, adaptable and easily replaceable in the future.
System Snapshot: New Parkland Hospital Central Utility Plant
System Owner: Parkland Health & Hospital System
Location: Dallas, Texas

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<tr>
<th>Steam/Hot Water System</th>
<th>Chilled-Water System</th>
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| **Startup Year**       | **2012 – Commissioned, began serving hospital construction project**  
                          **2015 – Will serve completed hospital** |
| **Number of Buildings Served** | **4**  
                          **2015 – Will serve completed hospital** |
| **Total Square Footage Served** | **Approximately 2.5 million sq ft**  
                          **Approximately 2.5 million sq ft** |
| **Central Plant Capacity** | **192,000 lb/hr steam**  
                          **98,400 MBtu/hr hot water**  
                          **7 boilers** |
| **Number of Boilers/Chillers** | **6 chillers** |
| **Fuel Types** | **Electric** |
| **Piping Type** | **Double-wall, preinsulated steel**  
                          **Preinsulated steel** |
| **Piping Diameter Range** | **Steam – 10 inches**  
                          **Hot water – 14 inches**  
                          **24 inches** |
| **System Pressure** | **Steam – 150 psig**  
                          **Hot water – 180 psig**  
                          **170 psig** |
| **System Temperatures** | **Steam – 358 F**  
                          **Hot water – 150 F supply/120 F return**  
                          **42 F supply/58 F return** |
| **System Water Volume** | **131,000 gal**  
                          **217,000 gal** |

Source: Burns & McDonnell.
The CUP’s major equipment bays were designed to hold an additional chiller, boiler, generator and ancillary equipment to accommodate future campus expansions. The CUP also features a spare equipment bay intended for an undefined equipment addition. While the systems within the CUP were designed and constructed based on today’s cutting-edge technologies, the design team endeavored to give Parkland flexibility to adapt to future technologies or potentially install additional energy conservation equipment (such as another heat pump chiller) if future loads and rates support the investment.

Areas currently used for storage were also designed for easy repurposing as office space to accommodate a growing staff. By strategically locating overhead monorails and using a mezzanine style for the second floor, designers made it possible for equipment to be moved around the building to increase flexibility, streamline major maintenance and assist with future equipment replacements.

Another collaborative success was the implementation of a temporary heat exchanger skid to test the CUP systems before connection of any hospital load. Via the CUP’s emergency piping connections, the heating and cooling systems were aligned to oppose each other and allow testing of each system. While no energy was saved through this process, it allowed the CUP to maintain its budget and substantial completion date, which kept the hospital project on track.

Utilizing building information modeling, the design was coordinated to minimize constructability issues. Upholding tenets of an integrated design and construction approach, the architects, engineers and contractors worked closely together – from concept through substantial completion – to deliver a successful facility to the residents of Dallas County.

Completed in December 2012, six days ahead of schedule and $4 million under its $78 million budget, the CUP is currently supplying utility services to support the new Parkland hospital construction. This much-needed health care facility is anticipated to be open by spring 2015. Parkland has a bright future with the CUP providing a state-of-the-art system designed to maintain efficient and reliable utilities for the citizens of Dallas County.

Jeff Easton, PE, CEM, LEED AP BD+C, was the Burns & McDonnell project manager responsible for oversight of the Parkland CUP’s cooling equipment planning and design. He is a graduate of The University of Texas at Austin and has nine years of experience, including with large-scale centralized chilled-water plants, utility distribution, combined heat and power, building-side HVAC design, utility master planning and overall campus design standards. He can be reached at jaeaston@burnsmcd.com.

Scott Williams, PE, CEM, was the Burns & McDonnell project manager leading the design of heating systems and site distribution, as well as overseeing subcontractors for the Parkland CUP. He is a graduate of Texas Tech University and has 12 years of experience, including with large-scale centralized steam plants, central chilled-water plants, utility distribution and utility master planning. He can be reached at swilliams@burnsmcd.com.

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