John Brown University Energy Efficiency Program

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Best Practice Initiative

In 1994, John Brown University (JBU) began a program to reduce energy consumption and operational costs. The initial steps included a qualification and selection process to identify an energy services company to work hand in hand with university staff. Johnson Controls Inc. was chosen as their business partner. This partnership resulted in annual savings of over $100,000 in energy consumption, and several building HVAC enhancements.

An intense building program was started in the summer of 2000. In order to ensure the best use of energy related to the systems selection, Vice President of Finance, Ms. Pat Gustavson and Facilities Director, Mr. Everett Easley initiated a study of alternative solutions for energy efficient building environments. This study included our energy partner to design the load profiles to compare equipment usage possibilities.

The results of the study indicated substantial savings by providing chilled water and steam from a single, remote location using the latest technologies and energy efficient equipment. The study also included modifications to the electrical distribution system consolidating the entire campus into one meter.

JBU now provides chilled water and steam to the campus from a new Central Plant. The original utility savings estimates indicated $296,000.00 per year but current analysis attributes over $332,000.00 of savings annually. The square footage of the campus has dramatically increased while the energy usage has remained virtually the same. Total utility savings from 1994 through 2002 are in excess of $1,029,000.

Energy efficiency has reduced the cost of operations and has provided a revenue stream sufficient to add buildings to the Central Plant distribution loops. Each connected building has systems redundancy and technologies unique to standard campus systems design. The Faculty, Students and Staff are now enjoying comfortable and clean building environments at a significantly reduced cost of operations.

John Brown University has provided a quality, Christian education since 1919 with students from over 44 countries. The University has always been sensitive to providing the best environments at the least possible cost in order to ensure the students and faculty of a safe, clean, learning environment. The energy consumption, since 1919, has always been efficient but with the advances in building technologies, Facilities Services chose to further implement newer and better methodologies. Through the use of Business Partnerships, they entered into an energy program in 1994 and have continued to seek newer, more creative applications each and every year. In the summer of 2000, JBU Facilities Services began a newer strategy to provide steam and chilled water from a single source as opposed to generating the tempering medium from individual locations. The result was a substantial decrease in utility costs, lower maintenance costs, fewer component life cycle costs and the ability to provide a more efficient and reliable environment.

John Brown University began a building campaign in late 1999 through 2000. Three new buildings were scheduled for construction within the next 18 months. These buildings would require more steam from the existing boiler plant than the aging boiler plant could reliably produce. In addition, the new buildings would also require chillers, cooling towers and associated HVAC components in each building.

The most pressing problem was the increased load on the electrical system, created by the added HVAC system loads, would establish new peaks and penalize the entire campus electrical KW costs. In addition, the building designs called for chilled water systems in each building that would result in higher operational costs from energy and manpower. Continuing to install individual chilled water system generation plants in a campus with such close proximity between buildings seemed problematic. A centralized steam system had been in existence since the founding of the University and it would stand to reason that centralized chilled water distribution would also be cost effective, as is the case in most major University systems across the country. Previous studies deemed this approach without financial merit and it wasn't until the building campaign began that another study was considered. Given the magnitude of the additional campus chilled water load, the new study revealed a substantial return on investment by establishing a centralized chilled water distribution system to serve new buildings on John Brown University Campus.

In addition to the mechanical system innovations, the electrical system on campus consisted of two independent radial feeds. One outdated primary feed at 4,160 volts had been in use in several older buildings on campus including the old boiler plant and three

older residence halls. The other system at 12,470 volts was also a radial feed to the second half of the campus that included the buildings constructed after 1960. A new 12,470-volt system was installed as a loop feed around campus that was wired to receive power from either end of campus with switching maintained by the City of Siloam Springs. With this system in place, and the old 4,160 volt system discarded, JBU now had flexibility to keep much more of the campus on line in the event of a failure of switching or cable, and the metering was reduced to a single source to diversify the peak demand. The result was a reduction of demand charges.

The best practice initiative was developed from an existing relationship with an Energy Services Provider that was selected in 1994 to assist John Brown University in reducing utility cost and implementing a more proactive preventive maintenance plan. Johnson Controls Inc. was chosen as the University's business partner and in turn provided energy guaranteed retrofits, controls and engineering application solutions for new buildings and maintenance services for the entire campus. They were given the opportunity to develop a plan to provide a Design / Build financial pro forma to locate a new Central Plant on a remote site of campus that would house a new boiler plant and chilled water plant. Also the plan would include the demolition of the unsightly existing heating plant located in a highly visible location on campus. Because electrical distribution from the 4160V primary was fed and distributed to other building loads through the existing heating plant, the electrical distribution had to be redesigned to ensure no loss of service to the buildings fed from this point.

Because of the vocational background of the University Facility Director, Everett Easley, coupled with the expertise of the Professor of Construction Management, Kent Davis, the University was able to oversee the campus expansion projects and the Design / Build project of the new Central Plant simultaneously. No additional personnel were hired during this period; however; the normal duties of the Facility Director were supported by the appointment of an Assistant Facility Director, Steve Brankle. The Central Plant involved the use of the latest technologies with respect to chillers, boilers variable speed drives, flat plate heat exchanger water economizer, digital controls and associated equipment that would yield the highest efficiency and longest possible life cycle at competitive costs. The Design / Build Contractor, Johnson Controls Inc., guaranteed the cost would not exceed $4,790,000.00 and the annual energy savings would yield, at a minimum, over $130,000.00 each year compared to using stand alone chilled water systems in the new buildings. This savings guarantee, coupled with the existing energy savings contract, along with additional savings accrued from the redesign of the electrical distribution into a single, loop feed distribution network represented an energy savings guarantee of over $296,000.00 per year. When evaluating the equipment cost required to provide chillers and associated equipment in each of the new buildings, the entire Central Plant project, paid for through energy savings and avoided capital cost, brought the entire investment for the Central Plant to a 9-year payback.

All new buildings scheduled for construction from this day forth will not require chillers and associated equipment, they will be able to provide chilled water with a secondary loop pump and control building loop water temperature with a primary chilled water

control valve. No engineering contingency will be required and the chillers in the central plant will be able to operate at the lowest KW per ton providing the optimal chilled water for the minimal cost. All new buildings will not require a boiler and associated equipment. A heat exchanger will be able to convert steam to hot water and provide all the heating and domestic hot water needs of the students, faculty and staff whether it be in an Education and General Building, a Residence Building or Athletic Building. All new buildings will avoid the added cost of providing air-to-air economizers from the Air Handlers. The flat plate exchanger at the central plant will be able to provide chilled water without the use of a chiller when outside air temperatures are at or below 55 degrees. Not only does this application save energy; it saves in the cost of construction and improves the ability of the Air Handler to bring in a constant percentage of outside air to meet Ashrae 15 standards.

During the initial design and planning stages of the Central Plant, all criteria relating to the initial cost, the life cycle cost and the future cost of new buildings were studied at all levels of the University Administration. The committee included the President, Dr. Lee Balzer, Vice President of Finance, Ms. Pat Gustavson, the Facilities Committee, consisting of many Faculty members, and the Board and Student representatives.

Once the decision was made to build a centralized steam and chilled water plant, the timeline became critical. Construction for the new Walker Student Center had already begun and modifications to the design had to be made immediately. The mechanical cooling equipment had to be redesigned to accept a secondary chilled water system loop,

removal of mechanical equipment, downsizing of electrical feeds associated with the mechanical system and provisions for the underground chilled water feed to the building.

Along the same lines, the new Central Plant had to be expedited in order to be able to provide chilled water within six months from the contract authorization, which began in November of 2000. The University placed a provision in the contract that the Design Builder of the Central Plant must be able to provide chilled water the following April for build out of the Student Center in a conditioned space. In essence, there were two projects facing a time line, both dependent on one another. The Student Center needed the conditioned space for finish out and the Central Plant needed the building load in order to place sufficient load on the chilled water system to effectively operate the chiller.

In order to maximize the return on investment of the Central Plant, John Brown University, along with Johnson Controls Inc. designed the chilled water distribution loop to double the current tonnage production of the Central Plant at 1000 tons of cooling. The piping, electrical service and space dimensions of the Central Plant building were designed for expansion up to 2000 tons of cooling.

In addition, the more cooling load the University could place on the new Central Plant, the lower the KW per ton cost of cooling would be to the University. It was decided to connect an existing dormitory since the distribution lines were in close proximity, feed the Student Center that was currently under construction and provide future connection to the Science Building that was scheduled to begin construction within the next 12 months.

With the future in mind, the chilled water distribution loop, using the latest technologies of HDPE piping materials, was also designed to provide chilled water taps at strategic locations to feed existing buildings as their individual mechanical chillers reach the end of their life cycle or the buildings are renovated.

The winter of 2000 – 2001 proved more severe than usual causing delays in the underground and Central Plant site preparation. The Design Builder, Johnson Controls Inc. used their National Support services and installed a temporary chiller to serve the Student Center as the Contractor neared completion. This situation turned out to be the best application possible because the existing dormitory and the Student Center could not provide sufficient load to effectively run the Central Plant until the Student Center was 95% complete.

By July of 2001, the Central Plant was producing chilled water for the J. Alvin Dormitory and Walker Student Center and steam for the entire campus. In September of 2002, Bell Science Building is also receiving steam and chilled water from the Central Plant. Not only is the University providing environments for these new and existing buildings, they are providing environments with much less mechanical equipment and much less energy compared to individual heating and cooling plants.

Since John Brown University began their search for creative and innovative ways to reduce energy and operational cost in 1994, the outcome has been a process, not just a single success. The more Administration, Faculty and Staff began looking for

efficiencies; the more they discovered that efficiencies not only saved money, but they improved the environments as well. The maintenance staff, prior to the efficiency programs, spent a great deal of their time chasing hot and cold calls, as is the case in most University systems. The outcome has been the more "energy aware" the entire campus became, the more savings were achieved, the better the building environments became and enrollment is at an all time high.

The Central Plant was in essence the culmination of the energy efficiency process. Since 1994, each project created by John Brown University was self-funding and resulted in substantial return on investment. The guaranteed energy savings, provided by the University's Energy Partnership with Johnson Controls Inc. is $296,000.00 annually, however the latest estimates of savings are over $330,000.00 each year. Total savings over the past eight years are in excess of $1,029,000.00 and the most incredible statistic is the decrease in cost, measured in dollars per square foot, has decreased 9% since 1994.

The simple payback for the Central Plant, which will decrease cost on every new building from this day forward, was less than 9 years. Taking into consideration that a single chiller or boiler in a building that fails for whatever reason will create an environment that simply would not be tolerable for the occupant. With the Central Plant there is redundancy and as long as there is electricity and gas available to the campus, the Facilities Services Department can provide the most energy efficient, operationally reliable environments possible to the Students, Faculty and Staff.

In retrospect, the Central Plant was designed with the ability to double capacity for campus growth and given the efficiencies the University is now receiving from this best practice, the ideal situation would have been a long term phasing plan to replace the existing systems as soon as possible. Waiting until the existing on-site equipment is at the end of its life cycle also means the equipment is not as efficient compared to the production from the Central Plant.