



Operator training yields big dividends

Page 12

Best practices in operator training

Member systems find that investing in their people pays off in enhanced operating efficiency and employee retention.

With every issue of *District Energy* magazine, readers learn about multimillion-dollar investments in campus and municipal district energy systems around the globe. New combined heat and power plants, distribution systems, solar thermal installations, biofuel conversions and microgrids all point to a heightened interest in thermal networks and their role in creating a more sustainable future. As impressive as these developments may be, they will never live up to their potential without a well-trained workforce to operate them effectively.

Courtesy Thermal Energy Corp. Photo Paul Howell.

The district energy industry today is confronting a massive wave of retirements as seasoned professionals make way for the next generation. At the same time, systems are facing new pressures to lower their carbon footprints, reduce fuel consumption and incorporate sophisticated new monitoring and control systems. All of these factors point to the need for a thorough and ongoing training program for plant operators.

Many IDEA member systems have already taken up the training challenge, and a few of their stories are profiled below. No two systems are alike, but there are surely lessons to be learned from their experiences.

THE UNIVERSITY OF TEXAS AT AUSTIN

The University of Texas at Austin is one of the country's premier research universities. With more than 51,000 students and 17 million sq ft of building space, it requires a substantial campus energy system to keep everything running smoothly. The university's Utilities and Energy Management (UEM) department operates four chilling stations, thermal storage and a CHP plant that satisfy all of the campus's heating, cooling and electrical power needs.

In September 2005 a training certification program was implemented in response to the ongoing retirements of longtime employees whose valuable knowledge and experience was being lost. The initial program, based on specific training by individual job title, was subsequently converted to a self-paced plan that combines a DVD-based learning program with hands-on training that is directly related to the job being performed. The program is periodically updated as new equipment is brought on line and old equipment is retired.

The current certification program educates employees using industry-standard power, steam and chilling station training procedures and resources. This is followed by plant-specific operations training

and a hands-on demonstration and verification process that ensures that the knowledge has been conveyed and that tools are being used appropriately. The learning process is ultimately validated via a written test. New employees, promoted employees and existing employees are required to finish the certification within 18 months.

An essential part of the process – beyond gaining familiarity with the operation of individual pieces of equipment – is to fully understand how all of the equipment is inter-related. Operators are not deemed qualified until they demonstrate proficiency in this critical skill. Even people hired with extensive power plant or chilling station backgrounds still require months of ongoing training to develop a full understanding of the specific systems at UT Austin.

UEM supports ongoing professional development in both soft skills (leadership, for example) and technical skills through formal training courses and industry conferences where new and emerging best practices are often presented. With regard to UEM-specific software, such as Termis and Optimum Energy, UEM relies on training and workshops offered by the specific vendor. With-

out regular training on this specialized equipment, however, UEM will never realize the full potential offered by these advanced technologies.

Another part of UEM's personnel strategy is to encourage employee retention. For example, UEM offers incentives both to new employees and to existing employees seeking a promotion to complete a training program by paying for up to six hours of overtime per week until the curriculum is completed. To encourage further progression of already-certified employees, an employee can recertify for higher-level positions, giving that individual an advantage over other candidates who are not precertified (however, precertified employees are not eligible for the overtime pay). Promotion opportunities are posted in-house before they are announced externally, further incentivizing employees to move up within the organization rather than seek positions elsewhere. This approach has served UEM well, allowing employees to advance within the department based on knowledge and experience.

Another effective policy was created whereby hiring committees consist of peer groups that will be working with the new employee. This



Courtesy The University of Texas at Austin.

Operator training plays a critical role at UT Austin, where a continually expanding campus places heavy demands on the heating, cooling and electrical networks.

teaches employees the responsibility that goes with the hiring process and encourages them to take ownership of selecting the candidate with whom they will be working. This has improved morale and made the hiring process fair in the eyes of employees.

Even in energy plants with a highly trained workforce, situations can arise that require an employee to make instant decisions needed to prevent serious injury to personnel or equipment ... but there is no time to check with the boss. Empowering employees to use their own judgment requires a culture that accepts a certain level of risk-taking. This creates a potential for more errors so it is important that errors be weighed on a case-by-case basis. If the error occurred because the intent was to prevent a more catastrophic situation, then it was a “good” error. Errors need to be analyzed to document the root cause of the incident, what action was taken and what was learned in the process. This analysis can then be used to teach others how to prevent a recurrence.

Finally, the UEM staff understands that the best way to make life easier for themselves is to make life easier for peers and co-workers, which is best accomplished by frequent and broad sharing of knowledge, observations and ideas. The ability to work effectively within a team environment is a key hiring criterion for UEM and is considered an essential expectation of the job.

THERMAL ENERGY CORP.

Training has always been important at Thermal Energy Corp. (TECO) on the campus of the Texas Medical Center in Houston. But when TECO added more than 700 pieces of new equipment during a \$377 million expansion from 2007 to 2011, training became paramount to the system’s reliability and efficiency.

In anticipation of the task at hand, TECO President and CEO Steve Swinson tapped Larry Null, the company’s senior vice president, to oversee development of an extensive new Operator

Training and Certification Program (OTCP) that included CHP operation. Null began in 2009 by focusing on how to run the new equipment, coordinating the program with Burns & McDonnell, which provided design-build services for TECO’s expansion.

“It’s one thing to talk about developing a quality training program,” says Null. “But it’s another to make it happen. There are many details to work out. First and foremost, we had to determine how we could provide proper training but still keep the plant running smoothly. For this initial phase we also needed to train not just the operators but maintenance, instrumentation and controls, and engineering personnel, too. Everyone had to be as familiar as possible with the same best practices when all new equipment and processes went operational. All equipment operation had to integrate seamlessly to give us the highest-possible system efficiency and reliability.”

To pull the program together, Null examined what training was needed, by when and who could provide it. Then TECO set up its initial training to include printed training materials for each employee and classroom and hands-on training by vendors, suppliers and supervisors. Scheduling the training proved to be a major task: TECO had to coordinate

each trainer’s schedule with TECO’s staff schedule – all in the midst of a major construction project at one of the nation’s largest district energy systems.

Also, before any training sessions were held, Null evaluated the proposed training materials and the trainers to ensure that TECO’s needs would be met. Burns & McDonnell teamed with Tri-Tech Energy Services Inc. to prepare system-based training manuals that employees could reference later and TECO could use to train new hires.

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Following a strict schedule to ensure training was completed before the new equipment went operational, Null and his team had this initial phase ready to go in late 2009. From late 2009 to mid-2011, multiple levels of TECO personnel completed 14,280 hours of training on new equipment during normal and extended work hours. TECO’s 22 operators each averaged 325 hours of training during the same period.



Courtesy Thermal Energy Corp. Photo Julian Brewster.

TECO’s Operator Training and Certification Program includes classroom and online learning as well as hands-on training.

Once TECO's employees had completed new-equipment training, TECO decided that operators and other staff could benefit from the same level of training on existing equipment. So OTCP development continues with a program being structured to take an employee through seven operational levels from trainee to operations supervisor. Online courses and additional training manuals for existing systems, equipment and operating tasks have been added, and more modules are under development. Tri-Tech continues to provide the hard-copy training manuals.

All experienced operators are participating in the program, and new operators are required to complete the OTCP to qualify for advancement. It starts with 73 generic online courses about operator responsibilities, heat transfer, compressors, basic electrical principles, etc. Generally, it takes six weeks for a trainee to complete the online courses, mixed into workdays that include other introductory training.

Next, TECO offers site-specific courses based on plant systems and operational tasks, and hands-on training rounds out the program. Employees pass each level and obtain certification by demonstrating through written and hands-on assessments that they know how to operate the related equipment and understand its function.

"It's important that the OTCP be more than just training," says Null. "So the program is being designed to spell out the requirements for initial and periodic recertification at each of TECO's seven operating levels. Plus, it helps prepare operators to take the city of Houston stationary engineer license exams. There is room for growth here if an employee is motivated and eager to learn. We are finding that the program is boosting employee confidence and aptitude."

From mid-2011 to mid-2015, 19 TECO operators logged 5,463 additional hours of training. During the same period, they attained seven positional promotions and 13 city of Houston

stationary engineer initial licenses or license-level advances.

Throughout new-equipment and existing-equipment training, TECO has carefully monitored progress, noted where improvements could be made and adjusted content and process as needed. In particular, it modified the program to accommodate different learning styles.

"Training is an investment in our people and our customers," says Null. "We allocated nearly \$1.2 million in direct and administrative expenses for OTCP from 2011 to 2015, which doesn't include OTCP startup. But it has been worth it. Admittedly, it's a lot more work than you think it will be. You need to be serious and get buy-in throughout the organization, beginning at the top, to be successful. It takes a lot of input from different parties, but if you commit to the program, it reaps rewards."

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

The University of North Carolina at Chapel Hill features an integrated energy system designed to achieve optimal efficiency from its chilled-water, cogeneration and electric distribution systems. In particular, UNC Cogeneration Systems plays a vital role in the Energy Services infrastructure by providing an uninterrupted supply of steam to the UNC campus and UNC Hospitals and by cogenerating electricity for cost savings and increased reliability. Cogeneration Systems Operations is charged with ensuring that a high operational standard is maintained by hiring and promoting capable individuals and setting high standards for operational training.

The training is structured in a way that gives UNC Cogeneration Systems maximum flexibility in the utilization of manpower. It also equips the individual with the tools necessary for advancement when appropriate positions become vacant. Comprehensive training is provided for new hires and for those promoted into a higher-level position from their

current classification. The training reflects the job duties for that position as well as an emphasis on maintaining proficiency in the next lower-level position such that coverage continuity is always maintained. The training requires the individual to demonstrate a working knowledge of all plant systems through comprehensive study of system descriptions, drawings and customized instruction with shift supervisors and senior operators. The individual must be able to identify the equipment in the field and its direct association with equipment indicated in the distributed control system; the operator must know the proper response to any alarm associated with all systems. Any employee who is authorized to relieve a position at the next higher level is required to have performed those duties in a training capacity a number of hours equal to or greater than the hours required for permanent promotion. All training must be documented and kept on file by the shift supervisors.

THE TRAINING IS STRUCTURED IN A WAY THAT GIVES UNC COGENERATION SYSTEMS MAXIMUM FLEXIBILITY IN THE UTILIZATION OF MANPOWER.

The overall training program consists of five phases. After operators complete the training cycle for the position one level above their current position, moving to that higher position depends on the evaluation of the shift supervisor and the employees' willingness to accept the added responsibility of that position. The five phases are as follows:

- Phase I – Auxiliary operator training: basic training in plant systems required for all operators to ensure a good understanding of plant equipment
- Phase II – Assistant control room operator/relief training: trains the auxiliary operator for relief duties as an assistant control room operator
- Phase III – Control room operator/

relief training: trains the assistant control room operator for relief duties as control room operator

- Phase IV – Shift supervisor/relief training: trains the control room operator for relief duties as shift supervisor
- Phase V – Operation superintendent/relief training: trains the shift supervisor to be able to act in the capacity of an operations superintendent

Another element in UNC's training program is aimed at cultivating new talent among the students enrolled at nearby Piedmont Community College (PCC). The Carolina Tar Heels Power Program is designed to attract the most promising community college talent, provide students an introduction to the business of power plant operations, support students' completion of a targeted two-year associate degree and ultimately prepare them for careers within the power industry. This work-study program offers hands-on experience primarily in operations and maintenance. Students are encouraged to apply for full-time employment at the UNC cogeneration facility after completion of their school degree as vacant positions become available.

The program expands employment opportunities through intensive education and information sharing of Energy Services' staffing needs with the community college faculty. This program works with PCC to enhance existing programs and offer new curricula to prepare students for careers in the power industry where young operating engineers are increasingly in demand.

To date, UNC Cogeneration Systems has hired three plant operators, one instrument and controls technician, and two plant mechanics through this program. In addition, its sister department, UNC Chilled Water, has hired two students that graduated from the program.

PRINCETON UNIVERSITY

The Princeton Energy Plant provides electricity, steam and chilled

water to the Princeton University campus. The plant has four main components: steam boilers, water chillers, a gas turbine and a 2.6 million-gal thermal energy storage system. The turbine can generate 15 MW of electricity and is connected to the campus microgrid that allows critical facilities to continue operating in the event of a grid failure, a feature that became widely admired during Superstorm Sandy in 2012.

PRINCETON UNIVERSITY HAS A RIGOROUS FOUR-YEAR APPRENTICE PROGRAM THAT BEGINS WITH A STRONG FOCUS ON CLASSROOM TRAINING IN VARIOUS TECHNICAL COURSES.

Keeping this complex system functioning at peak efficiency requires continuous training and improvement. Princeton University has a rigorous four-year apprentice program that begins with a strong focus on classroom training in various technical courses. On-the-job training starts with simple work to help the apprentice become familiar with the plant. Throughout the four-year sequence the program becomes progressively more technical. Eventually, apprentices stand watch with another operator until they are qualified to take the watch alone. Each apprentice is responsible for drawing a one-line diagram of every system in the plant so that they know the details of each one. In addition, every year the plant brings in vendors to tune equipment and conduct preventative maintenance. While the vendors are in the plant, the university requires them to retrain operators on their equipment.

Whereas the Princeton plant – like those on most other campuses – has traditionally kept a low profile, its activities are more visible today thanks to a heightened awareness of environmental and sustainability issues among students, faculty, staff and trustees. Plant operators also know that the university's admin-

istration cares about such issues as reliability, cost and carbon footprint. They take ownership of their plant seriously and believe – rightly so – that what they do matters. Each operator wants the plant to run well and, as a result, they have become skilled at communicating operating issues to both their relief operators and plant management.

Operators are encouraged to ask questions concerning equipment or systems, but they are also expected to research the various technical documents that are available for all equipment in the plant. They are invited to share their ideas about better ways to do things rather than simply assuming that "we operate a certain way because that's how we've always done it." Management believes that operators should know the fundamental reasons why things are done the way they are, but they are also encouraged to challenge those reasons. Timely communications with their colleagues are also critical, whether it's in person, written logs or email.

Creating financial incentives can also help motivate employees to act in ways that are beneficial to the system. Princeton has incentives built into the annual merit increase pool for operators covered by the union contract. These incentives are based upon the operator's success in following equipment dispatch signals (controlled by software and an outside partner) and the availability of steam and chilled water to the campus. All merit increases are team-based rather than based on the actions of any single person.

It is worth noting that while some plant operations could be automated, the most important decisions are made by trained, licensed operators. Those decisions are made with regard to the following criteria: safety, legal/regulatory, reliability, environmental impact and lifecycle cost. The professional operators of the plant are absolutely essential to getting the greatest value from the facility.

Princeton's commitment to training and continuous improvement

has not gone unnoticed. The university's cogeneration plant received a U.S. Environmental Protection Agency ENERGY STAR® CHP Award in 2007 for efforts to reduce pollution and improve energy efficiency. In 2009, Princeton received a letter from the CHP Partnership recognizing the university for a project in which equipment was added to the plant to improve the overall system energy efficiency and other measures. "[These] projects serve as examples of leadership in energy management and efficient energy production," the letter stated.

EVER-GREEN ENERGY

Ever-Green Energy is the service provider to District Energy St. Paul, one of the most integrated community energy systems in North America. It includes biomass-fired CHP; coal, gas and oil boilers; electric and absorption chillers; thermal storage; and state-of-the-art monitoring programs for satellite facilities on the hot water and chilled-water systems. It also incorporates North America's largest solar thermal installation integrated into a district energy network. The downtown St. Paul system serves a broad customer base that includes local and state government, arts, entertainment, hospitality, Fortune 500 companies and small businesses.

To achieve strong and reliable system performance, Ever-Green Energy relies on a variety of core operating principles including preventive maintenance, technology advancement, fuel flexibility and system redundancy. It has also begun implementing a business intelligence system that will allow it to improve analysis, real-time monitoring and predictive modeling. Key performance indicators are reviewed regularly to ensure the system is performing as intended.

But technology and processes can only take a system so far – what really matters is the team that operates it. "Our culture is rooted in strong values of integrity, delivering exceptional service, operating with excellence and putting our people first," says Cathy

Hart, senior vice president – administration. "Our team feels tremendous pride in the work they do, and we adhere to the principle that how we deliver results is more important than what we do to achieve them."

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The team is encouraged to communicate with each other through daily shift meetings, weekly operations management meetings, crew discussions and open lines of communication across all levels of staff. There is consistent collaboration across operations including plant, distribution, controls, fuel, engineering and customer service teams. Staff are encouraged to ask questions and share ideas for improving efficiency, and just last year the team was rewarded for the extraordinary efficiency outcomes of the cooling system. In addition, exceptional team and individual contributions are recognized at monthly all-staff meetings.

Ever-Green Energy employs various levels of training and development for its team, from detailed, documented procedures to on-the-job training, external seminars and education. A formal apprenticeship training program is now being developed in partnership with a local technical college, and online learning tools are becoming more available to staff on a variety of topics. Staff are encouraged to create individual development plans annually, identifying professional and technical skill-building goals.

The importance of safety is conveyed through monthly and spot training sessions, clear reporting tools, encouraging early identification of potential hazards and discussing near misses. A safety committee shares lessons learned, and safety incidents are met not with a punitive response but rather a commitment to learning

how to prevent future problems. Ever-Green Energy is fortunate to have earned a high degree of loyalty among employees, so retention has not historically been a challenge. But as its seasoned staff look toward retirement, the company is increasing its efforts to transfer knowledge to ensure that the remaining team is fully prepared. And it is always evaluating ways to make improvements so that it continues to be a great place to work.

The next frontier is to more broadly utilize the company's business intelligence system and engage operators further in optimization and analysis activities. As an example, a recent team training included managing demand peaks and brainstorming operating solutions. That type of analytical dialogue will continue on a regular basis. Ever-Green Energy also plans to increase development of its crew leads so as to encourage more real-time improvement dialogue between the operators and leads, reducing reliance on more formal communication methods. Another focus area for the coming year is to find ways to carve out time to further formalize more of the training program structure and conduct cross-training.

"In our organization, what comes first, middle and last is our people – their safety, development and inclusion in all aspects of our operations," says Hart. "As we look to continually improve our systems, technology and processes, we know that we're able to deliver reliable, renewable, efficient energy to our customers because of the amazing team we have. Our investment priorities will always reflect our people being our greatest asset." 

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