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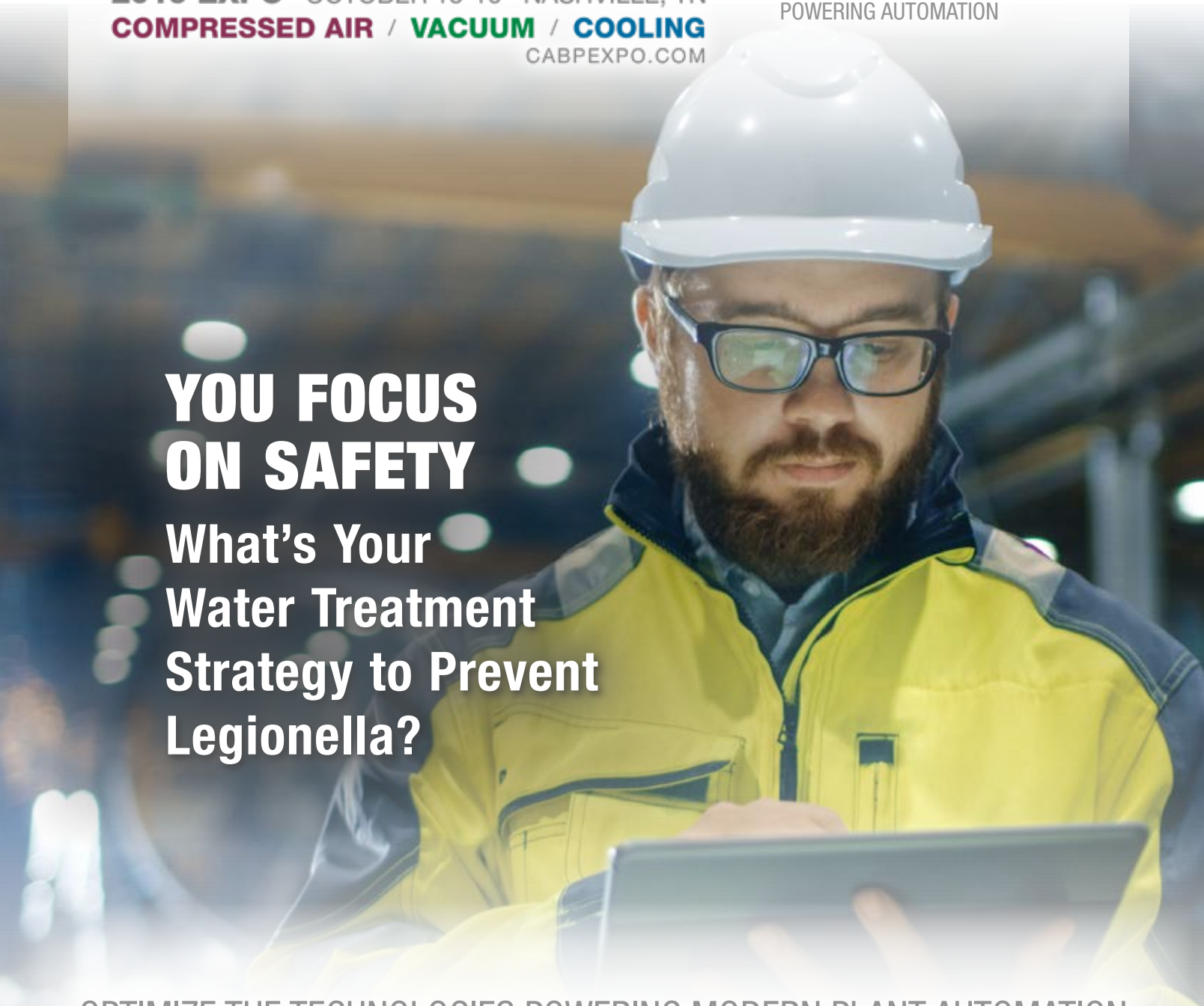

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COLUMNS

FROM THE EDITOR

NYC Health+Hospitals/Lincoln is a large, full-service community medical center and teaching hospital. Preventing Legionnaires Disease was the focal point of their selection criteria when it became time to replace aging cooling towers. We hope you enjoy an article provided to us, by Delta Cooling Towers, about how Lincoln Hospital came to select anti-microbial cooling towers.

As our readers know, we have always focused on systems far more than components. Temperature/pressure specifications often are major drivers for performance. For this reason, we are very pleased to publish an article provided to us by Hudson Technologies titled, "Optimize Chillers with an Automatic Entering Condenser Water Temperature Reset Strategy."

I just returned from visiting the impressive Knoxville-area location of Denso Manufacturing Tennessee. This 230-acre campus has 2.6 million square feet under roof and employs over 4,300 people. They've allowed us to publish a story about their very innovative Trane IceBank® ice-storage tanks. This ice-storage system, provides cooling during peak rate hours and works together with the air-cooled chillers to reduce their cooling costs per ton by 44% and create an annual CO_2 reduction of 18,000 tons!

The energy performance of buildings is the subject of a two-part article provided to us by Danfoss. This first installment examines the evolution of equipment-efficiency standards from full to part-load and their relationship to whole-building efficiency.

Improving quality, safety, reliability and efficiency, by optimizing self-generated utilities, is the focus of the 2019 Best Practices Expo & Conference, taking place October 14-16, 2019 at the Nashville Music City Center. Visit www.cabpexpo.com

Thank you for investing your time and efforts into **Chiller & Cooling Best Practices.**

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RESOURCES FOR ENERGY ENGINEERS

INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

Thermal Care HFCG Adiabatic Fluid Coolers Offer Savings

For those looking to reduce energy use, cut operating costs or provide clean water for a process cooling system, the HFCG Adiabatic Fluid Cooler from Thermal Care offers the potential for significant savings.

Most fluid coolers are closed–loop heat exchangers that cool process water using ambient air. HFCG units employ a unique adiabatic design that can provide leaving water temperatures in ranges similar to those achieved with conventional evaporative cooling tower systems year-round.

The Thermal Care HFCG Adiabatic Fluid Cooler

HFCG Adiabatic Fluid Coolers operate as air-to-water heat exchangers and use a number of variable speed fans as dictated by process cooling requirements. During much of the year and in warm weather climates, units can provide leaving water temperatures similar to using evaporative cooling towers.

Used on hot weather days, the Thermal Care adiabatic system decreases the air temperature as it enters the unit and results in lower leaving water temperatures when compared to those achieved by a fluid cooler using dry incoming air.

It is possible to run process water temperatures low enough using only an HFCG unit that it may actually be possible to operate equipment without the use of additional central chilling units, potentially resulting in considerable savings.

Less water is used for process cooling than with conventional evaporative cooling tower systems. Units are closed-loop so there is no need to replace evaporated process water. Thus, keeping process water clean and uncontaminated – without the need to treat for water scale or bacteria.

HFCG Adiabatic Fluid Coolers are designed for outdoor use. Airflow through the unit is maximized while the footprint of each unit is minimized. Modular and easy to install, additional units can be added when there is a need to expand cooling capacity. For more information visit www.thermalcare.com

Baltimore Aircoil Company Announces HXV Hybrid Cooler

Baltimore Aircoil Company (BAC) is proud to introduce the HXV Hybrid Cooler, which offers the best of both evaporative and dry cooling in a water saving and energy-efficient solution. The HXV is ideal for maintaining peak performance for a variety of applications where water is scarce, water costs are high, uptime is critical, or plume is a concern. It is perfect for the most demanding projects, including data centers, industrial, manufacturing, and HVAC.

The HXV Hybrid Cooler delivers energy-efficient cooling while maximizing water savings. Thanks to the power of evaporative cooling, the HXV is up to 60% more energy-efficient than air-cooled systems. BAC's innovative combined flow technology, which combines parallel air and water paths, ensures peak system energy efficiency. The HXV also offers up to 70% water savings compared to traditional fluid coolers with the ability to run with reduced water during the majority of the year. Even on a design day, 25% water savings can be achieved.

The HXV Hybrid Cooler also offers 25% maintenance savings compared to traditional fluid coolers. Maintenance is easy with immediate access to the cold water basin, prime surface coil, and the fan drive system. Operators can even inspect the spray distribution system while the unit is in operation. Maintenance costs are further reduced by virtue of 70% chemical savings.

When reliable year-round operation is critical, the HXV Hybrid Cooler offers trouble-free winter operation. Additional benefits of the HXV

RESOURCES FOR ENERGY ENGINEERS

INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

The Baltimore Aircoil Company HXV Hybrid Cooler offers the best of both evaporative and dry cooling in a water saving and energy-efficient solution.

include uninterrupted operation with multiple fans and optional redundant pumps. Longevity and corrosion resistance are further increased with superior material options including EVERTOUGH® Construction and TriArmor® Corrosion Protection System. For projects requiring plume abatement, the HXV has no plume when operating dry, and the dry coil provides natural plume abatement when running wet.

About Baltimore Aircoil Company

With over 80 years of industry-leading innovation and experience, BAC creates cutting-edge cooling equipment for the HVAC, Industrial, and Refrigeration marketplaces. We solve customers' unique needs with our expertise and wide range of high-performance systems. BAC leverages the power of evaporative cooling by optimizing the balance of water and energy, but the true BAC difference lies in our absolute commitment to creating sustainable solutions and delivering value to our customers.

For more information about Baltimore Aircoil Company, visit www.BaltimoreAircoil.com , tel: 410.799.6200, email: info@BaltimoreAircoil.com

Bacharach Introduces MVR-SC Controller for Networking VRF Leak Detectors

Bacharach, a leading provider of HVAC-R gas instrumentation and monitoring solutions, today introduced the new MVR-SC controller designed to seamlessly pair with MVR-300 refrigerant monitors to provide real-time status of refrigerant leaks throughout a facility. The key functions of the MVR-SC include:

- Centralized alarming for MVR-300 VRF leak detectors
- Network set-up and MVR-300 Modbus ID assignment
- System monitoring
- Seamless integration with MVR-300

The MVR-SC eliminates the need to integrate VRF leak detection into a BAS controller and the related custom programming expense. By implementing a hybrid Ethernet serial network the MVR-SC simplifies the Modbus integration, provides fast response for fault detection and troubleshooting and is quickly deployed in any size facility. The MVR-SC monitors up to 100 MVR-300 devices and has an integrated audible alarm. The MVR-SC has an intuitive user interface built on a color, touchscreen display. VRF systems are being increasingly deployed in multi-tenant building such as hotel, dormitories, assisted living facilities, and offices. The Bacharach VRF leak detection system, which includes the MVR-300 and MVR-SC, improves occupant safety in the case of a VRF system leak. Please visit www.mybacharach.com for additional information.

About Bacharach

Bacharach is a provider of cleantech solutions for gas and refrigerant leak detection and identification, refrigerant tracking, combustion and emissions analysis instrumentation, and high-purity oxygen gas analysis in commercial and industrial applications. Bacharach products make the heating, ventilation, air-conditioning, refrigeration (HVAC-R), and process industries safer, cleaner, and more energy-efficient, enabling customers to increase productivity, reduce costs, and protect lives and the environment.

Danfoss VZH Inverter Scrolls

Danfoss – the third-generation commercial inverter scrolls retain the strengths of the previous version, with the addition of the Intermediate Discharge Valve (IDV) technology for enhanced seasonal efficiency, and a wider operating map. The products are particularly suitable for comfort reversible applications and computer room air conditioning (CRAC) units.

Matthieu Stoll, Global Marketing Director A/C, Danfoss Cooling said: "The introduction of IDVs in the large models means that there's no

INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

longer a need for high- and low-pressure compressor optimization – potentially halving inventory management requirements. And the wider operating map brings huge value for strategic applications. We can accelerate the changeover from older Danfoss inverter scrolls to the third generation seamlessly."

Features and benefits of the new generation variable-speed scrolls include:

- Prequalified Danfoss compressor and drive package for time to market and reliability
- Accurate temperature control and humidity management for high energy efficiency and comfort
- Low start-up current, and manageable acoustic level with variable speed technology
- A complete line-up of models from 4 to 26 TR (up to 52 TR in hybrid tandems) all with IDV technology for superior part-load efficiency
- Wider operating map to cover more types of applications
- Smaller OEM inventory on larger models with the transition from two high-, low-pressure ratio to a single IDV model

Looking to the near future, multi-refrigerant capability is in the pipeline for the VZH range, including R452B and R454B, and a version derived from VZH will also be released for R32. This will enable OEMs to respond to future challenges in the refrigerant landscape, while addressing energy efficiency regulations.

For more information visit airconditioning.danfoss.com

Danfoss Inverter Scrolls VZH range from 4 to 26TR.

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RESOURCES FOR ENERGY ENGINEERS

INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

Endress+Hauser Releases Memosens CCS51D Free Chlorine Sensor

Endress+Hauser has launched the Memosens CCS51D amperometric sensors for free chlorine measurement in process water, drinking water, water & wastewater treatment, cooling water, and all utilities and processes requiring clean, treated water.

The Memosens CCS51D amperometric sensor

Free chlorine is the most important disinfectant in water treatment due to its easy handling, the strong disinfecting effect and the residual effect. Memosens CCS51D features a special membrane design providing an extremely fast response time.

The sensor's convex membrane made of dense, dirt-repellent material prevents soiling and makes it extremely resistant to biofouling. Ultrasonic welding of the membrane to the sensor cap ensures its integrity, preventing dilution of the electrolyte and thus a drift of the measuring signal.

The free chlorine sensor is equipped with proven Memosens technology. Memosens allows for direct commissioning of new sensors without further calibration. During on-going operation, plant operators can pre-calibrate sensors in the lab, swap them into the process with plug & play, and thus continue measuring faster. Finally, non-contact data transmission eliminates all measurement errors or even failures caused by humidity or corrosion.

Memosens CCS51D is connected to the Liquiline multiparameter transmitter that can serve up to eight sensors simultaneously, and the Flowfit CCA250 flow assembly offers mounting space for a simple installation of the additional pH sensor.

Visit www.us.endress.com/CCS51D for details.

The Endress+Hauser Group

Endress+Hauser is a global leader in measurement instrumentation, services and solutions for industrial process engineering. The Group employs approximately 14,000 personnel across the globe, generating net sales of more than 2.4 billion euros in 2018. For further information, please visit www.endress.com.

COOLING TOWERS & CHILLERS

South Bronx Hospital Staves Off Legionnaires Disease with ANTI-MICROBIAL COOLING TOWERS

By Dr. Joseph Kuhl, PhD, Delta Cooling Towers

NYC Health + Hospitals/Lincoln chose to increase protections against possible future exposure to Legionella bacteria by installing 18 anti-microbial cooling towers.

Deadly outbreaks of Legionnaires Disease have become an all too common occurrence. According to the Center for Disease Control and Prevention (CDC), more than 6,100 people per year in the United States are sickened by this serious form of pneumonia, and one out of 10 of those will die. Legionella – the bacteria that causes Legionnaires – proliferates in water systems like the cooling towers used in conjunction with large HVAC systems.

So when a cooling tower supporting the HVAC system at NYC Health + Hospitals/ Lincoln was nearing its expected end of life, the management of the 362-bed hospital in the South Bronx saw an opportunity. The year before, the neighboring community had experienced outbreaks of Legionnaires' disease, and even though the hospital's cooling towers played no role in those outbreaks, the chance to increase protections against possible

"The total electric power energy savings calculated by our engineering firm was figured at about 40%, which is quite an accomplishment."

— Louis Iglhaut, Associate Executive Director at NYC Health + Hospitals

future exposures of the bacteria that cause the disease was an important consideration.

Accordingly, the hospital's engineering and management teams prioritized the selection of an anti-microbial cooling tower option. They also gave extra weight to finding a system that would save energy, consistent with the larger health system's ongoing goals.

Finding the Source

Legionnaires' disease is a severe form of lung infection caused by exposure to bacteria known as Legionella. Found naturally in freshwater environments like lakes and streams, Legionella becomes a health hazard when it grows unabated in water that is not properly treated. While this can include

NYC Health + Hospitals/Lincoln is full-service community medical center and teaching hospital located in the South Bronx.

SOUTH BRONX HOSPITAL STAVES OFF LEGIONNAIRES DISEASE WITH ANTI-MICROBIAL COOLING TOWERS

showerheads, hot tubs and hot water heaters, cooling towers are often found to be the source of outbreaks.

Cooling towers have a long history of effectively expelling heat from the water used in many commercial and industrial applications. However, a recent study from the CDC found that an overwhelming majority of the cooling towers they tested contained Legionella DNA. This indicates that the dangerous bacteria were either currently present or had been at some point, and without proper precautions would eventually give rise to an outbreak.

Legionella bacteria can flourish in cooling towers and spread to humans when expelled water vapor or mist containing the bacteria is inhaled. Each year, as many as 18,000 people are infected with the Legionella bacteria in the United States.

Addressing Microbial Concerns

NYC Health + Hospitals/Lincoln, a large, full-service community medical center and teaching hospital – part of the largest public healthcare system in the United States – knew what was needed. Louis Iglhaut, Associate Executive Director at NYC Health + Hospitals, led the team responsible for the specification, acquisition, and installation of the new cooling towers.

Originally, one of Iglhaut's primary design priorities for Lincoln Hospital's new cooling tower was to focus on efficient and thorough water circulation. In other words, the design of the new towers should not have corners in the basin, as many do, including the stainless steel models the hospital was replacing.

"We needed to think outside the box," said Iglhaut. "Given our concern about the dangers of microbial growth, we decided to only consider towers with rounded basins."

Lincoln Hospital's water treatment program for its old cooling towers used strong biocides and acid feed treatment chemicals that had corrosive, life-shortening effects on its stainless-steel towers.

Iglhault's search for a superior design led his team to find a new breed of cooling towers that had just recently become available. Fully compounded with an anti-microbial resin, these advanced technology towers contain wide-spectrum additives that operate on a cellular level to continuously disrupt and prevent uncontrolled growth of microorganisms and biofilm.

"These towers, which are rounded, not only solved the circulation problem but also have anti-microbial chemicals embedded into the tower's HDPE material, which helps to prevent the growth of dangerous bacteria such as Legionella," he said.

The towers the hospital selected were made by Delta Cooling Towers, which introduced the high-density polyethylene (HDPE) cooling tower in the 1970s.

While some cooling tower manufacturers market a tower with an anti-microbial fill (the medium over which the hot water is distributed as it is being cooled), another option is to use a cooling tower that features the fill, structural casing, and sump all composed of anti-microbial material.

This is highly significant because biofilm growth and microorganisms allow a place for bacteria to hide from chemical treatments and also provide nutrients for pathogen growth.

Convinced the rounded design, HDPE durability and protective features of the anti-microbial material were a good solution for Lincoln Hospital, the procurement team selected Delta's Anti-Microbial TM Series model with 18 modular cooling towers that provide a combined total of 6,000 cooling tons.

Corrosion and Chemical Concerns

To reduce future outbreaks, cities like New York are increasingly requiring extensive use of harsh chemicals to be used within all cooling towers. For Lincoln Hospital, this requires a professionally maintained water treatment program that uses strong biocides and acid-feed treatment chemicals. While these could have a life-shortening corrosive effect on even stainless-steel towers, engineered plastic HDPE towers can withstand even the harshest chemicals.

"I think that the corrosion resistance of these HDPE towers is demonstrated by the manufacturer's 20-year warranty," Iglhaut said.

Significant Energy Savings

Another major factor affecting Lincoln Hospital's decision to adopt the new Delta cooling towers was the promise of substantial energy savings. New York City Health + Hospitals was well aware of the city's mandate to save on energy, so it teamed up with the country's largest state power organization, which is dedicated to innovative and energy-efficient infrastructure.

"We worked with New York Power Authority to ensure the new cooling towers would be as energy-efficient as possible. Our old towers used large, 30-horsepower fans on each unit, which required the use of a lot of electric power. The new modular units are equipped with smaller horsepower, 60-inch fans, so the energy consumption is far less," he said.

"Also, we have installed Variable Frequency Drives, which will give us even more savings. The total electric power energy savings calculated by our engineering firm was figured at about 40%, which is quite an accomplishment," he said.

Lincoln Hospital selection of an anti-microbial cooling tower option also factored in the ability to save energy, which is consistent with the larger health system's ongoing goals.

Iglhaut said even the installation of the new cooling towers added to efficiencies. Because the towers were smaller and lighter, the installation team was able to use a small crane to lift the towers into position, which ensures a seamless transition from the old system to the new one.

"Sometimes I think people like engineers should be judged by things that don't happen in the hospital," he said. "In this case, the cooling towers went in seamlessly without interruptions to any patient areas. It was up and running with zero downtime." BP

About the Author

Dr. Joseph Kuhl, PhD, is V.P. of Engineering at Delta Cooling Towers. (www.deltacooling.com). Kuhl has a PhD. in mechanical engineering from the Massachusetts Institute of Technology and has over 25 years of experience working in the HVAC and industrial cooling markets.

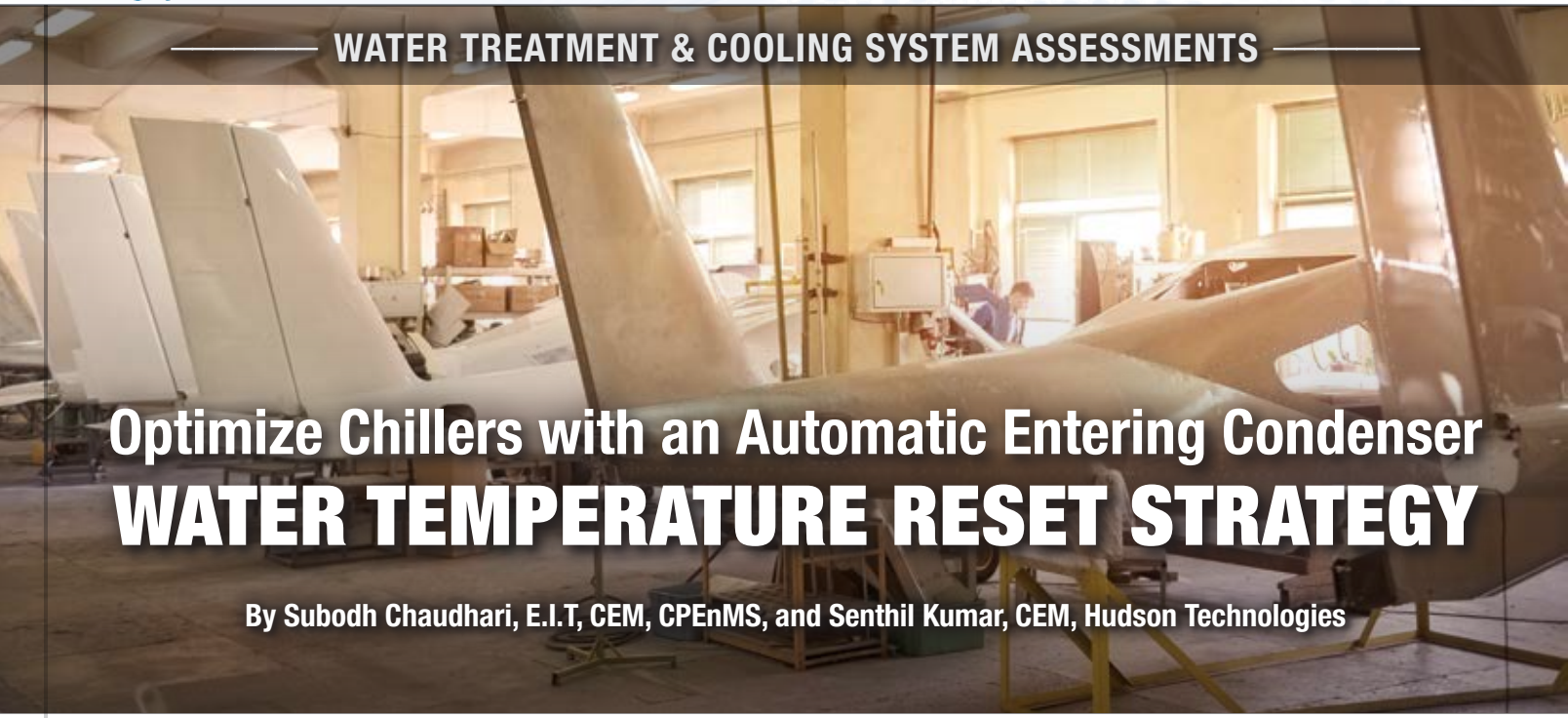
About Delta Cooling Towers

Founded in 1970, Delta Cooling Towers was the first company to manufacture a seamless, non-corrosive, cooling tower made out of engineered plastic. Over the last 45 plus years, Delta has introduced several revolutionary cooling tower products, including their Paragon Series Induced Draft Cooling Towers and TM Series – which shifted the company's single module capacity from 250 tons to 2,000 tons, respectively. Recently, Delta introduced its new anti-microbial cooling tower option, making Delta the first cooling tower company to implement a product solution to help prevent the potentially deadly Legionnaires' disease. For more information, visit www.deltacooling.com/products/cooling-towers/anti-microbial-cooling-towers.

All photos courtesy of Delta Cooling Towers.

To read similar ***Cooling Tower Technology*** articles please visit www.coolingbestpractices.com/technology/cooling-towers.

WATER TREATMENT & COOLING SYSTEM ASSESSMENTS



Optimize Chillers with an Automatic Entering Condenser WATER TEMPERATURE RESET STRATEGY

By Subodh Chaudhari, E.I.T, CEM, CPEnMS, and Senthil Kumar, CEM, Hudson Technologies

A chilled water plant's annual operating cost is a major contributor in a facility budget. Typical chilled water plants consist of multiple chillers, cooling towers, chilled water pumps, condenser water pumps, plate heat exchangers and water treatment equipment.

The chilled water is generated in the central plant and then transported through a piping network to cooling coils (air handlers), or to point of end-use in processes. Facility directors and energy managers are always chasing multiple goals – satisfying all the customers, maintaining a high-level of reliability and minimizing energy spends with varying demand and weather. Therefore, many modern plants employ a good chiller optimization package such as Hudson Technologies' SMARTenergy OPS® in conjunction with Building Automation Systems (BAS) to optimize the chiller plants.

Chiller Plant Efficiency Driven by Cooling Tower Management

In a water-cooled chiller plant, cooling towers facilitate heat removal. Cooling towers are designed for peak summer conditions – high temperature and humidity. The efficient operation of a chilled water plant is highly dependent on cooling tower management. In practice, four cooling tower management strategies are applied, i.e., constant setpoint, seasonal reset, manual reset, and automatic reset. Application of a strategy is based on the chiller plant configuration and operation philosophy at a particular plant. Automatic reset is the most energy efficient strategy. It uses prevailing ambient conditions and the actual cooling load to continuously make setpoint changes.

The cooling tower energy consumption can have significant impact on the chiller plant performance. The chiller power requirement is dependent on Entering Condenser Water Temperature (ECWT) supplied by the cooling tower. This is explained further in sections below. As the Wet Bulb Temperature (WBT) drops, the chiller can be supplied with a lower ECWT. However, it must be noted the cooling tower approach (ECWT-WBT) increases for the same cooling load, cooling tower flow, and temperature range when WBT drops.[1] Temperature range is determined by subtracting the ECWT from Leaving Condenser Water Temperature. If the ECWT is set close to WBT without considering the variation in approach, it will be harder to meet the setpoint, which results in higher cooling tower energy consumption. Hence, it is important to manage

"This strategy represents the single biggest potential opportunity to maximize chiller energy efficiency – every degree reduction in the condensing water temperature reduces chiller energy consumption by 1 to 2 percent."

— Subodh Chaudhari, E.I.T, CEM, CPEnMS, and Senthil Kumar, CEM, Hudson Technologies

ECWT in order to get optimum chiller plant performance.

The Impact of Condenser Water Pumps

In a refrigeration cycle, the chiller efficiency is commonly rated in kW/ton. The term is defined as the ratio of the compressor work in kW to the cooling load in tons. The lower the kW/ton – the higher the efficiency is for the chiller.

As the ECWT drops, the pressure in the condenser drops resulting in lower chiller compressor power while the cooling load remains the same. This results in lower kW/ton. Condenser water pumps are an integral piece of the puzzle when optimizing a chiller plant. There are several plant configurations that exist. If all the pumps are fixed-speed pumps and run continuously, their power consumption will not affect the optimum power requirement. However, in the case of Variable Frequency Drive (VFD) pumps, the pump power may vary, contributing to an energy trade-off between chillers, fans, and pumps, which makes it difficult to optimize the system.

Variation in load produces variation in heat rejection and flow for a condenser water pump. For simplicity of analysis for this article, it is assumed that within normal operating ranges, a VFD pump will not have significant energy trade-off with chiller or fans.

ECWT Reset Strategy Relatively Easy and Effective

An ECWT reset strategy represents one of the most effective and easily implemented energy efficiency measure for a chiller plant. The controls are designed to maintain the ECWT as low as feasible. This allows the condenser to operate at a lower pressure and reduces the overall lift delivered by the chiller compressor. The lift is the difference between condenser saturation temperature and evaporator saturation temperature, which drives the chiller efficiency.

When WBT drops, it is possible to reduce the condensing temperature thereby reducing lift. As a rule of thumb, each degree reduction in ECWT results in a 0.5% increase in chiller efficiency for safe operating range temperatures.[2]

As discussed, with reduction of ECWT, the chiller power consumption continually reduces due to reduced lift. However, the cooling tower fan power requirement gradually starts to increase as fans are tasked with operating closer to full speed. This results in the total power requirement reducing up to an optimum ECWT setting, and then rising again as the tower fan power requirements rise with dropping ECWT very close to WBT. The ECWT should be maintained to achieve the minimal total kW (chiller kW + tower fan kW + pump kW) for the most efficient chiller plant operation. This sweet spot can be seen in Figure 1.

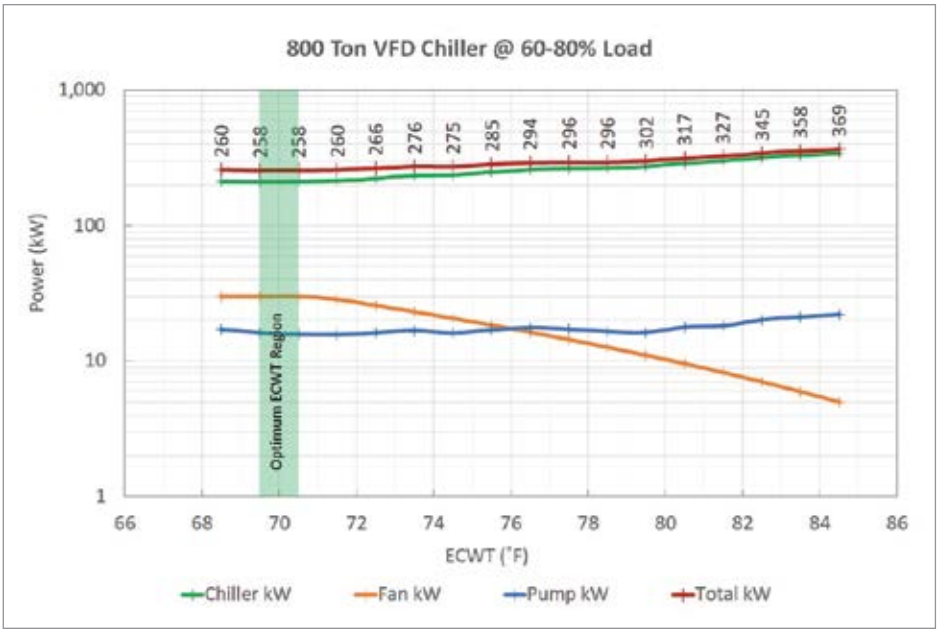


Figure 1: Depicted is the ECWT sweet spot for minimal power consumption.

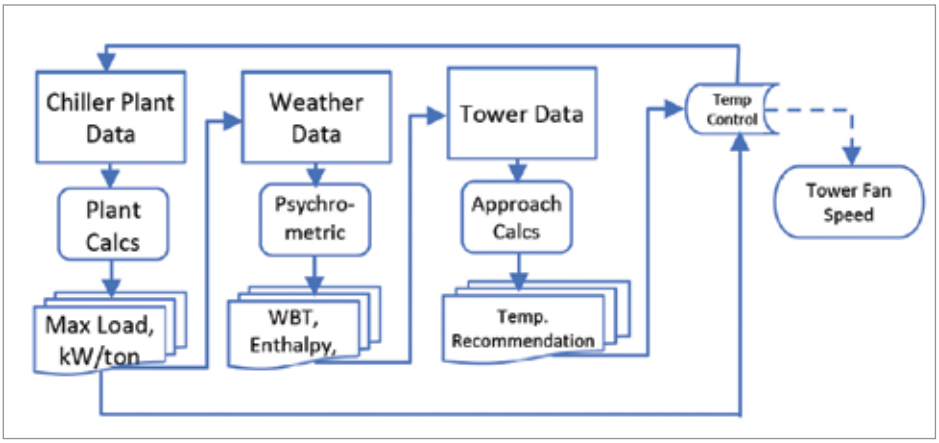


Figure 2: Shown is the SMARTenergy OPS ECWT control architecture.

OPTIMIZE CHILLERS WITH AN AUTOMATIC ENTERING CONDENSER WATER TEMPERATURE RESET STRATEGY

An important precaution here is to not let ECWT drop beyond optimal when the load on chillers is high. This can lead to refrigerant stacking, a situation where there is abnormal accumulation of refrigerant in the chiller condenser preventing the refrigerant's ability to flow back to the evaporator, and ultimately resulting in loss of cooling capacity.

Automated ECWT Controls Reduce Energy Consumption

Hudson Technologies has developed a smart ECWT control that incorporates a continuous reset strategy to optimize the cooling tower setpoint and reduce the overall system energy consumption.

The cloud-based SMARTenergy OPS system is a unique chiller optimization platform that continuously analyzes the chillers data for different faults and alarms to diagnose serious issues in the cooling systems. The diagnostics offered provide actionable insights, which if acted upon in a timely manner, can save significant amounts of energy costs.

The ECWT control avails data from three sections of the plant, i.e., chillers, cooling towers, and the weather station. Once this

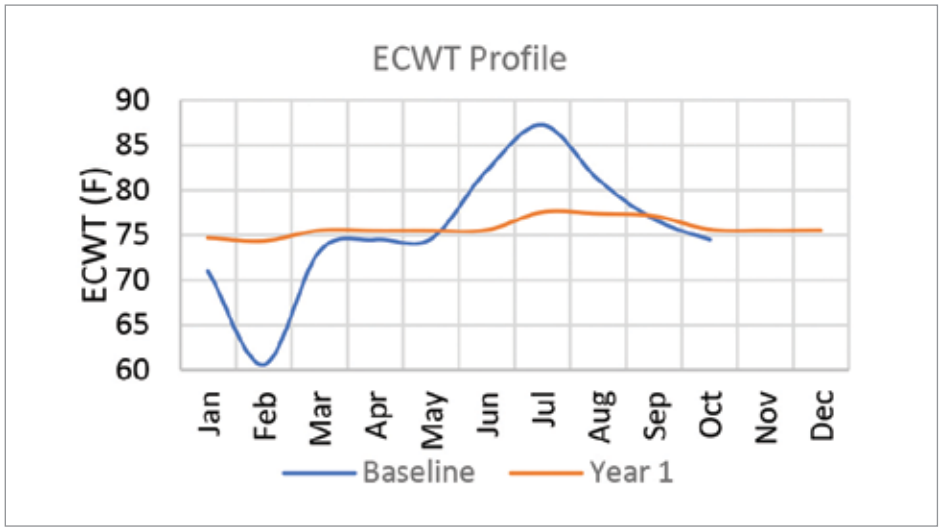


Figure 3: An ECWT profile for monitored chillers.

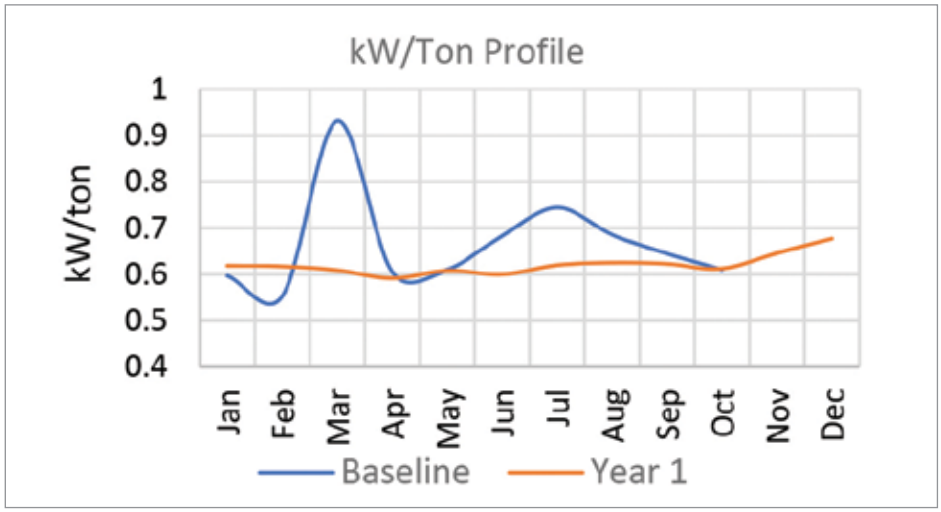


Figure 4: A kW/ton profile for monitored chillers.

data is available, the algorithm goes through calculations to determine recommended temperature, which in turn, is passed on to the local BAS. The integrated BAS then goes through appropriate sequence of actions to modify fan speeds, etc., to achieve the desired setpoint. The algorithm is designed to continuously check and optimize the setpoint to get the lowest kW/ton for the plant. The architecture of the ECWT is shown in Figure 2. The algorithm continuously searches for better efficiency through a heuristic method developed for the proprietary platform.

Implementation of the ECWT control through SMARTenergy OPS is easily integrated with any kind of existing BAS, or it can be installed as a standalone system. With an existing BAS system, ECWT control can achieve advisory, or fully automated control with operator override as desired. It can also complement existing analytics systems to achieve optimized ECWT setpoints with respect to chiller performance.

Control Strategy Saves Energy at Aerospace Plant

The benefits of an ECWT reset strategy can be demonstrated using a case study.

An aerospace manufacturing plant in the Southwestern United States uses four chillers to supply chilled water for process as well as comfort cooling demand. The total cooling capacity of the plant is 3,700 tons and is setup as a traditional primary-secondary loop configuration. The chilled water setpoint is maintained at 40 °F. The energy baseline in the first year shows total chilled water system consumption of 6.8 million kWh for a cost of $479,000.

There are seven cooling towers supplying cooling water to a common header. The towers are interconnected and can supply cooling water to any of the four plant chillers. Based on the data collected with SMARTenergy OPS, it was observed that ECWT supplied from the cooling towers averaged 80 °F.

The optimization platform recommended dropping the ECWT on the cooling towers to 75 °F. Necessary steps were followed to drop the overall system ECWT down on the cooling towers when the weather permitted. As the ECWT is reduced, there is a reduction in the kW/ton of the chiller as expected due to overall reduction in chiller compressor lift. Hence, implementation of this strategy that aims to keep condenser water temperature at its optimum levels led to drop in kW/ton. Figures 3 and 4 show the improvement in the kW/ton profile. As the weather cools, the load on the chillers drops down leading to an increase in kW/ton.

Substantial improvement is seen during summer months where the plant did not manage the ECWT. For the same months on the kW/ton profile significant reduction in power consumption can be noticed. During the base-lining period, the plant averaged 0.667 kW/ton whereas after implementation, the data analysis showed the plant averaged 0.618 kW/ton. Details are shown in Table 1.

Automated ECWT Reset Strategy Advantages Add Up

There are multiple benefits to the use of an automated ECWT reset strategy platform, including:

1. The dynamic reset obtained with consideration of weather and plant load eliminates the need for the plant operators to constantly monitor and manually adjust the cooling tower setpoint

TABLE 1: ENERGY AND COST SAVINGS DUE TO ECWT MANAGEMENT

	KW/TON	KWH SAVINGS	COST SAVINGS ($/YR)
Baseline	0.667	-	-
Year 1	0.618	91,879	$6,431

Table 1

2. Automated control can free up operators' time to focus on other tasks to improve overall savings.

3. This strategy represents the single biggest potential opportunity to maximize chiller energy efficiency – every degree reduction in the condensing water temperature reduces chiller energy consumption by 1 to 2 percent. BP

About Hudson Technologies

Hudson Technologies, Inc. is a refrigerant services company providing innovative solutions to recurring problems within the refrigeration industry. Its products and services are primarily used in commercial air conditioning, industrial processing and refrigeration systems, and include refrigerant and industrial gas sales, refrigerant management services, consisting primarily of reclamation of refrigerants and RefrigerantSide® services, consisting of system decontamination to remove moisture, oils and other contaminants. In addition, the company's SMARTenergy OPS® service is a web-based real time continuous monitoring service applicable to a facility's refrigeration systems and other energy systems. Its Chiller Chemistry® and Chill Smart® services are also predictive and diagnostic service offerings. It also participates in the generation of carbon-offset projects. The company operates principally through its wholly owned subsidiaries, Hudson Technologies Company and Aspen Refrigerants, Inc., formerly known as Airgas-Refrigerants, Inc. For more information, visit www.hudsontech.com.

All charts courtesy of Hudson Technologies, Inc. The authors would like to express their sincere gratitude to Mr. Derrick Shoemake, IT Lead, Hudson Technologies Company, for his help on the development of Entering Condenser Water Temperature Reset Strategy.

1 ASHRAE Handbook 2008 – HVAC Systems and Equipment, "Cooling Towers", Ch.39, pp.39.13-15, Atlanta, GA, 2008

2 Hamilton, G., "Optimizing Hospital Chiller Plants", Engineered Systems, Vol. 34, No.7, pp 24-29, July 2017.

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COOLING TOWERS & CHILLERS

Innovation Drives Sustainability Success at DENSO MANUFACTURING TENNESSEE PLANT

By Chris Kent, Contributing Editor

DMTN's 230-acre campus in Maryville, Tennessee.

Innovation is at the core of virtually every initiative at DENSO Manufacturing Tennessee, Inc. This includes a host of activities designed to allow the leading supplier of advanced automotive technology, systems and components, to realize its corporate vision of creating a sustainable automotive society.

Among key initiatives at DENSO's Maryville, Tennessee, facility is the use of an innovative ice-storage system engineered to provide environmentally friendly comfort cooling to employees at the company's main production facility. The system also allows Plant 101 to reduce cooling costs per ton by 44%, while providing a payback of less than four years. It also resulted in an annual CO_2 reduction of 18,000 tons.

Taking a Lead in Environmental Sustainability with Eco Vision 2025

The Maryville facility began operation in 1988. It encompasses 2.6 million-square-feet under roof for the entire campus and its

"The new cooling system allows us to achieve virtually every goal we set out to achieve."

— Mike Wingo, Section Leader of the Environmental Engineering Department at DENSO

230-acre campus is comprised of four major facilities and 13 buildings. Plant 101 – the main production facility where the ice-storage system is in operation – spans 708,575 square-feet. It is the largest production plant on the Maryville, Tennessee, campus. In addition to Maryville, DENSO operates a production facility in nearby Athens, Tennessee.

The DENSO Maryville operation produces starters, alternators, and instrument clusters, as well as various automotive electronic products and inverters for hybrid vehicles. The plant operates three shifts, seven days per week. In all, the plant employs more than 4,300 individuals and is ISO 14001, ISO/TS 16949, and QS 9000 certified.

Shown are Trane's IceBank® ice-storage tanks as part of the ice-storage system at DMTN Plant 101.

INNOVATION DRIVES SUSTAINABILITY SUCCESS AT DENSO MANUFACTURING TENNESSEE PLANT

Thermal Energy Storage System: A Closer Look

The following describes how Trane's IceBank® Thermal Energy Storage system works.

Step 1

During nighttime, off-peak hours, water that contains 25% ethylene or propylene glycol is cooled by a chiller. That solution circulates inside the heat exchanger within the IceBank tank, freezing 95% of the water that surrounds the heat exchanger inside the tank. The water surrounding the heat exchanger never leaves the tank.

Step 2

Ice is created uniformly inside the IceBank tank via CALMAC's, counter-flow-heat exchanger tubes. As ice forms, water still moves freely, which prevents damage to the tank. To fully charge an IceBank tank takes from six to 12 hours.

Step 3

During daytime on peak hours, the glycol solution circulates through the ice storage tanks to deliver the stored energy to the building to augment or offset electric chiller cooling. The cold glycol is delivered at the proper temperature to the cooling coil in an air handler.

Step 4

A fan blows air over the coils to deliver cooling to the occupant spaces. People feel cool and comfortable and never know ice storage is being used to save money on cooling costs.

Mike Wingo, a Section Leader who manages the Environmental Engineering Department at DENSO Maryville, said DENSO's corporate program, Eco Vision 2025, drives DENSO's commitment to sustainability. The impetus for this program was to decrease energy usage and CO_2 generation. Wingo said the sustainability goals, as well as a desire to decrease energy costs and ongoing improvements in operational costs, led to the decision to upgrade Plant 101's comfort cooling system, which was originally comprised of 21 direct expansion (DX) air-handling units.

"A number of factors went into the decision to improve comfort cooling at the plant as the operation and the cooling loads continued to grow, not the least of which is the continued opportunity to reduce our carbon footprint and energy consumption," Wingo said.

DENSO created Eco Vision in 1997, which is an action plan to help spark and invigorate a renewed awareness for environmental responsibility. The initiative also provides DENSO facilities with a blueprint to achieve a wide range of sustainability goals through various means, such as non-traditional methods and technologies designed to improve energy efficiency and waste reduction efforts.

Multiple Issues with Direct Expansion Air-Handling Units

As with any manufacturing plant, comfort cooling is crucial for optimal working conditions and employee morale, which also contributes to overall productivity. This is especially true in the depths of hot Tennessee summers.

Before the ice-storage system project, Plant 101's HVAC system included 21, stand-alone and self-contained DX units manufactured by Webco to provide comfort cooling. The air-handling units are located throughout the plant rooftop. A DX unit consists of a refrigeration system, compressor and condenser, with air handling working through the evaporator or the cooling coil,

One of five Trane air-cooled chillers as part of the ice-storage system at Plant 101.

air filter and blower. Air is directly chilled by the refrigerant (in this case R-22 or HCFC 22-Freon) via the unit's cooling coil.

The DX units at Plant 101 – each 20-years or older – lagged compared to today's more energy-efficient alternatives. Additionally, the plant's heat load requirements steadily grew. From a cooling standpoint the units were struggling to keep up, yielding a limited cooling range of 85-95 °F. They also became costly to operate. The units' refrigeration compressors required frequent replacements or rebuilds.

The air handling units also experienced frequent refrigerant leaks, driving the need to replace 2,600 pounds of R-22. From a sustainability standpoint, DENSO recognized an opportunity to eliminate R-22 and reduce CO_2 emissions in keeping with Eco Vision 2025, which calls for a commitment to reducing CO_2 emissions by half.

Ice-Storage System Examined

The DENSO team analyzed common cooling system options, which included the replacement of the DX units with new units. Another option was to invest in traditional chillers. Yet the planning process in partnership with Trane® and CALMAC led to the discovery of another option in the form of Trane's IceBank® Thermal Energy Storage system.

DENSO also regularly explores innovative ways to achieve sustainability goals and save costs, pointing to its ongoing participation in the Tennessee Department of Environment and Conservation's Tennessee Green Star Program. The voluntary program recognizes companies in Tennessee committed to sustainable best practices. (Read more about the program at https://www.airbestpractices.com/sustainability/energy-incentives/incentive-program-profiles/shining-spotlight-manufacturing-sustaina.)

"We are actively in involved in TGSP," Wingo said. "The program and its members are committed to going above and beyond state and federal requirements geared toward sustainability – and it provides a great platform for sharing sustainability ideas."

A key idea of the plant was thermal energy storage, which is known commonly as ice-

INNOVATION DRIVES SUSTAINABILITY SUCCESS AT DENSO MANUFACTURING TENNESSEE PLANT

storage. A typical ice-storage system includes a chiller(s), ice-storage tank(s), pumps, cooling coils, and heat-transfer fluid. The heat-transfer fluid, commonly a mixture of glycol and water, is circulated inside the heat exchanger within the storage tank in the process of creating ice. The purpose of the system is to save on energy costs for cooling by using the stored thermal energy to supplement traditional forms of process cooling.

An ice-storage system produces ice during off-peak hours and normally at night when utility rates are typically lowest. The ice is stored in ice-storage tanks. When the chilled water (heat-transfer fluid) is needed to supplement cooling during on-peak hours, the heat-transfer fluid is routed throughout the storage tanks at a temperature above freezing point, causing the ice to melt – and creating the chilled water at the desired temperature.

Unique System Includes Ice-Storage and Retrofitted DX Units

At the DENSO Maryville facility, the team opted to use the ice-storage system to provide chilled water to the DX units. Installed in 2018, the system includes five air-cooled chillers from Trane, each with a 500-ton capacity. All chillers have the ability to perform traditional cooling. Three of the five chillers serve as primary chillers used for comfort cooling in the plant. The remaining two chillers are able to make ice while also providing comfort cooling.

Also key to the system are the ice-storage tanks. There are four CALMAC Ice Bank® Model-1320CSF ice tanks with each unit rated at 324 ton-hours (1140 kWh); and three CALMAC Ice Bank® Model-1500CSF, each of which is rated at 486 ton-hours (1,710 kWh) for a total of 2,754 tons of cooling capacity. The system also includes piping, pumps and a glycol-based heat transfer fluid that contains 25% glycol in addition to water.

Mark Johnson with CALMAC Portfolio said the air-cooled chillers are an excellent choice for the ice-storage system at Plant 101.

"While traditionally water-cooled chillers are more efficient than air-cooled chillers, the latter with the use of ice storage can deliver similar energy costs to water-cooled chillers because they do most of the work at night when ambient air temperatures outside are cool and the chillers are running during off-peak hours when energy rates are low. Air-cooled chillers also eliminate the need for cooling towers, water make-up due to drift and blowdown, and water treatment."

The system of five chillers is designed as an N+1 system for redundancy to allow for system availability during routine maintenance, or the unlikely event of component failure.

The use of an ice-storage system drove the need to retrofit the DX units. To do so, the team switched out the refrigerant coils of the units with chilled-water coils, which essentially allows them to do what they've always done: deliver cool air where needed – but without the use of a refrigerant. The retrofit also included piping to connect the ice-storage system to the DX units. While typically steel piping is used, the team opted to use polyethylene piping given its comparatively lower weight and price and proven performance in cooling applications.

Flexible Comfort Cooling Strategy

Most ice-storage systems are a supplemental method of cooling used in combination with traditional chillers. This is the case with Plant 101 where two chillers are dedicated icemakers, and three chillers – referred to as primary chillers – function as any traditional chillers to provide cooling water. While all five chillers can function in this capacity, the two ice-making chillers also have the ability to run at lower set points to produce ice.

With this system cooling can be delivered in a number of ways depending upon system demand. During hot summer days or during on-peak high-heat demand, chillers and ice may be needed. However, during spring and fall when temperatures are milder, and heat loads are lower, the ice can exclusively cool the facility. In all, the system at DENSO allows for the following combinations of operating strategies:

1. Cooling with the chillers only.
2. Cooling with the supply from the ice-storage system only.
3. Cooling with a combination of chiller and a supply from the ice-storage system.

Ryan Miles, Facilities Mechanical Engineer at DENSO Maryville explained, "Typically, when the cooling water from the ice-storage system alone can't fulfill the cooling need at Plant 101, like during peak times, the three primary chillers work on a lead/lag scenario to provide cooling by chilled-water to the DX units."

The ice-making chillers have the capability to run for comfort cooling just as the three primary units; however, they can also run at lower set points to produce ice.

"These two chillers also rotate on a weekly lead/lag basis," said Miles. "During off-peak utility hours and when the plant heat load is lower, the ice-making chillers are isolated from the main process-cooling loop to the building so the system can cycle chilled water through the ice tanks to form ice. In this way, the N+1 system can operate up to four chillers at once."

Continued Sustainability Progress

Following the completion of the ice-storage system project in the summer of 2018, the DENSO team saw immediate results, including a more comfortable production environment since the system delivers cooling temperature at 78 °F, which is considerably cooler than the capabilities of the original DX units.

In keeping with Eco Vision 2025, the installation has also allowed Plant 101 to reduce the power consumption per ton of cooling by 44%. What's more, the cutback in power consumption creates an annual CO_2 reduction of 18,000 tons. The high costs of maintenance with the DX units have also been eliminated.

While the ice-storage system continues to deliver results, DENSO's Maryville plant continues to make progress on multiple Eco Vision initiatives.

Just one example is landfill reduction. Since 2000, the plant has reduced 99.7 percent of all waste. In 2017, it diverted nearly 30 million pounds to landfill and replicated this by reducing 27.5 million pounds in 2018. On average, annual waste headed to local landfills is now nine tons versus 2,928 tons per year before the plant adopted best practices in waste reduction.

"We're proud of progress we've made with all of our initiatives in support of achieving our Eco Vision," said Wingo. "The new cooling system allows us to achieve virtually every goal we set out to achieve. Looking ahead we're excited to see how the ice-storage system data shapes out in coming years, and we hope to see it lead to other ice-storage system initiatives. In the meantime, we remain committed to continuing to keep pace with our landfill diversion program." BP

All photos courtesy of DENSO.

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WATER TREATMENT & COOLING SYSTEM ASSESSMENTS

Advancing Standards and Equipment IMPROVE BUILDING ENERGY PERFORMANCE

By Ben Majerus, Danfoss

In recent years, the HVAC industry has witnessed the evolution of three distinct approaches to advancing energy efficiency. For decades, the industry focused on improving full-load efficiency before the current shift to part-load efficiency standards for equipment. Today, new part-load rating methods better account for how equipment operates at off-design conditions when loads vary hour by hour. The next stage in the evolution of building energy efficiency will focus on whole building efficiency for facilities.

This first installment of a two-part series will examine the evolution of equipment-efficiency standards from full to part load and their relationship to whole-building efficiency. The second article will look at how HVAC technologies are advancing to modulate capacity to match variations in building loads, a major factor in improving whole-building energy performance.

Continued Energy Savings Predicted

The energy performance of buildings is expected to improve significantly in the decades ahead. From 1980 to 2009, for every percent of growth in U.S. commercial building space, primary energy consumption grew by 1.19%. The U.S. Energy Information Administration estimates, however, that from 2009 to 2035, every percent of growth in space will increase energy consumption by only 0.79% – a 33% improvement in energy savings.

"Compared to equipment efficiency standards, a whole-building-efficiency approach looks at the big picture and is gaining momentum. The focus is on how mechanical equipment impacts a building's Energy Use Intensity (EUI)."

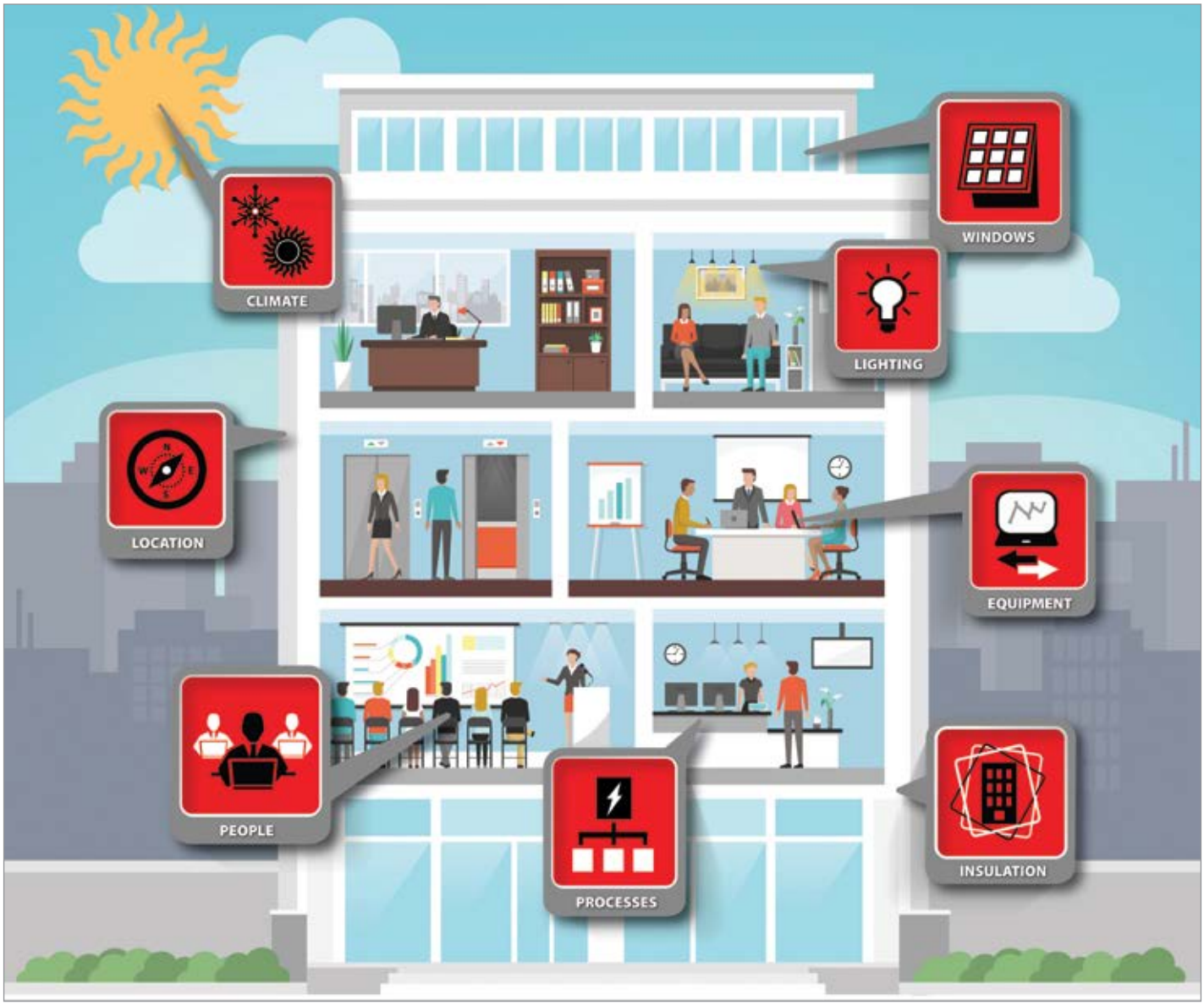
— Ben Majerus, Danfoss

That raises the question: How will those predicted energy savings be obtained?

Considering that approximately 40% of the energy in commercial buildings is consumed by HVAC equipment, it's reasonable to conclude that mechanical system efficiency will have to improve substantially to achieve those results. Consequently, HVAC equipment designers must look for new solutions to old challenges. To improve the efficiency of mechanical equipment, system designers face the perennial thermodynamics problem: how to move heat from one place to another using the least amount of energy.

Inside a building, heat is generated by people, processes, equipment, and lighting – factors that constitute the internal load. Outside, the climate and thermal performance of the building's exterior – including the amount of insulation, number of windows, and whether the building is north or south facing – comprise the external load. A building designer can reduce the load by improving the building envelope and cut energy consumption by employing mechanical equipment with the flexibility to modulate capacity at lower loads.

In some facilities, however, HVAC systems operate at full capacity and are simply switched on and off as cooling is needed. Accordingly, over the last few decades, system designers have improved the full-load efficiency of equipment. In fact, since 1980, average chiller full-load efficiency



Multiple factors constitute a building's heat load.

ADVANCING STANDARDS AND EQUIPMENT IMPROVE BUILDING ENERGY PERFORMANCE

has improved more than 35%, despite the adoption of less efficient refrigerants. Advances in refrigeration compressors, heat exchangers, cooling towers, fans, and pump motors have achieved significant improvements when the system is running at 90 to 100 percent of its designed capacity.

The trouble is, most buildings experience internal and external loads that vary throughout the day. Consequently, buildings with systems optimized only for full-load operation are wasting energy when the loads fall below 90%.

Because off-design conditions can occur as much as 99% of the time, a lot of energy can be wasted by systems optimized for full-load operation. To save that energy, systems must be designed for part-load operation. At lower loads, cooling capacity can be reduced or "turned down." Methods that can be used to turn down capacity exist today, such as employing manifolded compressors, reducing fixed-speed compressor power consumption at part-load, and using variable-speed compressors, fans, and pumps. These technologies will be discussed in the second article in this series.

Multiple Factors Dictate Energy Savings

Meanwhile, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) develops test methods and efficiency minimums, and the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) develops the performance rating for an application. Their work together influences the design of rooftop units, chillers, and other air-conditioning applications prominent in the United States.

Shown are Danfoss scroll compressors SH in a parallel installation.

Similarly, the International Ground Source Heat Pump Association (IGSHPA) has led the way in providing a complete set of standards for GSHP systems.

Although significant energy savings can be obtained by applying advanced technologies and system designs, the amount of savings depends on the specific technologies and the particular application.

Consequently, technical committees for some industries are developing their own building-efficiency standards to encourage the use of equipment optimized for part-load operation.

For example, data centers are recognized for using substantially more energy than office buildings. Because data centers run 24 hours per day, seven days per week each year at varying loads, systems optimized for part-load operation can realize energy cost reductions of 30% or more. These facility standards use a unique measure of "power usage effectiveness" (PUE) for the facility, which takes into account new HVAC technologies, the part-load efficiency of systems and various cooling strategies. PUE simplifies cost budgeting and estimating data center infrastructure efficiency (DCiE). Both measures were developed by The Green Grid, an association of IT professionals aiming to raise data center energy efficiency.

This indicates how whole-building efficiency and technology standards are evolving together. New standards are being created and existing standards are being revised for different applications within an energy-efficiency ecosystem. The goal is to improve equipment efficiency, as well as the equipment rating method, to reflect more closely real-world operation. As equipment standards define particular test methods used within the HVAC industry, these developments influence the definition of relevant regulatory requirements and energy mandates in the public sector.

As a microcosm, the data center industry shows equipment standards and a whole-building approach are co-evolving. Likewise, other private and public sectors are taking complementary paths that are improving equipment efficiency standards.

Part-load Efficiency Standards Evolving

The ASHRAE 90.1 Standard establishes minimum efficiency values for equipment. Compared to the ASHRAE 90 Standard in 1975, the improved ASHRAE 90.1 Standard has lowered annual chiller energy consumption as much as 59%. The efficiency of commercial rooftop units has improved 45%. And, an additional 30 to 45 percent in energy savings is expected with the adoption of ASHRAE 90.1-2013.

These developments are not happening in isolation. In California, the Title 24 Standard Energy Efficiency Standards for Non-Residential Buildings sometimes mirrors and sometimes modifies the ASHRAE 90.1 Standard. From 1998 to 2008, Title 24 increased required chiller efficiency by 25%. A similar increase in chiller efficiency was mandated by the 2013 Title 24 Standard. These changes coincided with changes to ASHRAE 90.1 Standard itself.

In 2003, ASHRAE adopted a part-load efficiency rating method known as the Integrated Part Load Value (IPLV) described in ANSI/AHRI Standard 550-590. IPLV was developed by AHRI to rate the performance of systems capable of capacity modulation at part loads. IPLV rates a system's cooling efficiency over a hypothetical season rather than at a full-load point at the worst time of the year.

Used to rate chillers, IPLV is calculated using four operating points. Each point is weighted by the amount of time a chiller spends at that load point: 1% of time at 100% load, 42% of time at 75%, 45% of time at 50% load, and 12% of time at 25% load.

For rooftop units, a different rating method is used: The Integrated Energy Efficiency Ratio (IEER). This method is described in ANSI/AHRI Standard 340-360. Similar to IPLV, four weighted load points are used: 100% (full load), 75%, 50%, and 25% of full load – each of which is multiplied by a weighted value (0.020, 0.617, 0.238, and 0.125, respectively).

Over the years, the part-load IPLV rating method – and more recently IEER – has undergone significant improvement, but the HVAC industry recognizes that shortcomings remain. Consequently, new test methodologies are under consideration. The short-term goal is to develop standards that include more rating points and more complex mathematics to model performance over a continuum of conditions.

The AHRI technical committee on compressors, for example, continues to investigate new mathematical polynomials to model variable-speed compressor performance curves. Finding better-fitting polynomials will more accurately describe what compressors can do. Equipment designers can then plug these expressions into simulation programs to get a better idea of how a system will perform in different conditions.

However, using multi-factor formulas to rate a system using two fixed-speed compressors can yield the same result as a variable-speed system, but miss the full energy-savings potential with variable speed technology. Also, the formulas don't have the flexibility to account for changing building loads encountered in different climate zones.

While AHRI and ASHRAE ponder these issues, further improvements in equipment efficiency are being spurred by other public initiatives:

- In 2014, the U.S. Department of Energy Notice of Proposed Rulemaking (NOPR) proposed further developments that would lower commercial rooftop air conditioner energy use by about 30%. This proposal would save 3.5 trillion kilowatt-hours over 30 years, achieving the largest national energy reductions of any standard ever issued by DOE.

Shown is a Danfoss Turbocor® TT oil-free, variable-speed centrifugal compressor.

ADVANCING STANDARDS AND EQUIPMENT IMPROVE BUILDING ENERGY PERFORMANCE

- The Consortium for Energy Efficiency (CEE) is promoting high-efficiency equipment specifications and quality installations by using an elevated tier rating system based on SEER, IEER, EER, and HSPF metrics.

A Whole-building Approach Gains Momentum

Compared to equipment efficiency standards, a whole-building-efficiency approach looks at the big picture and is gaining momentum. The focus is on how mechanical equipment impacts a building's Energy Use Intensity (EUI). This approach gives system designers a simpler and more useful measure of a system's actual annual energy usage in the building at real-world conditions.

The whole-building perspective also provides very valuable feedback that drives improvements in equipment efficiency standards. For example, from the equipment point of view, a system using tandem fixed-speed compressors and another using variable-speed compressors can both be rated 16 IEER. But the latter system with variable speed technology matches the temperature setting and the building load with significantly less on-off cycling, which improves building energy performance.

When a more holistic calculation of a building's operational and energy lifecycle costs is employed, it changes views about value. Instead of looking mainly at the first cost of HVAC equipment, the focus shifts to the operational energy savings that the equipment delivers in an actual application.

As with part-load rating methods for equipment, significant advances are being made in whole-building rating programs as evidenced by:

- ENERGY STAR building benchmarking. It is driving facility improvements and the use of more efficient mechanical systems – with benchmarked buildings already reducing energy use by an average of 2.4% per year.
- The 2030 Challenge issued by Architecture 2030. It creates a target for all new buildings and major renovations to achieve fossil-fuel usage reductions of 80% in 2020 and 90% in 2025, and to be completely carbon neutral (using no fossil fuel, GHG-emitting energy to operate) by 2030.
- Zero Net Energy (ZNE) goals. They drive facilities to use on-site renewable energy sources to equal the amount of energy used by the building. (California's 2013 Title 24 Energy Efficiency Standard is mandating all new residential construction to be ZNE by 2020. New commercial buildings must meet the ZNE goal by 2030.)

Alongside these developments, initiatives not directly bearing on the HVAC industry are raising expectations of what can be achieved:

- The Max Tech design competition managed by Lawrence Berkeley National Laboratory's (Berkeley Lab's) Energy Efficiency Standards Group is promoting rapid development of energy efficient appliances, including mechanical equipment, among the next generation of U.S. engineers.
- Global trends are boosting energy efficiency, such as Japan's "Setsuden" ("saving electricity") initiative, which is driving the adoption of inverters and variable-speed drives in HVACR equipment that has helped cut per capita energy use in half compared to the United States.

Whether it's within the microcosm of a particular industry, such as data centers, or a macro sector like public buildings, a whole-building-efficiency approach and metrics are evolving rapidly. That trend, in turn, is spurring the co-evolution of equipment efficiency standards, resulting in systems producing significant energy savings in the real world. The second articles in this series will examine how technologies are advancing to deliver more part-load energy savings. BP

About the Author

Ben Majerus is Manager, Application Engineering, at Danfoss.

About Danfoss

Danfoss engineers advanced technologies that enable us to build a better, smarter and more efficient tomorrow. In the world's growing cities, we ensure the supply of fresh food and optimal comfort in our homes and offices, while meeting the need for energy-efficient infrastructure, connected systems and integrated renewable energy. Our solutions are used in areas such as refrigeration, air conditioning, heating, motor control and mobile machinery. Our innovative engineering dates back to 1933 and today Danfoss holds market-leading positions, employing 27,000 and serving customers in more than 100 countries. We are privately held by the founding family. Read more about us at www.danfoss.com.

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INDUSTRIAL COOLING SYSTEM INDUSTRY NEWS

SPX Announces Purchase of SGS Refrigeration Inc.

SPX Corporation has completed the acquisition of SGS Refrigeration Inc. ("SGS"), based in Dixon, Illinois. SGS is a manufacturer and distributor of industrial refrigeration products in the North American market.

"We are excited about SGS joining the SPX team," said Gene Lowe, President and CEO of SPX Corporation. "As a leader in industrial refrigeration, SGS has operated as a close partner with SPX Cooling Technologies in the evaporative condenser market. I am very pleased with the progress this partnership has made and look forward to the next phase of our growth together, as we combine our resources to further expand our addressable market and product suite of industrial refrigeration solutions."

SGS's 2018 annual revenues were approximately $15 million, including approximately $3.5 million of inter-company sales with SPX. The company's results will be reported as a part of SPX's HVAC Cooling business unit within its HVAC segment. For more information, please visit www.spx.com

About SPX Corporation

SPX Corporation is a supplier of highly engineered products and technologies, holding leadership positions in the HVAC, detection and measurement, and engineered solutions markets. Based in Charlotte, North Carolina, SPX Corporation had approximately $1.4 billion in annual revenue in 2018 and approximately 4,000 employees in 17 countries. SPX Corporation is listed on the New York Stock Exchange under the ticker symbol "SPXC."

About SPX Cooling Technologies, Inc.

SPX Cooling Technologies, Inc. is a leading global manufacturer of cooling towers, evaporative fluid coolers, evaporative condensers and air-cooled heat exchangers providing full-service cooling solutions and support to customers in the heating, ventilation and air conditioning (HVAC), refrigeration, power generation, petrochemical, and industrial markets for nearly a century. SPX Cooling Technologies and its product brands are part of SPX Corporation.

About SGS Refrigeration Inc.

Headquartered in Dixon, Illinois, SGS Refrigeration Inc. is a manufacturer and supplier of high quality industrial evaporators and evaporative condensers. Founded in 2010, SGS has been involved in a partnership with SPX Cooling Technologies, Inc. since 2015 to produce the Cube™ line of forced-draft and induced-draft evaporative condensers designed to support a variety of industrial refrigeration applications.

New, Improved YORKworks Customer Edition Now Available

Johnson Controls has released an updated version of its YORKworks Customer Edition, an HVAC equipment selection software for commercial and industrial applications. The improvements to this edition include updates to YORKcalc, allowing the user to generate detailed reports and calculate energy use based on chiller plant operating hours and real-world weather data across cities around the globe.

YORKworks is used by customers, including engineers, building owners and contractors, to select, rate and configure small tonnage chillers, air handling units (including factory-packaged controls), packaged systems and related components. The technology was created with the intent to provide facility decision-makers with the tools they need to select, rate and configure Johnson Controls Equipment on their own. This makes for a smooth process during the estimate and bidding phases of a project. For more information visit www.YORK.com.

New Bacharach EU Office Supports Fulfillment, Sales, Service and Training

Bacharach, a leading provider of HVAC-R gas instrumentation, announces the opening of a new office in Dublin, Ireland to provide continued expansion and growth across Europe. The new facility will expand customer support and product supply and service capabilities to European customers and channel partners and will include a new on-site training center.

The new office is located in close proximity to the Dublin Airport for supply efficiency and offers easy access for customers and partners; in addition to some of the world's leading universities for recruiting top talent to the team supporting the company's growth strategy.

"We are delighted to announce the opening of this new office location in Dublin", said Barry Phillips, VP Global Sales at Bacharach. "This office demonstrates Bacharach's European and global commitment and will support our continued growth in the region. We look forward to incorporating expanded product training with our industry-leading service and support team performance to exceed our customer's expectations and support our channel partner's growth in our focus HVAC and refrigeration markets." Phillips added. Please visit www.mybacharach.com for additional information.

About Bacharach

Bacharach is a provider of cleantech solutions for gas and refrigerant leak detection and identification, refrigerant tracking, combustion and emissions analysis instrumentation, and high-purity oxygen

gas analysis in commercial and industrial applications. Bacharach products make the heating, ventilation, air-conditioning, refrigeration (HVAC-R), and process industries safer, cleaner, and more energy-efficient, enabling customers to increase productivity, reduce costs, and protect lives and the environment.

B&W SPIG Successfully Completes Cooling Tower Upgrade for Belgium Petrochemical Plant

Babcock & Wilcox subsidiary SPIG S.p.A. (SPIG) has successfully completed a cooling tower upgrade project at an Antwerp, Belgium, production facility owned by its customer, Total Olefins Antwerp NV (TOA). SPIG used its proven service engineering expertise to develop customized solutions to improve the performance of the plant's existing cooling towers. SPIG replaced 12 existing cooling tower cells with six new units.

"This project completion marks an important milestone in our relationship with TOA," said SPIG Managing Director Alberto Galantini. "SPIG's global reach and unmatched expertise in delivering tailor-made engineering cooling tower solutions allowed us to efficiently and effectively meet our customer's needs." SPIG completed the project on-schedule without disrupting the plant's production capacity.

SPIG's experience includes wet, dry and wet/dry hybrid cooling solutions as dictated by site-specific requirements. The company supplies mechanical and natural draft systems and designs for a wide range of project specifications such as high seismic loads, vibration control, corrosion, noise control, sub-freezing operation, and seawater use. Specialized services include preventive maintenance, equipment upgrades, replacement and spare parts, online performance monitoring, and a commitment to research and development to continually seek new and more efficient cooling system solutions. For more information please visit www.babcock.com/spig

About SPIG

SPIG is a subsidiary of Babcock & Wilcox Enterprises, Inc. and a global turnkey cooling systems supplier. Since 1936, SPIG has provided customers with an extensive range of high quality cooling towers, air-cooled condensers and related services.

Danfoss Names Public and Industry Affairs Director

Danfoss has announced the appointment of John Sheff as its new Director of Public and Industry Affairs for North America. Sheff will succeed Mark Menzer in the role when Menzer retires in July.

Sheff previously was Business Development Manager for Danfoss in North America, leading cross-business initiatives within buildings, including strengthening engagement with utilities and Danfoss partners to leverage incentive rebates to improve energy efficiency in existing buildings.

John joined Danfoss five years ago as part of its two-year Post Graduate Program after earning an MBA from the University of Maryland's Robert H. Smith School of Business. He also holds a second master's degree from the University of Maryland's School of Architecture in real estate development and sustainable urban development. He previously worked as a policy analyst for the office of former Maryland Governor Martin O'Malley, where he evaluated and developed energy efficiency and renewal energy plans for the State of Maryland.

Sheff succeeds Mark Menzer, who is preparing to retire after five years at Danfoss and 35 years in the industry, having successfully helped to raise the voice of Danfoss and its industry partners in crucial discussions throughout Washington, D.C., and within key industry associations. In 2018, Mark was

John Sheff

Mark Menzer

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Sustainable Energy & Water Savings with Chiller & Cooling Best Practices

Chiller & Cooling Best Practices is a technical magazine dedicated to discovering Energy and Water Savings in industrial chiller and cooling systems. Our editorial focus is on case studies and technical articles where application and system knowledge drives technology selection, creating energy savings in projects delivering excellent ROI's.

How Can Industry Learn to *Use Less* Cooling Water?

Our readers embrace Sustainability as a profitable business opportunity. We believe the industrial process cooling and HVAC installed base to be at a tipping point — one where "energy and water retrofits" will fuel a new era of market growth, similar to what we've seen in the compressed air industry. Who will teach plants how to use less cooling water by understanding "the constituents of demand" and exploring alternative options without jeopardizing reliability!?

- Replace water-cooled air compressors with air-cooled
- Replace liquid ring with dry vacuum pumps
- Raise temperature specifications in cooling applications

"We'll save over $16,700 in utility bills each year because we upgraded to a new energy-efficient water-cooled, magnetic-bearing centrifugal chiller that keeps our 382,000 square-foot building at a consistent temperature all day long."

— Marty Rowe, Director Facility Services, Holladay Park Plaza Assisted Living ("Deschutes Brewery and Holladay Park Plaza Save with the Energy Trust of Oregon," August 2018 Issue)

"Optimization can be a significant project, but given the immediate savings and a typical payback period of less than four years, it makes good sense to undertake it."

— Ian Dempster, Optimum Energy ("Barriers to HVAC System Optimization and How to Overcome Them," October 2018 Issue)

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INDUSTRIAL COOLING SYSTEM INDUSTRY NEWS

recognized by the Air-Conditioning, Heating, & Refrigeration Institute (AHRI) with its Richard C. Schulze award for distinguished service and commitment.

"Perhaps now more than ever – as issues, standards, and regulations affecting our industry continue to evolve, having a seat at the table for critical discussions and a voice that works to ensure the needs of our industry partners and customers are heard is imperative," said John Galyen, president, Danfoss North America. "John has great perspective on core issues and will be a true asset to all of our stakeholders as, through his work in this position, we continue to work with industry to advance efficiency and sustainability policy, among others." To learn more visit www.danfoss.com

About Danfoss

Danfoss engineers advanced technologies that enable us to build a better, smarter and more efficient tomorrow. In the world's growing cities, we ensure the supply of fresh food and optimal comfort in our homes and offices, while meeting the need for energy-efficient infrastructure, connected systems and integrated renewable energy. Our solutions are used in areas such as refrigeration, air conditioning, heating, motor control and mobile machinery. Our innovative engineering dates back to 1933 and today Danfoss holds market-leading positions, employing 27,000 and serving customers in more than 100 countries. We are privately held by the founding family.

ASHRAE Resources Help Reduce the Risk of Legionella

ASHRAE, a non-profit technical society headquartered in Atlanta, has developed resources to help reduce the risk of Legionella, including Standard 188, which provides a comprehensive approach to help prevent the growth and spread of Legionella within building water systems.

"With the recent outbreak of Legionnaires' disease in Atlanta, we would like to increase awareness of the resources available to help minimize health risks associated with building water systems," said Darryl K. Boyce, P. Eng, 2019-20 ASHRAE President.

The CDC estimates approximately 6,100 cases of Legionnaires' disease in the United States each year. Most of those cases result from exposure to Legionella found in building water systems. ASHRAE has also reached out to the Fulton County Board of Health and the Georgia Department of Public Health to make these government offices aware of ASHRAE resources.

In 2018, ASHRAE published a revised edition of Standard 188, which designers and building operators can use to help establish water management plans specific to the systems in particular buildings, campuses or health care facilities. Guideline 12, Minimizing the Risk of Legionellosis Associated with Building Water Systems, is currently in revision and provides more detailed descriptions of best practices.

"By creating a framework for proactively managing building water systems and reducing the potential for Legionella growth in these systems, following Standard 188 can help building and facility managers prevent many but not all cases of legionellosis," said Boyce.

The 2018 edition of Standard 188 provides:

- A description of environmental conditions that promote the growth of Legionella, such as water temperature fluctuations, water pressure changes and water stagnation.
- Minimum Legionellosis risk management requirements for buildings and associated potable and non-potable water systems.
- Requirements for Legionellosis control strategies and documentation.
- Clarification of compliance requirements, as well as an update to enforceable, code-intended language to facilitate adoption of the standard for code and regulatory purposes.

About ASHRAE

Founded in 1894, ASHRAE is a global leader in the advancement of human well-being through sustainable technology for the built environment. As an industry leader in research, standards writing, publishing, certification and continuing education, ASHRAE and its members are committed to shaping tomorrow's built environment today through strategic partnerships with organizations in the HVAC&R community and across related industries. For more information and to stay up-to-date on ASHRAE, visit www.ashrae.org

About ASHRAE Standards

ASHRAE writes standards and guidelines in its fields of expertise to guide industry in the delivery of goods and services to the public addressing such broad areas as indoor air quality, thermal comfort, energy conservation in buildings, reducing refrigerant emissions, and the designation and safety classification of refrigerants. ASHRAE standards provide guidance that do not have regulatory authority unless incorporated into local building codes. Each ASHRAE standard is developed by a committee comprised of academic, industry, and government subject matter experts.

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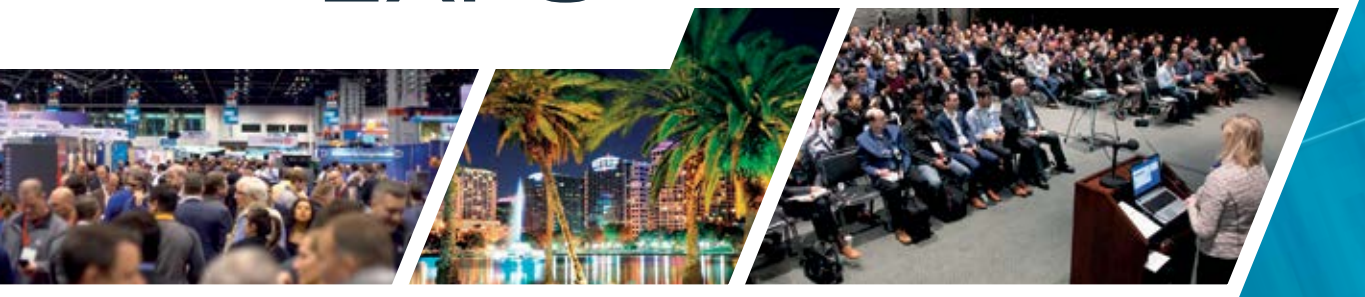

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