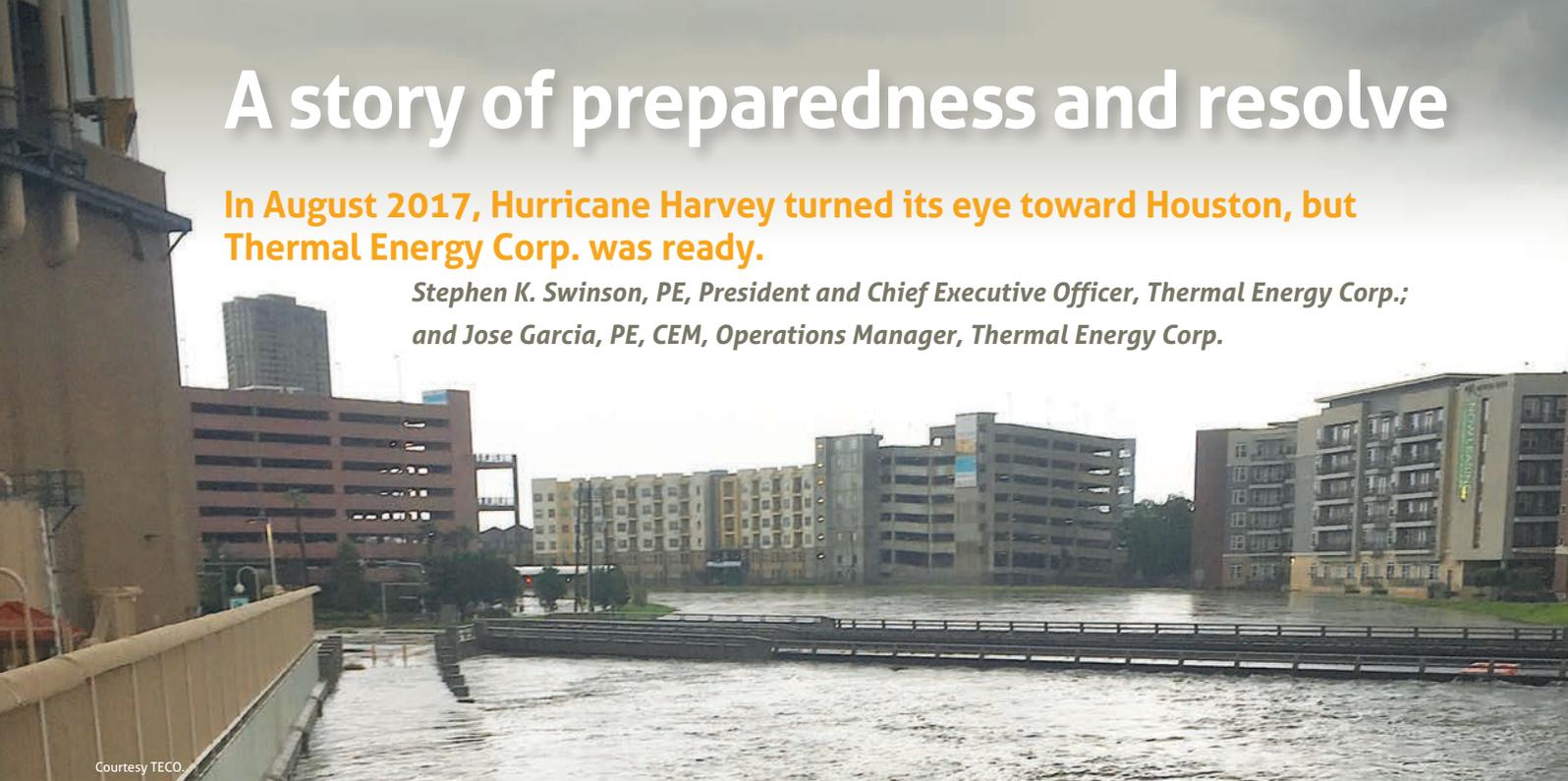


A story of preparedness and resolve

In August 2017, Hurricane Harvey turned its eye toward Houston, but Thermal Energy Corp. was ready.

*Stephen K. Swinson, PE, President and Chief Executive Officer, Thermal Energy Corp.;
and Jose Garcia, PE, CEM, Operations Manager, Thermal Energy Corp.*



Courtesy TECO.

The floodwall around TECO's Central Plant (far left) held back Hurricane Harvey's floodwater that peaked just under Brays Bayou's bridges.

The weather forecasts in late August 2017 were dire. Meteorologists warned that coastal areas in Texas could experience unprecedented flooding from a powerful storm that was headed their way. They were right.

For nearly a week, Hurricane Harvey formed and strengthened, hitting Houston with a record-setting 51 inches of rain falling over a five-day period, Aug. 25-30. Yet even before Harvey had a name, it was on Thermal Energy Corp.'s (TECO's) radar screen as a storm to watch.

Houston-based TECO – the chilled-water and steam supplier to institutions on the campus of the Texas Medical Center (TMC) – understood the challenge at hand. Service to the world's largest medical complex had to continue no matter the weather: The 20.7 million sq ft of space in customer buildings – including two Level I trauma centers, 9,200 hospital beds and multiple laboratories – needed uninterrupted thermal energy supply. Patients' lives and billions of dollars' worth of life science research were at stake. Failure was not an option.

The result? Chilled water and steam flowed without a hitch, made possible by earlier investments in equipment redundancy and reliability, a fine-tuned emergency preparedness plan, a dedicated

storm "ride-out team" of employees, and effective communication and coordination with customers.

LEARNING FROM EXPERIENCE

TECO is no stranger to hurricanes and tropical storms. It endured Hurricane Alicia in 1983; Tropical Storm Allison in 2001; Hurricane Rita in 2005; and then Hurricane Harvey, a Category 4 storm, in 2017. The company saw the resulting devastation.

While TECO's reliability has always been the cornerstone of its operations, such experiences continue to inform and influence the company's emergency planning efforts. It conducts debriefing sessions after each major storm event to help fortify the company's plans and procedures.

2001's Tropical Storm Allison was one of the worst disasters to ever hit Houston, dropping 36 inches of rain that flooded and knocked out power to the area. The destruction at the Texas Medical Center was unimaginable, with more than \$2 billion lost in research projects alone. TECO escaped serious flooding with 6 inches of water flowing from the adjacent Brays Bayou to the west side of the Central Plant; just an inch or two seeped inside the building, but that was too close for comfort.

In Allison's aftermath, TECO adopted a Central Plant Flood Protection Project to prevent future flooding. Installed in 2003, the project included a floodwall and floodgates designed to withstand a 500-year flood plus 2 ft. (The wall was extended in 2011 to cover new property as TECO expanded its plant.)

"In 2003 we drilled 254 shafts, 30 feet deep, for reinforced concrete piers to support the floodwall around the plant," says retired Vice President of Engineering Bruce Turner, PE, CPE. "The foot-thick wall was a major project that required great precision. It was a \$5.5 million initial investment in our system's future that was well worth it. Without the floodwall and floodgates, portions of our Central Plant would have been under water during Hurricane Harvey. Harvey was our floodwall's first major test, and it worked exactly as designed."

Allison also helped drive plans for a 48 MW combined heat and power unit, which was part of TECO's \$377 Master Plan Implementation Project constructed from 2007 to 2011 under the guidance of Burns & McDonnell. With the completion of CHP in 2010, TECO became a formidable microgrid. It can produce enough electricity to power TECO's entire Central Plant, keeping chillers and boilers running



TECO's Phyllis Sousley, Tim Reardon IV and Zhanna Kogan were on its five-person kitchen crew during Hurricane Harvey.

SUSTENANCE FOR THE RIDE-OUT TEAM

Every ride-out team member had his or her role. Phyllis Sousley, TECO's senior procurement and special programs coordinator, donned an apron and became TECO's head chef during Hurricane Harvey. She had helped prepare the food plan and was equipped to put it into action.

"My family owned and operated restaurants, so heading up TECO's kitchen comes pretty naturally," says Sousley. Four employees helped Sousley make nearly 120 meals a day for 5-1/2 days. "Everyone needs proper sustenance," she observes. "They all play an impor-

tant role in keeping the system running. They deserve a great meal and a mental and physical break. We thought our pantry was stocked to hold us seven days, but they ate a lot, and we had to make a grocery run to see us through!"

Sousley and a colleague slept in a room next to the kitchen, rising each day at 4 a.m. to get breakfast underway. Those on kitchen duty found themselves on their feet 15 to 17 hours each day, as one meal prep, service and dining room cleanup rolled into the next.

Distribution Supervisor Scotty Walker was responsible for keeping the piping system in working order. He and his crew were out in the elements as the largest total rainfall in U.S. history fell. Rain covered much of the system's underground piping in 100 vaults, trap boxes and manholes, posing a challenge for TECO's steam lines.

When a steam line is totally submerged, the steam inside condenses, requiring the plant's boilers to work harder to maintain steam load. Plus, the hot pipe can heat the rainwater, causing it to steam and boil, in turn damaging insulation and electrical systems in underground vaults. With steam service vital to 16.1 million sq ft of customer space for space heating, dehumidification, humidification, sterilization, kitchen, sanitary and process research use, lowering rainwater levels around the pipes was crucial.

"Being ready for anything is important, especially when facing such a catastrophic event as Harvey," states Walker. "We rented a dump truck in advance to ensure we could navigate flooded areas to get to our piping access points and pump out water. And we knew exactly where to head first. We were well-equipped and wore rain gear, but under those tough conditions, we still got soaking wet. It was hard to stop and go to the plant for dinner, but we knew we needed to sustain our energy so we could keep going."



TECO's Central Plant, back center, is located along Brays Bayou, which flooded during Hurricane Harvey. The bayou is part of the Harris County Flood Control District. At one point during the storm, 6.8 inches of rain fell in just one hour.

KEEPING CUSTOMERS IN THE LOOP

The Texas Medical Center and nearly every member institution had their own ride-out teams during Hurricane Harvey. TECO regularly emailed updates to customer teams to assure them that chilled-water and steam services were stable and operating normally.

All institutions remained operational during the storm. No institutions flooded. But that wasn't just by chance.

"The reality is that Texas Medical Center itself must be considered critical infrastructure," says TMC President and CEO William F. McKeon. "Our facilities are

cares for a sensitive patient population and conducting an enormous wealth of life science research. Plus, there's even more demand for our services during emergency situations. That's why we have extensive flood mitigation plans in place. Together with our member institutions, we've invested more than \$50 million in flood prevention infrastructure."

Ahead of Harvey, TMC activated those plans and maintained close contact with member institutions and large external stakeholders. McKeon and TMC's Chief Operating Officer Shawn Cloonan met with TECO management during the height of

CELEBRATING 50 YEARS: THE ENERGY BEHIND WHAT'S NEXT

Most people recall 1969 as the year the United States put a man on the moon. TECO likes to remember it as the year district cooling and heating were born on the Texas Medical Center campus.

Houston Natural Gas was the district energy system's original owner, beginning construction of the \$4.5 million system in 1968 and starting it up in summer 1969. The system expanded almost immediately, in both 1970 and 1972.

In 1978, after years of discussion and study and forming a cooperative, the Texas Medical Center and numerous member institutions acquired the system from Houston Natural Gas. TECO, then known as Thermal Energy Cooperative, took over ownership and system operation.

In 2019, the system celebrates its 50th anniversary, one year after TECO marked 40 years of system ownership in 2018.

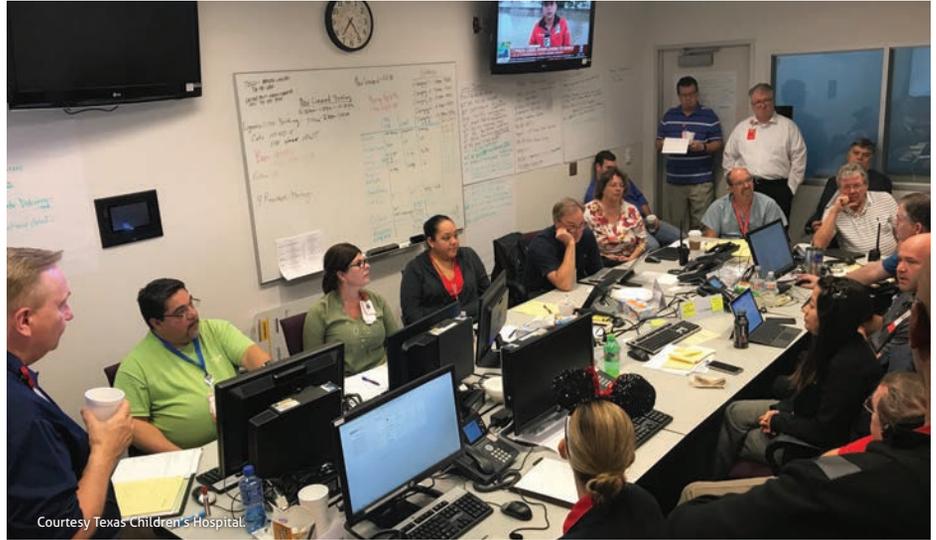


the storm to be sure all was proceeding according to plan.

MOVING FORWARD

Although most of TECO's staffing and operation returned to normal once Harvey subsided, the distribution crew was still operating in high gear. Scotty Walker normally heads a distribution crew of four, but that number expanded exponentially during and after the storm, with nearly 30 people handling post-storm repairs.

Well into October 2017 – two months after the storm had passed – crews contin-



TECO's customers had their own Harvey ride-out teams. These team members at Texas Children's Hospital met regularly to exchange information and stay the course.

System snapshot: Thermal Energy Corp.

	Steam/combined heat and power system	Chilled-water system
Startup year	1969 – Steam service began 2010 – CHP unit added at Central Plant	1969
Number of buildings served	36	48
Total square footage served	16.1 million sq ft	20.7 million sq ft
Plant capacity	Central Plant (Paul G. Bell, Jr. Energy Plant) and South Main Plant: 980,000 lb/hr steam (with heat recovery steam generator and duct firing), 48 MW electricity, 16 MW standby generation	Central Plant (Paul G. Bell, Jr. Energy Plant) and South Main Plant: 120,170 tons, including 8.8 million-gal thermal storage
Number of boilers chillers	9 boilers	27 chillers
Fuel types	Natural gas, diesel	Electricity, natural gas
Distribution network length	7.7 trench miles (portions have three pipes)	7.7 trench miles
Piping type	Welded steel, Schedule 40 with insulation	Welded steel coated with coal/tar epoxy
Piping diameter range	2 to 16 inches	6 to 60 inches
System pressure	400 psi plant, 250 psi distribution	55-75 psi supply, 30-45 psi return
System temperatures	450 F supply/150 F return	40-43 F supply/52-55 F return
System water volume	NA	12.4 million gal

Source: Thermal Energy Corp.

ued working seven days a week to restore vaults, trap boxes and manholes and to repair electrical systems. All work was safely performed and steam and chilled water continued to flow.

As it did with other hurricanes and storms, TECO held a post-storm debriefing that resulted in only a few suggestions for improvement: order more food provisions to accommodate a longer stay, order cots rather than air mattresses for greater comfort and convenience, and make high-water vehicles a permanent part of the plan.

But the true measure of TECO's resilience comes from its customers. "Thermal Energy Corporation is a treasure, cooling and heating our campus buildings to help us sustain life," says McKeon. "It is a cornerstone of how the Texas Medical Center operates. It is truly that important. The company goes out of its way to provide uninterrupted service. It stood strong throughout Harvey, and that's a real marvel of engineering, planning and investment." 



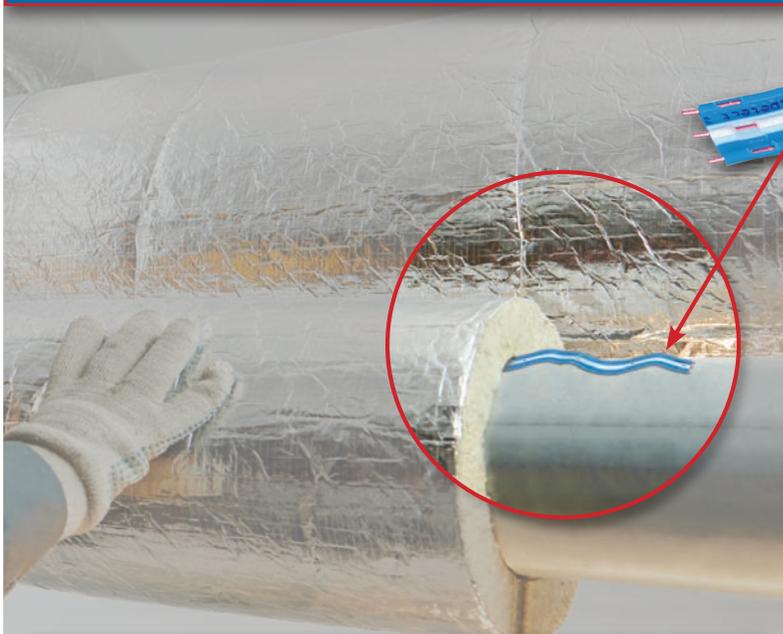
Steven K. Swinson, PE, is president and chief executive officer of Thermal Energy Corp. in Houston. He has overall responsibility for the company's management and strategic direction and led the company through its largest-ever expansion from 2007 to 2011. Prior to joining TECO in 2005, Swinson held positions at Midwest Mechanical Contractor's Central Division, Trigen Energy Corp. and Auburn University. He is a longtime IDEA member, serving more than a decade on its board of directors including terms as president and chairman. He received IDEA's Norman R. Taylor Award in 2015. He holds a Master of Business Administration from Northwestern University's Kellogg Graduate School of Management and a Bachelor of Science in mechanical engineering from Auburn University. Swinson is also a member of ASHRAE, the Association of Energy Engineers and the APFA Institute for Facilities Management,

where he served as a faculty member. He may be reached at sswinson@tecothermalenergy.com.



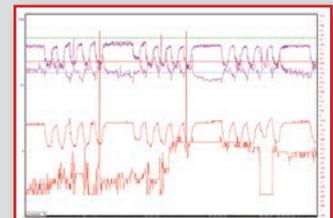
Jose Garcia, PE, CEM, joined TECO in 2007 and has been the company's operations manager since 2015. He is responsible for the safe and reliable production of chilled-water and steam service for TECO's customers. Garcia was previously a senior operations engineer and a senior project engineer for the company. Before starting at TECO, Garcia was a performance contract engineer and audit manager for Honeywell Building Solutions SES. He is a licensed professional engineer in Texas and a certified energy manager. Garcia graduated from The University of Texas at Austin with a Bachelor of Science degree in mechanical engineering. He is a member of IDEA and ASHRAE. He may be reached at jgarcia@tecothermalenergy.com.

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