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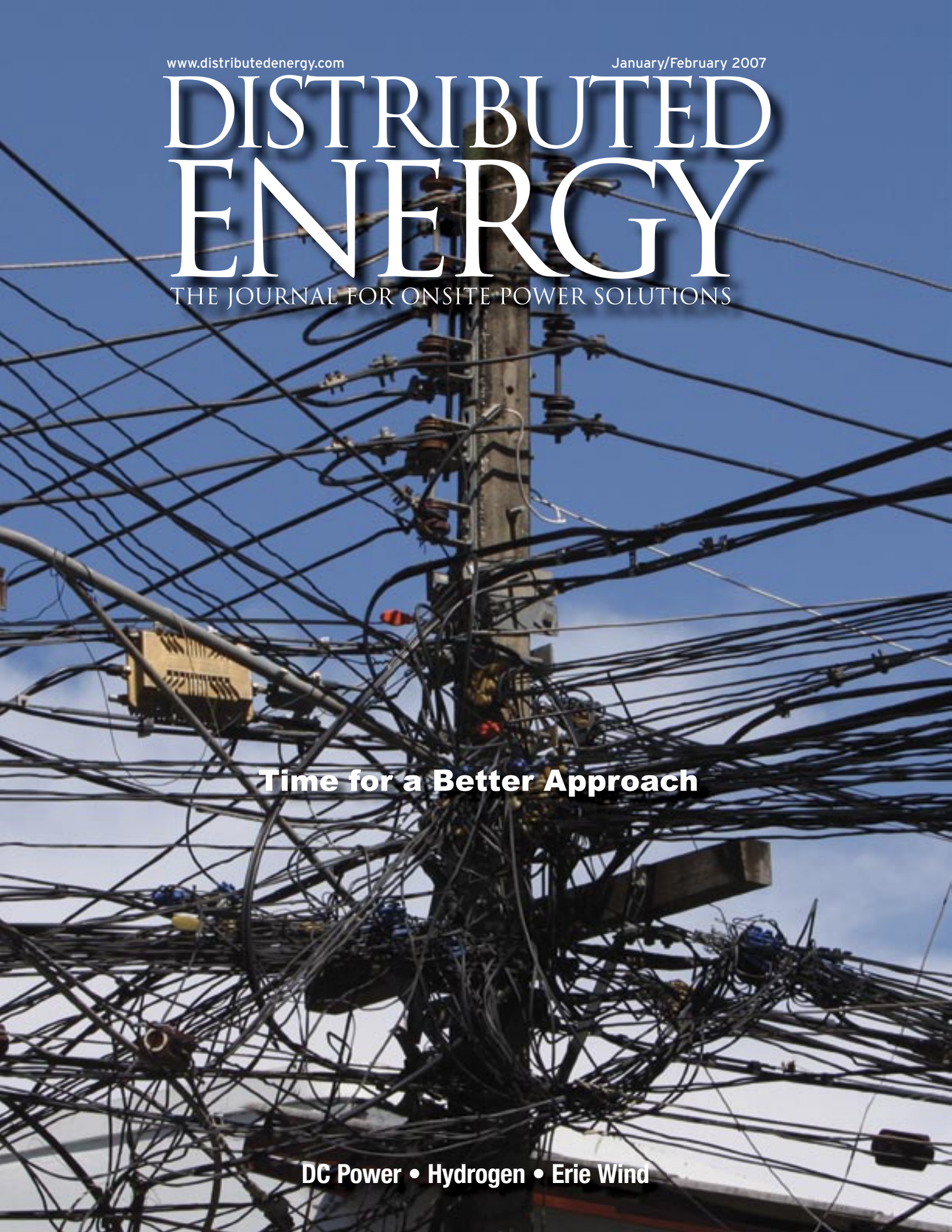

Time for a Better Approach

DC Power • Hydrogen • Erie Wind

Keeping DE Functions in Place

BY PETER HILDEBRANDT

Consumers Energy (CE), a natural gas and electric company, is one of the nation's largest combination utilities, providing electric and natural gas service to more than 6 million of Michigan's nearly 10 million residents, in all 68 counties of Michigan's Lower Peninsula.

CE's White Pigeon compressor station, located in southwestern Michigan, is a critical station in CE's system, receiving gas from pipeline companies for transmission, distribution, and storage for Michigan customers.

The White Pigeon compressor station normally operates on commercial power with power supplied by the local power company, AEP. In the event that the utility grid goes down, the station switches over to generated power. The generated sources are engine/generator packages put together by Waukesha Pierce.

The site has a critical need to pump natural gas through the pipeline; if that stops, it means a loss in supply. That factor, and also, importantly, the fact that this facility had a mishmash of obsolete and unreliable equipment and technology from countless updates over the past four decades, made a major overhaul and update of equipment at the White Pigeon station a virtual necessity. Forty years is an eternity when it comes to energy and control technology. CE's only other option in this case was to do nothing and continue to have unplanned station power outages and increased call-outs due to numerous equipment malfunctions, according to Terry Diefenbach, senior project electrical engineer with CE.

Large Area, Tight Footprint

The White Pigeon station basically has two large buildings where it receives and compresses natural gas. "They had switchgear that was old Westinghouse equipment, and they wanted to do an upgrade," says Rohit Duggal, project engineer at Belle Chasse, LA–based Point Eight Power. "A critical component in all this was that they had all the main cables run, so they didn't want to move the location. Every starter in the motor control center had to be left in virtually the same location. We had to exactly match the footprint of the area."

This facility had a mishmash of obsolete and unreliable equipment and technology from countless updates over the past four decades.

This is a fairly large compressor station, spread over approximately 25 acres of property. The station is composed of two similar plants, with Plant 1 on the south end of the property and Plant 2 roughly 800 feet to the north. Each of the plants has a long and narrow natural-gas compressor building, roughly 180 feet by 50 feet in size, each with four reciprocating engines. Approximately 100 feet to the east of each of the compressor buildings is an auxiliary building, roughly 180 feet by 40 feet in size for Plant 1 and roughly 60 feet by 40 feet for Plant 2. The auxiliary building of Plant 1 houses the office, shop, warehouse, station control room, large equipment room with the plants' air compressors, motor control center (MCC), generator, boiler, and other auxiliary equipment. Plant 2's auxiliary building houses the plants' air compressors, MCC, generator, boiler, and other auxiliary equipment. Between the plants is the suction-and-discharge gas piping that comes into and then exits the station, with pipe diameters ranging from 20 to 36 inches. The numerous valves, valve operators, and orifice gas-check metering—which actually measures the natural gas coming in from each of the suppliers, as well as metering the discharge gas going out of the station—all make this a rather large complex.

Each plant has its own auxiliary system, including the generator, air compressors, MCC, gas aftercoolers, and safety and data monitoring and shutdown systems. The plants also have their own power feeder from the local power company, including the capability to share power between plants for critical loads. Each plant has 12 gas aftercoolers in the yard for cooling the discharge gas.

"Consumers Energy had previously purchased material from Point Eight Power, so they knew that we already did this sort of work. They had a requirement, and they sent us the request to bid the job," says Duggal. "We did a site visit initially to look at the existing system and looked at how we could interface with the old system. The old control system consisted of many relays and pneumatics, while the new one is composed of

electronics. Another interesting factor was that they had a utility service coming in, the transfer switch and the generator controls all in the same lineup. In the MCC they had all of this on the shelf."

The order for the start of work on the project came in July 2005. As project manager for the job, Duggal had his own team of designers. They did all the design work at their offices in Louisiana. "Matching the existing footprint onsite was the major hurdle from our standpoint," says Duggal. "Other than that, things were fairly straightforward for us with this project."

Point Eight Power, successful bidder of the MCC and generator panel equipment, had the equipment built and factory witness-tested by CE. The equipment shipped out in November 2005. Power Specialties Electric Inc., of Holland, MI, was responsible for the installation. Point Eight Power's field service crew then went to the site to do the final commissioning of the project. Due to the plant outages that had to take place before startup, the actual dates of commissioning of the project were not until mid-April (Plant 1) and early May (Plant 2) 2006.

"This station was constructed back in 1962 or 1963; that's how old this equipment was," says Diefenbach. "In addition to the unreliability, it was getting harder and harder to track down replacement parts.

"Breakers and starter control components were going bad, and when you had a part go bad in the MCC, it was very tough to find replacement parts for it anymore. Factory replacement parts were either specials at an inflated price, other components found previously used on the secondary market, or similar components requiring custom-mounting and resulting in a mishmash of parts. It simply became too costly and timely to replace parts."

Part of this project came about when automation of the station began. "Along with the motor control center and the switchgear being so old, many of the other controls at the station were very old also," says Diefenbach. "From valve operators, transmitters, engine panels, and gas aftercooler controls to battery charger systems to control and power wiring in the yard, everything was outdated and failing on a more frequent basis.

"We'd started this project about a year and a half before this by simply upgrading pieces of equipment, with the largest part of the work being the automation of the station and the replacement of the entire station control system.

"When this took place, much of the old equipment was especially difficult to interface with; this is basically what got the project going, the difficulty with interfacing to the obsolete equipment."

New generator breaker controls were essential to the upgrade.

Segments of the Upgrade

The original Westinghouse switchgear was replaced with Cutler-Hammer switchgear. Aside from the Westinghouse MCC switchgear being circa early 1960s, the station's Waukesha Pierce Enginators (engine/generators) are from the same era. The Waukesha package has a 376-horsepower, natural-gas-fueled Waukesha engine; 250-kW, 480-V-AC generators manufactured by Electric Products Company (Plant 1) and Electric Machinery (Plant 2); a Starfire ignition system; a Woodward UG-8 governor system; starting-air solenoid; gas valve and solenoid; a KIM jacket water heater; miscellaneous instrumentation; and a remote-mounted cooling fan.

The switchgear components were failing with increased regularity, according to Diefenbach, and there was also a growing stream of technician and operator call-outs due to the breakdown of equipment parts. Many years had passed in which to misplace documentation, and there had also been a series of revisions over the decades. Both of these factors added urgency to completing the upgrade.

It was the same story with the generator panel. On-engine, electro-pneumatic components needed to be replaced with electronic instrumentation; obsolete controls and the old relay logic system needed replacement with a new PLC-based control system. Whereas the old panel had a combination of 12-V-DC, 24-V-DC, 120-V-AC, 250-V-DC, and 480-V-AC power, the new generator panel has 24-V-DC controls with 120-V-AC and 480-V-AC where required.

The new panel interfaces well with the new station automation and controls upgrade. The generator instrumentation upgrade also in-

cluded new 24-V-DC fuel-gas and starting-air solenoids, lube oil pressure and jacket water-temperature switches, static exciter/voltage regulator, and new magnetic pickups.

For the automation of the two 75-horsepower and two 25-horsepower air compressors, a soft-start was added to each of the 25-horsepower units (two existing stand-alone soft-starts existed for the two 75-horsepower units). Each air compressor also had a skid-mounted control panel; to each of those an interface was also required. A main 120-V-AC air compressor control panel that controlled all four air compressors was removed.

This old main panel comprised numerous relays, timers, selector switches, and pressure switches. The panel had start-and-stop controls based on individual pressure switches and operator-selected lead/lag (primary/secondary) unit selector switches. Now that the project is completed, air compressors can be manually controlled by each unit's starter or automatically started or stopped via the station automation system, based on operator priorities, online hours, individualized start/stop setpoints for each unit, and the station air value from the station air-pressure transmitter.

The commercial power section was designed by Point Eight Power.

Weather Factors

One glitch occurred early on. The project went out for bid in May 2005, and the job was awarded in July, with a planned installation for late 2005. Around the time CE received and reviewed its set of approval drawings from Point Eight Power, Katrina struck the New Orleans area. There was no longer a place to send the approval drawings back to.

"We were delayed about a month due to that turn of events," says Diefenbach. "But fortunately Point Eight Power—right across from New Orleans—had minimal damage to their offices. Though they were down about a month, they still had to locate all their employees.

"We had four weeks total to get the old system removed and the new system installed and back up in service. A four-day 'total power outage,' followed by a week of generator panel check-out and startup, was allowed for each of the plants. But we also had two plants at White Pigeon, and one of them had to be kept operational at all times. In the end, because of the delay and the fact that the gas control department did not want to give us a plant outage in the winter months, we ended up postponing the whole installation and startup until spring, with gas control giving us the outage for Plant 1 starting on April 10 and Plant 2's outage starting on April 24."

From the Point Eight Power end of things, there were issues with material, because many of the vendors would not ship down to the New Orleans area, according to Steve Liggio, engineering manager for Point Eight Power. The company learned very quickly—as did many other businesses and citizens at this time—the power of the Internet in making contact and communicating in disaster's wake.

"We didn't realize how important a tool the Internet was until after the fact," says Liggio. "We started posting daily updates, such as 'people back' or 'business open,' via the Internet, as we did have a lot of clients out there and because phone service was slim to nonexistent. We were running on backup generators at this time. But the Internet was definitely something we didn't exploit as much as we should have.

"One major problem was that vendors would not ship material to the area, because trucks could not get in and out because of the debris," according to Liggio. "Most of the city was locked down for at least several weeks. We had a lot of logistics to do there, and the White Pigeon project did get caught up in some of that."

Point Eight Power's management relocated to Houston in the wake of the hurricane, and Duggal traveled to family in New Jersey. "There definitely was a two- to three-week time period where customer contact was slim—if there even was any," says Liggio. "For us, this was a lesson learned; we have actually come away with a disaster contingency plan completed in time for [the 2006] hurricane season."

The end result, despite the major Katrina-style glitches before completion, has been that the system is more reliable. It interfaces with the new station control system, and there have been no power-related call-outs. If the station loses power, the generator comes online and ramps up, and the load transfers smoothly.

Getting Used to the New System

On the Monday mornings of each of the outages, CE started out with safety meetings followed by tag-and-lockouts, prior to the power company disconnecting power from the plant.

The tag-and-lockouts prevented any power from back-feeding from the online plant to the plant where the Switchgear work was taking place.

"At this time, we also needed to supply temporary power to the critical loads that needed to remain in service," says Diefenbach. "Power remained disconnected for three and a half days. By noon Thursday, power was restored, check-out began, and the plant was slowly put back online. The following week, Point Eight Power came out for the generator startup.

"During the outage week, not only did we disconnect and install the new switchgear at the plant, but we also totally redid the on-engine generator controls. It was a hectic and busy week."

Since each update on equipment is unique and involves so many variables, it was nearly impossible to have a flawless startup. "We found that the new electronic controls were more sensitive to noise," says Diefenbach. "Upon startup of Plant 1's generator and initiation of a load transfer, we noticed voltage increasing, followed by a spike of over 600 volts, resulting in a high-voltage shutdown.

"After checking out the brushes, slip-rings, wiring, voltage-regulator resistance, and winding resistance, we finally identified the problem as both generator and ignition noise or interference, which was affecting the voltage regulator. In addition, we later found ignition noise was getting into our gas/fire system monitoring equipment in Plant 2, causing false alarms. These nearly tripped our firegate system at the plant, which would have shut down the online engines, tripped the stations' 480-V-AC power, locked in the station gas piping, and vented all gas piping in the station yard," says Diefenbach.

The noise-related problems were solved with additional grounding, along with corrections in some existing grounds, according to Diefenbach. "Also during startup, the Point Eight rep found that a flash circuit was needed for the generator in Plant 2. Point Eight Power field-designed and installed the circuit, and we were able to get the generator up and running," he says.

Another problem encountered was that on startup of the 75-horsepower air compressor, the main MCC breaker was tripped. "It was found that we needed a special handheld software tool to set the trip and trip delay timer parameters of the main breaker," says Diefenbach. "Working with a local supplier, we were able to obtain the handheld programmer, which we later found was supposed to be shipped with the system. With Point Eight's assistance, we were able to set both the main and generator circuit-breaker trip settings based on the "time-versus-current curve" of the breaker; there were also miscellaneous PLC set-points, timers, and switch contacts which had to be field adjusted along with a few minor software logic changes. But this is typical of any startup."

Now when technicians troubleshoot the panel, the equipment labels, layout, and documentation help make them more aware of what they are getting into.

Safety Increases

The system at White Pigeon now contains state-of-the-art technology. The generator panel is a PLC-based system with minimal parts. Digital readouts now replace the old analog meter displays.

The kilowattage of each plant is now monitored at the station level for trending and future load control. The system's automatic transfer switch (ATS) has programmable set points and timers for easy configuration in addition to having a plant exerciser to automatically test the generator on a weekly basis—with or without a load transfer.

The ATS is used to monitor the primary source of power and backup power source. In the event that commercial power is lost for a preset amount of time, the ATS will send a command to the generator panel to automatically start the generator.

Through this new system, CE has also increased its safety. "I'm not saying our original system was unsafe," says Diefenbach. "But rather, this new equipment and panel layout has increased our safety. Four hundred-and-eighty volts-AC can be an extremely hazardous voltage if not handled properly. With this voltage, as with others, flashing can occur and old equipment can become unreliable, resulting in a rising possibility of hazards. Safety, awareness, and proper training are extremely important."

Before the new system was installed, he notes, there were numerous voltages inside the panels. "Now the system is mainly 24-V-DC, 120-V-AC, and 480-V-AC; 480-V for the main power; 120-V for a majority of the motor controls; and 24-V for the generator controls and interface with the station control system. The various voltages are separated by their own set of terminals, with all terminals labeled per their voltage level."

In addition, they utilize finger-safe, 480-V control fuses in the generator panel. Now when technicians troubleshoot the panel, the equipment labels, layout, and documentation help make them more aware of what they are getting into. "With the prior panel, terminals and equipment had become unlabeled over the course of the years, and other components had failed and been replaced. It's simply much safer working in the panel now. In addition, the insulated buss bars in the new MCC make it much safer when routing new cables."

This station is contracted to take an allotted amount of gas from its suppliers. "If we are down for any period of time and cannot run the engines, we can't move the gas," says Diefenbach. "The new system should give us many years of reliable service. If any major renovations were to occur, the system is easily expandable.

"In the end this was a challenging project, especially with the installation and outage schedule. With the assistance of Point Eight Power, station personnel, PSE, our contractor, and our gas control department, the White Pigeon compressor station revamp was a great success. We now have a state-of-the-art system easy to modify and troubleshoot, with good documentation and, most important of all, increased reliability and safety." DE

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