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COMBINED CYCLE Journal
User Groups Gas Turbines HRSGs Controls

Gut rehab turns South Jersey cogen plant into electricity market gem

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"The bones of the plant were still really good," Plant Manager Jeff Zelik said, referring to the condition of the Eagle Point Power Generation facility in Westville, NJ, when Rockland Capital purchased it in April 2012. But five years of essentially no maintenance investment or capital improvement had clearly taken its toll. That was then.

Today, Eagle Point expects the plant capacity factor to approach 50% once the last of the capital improvements are finished. Those improvements include everything from a punch list of 146 maintenance activities to return the plant to a safe, reliable operating environment, as well as capital upgrades, including a new steam turbine/generator, wet compression and fogging, and a complete gas turbine optimization and augmentation package which helped avoid the $11-million cost of an SCR.

"We're committed with PJM to a June 1, 2016 deadline with our additional capacity and improved heat rate," Zelik observed.

Recent history. Many combined cycles around the country have experienced some version of this story. Eagle Point was commissioned in 1991 as a refinery cogeneration facility during the waning years of PURPA and the beginning of the IPP era. The refinery was sold in 2004. In 2009, the refinery's new owner announced its intention to shut down all but a small portion of the petrochemical operations there. When you know you are going to abandon a car or a home, you don't usually invest in it.

Expectedly, people issues were legion. Morale was low. Employees responsible for other refinery facilities (not powerplants) in the area were "assigned" to this site, after 80% of the cogen staff was let go.

"The one-mile river intake piping resembled a sprinkler system," noted Zelik, wryly, as just one example. The dry low NOx equipment retrofit to the gas turbines prior to 2004 was "a mess," too, so much so that trying to fix it under the previous owner bankrupted the vendor. The compressor was the "dirtiest anyone had ever seen."

"We also had to rewind the steam turbine/generator stator," said Zelik. Sending 350,000 lb/hr of process steam to atmosphere (with the refinery shuttered) didn't exactly make it easy to bid into the PJM market with a stellar heat rate.

However, part of the sturdy "bones" of the site were the two 7EA gas turbines, still in "pretty good shape" when Rockland got hold of them, mostly because they had seen minimal run time since the DLN retrofit fiasco.

Getting back to zero. The condition of Eagle Point at sale, frankly, was as bad as Zelik had seen for a 20-year-old facility (and seconded by the **CCJ** analyst touring the facility with Zelik, based on his three decades visiting power stations all over the world and evaluating new technologies and systems). Without dwelling on how the facility reached this point, the photos of as-found deficiencies certainly makes it clear:

- Corrosion issues that started at the office door and continued throughout the plant, ranging from electrical junction boxes, seams at tank shell welds, and major piping runs.
- Insulation issues throughout the plant and staff disregard using insulated pipes as work platforms.
- Housekeeping issues that ranged from safety codes concerns to creating inaccessible areas.
- Chemical feed and associated tanks continuously leaking into containment areas.
- Dirt, oil, and general housekeeping and safety issues around the gas turbines.
- Raw river water pipeline abandoned, and then tapped into the plant's fire water system.
- Poor sealing and failed strip heaters in bus ducts, which led to failed bus insulators.
- Block valve installed upstream of a safety relief valve on a high-pressure steam line.
- Misaligned and poorly supported pipes.
- Plugged, scaled, and corroded HRSG tube bundles and rusted outer areas.

One positive: Around $300,000 worth of gas turbine replacement parts were found "dumped in the main parking lot," not nearly enough, though, to offset the approximately $10-million spent to get the plant back to a safe and reliable state—$3-million alone for extensive piping fixes, insulation, and heat tracing. Compare the rehabilitated equipment in the second montage to the as-found photos.

Typical of as-found deficiencies at time of sale

Insulation generally was in poor condition

Do not stand on insulated pipes

Junction box in poor condition

Internal shell of backwash tank

Water treatment and chemical room when plant was sold

These tubes have seen better days

There's a desk here somewhere

Gas turbine area suffered from lack of attention

Firewater system supplied water to the plant

Major upgrades. The big investment was the addition of an auxiliary 27-MW steam turbine/generator to productively use the bulk of the cogen steam and convert the site into a 2 × 2 combined cycle. More interesting, perhaps, is the investment in EthosEnergy Group's ECOMAX® performance optimization system; PSM's patented Power Augmentation (PAG) system to integrate gas-turbine steam injection/inlet bleed heat (IBH) mechanically as well as from a controls standpoint; and Mee Industries Inc's overspray, wet-compression capability to the existing inlet fogging system.

"This is the first EA machine with ECOMAX," Zelik said. All the upgrades have been operating for one year and a few months, "as expected," he claimed. "We're comfortable with our ability to tune the units for summer operation, although we feel we still have some learning to do for winter ops."

Tuning is critical. The original Eagle Point HRSG includes a CO catalyst but not a NOx catalyst. The permitting authorities tried to force a NOx SCR, but Rockland investigated other ways to gain a permit and maintain compliance. Thus, the permitted 7 ppm NOx emissions level is met solely through combustion optimization (with the steam injection). While 7 ppm appears to be a modest reduction compared to the original 9 ppm, it does represent a 25% decrease. The larger point is there's no "big box" at the end of the pipe to rescue them if combustion tuning is out of spec.

Combined, the upgrades net about 12 MW per unit, 4 MW total from wet compression alone. In the 2 × 1 configuration, the plant's output is around 210 MW, 238 MW max in cold weather. With the new aux steam turbine/generator, max facility output is more than 250 MW. Minimum load of 105 MW is typically handled in 1 × 1 mode. In 2 × 2 mode, Eagle Point achieves a heat rate at or near 8200 Btu/kWh.

"Our traders, EDF, bid the facility into PJM and our gas buyers expect that they can secure natural gas at the price we base our electricity bid," Zelik said, "which is usually no problem because we're located in a highly industrial area with multiple suppliers and good options." This year (2015) the plant typically runs for 12 to 18 hours daily at or near maximum output, then shuts down. When called, Eagle Point runs for a minimum of four hours. Somewhat contrary to what one might expect, capacity factors have been higher in spring and fall. "Last September, we ran continuously the entire month," said Zelik.

The *flexibility* offered by the upgrades may prove as important over time. "We can be very responsive to real-time market conditions," Zelik added. He further noted that it is very unpredictable when the plant will be picked up by PJM. By 4 p.m. the day before, we know if our day-ahead

bid has been accepted and around 4 p.m. the current day, real-time prices typically begin to rise. Eagle Point thus can optimize revenues earned between capacity and energy payments.

"We also are required to follow PJM's Lambda schedule, and have to slightly alter output during the run period." At peak loads, the facility will use a combination of steam augmentation, wet compression, and fogging to adjust the load to meet the PJM Lambda schedule. "Although the changes can be made instantaneously, it is normal to allow the ECOMAX system about 10 minutes to stabilize the NOx and CO," said Zelik.

More on ECOMAX, PAG, fog. Zelik described the original software for gas-turbine performance like "training wheels," a flat two-dimensional spreadsheet approach, compared to the multi-dimensional capability of ECOMAX, which integrates readings from the combustor dynamics monitors (CDM), air flow, and firing temperatures.

The system monitors pulsations of each burner, or combustor can. Zelik noted that Eagle Point turbines have 10 cans each but the plant chose to monitor every other can so far. Based on the results to date, Zelik recommends monitoring each can for better response.

The logic adjusts both air and fuel flow to each can in real time. However, this wasn't something that happened overnight. "We started in May (2014) and it took us the whole summer to figure out the logic, before we felt comfortable." Now, plant staff knows enough that they can make their own adjustments during winter ops. Tuning for operation below 30F still has to be tweaked, according to Zelik.

Still, no one else is attempting to control DLN turbine emissions at 7 ppm or less with the DLN equipment, he emphasized. This is the reason firing temperature plays such a large role in combustion and performance optimization. The control system adjusts bypass air with the inlet guide vanes.

Essentially, ECOMAX optimizes among emissions, output, and heat rate under varying ambient conditions, fuel quality, and market economics, while remaining within the OEM's recommended setpoints.

PAG makes use of existing equipment orphaned by the old steam injection NOx control system, but with a twist. The existing ports used for cold inlet bleed heat on the compressors during startup were converted with reverse-acting valves to also handle injection of steam at high-power conditions. This upgrade alone allows the plant to redeploy up to 55,000 lb/hr of excess steam for 8 to 10 MW of power augmentation from each GT year-round, acknowledging the 1.3:1 hit on equivalent operating hours (EOH).

Rehabilitated equipment puts plant on track for dispatch

Boiler feed pump equipped with new motor driver

Service water and many other pumps reconditioned

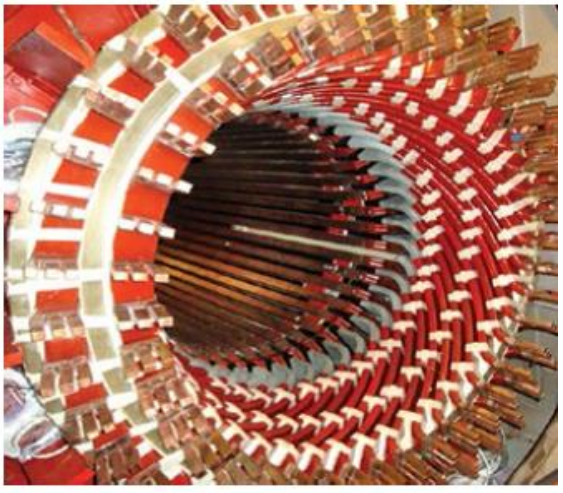
New junction box

Main and auxiliary circ-water pumps overhauled

New raw-water line

Water treatment area like new

Eureka!



Rewound generator stator

Ancillary benefit: The compressors are continuously washed. Borescope inspections show the compressors to be clean, avoiding independent online or offline cleaning.

The fogging system was existing but not functional when Rockland came in. Wet compression (WC)uses the same equipment but at a different location. Fogging reduces temperature and adds air for compression, wet compression adds volume and density to the air. WC helps under high-humidity conditions when the fogging system is flagging. Each one adds about 2 MW, and is used primarily for operations between May and September. Below 60F, there's risk of icing and freezing.

There are six high-pressure pumps for fogging, two for WC. Both can now be controlled from the control room. When both are turned on, the "turbines will take as much water as we can give them." Keeping the filters clean and ensuring a good fogging pattern from the nozzles are both critical to good performance from the systems.

Controls. Part of the original controls included an ABB analog system (essentially manual controls by today's standards, says Zelik) for the VAX type steam turbine and an INFI 90 for the balance of plant (BOP). After the DLN conversion, the gas turbine Mark IV controls were replaced with a system from Turbine Technology Services Inc, at the time owned by Sermatech, which was responsible for the DLN retrofit.

Today, Eagle Point has an Ovation™ backbone and a long-term plan with Emerson Process Management to upgrade and expand it as they go. The new Siemens steam turbine/generator will feed data to the Ovation system. Currently, the plant operators see Emerson screens for the GTs, INFI 90 screens for the BOP.