Completing a half-built mothballed plant presents special challenges

There are benefits associated with buying a partially complete combined cycle. Some that come to mind: Construction permits are in hand; most design work is complete; foundations and buildings are finished, or nearly so; major equipment is onsite or in a nearby warehouse; installed cost will be less than building the project from scratch.

However, it’s what you don’t know, or are not sure of, that can present challenges rarely encountered when a plant is designed and built by the original owner without stopping in the middle of construction.

Absent workforce continuity, vital information can be misplaced or lost, dictating that some tasks—such as critical weld inspections—be redone. Reality suggests that no amount of due diligence can identify all potential sticking points. Thus budgets and schedules for completing mothballed units should be more flexible, perhaps, than those developed for new power projects.

The 580-MW, 2 × 1 Dell Power Plant, located in northeastern Arkansas about 90 minutes by car from the Memphis airport, is a case in point (Fig 1). It had two owners and a construction hiatus of three years before Associated Electric Cooperative Inc, Springfield, Mo, bought the 65%-complete facility in August 2005. AECI finished construction and the plant started commercial operation on Aug 23, 2007.

Though designed for base-load operation like most F-frame combined cycles of its era, Dell operates today in intermediate-load service to meet the specific needs of member cooperatives served by AECI. It is equipped to start and load quickly. Day-to-day operation and maintenance is under contract to Primesouth, a global third-party supplier of O&M and other powerplant services headquartered in Columbia, SC. Plant Manager is Maurice Mulqueen.

History. Massachusetts-based GenPower LLC began developing the project in 1999 and sold it in November 2000 to a now-defunct subsidiary of TECO Energy Inc, Tampa, after receiving construction permits. TECO selected Enron Energy Services subsidiary National Energy Production Corp (NEPCO), Bothell, Wash, as the EPC contractor and began construction in June 2001. Work was suspended in September 2002, reportedly because of the rapidly escalating price of natural gas.

When construction stopped, the two Model PG7241FA gas turbines (GTs) supplied by GE Energy, Atlanta, had been installed; the two duct-fired Pioneer™ heat-recovery steam
generators (HRSGs) from Aalborg Industries were mostly complete (Fig 2); the lower casing for the GE D11 steam turbine was installed (Fig 3); and most of the large-bore piping was in place.

Restarting the project had its moments—such as the inability to quickly locate information needed to complete design and construction. One reason for this problem: Significant changes to the status of several major contractors hired by TECO occurred between the time the project was shut down and AECI restarted it.

Specifically, Enron Energy Services folded; the NEPCO business segment associated with powerplant EPC services was sold to SNC-Lavalin Constructors Inc; Aalborg’s Erie (Pa) boiler shops were acquired by Erie Power Technologies Inc and then were purchased by Belgium’s CMI and renamed CMI-EPTI LLC. And, as noted earlier, even the TECO unit responsible for Dell and other merchant power projects was shuttered.

One of the first steps taken by AECI to move the project forward was to hire Burns & Roe Enterprises Inc, Oradell, NJ, as its original design engineer and TIC had been TECO’s construction manager. Although some key personnel at both companies were new to the Dell project, they did have direct access to any information still on file.

Much needed continuity between construction stop and restart was provided by a team of four experienced technicians—including Dell’s current O&M Manager Wesley Maupin—who participated in the layup managed by SNC-Lavalin and TIC and then stayed on to maintain the buildings and equipment when the project was put on hold.

Use of OEM-approved procedures for equipment preservation are critical to the success of any layup. This is especially true when construction is beyond about the 50% mark because most major equipment already is in place and the manufacturers’ protective packaging has been removed.

TECO hired key OEMs—including the turbine and boiler suppliers—to preserve their equipment. Small equipment and instrumentation not yet installed was stored in the steam-turbine (ST) building where temperature and humidity were tightly controlled.

Maupin said procedures for the Dell preservation program that contributed to its success included these:

- Rotated motors 10 revolutions monthly. Despite this effort, the plant suffered an abnormal number of motor failures during commissioning. Hindsight suggests that the motors should have been shipped to a shop for detailed operational checks prior to use.
- Maintained desiccant according to manufacturer recommendations.
- Lifted GT rotors weekly on hydraulic oil; they were not rotated.
- “Megged” generators periodically. One lesson learned was that megger readings trended low with both dehumidifiers and internal heaters in operation. After turning off dehumidifiers, readings returned to normal.
- Stored the ST rotor on the turbine-building floor in a special harness. Fig 4 shows that the rotor rested on wood beams and was not in direct contact with the metal frame.

The nominal 100-acre, flat-as-a-pancake Dell site sits among cotton fields (Fig 5). The so-called “gumbo” soil indigenous to the area required preparation before construction could be restarted. Ground surrounding the plant was plowed and lime was mixed in before covering it with sufficient crushed rock to keep equipment and worker vehicles from getting stuck. AECI’s Keith McMillion explained that when this soil gets wet it sticks to tires and shoes and is difficult to remove.

While site remediation work was in progress, system assessments and
a thorough inventory of equipment were conducted to identify needed items and to develop a detailed scope of work. This effort included a search for important documentation—such as welding and inspection reports for alloy piping, including P91. Where it could not be found, hardness and other nondestructive examinations (NDE) were redone, both to assure proper workmanship and to establish baseline data for future reference. In some cases, welds had to be cut out and remade.

Many people involved in the design, construction, operation, and maintenance of electric powerplants think the industry just plods along, changing little over relatively long periods of time. The Dell experience testifies to the industry’s vitality and dynamic nature. In addition to the company changes noted above consider those associated with just the gas turbine, especially the following:

The plant’s 7241s sat idle while several 7FAs experienced compressor failures caused by cracking of first-row (so-called R0) blades. Bob Pasley, who is responsible for keeping AECI’s GT fleet at a high level of reliability and availability with an aggressive maintenance program, kept current on industry experience by attending 7F User Group meetings and by monitoring user experiences on the group’s website.

He knew failures typically were associated with compressor blades of the type installed on Dell’s machines—particularly at plants with a long-term history of inlet fogging and online water washing. So Pasley had the OEM install the P-cut blades that promised more reliable performance. However, those blades were found to have other flaws and Pasley had them removed just prior to first fire. They were replaced with blades of the original design, but with tips ground to prevent casing rubs experienced by some units in the fleet.

The Dell GTs are equipped with Mark V controls and DLN 2.6 combustors, which are a generation or two behind what is being offered today. However, fleet experience with these systems attests to their reliability and the ability of the plant to maintain NOx emissions at the 3.5-ppm permit limits with an SCR using 29% aqueous ammonia reagent. No CO catalyst was installed because the permit specifies emissions in tons/yr that is achievable given demonstrated combustor performance, natural-gas fuel, and intermediate-load duty.

In addition to compressor mods, Ryan L Mayo, senior CT specialist, said that AECI had GE update the engines as recommended by the OEM’s TILs (technical information letters) sent to the fleet while the units were inactive.

The utility also chose to upgrade its controls package with OpFlex™, a GE proprietary software improvement that manages the fuel splits and control of fuel temperature to minimize NOx and CO emissions at part load. OpFlex also significantly reduces NOx production during startup and allows the GTs to operate down to about 45% of rated load and remain in emissions compliance.

The GTs are rated a nominal 170
MW each, but are capable of an additional 10 to 15 MW during the winter. Summer’s high temperatures and high humidity dictated the need for chillers to maintain design output. Jacksonville-based Stellar Power & Utilities provided three packaged chillers and arranged them in parallel with a common header to serve both engines simultaneously (Fig 6). Depending on ambient conditions, one, two, or three chillers may be in service at any time.

HRSGs and main steam piping also received careful review from AECI given industry experience with triple-pressure F-class boilers in cycling service. The HRSGs are equipped with Forney Corp (Carrollton, Tex) duct burners, each capable of boosting ST output by 30 MW. No special attention was paid to the burners during layup. But prior to restart, holes were redrilled to eliminate the buildup of corrosion products later removed by vacuuming. AECI generally operates today without duct firing.

Regarding piping, hangers and supports were re-evaluated and modified as necessary to accommodate cycling operation. Bypass stations were designed to “old” base-load criteria and were carefully investigated for quality, functionality, etc. In some cases, undersize actuators had been installed and casting defects had gone unnoticed.

TECO had the plant equipped with an auxiliary boiler to supply steam to turbine seals, thereby reducing startup time and improving operating flexibility. AECI went a step further, adding a steam sparging system to keep HRSG drums and headers warm during shutdowns.

I&C systems required thorough review as well. All critical control loops were “re-shot” to avoid problems and prevent delays during commissioning.

Water treatment. Little work had been done on the water supply and treatment systems before the plant was mothballed. AECI made some changes and is contemplating others. Potable and sanitary water come from the city of Dell’s supply system; cycle makeup from wells. Well water is aerated and run through multimedia filters before flowing to a 1.5-million-gal tank that provides a 330,000-gal reserve for the fire protection system. Water for the condenser—and for the closed cooling system that removes heat from turbine lube oil as well as other critical components—comes from the cooling-tower basin. The 12-cell tower blows down to a retention basin (Fig 7) where residual chlorine is removed before discharge to a natural watercourse.

Demineralized water is produced by coupling a single-pass reverse-osmosis system to five electrodionization (EDI) units arranged in parallel. Tankage for boiler-water makeup now totals 350,000 gal, up from the 100,000-gal demin tank specified by the original design. The general assessment of AECI engineers was that the water treatment system was generally undersized for the application.

Experience thus far indicates that the EDI units don’t have the tolerance for inlet water variability that the new owner would like, demin capability is insufficient, and silica levels in the outlet water cannot be held below the 3 ppm limit that AECI wants. Engineers are evaluating the replacement of EDI units with mixed-bed demineralizers. CGJ