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Carneys Point Case Study: Converting a DCS in 60 Hours

By Jason Noble, Project Manager, Siemens Energy Instrumentation, Controls & Electrical, and Tim Clark, Maintenance Manager, Carneys Point Generating Plant

The Carneys Point Generating Plant, owned by Chamber's Cogeneration LLC, is a coal-fired cogeneration plant that supplies both steam and electricity to the DuPont Chambers Works, which is the company's largest chemical plant on the U.S. East Coast. The plant has a 266 MW non-reheat steam turbine with a single extraction point for cogeneration steam. Reliable operation of this plant is critical as it is the sole source for steam to the Chambers Works, which has many sensitive chemical processes.

The legacy Westinghouse Distributed Processing Family (WDPF) controls system at the plant was facing obsolescence with unreliable operation, insufficient technical support and discontinued components. It obviously could no longer provide the availability and reliability both the plant and its cogeneration partner were looking for. A complete upgrade of the existing controls system was inevitable.

In the fall of 2007 the plant's management team was challenged with the task of upgrading the existing plant control system. The team faced a dilemma almost immediately: how to perform a major outage encompassing extensive turbine work (including a complete baghouse refurbishment and a distributed control system—DCS —migration) all in a short period of time. With a contract requiring production of uninterrupted steam for its cogeneration partner, Carneys Point Plant had a 72-hour window to execute a DCS migration from shutdown back to steam generation. Out of those 72 hours, only the first 60 were made available to switch over the existing WDPF control system to the chosen new technology, prior to the restart of Boiler 1.

Carneys Point Plant is fueled by pulverized coal; its two 50 percent capacity boilers can provide up to 1,000,000 pounds per hour of export steam capability to DuPont's Chambers Works. During the outage, the steam turbine and Boiler 2, whose baghouse was to be worked on, could be taken out of service and the remaining boiler could supply the needed process steam.

Siemens IC&E Group has developed a migration solution that upgrades the legacy WDPF control program to Siemens' fourth-generation control system SPPA-T3000.

In the past, hardware replacement has been done by completely replacing both the input and output modules and the field cables. Siemens I&C developed a special connector called Ad-Con 4W. This connector allows the direct connection between new input/output modules and the existing field wirings. The benefits are cost saving due to reusing existing field wiring and input/output termination and reduced outage time due to straightforward installation process and required re-testing time.

Siemens also developed an innovative approach to automatically convert WDPF source codes directly to SPPA-T3000 logics. In the past, code migration and conversion was a manual process, which required an extensive knowledge by the controls engineers of both source and target systems. By using the automated software-driven control code conversion tool, significant engineering effort is no longer required. In addition, automatic code conversion permits a certain level of built-in code optimization, reducing unnecessary load on the new SPPA-T3000 system. Cleaner, consistent code makes commissioning and maintenance easier.

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Upon the contract award of the Carneys Point project, the team had nine months—from July 2008 to March 2009—to execute the entire project. The project execution included multiple critical steps consisting of planning, engineering both hardware and software, manufacturing, assembly and testing and project management. The ultimate success or failure of the DCS migration would hinge on the execution of three main areas: software migration, hardware migration and outage/project execution.

Software Migration

Converting WDPF software into SPPA-T3000 is a complex task. Legacy code conversion has typically been done as a manual process from detailed analysis of the source code. This requires detailed knowledge of both systems and an extensive amount of time. The output of such work depends on engineers' skills and their personal preferences. Time required for the work and time constraints given by project schedule often require multiple engineers to be involved in the process, which is likely to result in problems due to code inconsistencies. Backward references to the source code are often needed to test or correct the converted code; however, the source code references are often lost during manual conversion. These issues may propagate into later stages of the project execution, specifically the factory acceptance test (FAT) and even into site commissioning. This makes the process costly and endangers successful project execution.

The solution developed by Siemens IC&E Group introduced software tools for WDPF control code automatic conversion of loops and text algorithm. This eliminated many drawbacks of manual conversion. Automatic conversion creates consistent code, free of human preference factors and typing errors. Migrated code is documented so that it maintains backward references to its source code. Parameter values are transferred from source code without errors. In places where parameters have to be adjusted, they are exactly calculated. Automatic code conversion process incorporates code optimization, reducing unnecessary load on the new system. Cleaner, consistent code makes commissioning and maintenance easier.

A parser reads input data from source files. It passes its result into a data analyzer that is responsible for functional data recognition. The result of analyses is a list of function blocks used, together with a detailed report on code structure. Formatted intermediate data is passed to the plan generator.

The plan generator takes the result of the data analyzer, combines it with pre-generated templates and creates the SPPA-T3000 plan files. Files are combined into one jar or zip archive file that can be directly imported into SPPA-T3000. The plan generator also provides a list of created plans.

The plan list can be edited and code from multiple plans can be merged together by plan list editing. The generator can be rerun with the plan list as additional input, resulting in code structure better corresponding to the controlled process.

The generator also combines code from text algorithms into plans with loops if there is a functional connection. This feature reduces the number of plans.

Signal scaling, which is common in most WDPF function blocks, is applied only when necessary. This approach eliminates unneeded function blocks, reducing controllers load and making logic plans cleaner.

Logic in T3000 plans is created with graphical objects. Clear graphical layout is important for easy code maintenance. This represented additional challenges for automated code conversion. Proper implementation of converter eliminates preferences of individual engineers. Manual adjustments are performed on converted code during tuning phase.

The use of these conversion tools by the project team enabled them to accomplish a large engineering feat in a reduced amount of time.

By using this automatic conversion tool, Siemens was able to migrate the WDPF codes and generate SPPA-T3000 logics on schedule. The new logic was checked by Carneys Point Plant engineers and Siemens engineers at the FAT and released for site implementation in time for the planned outage.

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Hardware Migration

A special connector developed by Siemens, the Ad-Con 4W, allows the direct connection between new input/output modules and the existing field wirings. In the migration process, the existing WDPF DPU's and Q-Crates are removed from the front of the cabinet, while the field termination half shells are untouched at the rear side of the cabinet. The Ad-Con 4W connector interfaces the existing WDPF card edge connectors from the half shells and mates them to the new Siemens S7 input and output modules.

Instead of taking days or even weeks to completely demolish the existing DCS field cables and install and commission the new cables, the Ad-Con 4W connector enables a much shorter turn around by leaving the field cable intact. By not disturbing the I&C cabinet's field termination, I&C loop checks during commissioning could be performed by checking at the cabinet terminals in most cases instead of having to test the loop from the field device. This new technology was essential to meet the 60-hour migration window.

Outage/Project Execution

A major opportunity that presented itself was the possibility to migrate the controls of Boiler 2 ahead of the 60-hour outage window. From the start of the outage for the refurbishment of Boiler 2 burner exhaust bag house, the Boiler 2 I&C cabinets were powered down. This presented an opportunity to perform the switch-over from previous DCS to SPPA-T3000 for Boiler 2 ahead of the critical outage window. This opportunity was the ultimate walkthrough for the 60-hour outage and allowed the team to take a learning approach to the demolition and installation. Although the Boiler 2 cabinet migration could have been accomplished in two days by a single crew, the time for this task was extended so that all members of the installation team could get hands-on experience. Concerning I&C loop checks, a complete checkout of Boiler 2 was performed by the commissioning team. As issues arose, they were not only corrected in Boiler 2 but also put into the 60-hour plan. Corrective actions were implemented on the remaining equipment.

At 7:20 a.m. April 22, 2009, the power to the WDPF cabinets in the BOP Spreader Room was powered-down for the last time and the 60-hour effort began. By the evening of the first day, all eight control cabinets in the BOP cabinet room were switched over to SPPA-T3000 and the critical loop checks for that area began. That night saw demolition and installation of the seven control cabinets of the Boiler 1 cabinet room. Back in the BOP cabinet room, 80 percent of the critical loop checks had been completed by 9 a.m. the second morning. By that afternoon, 95 percent of the checks were completed. Work continued on a 24-hour-a-day basis with day and night shifts of the project team.

By the afternoon on April 24, all critical input and output modules had been checked and the plant was ready to power-up equipment and bring systems back online. The first sets of equipment to come back up were the induced draft fans at 55 hours post Lock-Out Tag-Out.

The plant was back at full process steam capacity on schedule. The game was not over, however, with another boiler needing to be upgraded. In the following weeks the second boiler was brought back online and the steam turbine work was completed.

Six months after completing this migration project, the operators, EI&C technicians and management at Carneys Point Plant are pleased with the SPPA-T3000 controls system. With the many flexible and easy to use operational and engineering functions SPPA-T3000 offers, the ability to analyze process data in real time and troubleshoot extensively within the system first before sending technical experts to the field for physical trouble-shooting are two major benefits for the plant. Both features are able to realize significant cost savings for the plant.

Success at Carneys Point proves that a team can accomplish any complicated and ambitious goal as long as they have a unified goal and commitment. A power plant operator, a DCS vendor and subcontractors can become an integrated team and work toward common goals.

The newly installed SPPA-T3000 provides the reliability, flexibility and availability Carneys Points needed to fulfill its cogenerating contract as well as to stay competitive in today's energy market.