# Application Highlight

# 2500 Series®
# Programmable Automation Control System

## Smart Modernization Refresh Plan Provides Municipal Water Treatment Operator with Low-Risk, Low-Cost Plan to Ensure System Sustainability and Maintain Continuity of Operations


**Summary**

In order to future-proof its control systems and ensure preparedness for potential disasters, a Southeastern utility company and its engineering firm worked with CTI to create a phased Smart Modernization plan. The end result: a reliable, modern, fully supportable control system for a fraction of the cost, risk or downtime as any other alternative.


As part of a disaster preparedness project, a public utility in the Southeastern United States engaged an engineering firm to help it prepare for potential disasters and modernize its control systems to ensure continuity of operations. The utility operates three water treatment plants that use a mix of Siemens/TI Simatic 505® and CTI 2500 Series® hardware.

In the engineering firm's initial evaluation of the system, one migration option was to the Siemens S7 platform to "futureproof" the system and ensure that it remained supportable. This seemed to be an obvious and viable option as a significant portion of the current hardware was of the same brand. However, the engineering firm determined that there was not an easy and seamless migration path from the existing hardware and software to S7 after all, and that the cost to replace hardware, rewire, and rewrite programs was outside the budget parameters for the utility. Since the existing hardware also included a wide range of CTI components, the engineering firm turned to CTI to explore possible options.

Because of CTI's line of 100% compatible products, including new and continually upgraded CPUs, I/O, power supplies, and communications products (including with master EtherNet/IP capability and IEC 61131 programmability) as well as CTI's next-generation Janus PAC, the firm invited CTI to join their next meeting with the utility company to discuss possible solutions both for system modernization as well as for disaster preparedness.

CTI proposed conducting a system sustainability assessment to determine where the utility's control systems were most vulnerable to age-related or other failures, most at risk of technological obsolescence and to identify where the utility's current and future needs were not currently being met. Based on the results of the assessment, CTI planned to create a phased Smart Modernization plan, almost a system modernization road map, that would help the utility prioritize upgrades based on their goals and the criticality of failure of the various system components.

The utility accepted the proposal. They also asked CTI to create a list of recommended spares and to provide a proposal for the retrieval and back-up of all programming and applications that were currently in-use on their existing Siemens/CTI processors.

*Figure 1: Wastewater treatment plant*

## System Sustainability Assessment

After conducting the audit of the PLC systems in the three plants in question on June 1, 2019, CTI and the engineering firm met with the utility to discuss their goals, needs, plant SCADA requirements and possible modernization scenarios. CTI then reviewed the results of the audit to identify and prioritize "at-risk" components based on the following criteria:

- Types and ages of installed products to assess obsolescence and "wear-out" risks
- Likely failure scenarios, including magnitude of impact should failure occur, of the products with identified risks
- Whether options for eliminating or mitigating the identified risks exist, including whether a direct replacement product exists and whether engineering/ electrical work would be required to replace the product

The resulting "System Sustainability Assessment Report and Smart Modernization Plan" detailed CTI's findings and recommended plan of action.

## System Sustainability Assessment Results

The system sustainability assessment uncovered a variety of problems that the utility had been experiencing. Problems that had been reported in the previous year included:

- Occasional I/O module failures
- Failure of system to restart properly after power-down
- Unexplained fatal errors on CPUs

The utility also expressed concern about the viability of existing program backups and the unknown status of module spares.

System improvements and new features the utility was hoping to see with any new investment in its control systems included:

- Faster response on HMI and SCADA
- Better resolution on analog inputs
- Ability to communicate with variable speed drives using EtherNet/IP

## Individual Component Review and Smart Modernization Plan

CTI reviewed all of the individual components of the three control systems and prioritized them from most urgent to least urgent. In its Smart Modernization Plan for the utility, CTI proposed segmenting the modernization effort into phases to minimize risk and the impact on budget.

Critical/Urgent Priority: 505-6660 Power Supplies

For the utility, the most urgent "at-risk" components were the twelve Siemens 505-6660 power supplies that were at least 16 years old and possibly much older. Power supplies use electrolytic capacitors with a rough life expectancy of 10 years for energy storage and filtering. Given that a failure in a power supply will take down an entire base, or if it is in the CPU base, the entire system, these units were in desperate need of replacement.

With an easy replacement option of the CTI 2512 power supply (during a shutdown), CTI recommended that the utility replace these power supplies in Phase I of their Smart Modernization.

To learn more about the life expectancy of power supplies, please see our Tech Tip: http://controltechnology.com/Files/common-documents/tech-tips/power/Power-Supply-Tech-Tip

High Priority: 505 Series Relay modules (505-4908, 505-4916, 505-4932)

Again, because of their age and their use of electrolytic capacitors that degrade over time, relay modules were identified as a high priority to replace. In addition to the recurring electrolytic capacitor issue that affects them, relay modules are also, importantly, a wear item, so CTI recommends replacement of these modules when any relay on the module reaches 250,000 cycles. Symptoms of failure include failure of outputs to turn on or turn off. These symptoms might be intermittent in the beginning but will likely increase over time.

With no wiring changes required, these relays are also easy to replace during a shutdown with fully compatible CTI replacements (2534, 2532, and 2531, respectively). CTI suggested that the utility replace these modules in Phase 2.

Medium Priority: Siemens/TI CPUs (545-1101/545-1106)

CPUs use electrolytic capacitors in their internal power supplies and include complex semiconductors (microprocessors, gate arrays, and memory components) which are more susceptible to accumulated damage from thermal and electrical stress. All 505 Series CPUs carrying the Texas Instruments or Siemens logos are in excess of 16 years old.

Failure in a CPU will take down the entire system and is usually critical. While CPUs usually "go dark" when a critical component onboard fails, it is not unusual to have "degradation" related failures which normally show up as repeated Fatal Errors because of problems in memory chips of the microprocessor. Communications ports are another frequent failure item due to accumulated damage from electrical and ESF transients coming in on attached communication cables.

CTI's 2500 Series CPUs are a direct replacement for the utility's aging CPUs and have the advantage of better performance, more memory for programs, a built-in Ethernet port, and support for new instructions not available on Siemens/TI 505 processors. Because a program reload is required when replacing a CPU during shutdown, CTI recommended that the utility backup the existing program(s) before replacing these older CPUs in Phase 3 of its Smart Modernization Plan.

Medium Priority: Remote Base Controllers (505-6851-A)

Remote Base Controllers also use electrolytic capacitors in the internal power supplies, and three out of four of the utility's RBCs were Siemens RBCs, making them sixteen years old or older. Because a failure in an RBC will cause an entire base to stop operating, it is usually a critical failure. RBC failures are usually "hard failures," i.e., they completely stop working or stop communicating with the CPU because of an I/O port failure. It is unusual, but not impossible, to have a degradation or intermittent failure.

*Figure 2: CTI 2500 Series® 16-slot rack*

The Siemens RBCs are easily replaced with the CTI 2500-RIO-B RBC, and because only the affected base needs to be shut down to replace the old module, it is often possible to replace an RBC in a running system.

CTI recommended replacing the three Siemens RBCs in Phase 3 of the Modernization Plan.

Medium-Low Priority: Analog I/O Modules (505-6108, 505-6108-A, 505-6208, 505-6208-B, 505-2555)

All of these analog modules utilize electrolytic capacitors in the internal power supplies putting their continued worry-free operation in doubt. As the capacitors degrade, they will no longer provide adequate filtering, resulting in both continuous and intermittent errors in the analog readings. Additionally, some kinds of failures in the analog chips on the module will cause similar errors.

CTI recommended replacing these modules with their CTI equivalent modules in Phase 4 of the Modernization Plan.

Low Priority: Digital I/O Modules (505-4216, 505-4232-A, 505-4332, 505-4532, 505-4632, and 505-4816)

These digital I/O modules use electrolytic capacitors in their internal power supplies and as these models are often switching high voltages and currents, transients and ESD can cause accumulating damage to the semiconductors over time. These digital I/O modules normally fail in a "hard" manner (the channel stops working completely), but it is not unusual for the remaining channels to continue working normally.

CTI recommended replacing these older modules with CTI equivalents during Phase 5 of the Smart Modernization Plan.

## Recommended Spares and Program Back-ups

In addition to the System Sustainability Assessment and Smart Modernization Plan, CTI also provided a list of recommended minimum spare hardware and a quote to have CTI engineers visit all three water treatment plants to back up copies of all programs on the existing Siemens/TI and CTI processors.

The entire process from initial audit to report and proposal delivery was less than two weeks.

## The Results: A Smart Control System Refresh

After reviewing CTI's findings and recommendations, utility plant managers had a better understanding of the reasons for the problems they had been seeing and felt comfortable with CTI's proposed path forward to ensure ongoing system performance. They were pleased to discover that they did not need to replace their entire control system in order to achieve improved performance and the system reliability essential for a mission-critical public utility. Instead, with minimal downtime, no rewiring or reprogramming, minimal risk and low cost, they could "refresh" and modernize their control systems by simply swapping out aging modules for their brand new, updated CTI replacements.

The utility asked CTI to immediately retrieve and back up all of its programs currently in use in its plants. A controls technician attended one of CTI's programming training classes at CTI's headquarters in Knoxville, TN, and management determined the timing and budgeting of the phases proposed in the Smart Modernization plan.

The customer decided to implement Phase 1 and Phase 2 immediately, purchasing CTI 2500 Series® power supplies and relay modules to replace the aging Siemens/TI modules, including the recommended spares that corresponded with the products being replaced in each phase. The utility has included Phases 3, 4 and 5 in the budget for late 2020-early 2021 and hopes to install shortly after purchasing these items. They also plan to begin using CTI's new Janus PAC as soon as it is available (see "Sneak Peek" below) for new projects and applications.

In summary, the customer was pleased to be able to "future-proof" its control system, including ensuring its readiness in event of a disaster, and end up with a like-new control system with updated technology, performance and capabilities at a fraction of the cost — and significantly less risk — of purchasing and installing an entirely new system.

**At CTI, that's what we call Smart Modernization™.**


### SNEAK PEEK

CTI's break-through line of Programmable Automation Controllers look both to the future with state-of-the-art programming, protocols and capabilities as well as to the past to work seamlessly with existing Siemens/TI 505 and CTI 2500 Series systems.

### Introducing the CTI 2500 Series® Janus PAC™

- Up to 10x execution speed compared to current 2500 Series CPUs
- FOUR Ethernet ports with extensive built-in communications capabilities, including Modbus Ethernet, CAMP, MQTT to access the IIoT, and EtherNet/IP
- Programming in CTI's Janus Workbench Software which includes all IEC 61131 languages (SFC, FBD, LD, ST and IL)

**Available in 2Q 2020— Ask for a demo today!**



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