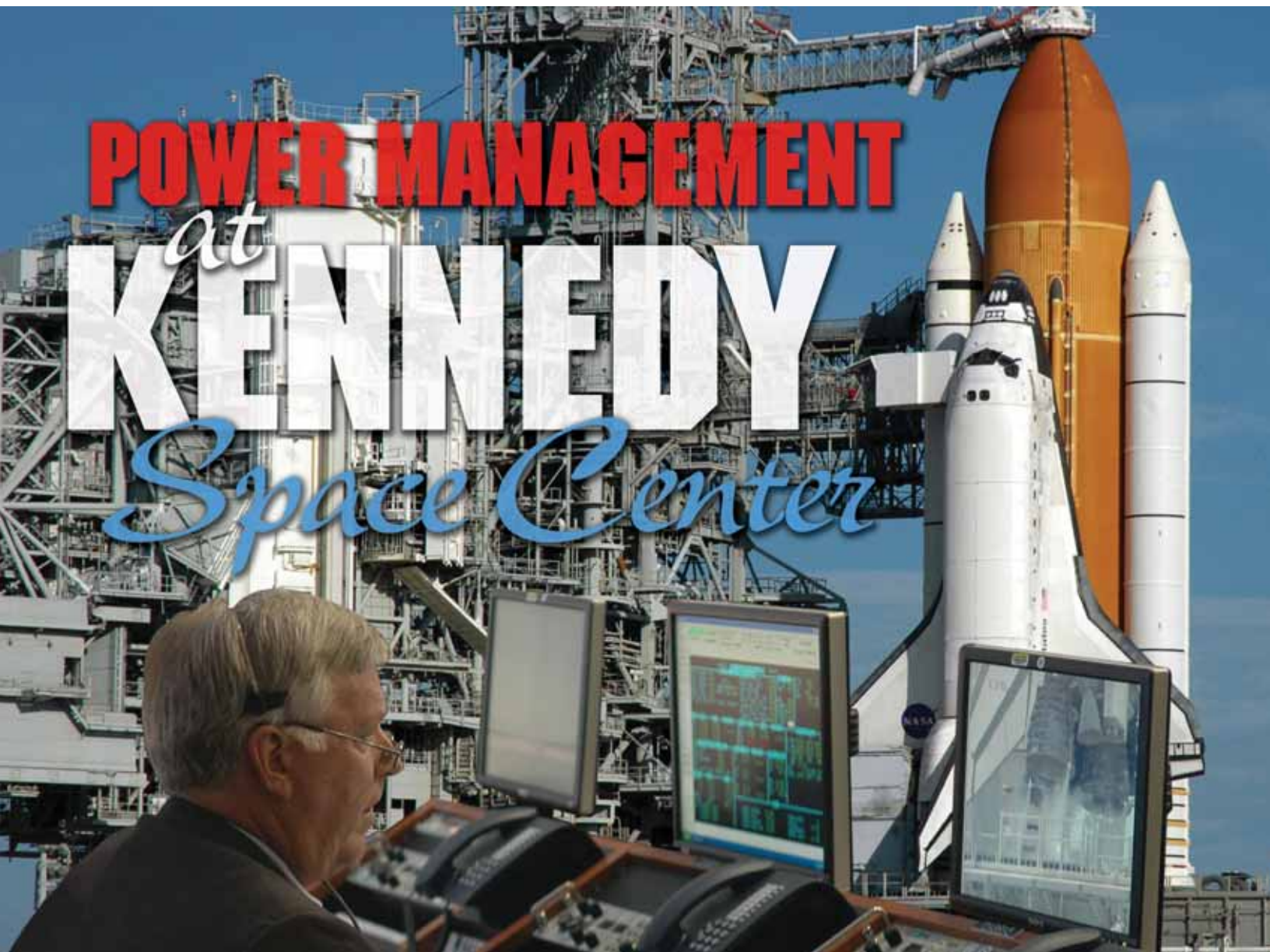


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# POWER MONITORING HELPS NASA REACH LOFTY ENERGY GOALS

Space agency does part in this era's national challenge

BY JIM TAUFER

For NASA and its Kennedy Space Center (KSC) the value of having a robust system to monitor its power events and consumption wasn't enough. The greater value came in implementing a system that could be integrated into a base-wide supervisory control and data acquisition system (SCADA), allowing for more advanced monitoring and opening the door for uses that go well beyond simply power.

The Kennedy Space Center (KSC) covers over 140,000 total acres of land, 55% of which are dedicated to space shuttle operations, with more than 200 facilities of varying sizes and missions. The facilities are subdivided by user programs which drives the need for allocation of energy costs and consumption metrics.

The facility's northernmost controller is 10 miles away from its southernmost location. One of the challenges of occupying such a large campus has been the difficulty of collecting data from geographically dispersed facilities.

The progression of the KSC metering system began in 1995. This original system was installed to enable electricity to be charged directly to accountable programs as well as to track progress toward federally mandated energy reduction goals both on a per facility basis as well as by program. The original Square D PowerLogic system comprised 60 meters communicating over long Modbus serial chains to a PowerLogic System Manager Software (SMS) workstation.



Power management at the KSC enables facility personnel to manage energy costs and track flows.

*A base-wide (SCADA) . . . opening the door for uses that go well beyond simply power.*

In 1997, the system underwent a major upgrade that included Ethernet connectivity. In addition to improving the overall reliability of the network and the metering components, the upgrade also helped KSC to use the system for power system operations-

related work. For example, it allowed KSC staff to more accurately size new backup generators because it provided an accurate understanding of typical and maximum loads within particular areas.

"Some of the initial usage would be where we had a facility outage and we needed to size a backup generator," said Dr. Chris Iannello, KSC Shuttle Program energy manager and power systems engineer, of the 1997 upgrade. "Rather than shotgun it, now people were realizing they could go and get the trended data on what the real generator size should be."

## KCCS IS BORN

In 2000, the metering system merged with the newly developed KSC Citect SCADA system known as the Kennedy Complex Control System or KCCS. With it, power meters replaced other discrete field relays and functions, and a control element was introduced to the power monitoring system, via Modbus/TCP.

“The power meters could now serve multiple functions,” Iannello said. “They’re not just energy monitoring and billing. They’re now something more akin to a combined fault recorder, an under-voltage sensor relay, these types of functions. Kennedy uses the system as much or more for non-energy related issues. The beauty of that is the system gets maintained because the O&M (operations and maintenance) group uses these meters in a variety of ways unrelated to energy. That keeps them interested in maintaining the data and the meters and understanding how to use them.”

In addition to power monitoring, KCCS monitors and controls water, HVAC, and pneumatics throughout the base. With the installation of hundreds of networkable devices, overall system functions were greatly expanded from the previous control system.

“We saw rapid growth of the SCADA system largely because we made sure that all new components were compatible with the integrated system by writing this requirement into our boilerplate specifications for construction projects,” Iannello said. “Any other devices had to use Modbus/TCP as their open protocol. Once we did that, as projects popped up, even projects that we weren’t actively tracking had a standard hardware set that could be plugged easily into our system.”

The power component of the KCCS system includes three redundant I/O server sets as well as other trending and alarming functions. It includes display nodes at multiple KSC locations. Other key features of KCCS include:

- 1,200 communicable devices including PLC, Power Meters, Trip Units, UPS and a small subset of other hardware
- 200 concurrent TCP-IP connections
- 60,000 data points
- Trended tags at frequencies from 1/second
- Alarm scan rates as low as 100 millisecond (ms)

In addition to the Citect SCADA system,

the PowerLogic SMS software is also maintained as an engineering tool.

Iannello noted that being able to program the Citect software to extract information from the Square D meters in a manner similar to the vendor’s SMS software was a major benefit in the process. Support from the power monitoring system’s manufacturer proved essential in integrating the two systems.

“One great thing about our relationship with Square D, unlike a lot of the other manufacturers we spoke with, is we were able to work closely with their technical support team,” Iannello said. “They were able to give us the information we needed to program the Citect software with the ability to extract the information from and control those meters the way SMS software does with regard to certain features. For example, it allowed us to configure, through the Citect system, any of hundreds of alarms that a meter affords you.”

## MEASURE AND MANAGE

With its metering system, the KSC is able to use the data collected to focus its energy management efforts and identify adverse trends to reduce costs as well as justify funding to support additional energy conservation measures.

Metering also allows the KSC to reclaim tenant energy costs, such as from the tour-

ist attractions and other commercial activities on the KSC’s campus. Additionally, the metering data provides KSC management with traceable energy metrics for on-site performance based contractors.

With trending in place, utility expenditures became an accountable program. Of particular importance are the metering and distribution of costs surrounding the shuttle launches. On an annual consumption basis, the entire KSC accounts for 250,000 megawatt-hours (MWh). The shuttle itself accounts for 155,000 MWh.

“Prior to the metering, there was really no cost accountability for electrical consumption,” said Iannello. “Once metering began, we saw much more of a focus on electrical consumption at budget reviews.”

For example, after several energy conservation measures had been put in place, metering data revealed that those changes had a significant impact on utility expenditures. Through power monitoring data, KSC was able to show a reduction of nearly 70,000 kilowatt-hours (kWh) in consumption when comparing 2005 usage to 1994. That reduced usage represented a total saving of approximately \$6 million in utility bills for 2005 as compared to what we would have spent with out energy management.



Square D equipment provided tracking and monitoring functionality but also load control the starts generators and drops low priority demand.

Once these data were presented at budget reviews, energy savings data collected as early as 1998 became the catalyst for more than \$10 million in additional energy saving initiatives implemented between 1998 to the present.

The useful applications of the KSC power monitoring system have been numerous and varied. In nearly all instances, the system provides operators with the data to save on time and money and make more informed decisions about the overall operations.

### **PRIORITIZED LOAD SHEDDING**

KSC is currently developing a system for energy load control, which would prioritize loads within a specific area during utility power outages. The area known as Launch Control 39 demands 18-20 megawatts (MW) for normal operations. It also has emergency generators that produce 10 MW, leaving the area vulnerable during an extended utility outage. In order to make good use of the available power, operators needed to find a system for prioritizing and maintaining the most important 10 megawatts and shut down the remainder.

In response, the KSC power systems group is developing an emergency load control procedure that will be implemented through KCCS. When activated, an algorithm will shut down loads in phases, and in priority. In the event of a power outage the KCCS will progressively advance load shed phases until the load reduction goal is met. The algorithm could be activated by Florida Power & Light (FPL), the local utility, or manually by KSC staff, which would begin the process of shedding non-essential loads.

“The problem was that we hadn’t done a good job over the years of isolating those non-essential loads, and it’s really difficult to split this stuff out,” Iannello said. “The beauty is the power controls are on the same network as the power meters that read the demand, so we’re able to get very surgical in what we remove or shut off.”

The result is a load control process where generators start up and the least critical load will be automatically shut down in a phased response to an emergency utility condition.

As part of the initial planning and testing of the system, air handlers are among



NASA's cost and operations benefit from an overall load control plan.

*Prior to metering, there was really no cost accountability for electrical consumption. Once metering began, we saw much more of a focus on consumption at budget reviews.*

the first loads to be secured during the shut down process. KSC also utilizes a Square D Powerlink lighting control system, which shuts off non-essential lights within the facility at the branch circuit level. As part of this planning process, energy managers reviewed the facility’s design drawings and identified areas that had access to ambient lighting. During a daytime power emergency, those lights would be automatically turned off through the KCCS system.

While the phased load reduction program is still being developed, KSC plans to imple-

ment it during emergency utility conditions or upon request by FPL, as part of NASA’s participation in the utility’s Commercial Industrial Load Control (CILC) program. As part of that program, FPL offers reduced billing rates to facilities that volunteer controllable load during periods of peak electrical demand.

Iannello anticipates that by developing a system that will prepare KSC to be self-sufficient in the event of a utility outage and by participating in the CILC program, KSC will receive, initially, an additional \$60,000 annually in savings directly from FPL and this number will rise each year as more loads are added.

### **GENERATOR SOFT START**

In another example, KSC sought to install soft start drives on two 2000-horsepower (hp) motors that support chillers for the north end of the space center. Conventional wisdom indicated that motors of this size and type could not be soft started and hence could not be brought up from a generator set. This created a significant problem in the event of an outage, because the space center Launch Processing System needed cooling to run. The chillers were a critical function to continue even minimal operations during an outage.

# POWER MONITORING HELPS NASA REACH DOFTY ENERGY GOALS



NASA's attention to on the ground details helps the agency meet its energy cost control goals as part of its overall mission.

*We've seen exponential growth of the SCADA system because we made sure all the new components were equipped to integrate into this singular system.*

The concerns were twofold. First, that a soft start from generator power would not be possible. Second, even if it were possible, that severe harmonic distortion caused by the solid-state soft start drives would proliferate across the network and cause other devices to fail. Iannello turned to the power monitoring system for the data to address both concerns.

Operators ran detailed tests through the power monitoring system using a 100-ms capture log available on the meters already installed at the serving substation. They monitored the soft start of one and then two 2000-

hp motors, and after some adjusting they were able to establish that the soft start could be accomplished using generator power.

"People will say you can't do it, and they'll throw out a reason why," Iannello said. "In our environment, where safety is paramount, those kind of concerns get a lot of attention. If we didn't have the data to justify our position, I don't think we'd be able to do a lot in way of change."

The second issue related to harmonic distortion and the impact it would have on other equipment was also addressed through the power monitoring data.

"We had experience with this and felt confident that it wouldn't cause significant distortion, but we needed proof," Iannello said. "So during the test, we captured a waveform through the SMS program, and we were able to see less than 2% distortion. That's the kind of irrefutable data you need to alleviate concerns within the organization."

## EVENT LOGGING

In another example, a downstream molded case circuit breaker supporting a launch pad tripped during a launch event. Before the

implementation of the power monitoring system, engineers would need to wait to diagnose the problem because they wouldn't have immediate access to the secure launch site.

A contactor on the breaker indicated it had tripped, but to determine why, KSC staff were able to pull an event log from their Citect SCADA system, and see that the current swelled from 300 to 2000 A, indicating that a fault had tripped the breaker. The problem was diagnosed before an engineer would ever have access to the launch pad equipment.

"In this instance it was a molded-case circuit breaker, but if it was a controllable breaker, and we needed to close it, knowing if it was tripped or if it opened because of mechanical jostling is an important thing to have access to remotely. That's a major benefit that we didn't have in the old system."

## CONCLUSIONS

Iannello lists among the major lessons learned in the process the importance of synergizing the power monitoring system with the control monitoring system used by the operations and maintenance group. By combining both systems, KSC saw better utilization, understanding and attention to maintenance and repair of both systems. As part of the synergization process, Iannello said establishing a standardized hardware set that uses an open Ethernet-based protocol was critical to bringing both systems on line as they continued to grow.

"Over the last few years this system has expanded into something much larger," Iannello said. "We've seen exponential growth of the SCADA system because we made sure all the new components were equipped to integrate into this singular system. That has made all the difference in getting the greatest value out of both systems." *e&pm*

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**About the Author:** Jim Taufer is a Senior Sales Executive for Schneider Electric's Power Management Operations, an organization focused on providing enterprise energy reduction and reliability solutions. In his role, he assists Schneider Electric's customers with the design, cost justification and implementation of power management and control systems.

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