Lawrence Lebeau President American Control Technologies, Ltd. demonstrates the operation of the Modicon Quantum and Modicon Momentum Wireless interface at the Readville, MA layover station

AMTRAK AUTOMATES POWER CONTROL TO REDUCE ERRORS, BOOST SAFETY IN RAIL YARD

MODICON PLCs link Boston layover station with regional office

SOMERVILLE, Mass. – April 2001 – Amtrak has deployed an automated power monitoring and control system that's slashing costs by protecting maintenance employees and electrical equipment at a Massachusetts Bay Transit Authority layover yard. American Control Technologies (ACT) Ltd designed and integrated this novel system that combines programmable logic controllers (PLCs) and power meters from Schneider Electric with Metricom's radio frequency technology. Because it improves the safety of the most dangerous railroad operation, it will likely be replicated at more MBTA yards throughout the Boston area.

Besides providing inter-city rail service in 45 states, Amtrak is the nation's largest provider of commuter service for state and regional authorities. Its contract to support the Boston-based MBTA includes responsibilities for tracking the status of all power and signal equipment to minimize downtime. To fulfill that role while controlling costs, Amtrak's New England Central Engineering department replaced its manual power monitoring system.

The automated system was implemented at the MBTA's Readville Yard, where trains park at 11 docking stations for overnight cleaning and servicing within a residential neighborhood. To minimize noise and protect air quality, Amtrak shuts off the trains' diesel engines and generators. However, during layovers, train lights and air conditioning must remain on in order for maintenance personnel to work and to avoid coolant freeze-ups. Therefore, Amtrak transitions to 480-volt electrical utility power for servicing while trains are docked.

Changing from on-board power to yard power requires three steps. First, maintenance personnel lead a power cord through the docked train to ensure that all cars coupled to the engine are wired together. The train loop line is a two-pin, two-wire connection supplied with 120 volts AC within the power cord. Second, before making the utility hookup, the worker turns off the train's generator. Finally, the worker connects the power cord to the train. Hooking up the power cord without turning off the generator – a mistake that occurred often – disables the tracks' high-power utility contactors.

Although the changeover procedure is fairly straightforward, Amtrak intermittently suffered contactor blowouts due to human error during transition. Each blown contactor costs Amtrak $2,300 and required the engineering department to dispatch a service crew from its regional office in Somerville, a 1 hour drive away from the main layover yard.

The problem was aggravated because the regional office's manual monitoring system could provide no detailed, timely information on power status or failure alarms from the layover facility. MBTA's 13 other layover yards located from western Massachusetts into New Hampshire and Rhode Island also operate under the same limitations.

"We tried a solution that involved using lower cost voltage detection relays to take the over-voltage," said John Flanagan, Amtrak's regional chief electrical engineer. "Using the relays, we could spare the generator. But troubleshooting was still a costly problem because we had to replace the blown relays. If the fault was caused by 480 volts on the 120-volt loop lines, maintenance people would have to go through the train car-by-car until they found the voltage cross-connection. They'd be blowing out relays with each attempt to restore power."

Flanagan found a solution in an ACT designed automation system that uses MODICON MOMENTUMÒ processor adapters on each track for sequencing when trains are docking. The processors read line and over-voltage digital status signals from contacts and ground fault current monitoring switch inputs. Each processor is connected to a local area network supervised by a central MODICON QUANTUMÒ PLC. The PLC reads the alarm status of each processor and the track voltage and current values from
SQUARE D EnerceptÒ power meters.

Lawrence Lebeau, president of ACT – the firm that integrated the link capability into the system – selected the specific system components based on what Flanagan said he wanted to achieve. "I chose the QUANTUM as the master because it provides a large amount of processing power and expandability for the future. The MOMENTUM was right for this application because it offers multiple communication ports and uses Modbus protocol, which is the most universal."

The new system leads the yard maintenance personnel through a simple sequence cued by indicator lights at each step. The processors enforce the proper plug-in progressions and turn on the indicator lights as each step is completed.

"First, the maintenance person turns on the key switch beginning the sequence," Flanagan said. "Then, he plugs the power cord into the train. If the train loop can be completed, a green light reading 'Loop Made' turns on and the sequence continues. But if there are 480 volts on the loop, or if the on-board generator is still running, red lights indicating '480V on Loop' or 'Generator Alarm' are activated. These alarms prevent the PLC from closing the utility 480-volt contactor until the problems are cleared, which eliminates the need to sacrifice relays.

"If the loop is satisfactory, the PLC moves to the next step and lights a green 'System Timing' lamp and waits a timed interval before permitting the contactor to be turned on," Flanagan continued. "Each track's processor uses a different time delay to avoid a large demand surge if several trains are plugged in at the same time."

In the next step of the sequence, the processor turns on the utility contactor. If the contactor closes, the processor turns on the 480-volt power. It then checks for ground faults on the track feed. While the contactor is on, the processor continues to watch for faults.

“The sequence is controlled by yard maintenance personnel but executed by the PLC,” Flanagan said. “The new system reduces human error and increases the safety of the maintenance people.”

Amtrak uses Metricom’s 900 MHz spread spectrum radio frequency technology to send the data to its regional engineering office. The yard’s 80 KVA Uninterruptible Power Supply system, which powers the computer network, is connected to a digital spread-spectrum radio link. Spread-spectrum radio signals resist jamming and allow users to share a frequency band with conventional microwave radio users – without one group interfering with the other.

“The combined data captured by the yard’s central PLC is then transmitted through the link to another QUANTUM PLC at the engineering office in Somerville,” said Richard Zapolin, the project’s lead engineer for ACT. “The remote information from the yard is displayed on a computer workstation, where operators can monitor, evaluate and respond to situations in the layover yard.”

In responding to an electrical failure in the yard, Flanagan now has diagnostic information he previously lacked. “The new system tells me exactly what is wrong,” he said. “I’ll know whether a circuit breaker tripped or the main tripped or if a ground fault interrupter went out – before I dispatch workers. It also lets me go in and override those things so that we can reset the sequence.”

Flanagan is preparing a proposal that MBTA replicate the system at 13 other layover stations as well as at the terminus points of various commuter lines. He’d also like to install MOMENTUMs to monitor status of 260 sets of switch heaters. Switch heaters are attached to 12-volt motors located at switch points along railroad tracks. The switches allow rails to disconnect from one line and connect to an adjacent one. The heaters produce up to 10 kW to melt ice and snow so the switches don’t freeze.

Flanagan would like to go even further with the wireless system by applying it to controlling the lights at 160 passenger stations. In such an application, current sensors on lighting circuits would be wired through a PLC and convey data via radio link to the regional office. Automating power control at other stations would allow Amtrak to multiply the system’s two major benefits – reduced costs and enhanced safety.

“Automating is great for the budget,” Flanagan said. “Relays and fuses cost about $25 per hit. Add $50-$60 in labor costs for each repair. Multiply that by about 50 hits per station each year at 11 docking stations. These costs add up.

“It also improves safety by not exposing maintenance people to hazards that couldn’t be checked by the old method, plus the safety considerations of having repair people doing less driving from station to station. Layovers are the most dangerous railroad operation. They should be prime candidates for this type of automated control system to minimize their risk.”