From port to plant: Developing an automated control system for a new biomass fuel handling project

Industry:
Electric Power

Location:
North East England

Challenges:

- Multiple vendors and bespoke equipment designed by others
- System communications unproven in this environment
- Changes to schedule
- Integration to Wharf Hopper Control Systems; Siemens S7/300 PLCs [provided by subcontractor for port]
- Integration to Storage Silo Vibrafloor Systems; Allen Bradley CompactLogix PLCs [provided by subcontractor for client].
- Operators not onsite during implementation, so specific training needed

Solutions:

- Rockwell ControlLogix PLC
- Wonderware InTouch 2014 R2 for SCADA
- Allen Bradley GuardLogix (L73S and L72S) CPUs
- Allen Bradley ControlLogix L71 CPU
- Delta Motion RMC150E controller

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Background

A power generating facility in North East England requires sustainable, low-carbon biomass for its electricity production. From a Biomass Fuel Handling System (BFHS) facility constructed at a port site, the fuel is unloaded from ships onto conveyors and then deposited into one of three storage silos using a movable chute. From the silos, fuel is decanted at a controlled rate and then taken by conveyor to a rail-loading silo for eventual shipment by train to the power station. When necessary, the fuel can be transferred directly from the ship to the rail-loading system.

Our Actemium Automation Yorkshire team in Huddersfield was brought in to automate the control system for the biomass transfer and storage processes. The control system needed to assist operators with ensuring target load figures were met, while also monitoring moisture content and weight of the material, CO2 levels and thermal temperature safety levels within the silos, and condition monitoring, spark Suppression and fire prevention systems on each conveyor. This was a multi-million-pound construction project involving hundreds of contractors and many thousands of man

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Processes implemented in control system:

- Vessel unloading
- Material sampling/weighing
- Screening/removal of oversize material and metal (both ferrous and non-ferrous, including stainless steel),
- Conveying to silos
- Silo monitoring
- Silos reclaim
- Dust extraction
- Fire and explosion detection and protection
- Modifications to existing rail system
- Conveying to rail loading facilities
- Rail wagon loading/weighing facilities

System quantification:

Total IO on system

- 961 x conventional IO signals
- 791 x safety IO (high integrity) signals
- >3000 x Fieldbus (soft) signals
- 558 x Rockwell CiP connections
- 286 x Rockwell TCP signals

Total MCC load schedule counts

- 117 x DOL
- 10 x DOLRs
- 26 x SoftStart
- 24 x VFDs
- 40 x MCCB/FSWs

Challenges

Integrating the work of multiple vendors and bespoke equipment being designed outside of our control proved to be the biggest challenges we faced when designing the main control scheme. Some of the system communications being used were proprietary and unproven in the environment in which we were working. For example, a vendor of a fire alarm system had never interfaced with a PLC before. As a team, we had to be extremely fluid in accepting and adapting to design and project changes that were beyond our area of responsibility, such as major components that were not fit for purpose or had been incorrectly sized, or when the construction phase and budget overran initial targets.

As this was a new installation, site operators were not present during the extensive commissioning phases, and we were tasked with delivering a comprehensive training package.

Solution

Our Actemium Automations Yorkshire team developed, tested and commissioned a PLC-based site-wide Control System to principally control, monitor and record the movement of biomass pellets from the quayside to storage silos and ultimately to the rail-loading facility.

The process uses a Rockwell ControlLogix Safety PLC platform/Wonderware SCADA control system operated from a dedicated control room at the port with minimal manual intervention. The system (with built-in redundancy) is linked in real time to the power station to allow personnel there to track the transportation and storage of the biomass pellets as well as monitor the operation of the plant at the port. Industry standardised OPC communication protocol was used for this purpose.

PLC Control Hardware

To align with two Rockwell IntelliCenter Motor Control Centres (MCC), the Control System functions were split between two safety-orientated PLCs. One is dedicated to unloading into the storage silos at the port and the other controls the discharge from the silos to the rail-loading facility. The split was necessary to allow for the sheer quantity of Remote I/O, Fieldbus I/O and CiP connections associated with the volume of MCC equipment on the system.

Both SIL-rated PLCs consist of Allen Bradley GuardLogix (L73S and L72S) CPUs complete with a Safety Partner module to conduct safety-orientated high-integrity tasks (i.e., machine guarding, E-stop and Pull Cord functions). Dedicated modules facilitated numerous vendor communications protocols.

A separate controller (comprised of an Allen Bradley ControlLogix L71 CPU in unison with a Delta Motion RMC150E controller) was used for the rail loading silo discharge and loading of the biomass material into rail cars. The rail loading PLCs do not handle any safety-related functions, but do interface with the main safety PLCs and MCCs via the plant-wide PLC RIO and MCC Ring networks

SCADA System Overview

Wonderware InTouch 2014 R2 was used for the SCADA system, and is comprised of two IO servers supporting 11 clients. Three of these clients are desktop machines, with two machines located in the control room, one in the rail-loading area. The remaining eight are panel-mount touchscreen-type machines designed to provide local-level control and visualisation at key locations around the plant.

The two SCADA servers operate in redundancy mode; if one server fails, the remaining one can maintain full plant operating functionality. Each of the servers communicate directly with the PLCs and serves this data to the clients.

Common communication protocols used by Control System:

- BacNET interface (ProTec fire alarm monitoring)
- Modbus TCP/IP interface to existing PLCs – 2x Siemens S7/315 (Wharf Hoppers)
- Modbus TCP/IP interface to proprietary Monitran controllers (condition monitors) and 2-off dedicated UPS Controllers
- Ethernet TCP/IP (producer and consumer) data exchange between main Control System PLCs and interface to 6x CompactLogix L30ER PLCs – Vibrafloor controllers
- CiP/TCP protocol with Rockwell Automation IntelliCenter MCC devices: E300 Overload Relays {DOLs}/ SMC Flex SoftStart/PowerFlex VFDs
- Ethernet TCP/IP interfaces to encoder and sampling systems [RFiD Reader] and to Delta Motion controller (rail loading chute)
- Modbus Serial (RS485 Slave) connections for silo temperature string and Crowcon gas detectors

We also provided a dedicated engineering station to facilitate testing and modifying the PLC and SCADA software without disrupting the plant operators.

In addition, we provided a historian and product tracking database/webserver system. Both the engineering station and the Historian/Tracking PC are rack mounted and located in the site server cabinet along with the SCADA servers.

KVM extenders and an associated matrix switch was provided for control and visualization of the Servers, engineering Station and Historian/Tracking PC from a single terminal. The matrix switch uses keyboard shortcuts to easily switch between these machines.

Results

The system fully meets the needs and expectations of the client. It can deliver a maximum flowrate of 850 tonnes/hour. Flow from the operator-selected silo to the rail-loading silo is available in two streams controlled by motorised discharge gates. The load of fuel on the conveyors is monitored by weight, and the gates are automatically controlled to achieve the target figure. If needed, additional streams from another silo can be enabled to bring the mass up to target, with dual conveyor streams between the storage silos and the rail loading silo facilitating this.

The control system constantly monitors all plant items, displaying status and availability on a SCADA system. The condition of the stored material within the silos is monitored with gas detectors, thermal imaging and temperature probes. Operators can select routes for fuel storage and delivery and monitor fuel transfer status, including plant warnings and alarms.