APPLICATION PAPER

Wireless Control Update Continues Efficiency Goals for USS-POSCO

Mike Denholm
Systems Engineer
Rockwell Automation – USS Posco

Eric P. Marske
Customer Service Engineer
Electronic Systems Technology, Inc.

USS-POSCO, the world's most technologically advanced steel finishing plant, continues to increase production efficiency by recently updating their wireless control system. A model for material handling and production efficiency, USS Posco provides 4,400 tons of finished steel products daily to 250 trucks and 12 railcars through an elaborate system of conveyors, automatic Coil Transport Vehicles (CTV), and overhead cranes. The entire transport operation is monitored and controlled by Allen-Bradley PLCs linked through a wireless network. A recent update of their radio network with state-of-the-art ESTeem Model 192 series wireless modems has allowed the Traffic Control computer to increase update times from the 10 CTVs and 2 overhead cranes nine fold. This paper will overview the operation of the USS Posco system, describe how a PLC based wireless network was implemented and why Rockwell Automation and Electronic Systems Technology's hardware fit within their modernization goals.

USS-POSCO Industries is located in Pittsburg, California approximately 40 miles east of San Francisco. They ship more than 1,500,000 tons of steel each year to 13 western states, Mexico, Canada and Pacific Rim countries. Each day approximately 1,000 employees will finish 4,400 tons of steel, package, label and load 500 coils on 250 trucks and 12 railcars. The Pittsburg facility primarily converts hot rolled steel into three main products; cold rolled sheet, tinplate and galvanized sheet. The continuous processing flow at USS-POSCO is considered a model of material handling and production efficiency. All key steel finishing processes run at continuous high speeds without interruption. Each step of the operation is monitored, scheduled and controlled by an elaborate integrated system of computers, walking beam conveyors, automatic coil transport vehicles (CTVs), state-of-the-art processing equipment.

USS-POSCO began operations as Columbia Steel Company in 1910 building steel castings for the growing state of California. In the 1920's the first hot-dip tinplate west of the Mississippi River was installed to support the food processing industry. In the 1930's the facility was purchased by US Steel Company and expanded to server the large public works projects such as the San Francisco Bay Bridge which consumed 200,000 tons of steel. The size of the plant peaks in the 1950's with 5,200 employees and covering 1,072 acres with 87 acres under roof. The 1960's and 1970's saw a large downturn in the steel industry and the company began focusing on the most efficient and competitive product lines to stay in business.

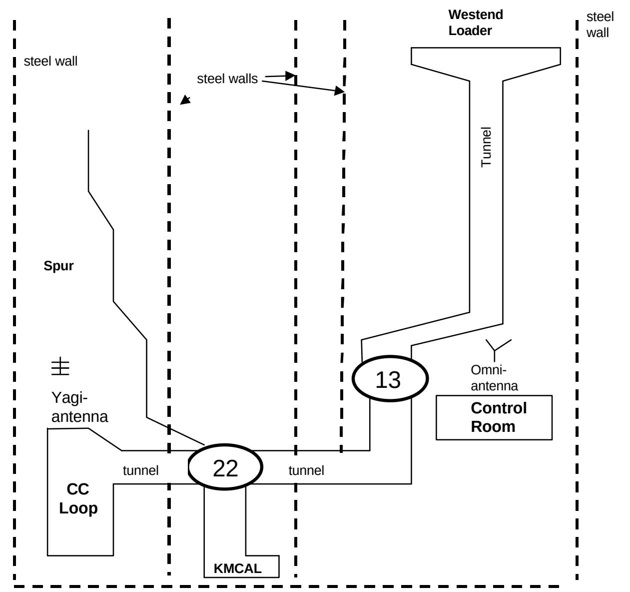

Figure 1: Site Layout Diagram

In 1986 the plant was purchased in a joint venture with Korean Pohang Iron and Steel Company and US Steel to create USS-POSCO Industries. Under this new venture ownership the plant began a large-scale modernization at a cost of 450 Million dollars. The company embraced the new technological changes available and began to their pursuit of becoming the world's most technologically advanced steel finishing plant. These on-going plant wide improvements have allowed the construction of two, state-of-the-art, continuous processing lines in 1989 and the company received ISO 9002 Certification in 1996.

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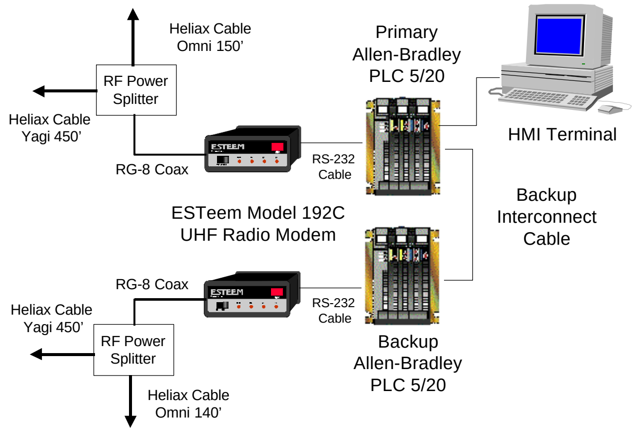

Figure 2: Control Room Layout Diagram

The process starts with 30-ton coils of hot band steel welded together while computers adjust for individual order requirements as the steel is processed at speeds up to 7,000 feet per minute. What starts as a 4,000 foot long coil of thick, hot band steel comes out as a coil of much thinner steel that is 40,000 feet long. Computer controlled automatic transfer mechanisms allow the coils to arrive at the next destination just in time for the next process (Figure 1). Gantry cranes are updated on the arrival of the cars and transfer the coils to the next operation. Continuous looping towers keep all key processing lines operating at maximum efficiency. The result is a seamless flow of operations, converting the hot bands into the cold rolled, galvanized and tinplate.

The PLC based system that monitors the operation of the Coil Transport Vehicles (CTVs) and Gantry Cranes is the traffic control system. This system controls the movement of two gantry cranes and ten CTVs from a central control room. All equipment in the traffic control system uses a common PLC model, the Allen-Bradley PLC 5/20®. The PLCs communicate with each other through a wireless control network. The process starts as the control room PLC sends a coil schedule to one of the cranes in the storage area. The crane then loads one of the steel coils on a CTV at the same time the CTVs PLC 5/20 receives the job schedule from the control room PLC. The CTV then moves to its scheduled area of the plant to complete the finishing process. All CTV locations are monitored from the control room to avoid a collision. Recent updates to the system have allowed such features as a system wide slow down command and a global system emergency stop. These features were only made available by an update in the wireless control system.

The original wireless control system was very slow and unreliable. It had a maximum baud rate of 4,800bps and used a half-duplex radio link that required two UHF frequencies. The average time to poll all 10 CTVs and 2 gantry cranes was 18 seconds. In 1999 Mike Denholm, the Rockwell Automation representative at USS-POSCO, begin researching the Encompass® Program Directory of all third party solution providers for a new wireless technology. He selected the ESTeem Wireless Modem products manufactured by Electronic Systems Technology, Inc. (EST) based upon reputation and reliability. The ESTeem Wireless Modem has an integral Allen-Bradley protocol driver that allowed quick update on the system with no additional PLC hardware or programming required.

USS-POSCO hired EST to conduct an on-site radio analysis. The analysis resulted in the selection of the ESTeem Model 192C, UHF radio modem that could operate on a single existing licensed frequency. Unlicensed radio modems were tested but found to be unreliable in the dense metals of the plant where there was no line-of-site (LOS) between the antennas. The ESTeem Model 192C could operate at 19,200 bps in the same bandwidth as the original radio system that reduced the overall polling speed of the network to 2 seconds. The additional programming features such as system slowdown and emergency stop were added to the network with minimal impact on the speed of the system.

The control room uses the Rockwell Software RSView32 to provide the Human-Machine-Interface (HMI) for operators of the system. The HMI software provides information on order scheduling, positioning information, system status and manual control. The control room has redundant Allen-Bradley PLC 5/20 processors (Figure 2) for continuos operation of the system. Each PLC is connected into a separate radio system (Figure 3) for complete system redundancy. The ESTeem Model 192C has to provide communication to CTVs that move between two buildings where a single antenna location could not provide reliable communication to both. To overcome this problem, two

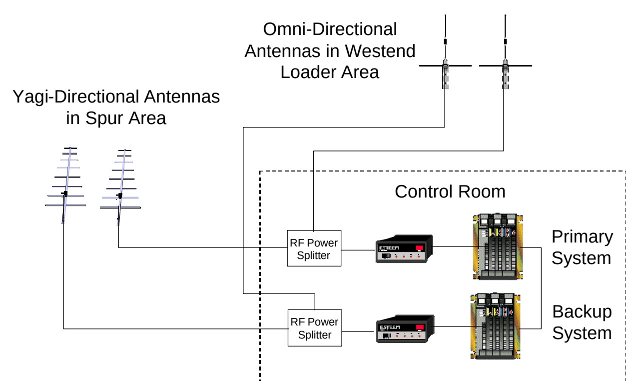

Figure 3: Control Room Radio Layout

antennas were installed and connected to the radio with an RF splitter. The RF splitter provides equal amounts of output power for each antenna through different coax cable lengths. A directional antenna was installed in the Spur area of the plant to provide communication down the narrow building while an omni-directional antenna installed in the West-end Loader area to provide communication through the remainder of the plant.

The gantry crane and CTVs have very similar equipment layouts (Figure 4). Each Allen-Bradley PLC 5/20 is connected directly to the ESTeem Model 192C's serial port. Both systems use mobile UHF antennas tuned for the operating frequency. The CTVs provide a very challenging communication platform with 11,000 lbs. of vehicle and a 30 ton capacity load moving throughout the plant at 500' per minute. There is a very high vibration as the vehicle moves along the 2 miles of indoor track.

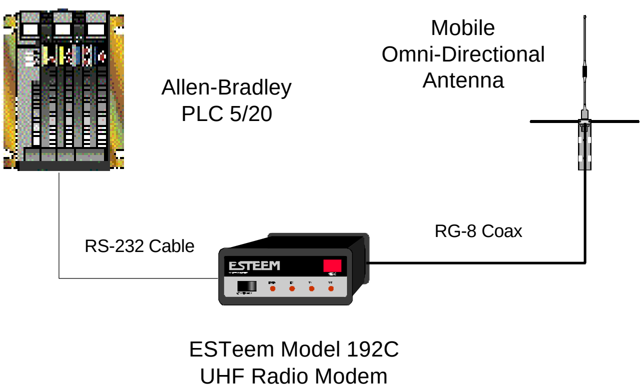

Figure 4: Gantry Crane and CTV Layout

The upgrade of the radio control system had dramatic affect on the overall performance of the system. The following are a few of the benefits provided by the radio control update:

- Dramatic speed improvement from a total system update time of 18 seconds to 2 seconds
- Additional features such as system slowdown, sending coil schedules to cranes and a broadcast stop message implemented with little impact on overall update speed of system
- Radio system replaced without any additional PLC hardware or software required
- Improved system reliability with no radio failures in year of operation since upgrade
- Continued USS-POSCO's scope continual improvements

USS-POSCO embraces the latest advancements in automation technology and has become the "W*orld's most technologically advanced steel finishing plant"* because of it. With targeted system upgrades, such as the communication system in this paper, USS-POSCO can continue their goal of efficiency with dramatic results for a small financial investment.

Electronic Systems Technology, Inc., 415 North Quay Street, Kennewick, WA 99336
Ph: (509) 735-9092 Fax: (509) 783-5475