May 2002

Control Solutions

Formerly *I&CS*

CONNECTORS FOR INDUSTRY

p 14 & 22

The Publication of Control Technology for Engineers and Engineering Management

APPLIED SOLUTIONS

New PLC-based system increases efficiency of explosives plant, maintains safety

Nigel House
Operations Director
Royal Ordnance
North America

The Holston Army Ammunition Plant in Kingsport, TN makes HMX and RDX high explosives that are used in a variety of military weapons and ordnance (Fig. 1). If put on a wartime footing, the plant can make 400 million pounds of explosives annually.

After the Cold War came to an end, the demand for HMX and RDX dwindled. In1998, the Holston plant produced only 2.5 million pounds of high explosives–at which point, the Army decided it was time to restructure the way the plant was managed.

In 1999, it contracted with my company, Royal Ordnance North America (RONA), to run the facility on a fixed-price basis. RONA is a wholly owned subsidiary of BAE Systems, a global aerospace and defense organization based in England.

Our management decided to invest in a modernization project to improve the plant's efficiency and safety, while simultaneously adding flexibility to the production buildings. The project included the installation of a Siemens PCS 7 control system, which contains a redundant programmable controller (PLC).

A batch of HMX

Making explosives is a complex batch process, performed in a series of different buildings for safety reasons (Fig. 2). The basic explosive molecule is first produced in a flexible batch reactor train in Building D5, the Nitration Building. We can make the basic RDX or HMX explosive from the same raw materials; the only difference is the temperature and pressure conditions in the nitrator (Fig. 3).

The Nitration Building has two nitration reactors, two aging tanks, and four simmer tanks. The batch reaction is carried out in acetic acid, so when the reaction is complete, we end up with a solution that's 55% acetic acid. Next, the solution is pumped to Building E6, the filtration and wash building.

Reprinted with revisions to format, from the May 2002 edition of **CONTROL SOLUTIONS**

Here, we remove the acetic acid from the explosive, wash it with water, and reach a very low level of acidity. The building has ten wash, filtration, collection, and storage tanks, plus flush, blowout, and vacuum systems.

The solution is pumped to Recrystallization Building G6, where the explosive is dissolved in a solvent—either acetone or cyclohexanone—to release any additional acidity and to modify the crystal size and shape. By applying different steam conditions, we can reform the crystal into the size we require. From here, we go to another filtration building.

The remainder of the process involves a series of washing, cleaning, filtration, and packaging operations that do not require close control of temperatures and pressures.

A hodgepodge of control systems

The Holston plant has expanded substantially over the years, and today has ten manufacturing lines similar to the HMX/RDX process, spread over 100 buildings neatly arranged in a 10 x 10 matrix. Other operations at the facility include an acid plant and a wastewater treatment plant.

The overall system architecture that we inherited was very loosely structured. Each of the control systems had been installed individually, and none interfaced with each other.

"All the buildings were standalone," explains Jeff Pierson, the electrical engineer responsible for instrumentation and control system installations. "Each one had a programmable controller (PLC) or single-loop controllers, but they were in no way tied together."

We decided to completely reconfigure the plant, starting with the HMX/RDX line. Our goal is to automate everything and control it from a central, safe location. To do this, we have to upgrade all of the existing control systems and tie them together via a network.

"Because of its networking and batch control capabilities, we first considered the Siemens PCS 7 control system," says Pierson. "We had been using Siemens 500 series PLCs, so the PCS 7 was a natural upgrade. Even more important, though, was that we have a system which offered hot backup PLCs, redundant networking, flexible batch tools, and the ability to form a totally integrated production facility."

Redundancy is important because a hardware failure at a critical point in the manufacturing of explosives can have disastrous results. Parts of the process are exothermic (generate heat) and must be carefully controlled. Redundancy is particularly vital here.

The PCS 7 control system consists of three operator stations in the central control room, four operator stations in the production buildings, one S7417 hot backup PLC, three S7416 PLCs, and one 545 PLC (see Figure 4, above left). All of the 100+ buildings in the Holston complex are linked by a redundant H1 network (see Figure 5, above right).

FIG. 4 (left): Holston's PCS 7 system consists of three operator stations in the control room, four operator stations in the production buildings, a S7417 hot backup PLC, three S7416 PLCs, and a 545 PLC. FIG. 5 (right): A redundant H1 network connects a series of redundant PLCs . Profibus is used for control at the cell level.

Smoother operations

In addition to improving safety, the new system is improving operations. "We use it to track batches through all the various buildings," says Pierson. "We can provide batch reporting capabilities throughout the process. We also plan

to provide the ability to operate the entire production line from the central control room or any other building. This lets us use fewer people in the process areas."

The system has also improved product changeovers. The old system could accommodate different processes, but its software had to be completely reloaded. Roger Williams, team manager, explains: "Before, we had multiple PLC programs for each product. We had to take the system offline to download programs every time we changed products. An engineer had to do the download, check out the software, and set up the program. This would take hours. If we ran into a problem, it could take three days to change products."

Now, the system can change products almost immediately. "Even more important, we can now run two products simultaneously," says Williams. "This maximizes our production capability. We could never run more than one product at a time before."

Our programmers have written the entire batch control system from scratch, developing a custom device function blocks and symbol library using Siemens' WinCC and ES-Tools software development packages. "The entire system has around 2500 I/O points, and we are programming it at a rate of 1.5 hours per I/O," says John Arnold, lead software developer.

Going for the entire facility

Thus far, we've completed installation of the entire HMX/RDX system, and are currently working on renovating and integrating the remainder of the facility, including all of the other process lines, the acid plant, and the wastewater plant. ◆