Figure 1. Motiva's new central control room was designed to increase operator awareness.

21st century challenges

Evelio Hernandez, Motiva Norco Refinery, USA and Fred Manley, Emerson Process Management, USA, explain how the Motiva Norco refinery is meeting the challenges of 21st century refinery operation.

Several years ago, key parts of the Norco refinery were running with outdated pneumatic controls. Increased demand and sulfur content in crude put stresses on hydrocracker and coker performance, resulting in poor reliability and frequent shutdowns. Norco made the decision to modernise its instrumentation and controls with the goal of increasing refinery reliability. The seven year project involved upgrading 6000 I/O points to the newest technology available including digital valve controllers (DVCs) and guided wave radar level measurements with foundation fieldbus networking. Controls for eight major process units were consolidated into one new central control building. The result has been a substantial improvement in reliability, the main driver of safe and efficient refinery operations.

Plant overview

The Norco Refining Company is located on the Mississippi River, approximately 20 miles west of New

Figure 2. The Norco refinery processes 240 000 bpd of crude oil.

Orleans, Louisiana. The refinery processes 240 000 bpd of crude and produces 170 000 bpd of petroleum spirit, 46 000 bpd of jet fuel and 50 000 bpd of low sulfur diesel fuel. The refinery dates back to 1918 when the New Orleans Refining Company purchased 366 acres of rice, indigo, and sugar cane fields from the Good Hope Plantation and began operating it as an oil terminal later that year. In 1919, the company provided its employees with onsite living quarters, schools and recreational facilities. As the town grew up around the facility it adopted the name Norco, which was the acronym for the company name.

In 1929, Shell acquired the Norco facility and constructed the first refining units. In 1998, Shell Oil Products Company sold Norco to a joint venture owned by itself and two other primary oil companies, Texaco and Saudi Aramco. In February 2002, Texaco exited the merger and Motiva Enterprises became a 50/50 joint venture between Shell and Saudi Aramco. Today, Motiva Norco employs nearly 700 full time employees and approximately 300 contractors.

Operating challenges

The Norco refinery faces many of the same challenges as the rest of the industry. Refining margins are high due to the shortage of refining capacity in the global market. But the available crude is increasingly heavy and sour, requiring heavy investments on the part of refineries. The maximum sulfur content in petrol has dropped from 120 ppm in 2004 to 90 ppm in 2005 to 30 ppm in 2006. Given the high demand for petrol and diesel, high conversion refineries that are equipped with cokers and hydrotreaters are showing the highest profits, so significant investment is being made to upgrade existing refineries.

A few years ago Norco faced additional issues. The cokers, reformers and hydrotreaters were running at maximum capacity with pneumatic controls. Removal of methyltertiarybutylether (MTBE) as an additive increased demands on the reformer. All of this resulted in poor reliability and frequent shutdowns.

Reinstrumentation objectives

Management made the decision to reinstrument the plant with the goal of increasing reliability to world class standards. In a world where the global supply for fuel is almost equal to the global demand, it is a problem any time a plant is down. The goal was to increase instrument reliability and improve maintenance effectiveness through more efficient diagnostic tools. Norco wanted to enable predictive monitoring of instrumentation assets to give operations the ability to monitor the plant and take proactive action to avoid upsets and other abnormal situations. Another goal was to improve communications between units and eliminate duplication of effort by relocating five control rooms into one.

Norco refinery worked together with Shell Global Solutions to evaluate alternative technologies. Foundation fieldbus was an attractive technology but Norco had no real experience with it. At this point, Norco already had five years of experience with HART® digital valve controllers. It was apparent that existing DVCs were capable of identifying maintenance problems before they affected operations. On the other hand, similar problems with pneumatic controls often went undetected for a long time, which cost a lot of money.

Figure 3. Intelligent digital valve controllers identify maintenance problems before they affect operations.

Technology and services

Norco decided to make the leap to the foundation fieldbus technology and looked for a company that had the right technology and also a strong and available support network. Norco selected the PlantWeb® digital plant architecture from Emerson Process Management. PlantWeb includes the DeltaV™ digital automation system which is built for buses and fully supports foundation fieldbus and other bus technologies. AMS® Suite: Intelligent Device Manager software connects over fieldbus to intelligent field devices that deliver advanced diagnostics for use in the control room and maintenance shop. Norco also selected Emerson as the main automation contractor because of its proven project management experience and intimate knowledge of the technology that was selected.

As the main automation contractor, Emerson performed the front end engineering, including a discovery process designed to analyse every control point and determine what was required to upgrade it to the latest technology. The existing plant included a wide range of analogue and digital technology although it primarily consisted of pneumatic controls. The front end engineering process specified digital instruments that run continuous predictive diagnostics used by the asset management functionality to provide advanced information about instrument and process health. For example, Fisher® DVCs enable operators to see the true position of the valve on their screens. This makes it possible to troubleshoot the valve from the control room by checking its alignment online and evaluating the actuator and making sure it has pressure.

The project scope encompassed eight major process units, 6000 I/O points, 636 control valves, and consolidated five separate control rooms into one centralised, integrated control room. The new central control room was key to the project. The design radiates from the operator outward, focusing on increasing awareness. An overview layer is always present on the big wall screens, giving the operators a bird's eye view of the entire plant. When an alarm occurs, operators can quickly drill down though four graphical layers to get full details on the problem as well as the ability to take action to correct it.

Flow and level measurement technology

Rosemount® guided wave and non-contacting radar level measurement systems were used. Guided wave measurement provides the highest level of precision but has a probe that touches the process.

Rosemount guided wave radar level measurement is based on time domain reflectometry (TDR) technology. Low power nanosecond microwave pulses are guided down a probe immersed in the process media. When a radar pulse reaches media with a different dielectric constant, part of the energy is reflected back to the transmitter. The time difference between the transmitted and the reflected pulse is converted into a distance from which the total level or interface level is calculated. The intensity of the reflection depends on the dielectric constant of the product. The higher the dielectric constant value is, the stronger the reflection will be. The transmitter automatically adjusts gain to maximise the signal to noise ratio in each application. This increases measurement reliability and capability.

The Rosemount non-contacting radar level transmitter is used for level measurements on liquids and slurries with various temperatures pressures and vapour gas mixtures. The level of the liquid is measured by short radar pulses, which are transmitted from the antenna at the tank top towards the liquid. When a radar pulse reaches a media with a different dielectric constant, part of the energy is reflected back to the transmitter. The time difference between the transmitted and the reflected pulse is proportional to the distance, from which the level is calculated.

Pressure measurement and safety interlock technology

Diaphragm seal systems were used with Rosemount 3051 pressure transmitters for differential pressure measurements in many applications. Emerson engineers were careful in selecting diaphragms to match the process. For example, gold diaphragms were used in many applications to handle hydrogen. The Rosemount 3051 smart transmitter delivers ±0.04% reference accuracy, resulting in total operating performance of ±0.15%. Diaphragm seal systems respond to changes in both process pressures as the level changes, and in static pressure over the liquid. These variations in pressure are transmitted through an oil filled capillary to a differential pressure transmitter sensor. The capillaries and seals are filled with incompressible oil compatible with the process temperature, pressure, and media composition. The transmitter is commonly mounted at ground level, or in close proximity to the high pressure process connection.

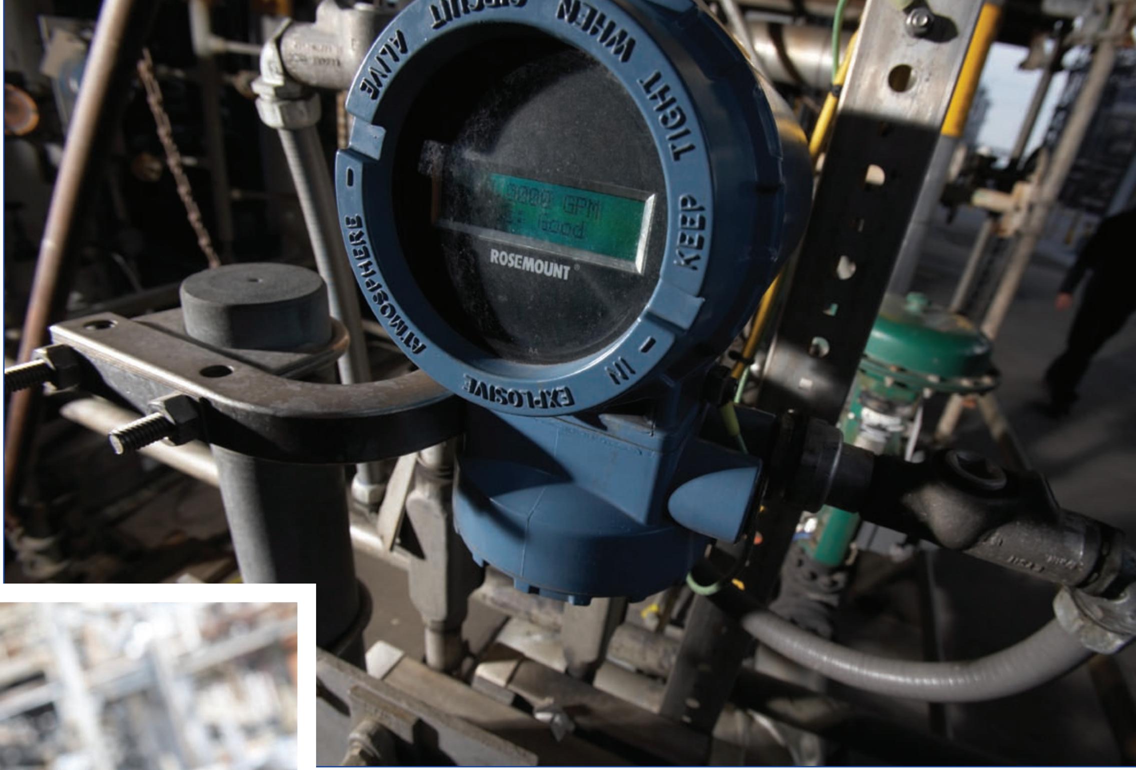

Figure 4. Rosemount radar level measurement systems were used throughout the plant.

Figure 5. Rosemount smart pressure transmitters were used in many applications.

Norco has historically used programmable logic controller (PLC) technology as the backbone of its safety certified interlock systems. When the new instrumentation system was being designed, safety instrumented systems (SIS) based on foundation fieldbus had not yet been certified by global standards organisations. For this reason, the existing PLC based technology was left in place and Emerson developed integration with the DeltaV digital plant architecture using the OPC protocol to communicate between the two different controllers.

For future SIS needs, Norco will strongly consider utilising the DeltaV SIS, which recently became the first digital SIS to be certified by the TÜV organisation to meet the requirements of the IEC 61511 global standard for functional safety in the process industries. Comprising 16 channel modular logic solvers, the DeltaV SIS system can be deployed in distributed fashion to perform programmable electronic system functions for process safety. In addition to the DeltaV SIS systems, the smart SIS solutions integrate Emerson's Fisher digital valve controllers, Rosemount temperature and pressure transmitters, and Micro Motion® Coriolis flow meters.

Investing in people

While the reinstrumentation project has been extremely beneficial, in the end it is Norco's educated, empowered workforce that has made the difference for the refinery. Norco management has invested in a test system and used it to teach system architecture and troubleshooting skills and design and develop infrastructure ideas. The company has also invested in medium fidelity simulators. The company has sent project engineers, digital engineers, instrumentation engineers and advanced process control (APC) engineers to training programmes at Emerson, and sponsored Emerson programmes at the refinery for technicians and operators. When they complete training, employees are given support and project assignments that provide the opportunity to put their new knowledge to work immediately.

Benefits of the project

The digital architecture and digital automation systems have been used extensively to improve reliability and control performance. Predictive capabilities have been upgraded so that maintenance can be performed proactively. Communications have been streamlined which reduces response times. Maintenance direction and focus has been improved, empowering the workforce to own reliability. Much more information is available from each unit than in the past through the use of the new digital architecture. Predictive diagnostics make it possible to identify and correct problems in the instrumentation before they actually become a problem in the field. In this way the new instrumentation improves reliability by avoiding problems that otherwise might force the plant to be shutdown.

Reliability is the main driver of refinery operations. It improves maintenance direction and focus, enables proactive maintenance, improves predictive capabilities, improves response times and communications and empowers the workforce to own reliability. As a result Norco have seen preliminary results of improved reliability and control performance. The documented results include one off saves and sustained improvements due to developed work processes that incorporate the new technology. Norco has delivered its best ever reliability utilisation, and is now among the best in class based on Motiva global standards. These goals were accomplished through strategic investments in leading edge instrumentation and in the skills of the people that made the technology investment pay off.