

## **CASE STUDY**

*Marathon Oil Yates Field and Indian Basin Gas Plants—Iraan, Texas, and Lakewood, New Mexico*

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### **Value of Digital Protective Relays Is Discovered at Oil and Gas Facility**

*Oil and gas industry leader Marathon Oil turns to SEL-351 Relays to improve power stability, enhance control and safety, eliminate costly shutdowns, and increase operational knowledge at two natural gas facilities.*

*Iraan, TX and Lakewood, NM*—In the world of oil and gas production, industrial facilities like petrochemical refineries and natural gas plants are essentially vast, intertwining chemistry experiments, with each process a critical step in the complicated whole. Like every other important piece of a modern industrial operation, they depend on a steady supply of electrical power to keep the machinery in motion.

However, unlike a manufacturing plant, when the power goes out, either due to a fault on the power system or improper protective relay operation, not only do production and processes grind to a halt, but also in the case of a natural gas plant, the entire production run can go up in flames, literally, to the tune of hundreds of thousands of dollars in lost revenue per day.

As a result, most large oil and gas facilities maintain on-site power generation, with their connection to the grid serving primarily as an insurance policy. The proper protection and monitoring of this on-site generation is of great importance at facilities such as Marathon Oil's Yates Field and Indian

Basin gas plants, respectively located in Iraan, Texas, and Lakewood, New Mexico. The two facilities are the premier asset bases at the company's Southern Business Unit, said Marathon Oil Senior Engineer Charlie Adams.



*Figure 1—Most large oil and gas facilities maintain on-site power generation, with their connection to the utility grid serving as a backup power source.*

With nearly 20 years in the oil and gas industry, the first 15 with Exxon after graduating from Texas A&M in 1983 with an electrical engineering degree, Adams is one of a handful of engineers at Marathon called upon to support the power systems driving the company's upstream operations. His work on a diverse range of projects includes the design and installation of SCADA measurement systems, instrumentation, controls, and power systems.

The Yates plant is primarily a support facility for the Yates Oil Field, serving as a large compressor station that recycles gas for injection into the reservoir.

“At Yates, the utility is a backup, an insurance policy. The generator sets are self-contained, and when the utility trips offline, it doesn’t necessarily mean the plant stops, but it does mean we’ve lost our insurance policy, and it’s only a matter of time before that bites you,” he said.

According to Adams, a short power shutdown presents the very real risk of losing control of plant processes where chemical and cryogenic functions within the plant go “off spec.” Based on market values, it may cost \$15,000 in fuel alone to restart the Yates facility, which must be purchased commercially.

Beyond the costs of even a brief plant shutdown, an extended power outage can also make a significant dent in production from the Yates Oil Field, which generates about 20,000 barrels a day. At \$25 a barrel, that’s a daily revenue stream of around \$500,000 a day.

The Indian Basin plant has a much higher exposure due to the large volume of natural gas that goes to flare during an outage. Running at production levels of around 250 million cubic feet a day, if natural gas is selling at \$3 per thousand cubic feet, a \$750,000-a-day revenue stream goes up in smoke at a rate of about \$30,000 an hour, not to mention fixed facility start-up costs in the neighborhood of \$100,000.

His power system challenges at Marathon began in 2000 and involved a

number of tricky problems with two main switchgear facilities. The first project was at Yates, a situation which Adams described in hindsight as “frankly, a little scary.”



*Figure 2—With a history of unreliable power service and paper maintenance records showing 1,000 trips on the utility tie breaker for a total of 24 hours of power outage, the priority was to reduce the trip index and increase power reliability to the plant.*

“The Yates Gas Plant had a history of unreliable power service, and one of the things I initially struggled with was developing a solid way to measure the results of our work. One of the metrics we zeroed in on was the breaker trip frequency of the utility feeders that tie into the bus, where we have a utility tie and two generator sets that feed power into the bus. We refer to this frequency as the trip index,” he said.

With paper maintenance records showing 1,000 trips on the utility tie breaker in just three years, translating to about one a day, Adams knew the primary job was to bring the trip index down.

Further investigation uncovered a messy, overlapping combination of generator and governor control problems, reverse power trips, significant transient issues, and unreliable electromechanical relays

with questionable maintenance histories. There would be no quick fix.

“The existing hardware was all pure analog devices with no historical data-capture capabilities, so pinning down problems was really a series of educated guesses, since most electrical power events are so quick and there is very little evidence left behind as to what happened,” he said.

The project’s scope eventually encompassed replacing the unreliable relays on the utility feeders with SEL-351 Relays, installing two SEL-300G Generator Protection Relays, and replacing 34 aging electromechanical relays with new hardware from Schweitzer Engineering Laboratories, Inc. (SEL)

Founded in 1984, Pullman, Washington-based SEL is a leader and innovator in the design and development of power system relays and monitoring technology for industrial and utility power users.

Adams first learned of SEL while at Exxon through utility engineer David Renfro, who recommended that he install a SEL-351 simply to demonstrate its abilities as a data-capture device in an application.

“We put the unit in, hooked up a modem, and monitored it. It was impressive. Renfro is a mentor of mine, and as a respected utility power engineer, his testimonial carried a lot of weight. When I began to ask colleagues at other companies about the product, and other utility people, the feedback was 100 percent positive. Not a single negative word (was said) about SEL’s technology,” Adams said.



Figure 3—“Reliability is a big issue due to the exposure a public utility has, and the utility made the decision to change out the other relays and go exclusively with the SEL-351 Relays. When I heard that, it was all the testimony I needed. When I showed my people what our local power supplier down at Yates had gone through, that was all it took. My recommendation wasn’t even challenged,” Charlie Adams said.

Knowing that Marathon already had an installed base of another manufacturer’s relay, he knew he would need compelling data to justify the switch to SEL. Calling a number of people who had used both relays, he received extremely favorable reports about SEL. He then called a representative from a nearby large electric utility in Texas, which also just happened to be the power supplier to the Yates plant.

When Adams started asking questions, it turned out the utility had recently purchased many breakers for its substations and the same non-SEL relays he was evaluating. The experience was not positive, and the list of problems included service and firmware.

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The retrofit of the 12.5 kV switchgear at the Yates Gas Plant was significant and had to be orchestrated within a rigid,

one-week shutdown window fixed by the plant's mechanical maintenance schedule.

Six months of planning and preparation for the relay integration, working closely with SEL and colleagues at Marathon, anticipated every aspect of the project. In addition to removing the old relays and installing and programming the new hardware, they also installed new power factor correction capacitors to stabilize the generator sets, which enabled them to run more efficiently and much closer to unity.

The ultimate measure of the project's success was a four-fold improvement in the trip index. When the power system was brought back up, the trip index factor decreased from nearly 1.0 to about 0.25. Adams stated unequivocally that the SEL-351s were the biggest part of the story.

Engineers also started collecting data that gave them the ability to look into the root causes of their problems and suddenly knew without question whether trouble emerged on the supply side or demand side.

"Finally having legitimate data collection and reporting let us focus on smart fixes, and there have been times when we've gone to the power company and said, 'We have information here that we've captured, and we think you should see it.' The data helped us solve problems on their side of the system," he said.

As a result of the Yates project, the first application of SEL relays at Marathon Oil, Adams received a call from the Indian Basin plant, which has a more complicated power system consisting of

a 480 V bus, three turbine generators, a utility connection, and a standby feeder.

The challenge: Integrating two additional distributed generators and one 900-horsepower motor that both feed into and draw start-up power from the bus. Many of the same types of problems at the Yates plant manifested at Indian Basin, including phantom trips and fluttering generator controls.

Based on what Adams had accomplished at Yates, he was asked to take a look. An SEL-351 was installed on the utility feeder, but the generator relays and other aging hardware were not replaced.

"It was a tougher sell, since we hadn't quite won the confidence of the plant superintendent. He wanted us there, but he was pretty possessive of the generator controls and packages, as they were critical to the plant. He didn't want us working on anything more than what needed to be worked on," Adams said.

With SEL-351 success stories accumulating, the superintendent was impressed enough with what Adams' team and SEL technology had done for plant reliability that he asked them to install an additional SEL-351 Relay on his bus. Adams is pitching a retrofit of the generator relays, with hopes of installing the SEL-300Gs at Indian Basin as well.

"The common technology will make integrating the data we collect much easier," he said.

While SEL built its foundation in the utility industry, a fact that's apparent in the design and function of its entire product line, Adams' perspective on what that means to prospective industrial users of SEL technology is illuminating.

“On the industrial side, we’re on the flip side of the meter. Instead of power going out, power is coming into our facility, but their technology fits nicely anyway because power is power,” he said. “A relay doesn’t know a utility application from an industrial one. It only knows current, voltage, vectors, and so on.”

Adams has personally assisted SEL engineers to develop improved reporting semantics geared toward the industrial user. Another key feature of SEL technology that he values highly is remote access and monitoring capability.

“I think Marathon is typical of many industrials in that we don’t have a very broad power engineering base,” he said. “With just a handful of people to support power systems throughout the company, which is pretty spread out geographically, having the ability to remotely manage devices is a tremendous advantage.”

Adams uses remote access to configure devices and review surveillance reports, typically calling the relays twice a day to check status and look at triggers and histories. The result has been a number of calls to local engineers, prompting them to look for possible problems.

For example, Adams noticed a problem with the dc batteries that power the critical trip circuits for the breakers at Yates. Twice a day, he observed a pattern where the 125 Vdc battery systems would cycle through an intense

recharge well in excess of 140 V before cycling back to normal levels. Keeping an eye on the pattern for a few weeks, he captured hard data demonstrating the event and passed it on to electricians, who located and fixed some problems with the charging connections.

“We provide the model for the rest of the company on the upstream side of our business, and having SEL technology entrenched here means it will eventually find its way into our other operations, including downstream petrochemical facilities,” Adams said. “Since I’ve been at Marathon, I’ve gained an awful lot of first-hand experience and knowledge that supports everything I’ve heard about SEL, and they have earned my respect. I’m a pure industrial end user, and I will consider them for every opportunity.”

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### ***About SEL***

Schweitzer Engineering Laboratories, Inc. (SEL) has been making electric power safer, more reliable, and more economical since 1984. This ISO 9001-certified company serves the electric power industry worldwide through the design, manufacture, supply, and support of products and services for power system protection, control, and monitoring. For more information, contact SEL, 2350 NE Hopkins Court, Pullman, WA 99163-5603; phone: (509) 332-1890; fax: (509) 332-7990; email: [info@selinc.com](mailto:info@selinc.com); website: [www.selinc.com](http://www.selinc.com).

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