No juice, no oil

Highly accurate power monitoring is a must for refineries, because outages shut down production of a commodity so valuable it's called black gold. But finding the gremlin in a refinery's circuits is about as easy as finding a needle in a haystack.

When the power fails in a home or small office, it can be inconvenient and irritating. But fixing the problem usually involves nothing more than fumbling around—sometimes in the dark—for a few minutes to find out what went wrong and resetting a tripped breaker.

However, no home or office is spread out over several square miles and has many miles of wires and cables as well as thousands of high-voltage devices. If something trips a breaker in that kind of operation, it's a major problem that can cost millions of dollars in downtime and repairs.

Such was the problem faced by Bakersfield (Calif.) Refining Co., a subsidiary of Equilon Enterprises LLC, a partnership between Shell Oil and Texaco. The Bakersfield refinery has a capacity of 70,000 barrels of oil per day and occupies four square miles of land. Most of its operating and control systems run on electricity, so when the power fails somewhere on the sprawling site, the time and money clock begins ticking. Knowing where to look for the cause of the failure is only one problem. Loss of revenue is an even bigger one. Multiply 70,000 barrels times the current price of oil—nearly $40/bbl, divide by 24, and you can see that even a one-hour outage at Bakersfield, if running at full capacity, would subtract more than $100,000 from its gross.

Where's the problem?

At Bakersfield, the occasional outage would have been tolerable, but unfortunately outages weren't occasional; the flow of juice was cutting off with some regularity. Even worse, two kinds of outages were occurring. Sometimes the refinery lost service from Pacific Gas & Electric Co. (PG&E), and sometimes there were internal interruptions. In one instance of the latter, improper loading of a transformer caused overheating, threatening to shut down a large portion of the refinery. But in other instances, no one could pinpoint the source of the problem.

Finally, Bakersfield said "enough." Top management asked electrical reliability engineer Chuck Soderstrom and consulting engineer P.R. Calkins to find a power monitoring system that would enable the refinery to keep better track of its internal loads in the hope that such a system would make the disruptions less frequent or eliminate them altogether. After investigating several options, Soderstrom and Calkins turned to Electro Industries/Gauge Tech, Westbury, N.Y.

"All large manufacturing facilities have problems at one time or another with variable-frequency drives, motors, electronics, high-voltage equipment, and heating and cooling devices," explains Erran Kegan, CEO of Electro Industries, which he says is the largest and oldest manufacturer of power monitoring equipment. "In this application, saving money was the secondary objective. The primary one was making their electricity reliable. The Bakersfield refinery now has better power monitoring equipment than its utility has."

Where's the evidence?

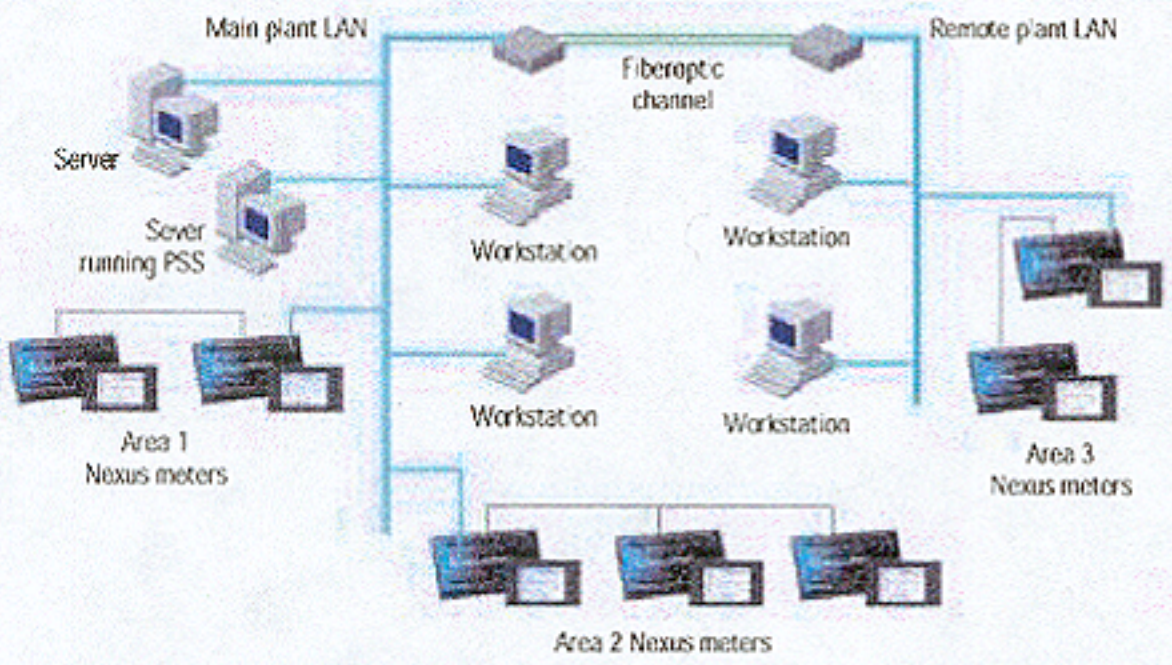
Though internal problems were suspected for a number of the unplanned outages, Bakersfield executives also wanted to be able to show PG&E hard evidence that its supply was the culprit when that was the case. Supplying that level of proof required a system that could provide detailed tracking of the currents, voltages, and loads of all plant equipment and on all feeder lines (see box).

Electro Industries' Nexus 1250 power monitor met the specs, so Soderstrom and Calkins supervised its installation, along with a software package called Power System Supervisor 3.0. The refinery's existing high-speed Internet LAN eliminated the need to put in a new communications system (Figure 2).

The Nexus 1250 accurately measures all electrical parameters on the refinery's 14 feeder lines and internal circuits and provides immediate notification of breaker trips. It includes a 1-millisecond-resolution event recorder to track events and the sequence in which they occur. To synchronize the time tracking, Electro Industries installed a GPS clock.

The Nexus 1250 monitor does power quality and waveform logging of up to

2. Diagram of Bakersfield Refinery's power monitoring system



Courtesy: Electro Industries/Gauge Tech

System requirements for the Bakersfield Refinery power monitoring system

- Monitor volts, amps, and power values at each feeder circuit breaker.
- Record voltage transients to capture sags and surges.
- Record waveforms during voltage transients or fault conditions.
- Record voltage, current, and power values for load analysis.
- Provide event recording with millisecond resolution.
- Provide time synchronizing across the entire plant to allow event analysis.
- Install monitors on existing plant Ethernet LAN.
- Provide system information to plant operations office.

64 events. The software was installed on a dedicated server that runs Windows NT 4.0 and is connected to the LAN. Users can log on from any location. The system also includes a display client to enable operating and engineering personnel to monitor plant conditions from any location.

"The number-one cost for this refinery is fuel (petroleum), but its number-one need is electricity," Kegan points out. "With this power monitoring system, Bakersfield can not only do root-cause analyses of interruptions but can make better decisions on electricity cost issues as well."

Electro Industries/GaugeTech is a privately held company founded in 1973. It is one-third-owned by General Electric. The firm has worked with PG&E before and, in fact, provides many of the utility's power quality monitoring systems. Kegan says half the company's customers are large investor-owned U.S. utilities, and the other half are large commercial and industrial firms such as Bakersfield Refinery Co.

The level of power quality monitoring installed at Bakersfield isn't necessary, or even available, for homes and small offices. Then again, when your lights go out, it doesn't you cost several million dollars to get them back on again. ■

—Warren B. Causey