FLOWSERVE

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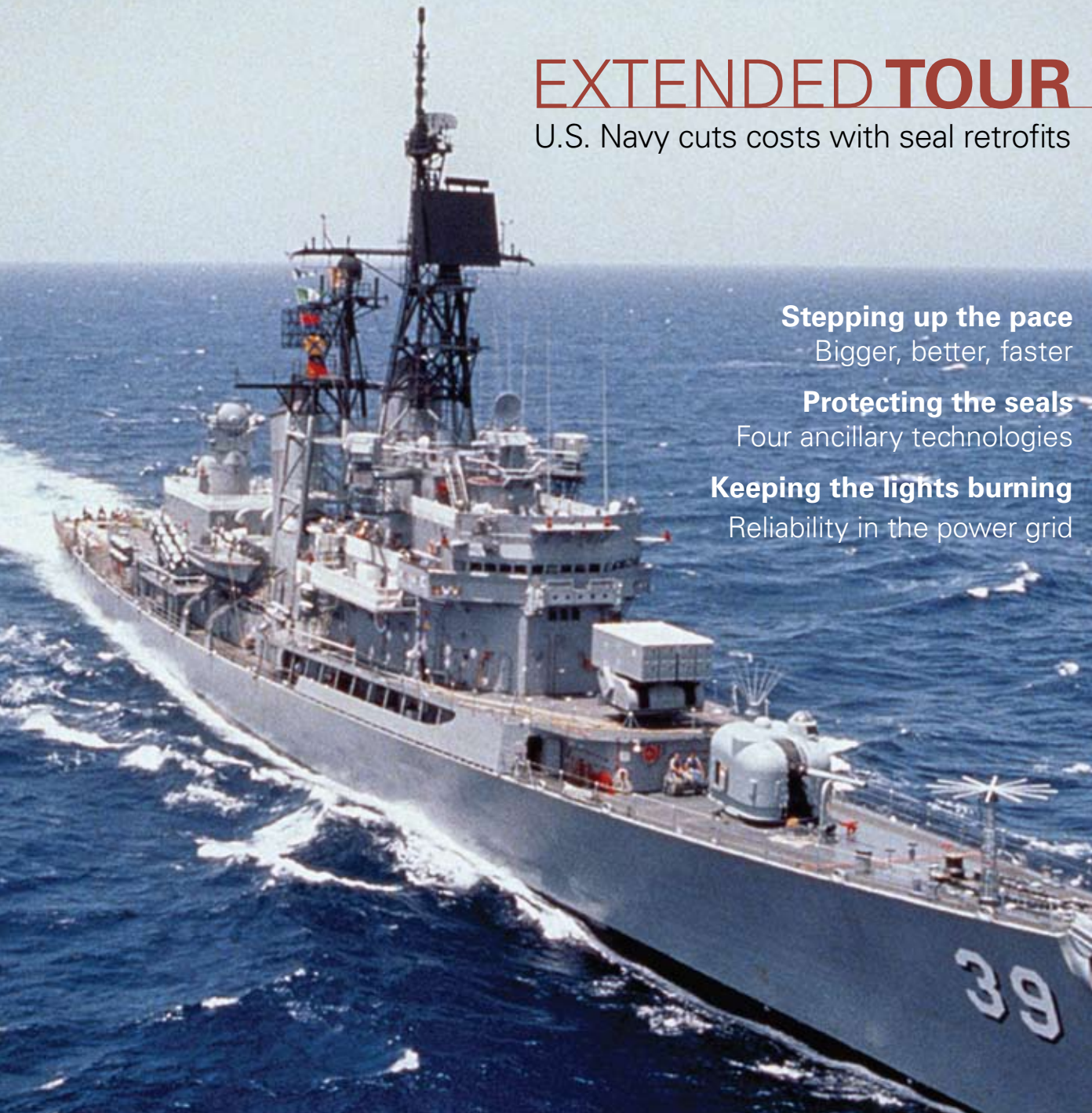
Face to Face

THE SEALING TECHNOLOGY MAGAZINE



EXTENDED TOUR

U.S. Navy cuts costs with seal retrofits

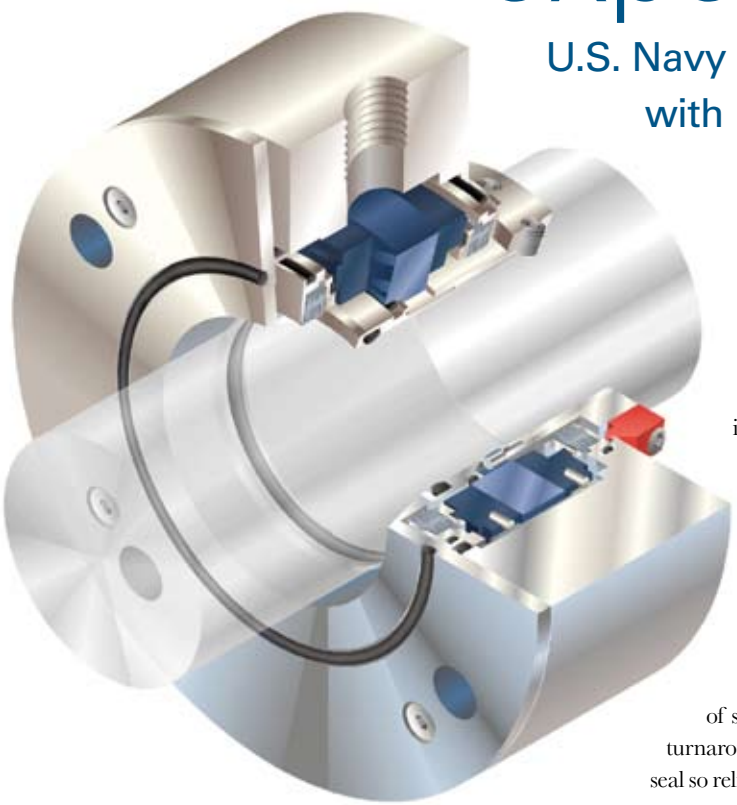
Stepping up the pace
Bigger, better, faster

Protecting the seals
Four ancillary technologies

Keeping the lights burning
Reliability in the power grid

Exceeding expectations

U.S. Navy cuts maintenance costs with Flowserve GX-200 non-contacting seal retrofits



"On a Navy ship," explains Bob Epperson, Flowserve sales engineer, "they can't simply replace seals. They must also repair the entire pump. Because the existing seal is internal to the pump, this causes both time-consuming and expensive maintenance."

Although the mechanical seals cost only $300 to $600, replacing them is a $25,000 process and, generally, four pumps have to be replaced on each ship on a yearly basis at a minimum. The bottom-line cost can be $100,000 to replace four $300 seals.

The Navy needed to reduce the frequency of seal failures, cut its replacement costs and speed turnarounds. What the Navy got for its effort was a seal so reliable that it is reusable — even outlasting other pump components such as thin paper gaskets.

The U.S. Navy needed a fleet-wide solution to a problem plaguing vertical screw pumps being used for fuel oil, lube oil and hydraulic lube oil service on its Spruance DD 963 Class Destroyers, CG47 Class Cruisers and DDG Class Destroyers. The LOSP pumps are mounted above the sump, a geometry that can result in the seal running dry if the fluid drops below the pump centerline. The OEM's conventional mechanical seals required a liquid between the seal faces to counteract heat generation. Without the liquid, the seal faces blister, which generates pockets of carbon debris, degrades seal flatness and initiates leaks. Ultimately, the OEM seals failed prematurely and the maintenance that followed was expensive.

Technical challenges

The Navy uses many kinds of pumps, pump configurations, seals and seal manufacturers. Zero leakage was the top requirement for a seal on fuel oil — a requirement that ruled out the OEM's contacting mechanical seals. "Contacting seals leak and fail," says Rudy Hatala, life cycle manager at the Navy Ship Systems Engineering Station (NAVSSES), in Philadelphia, Pa. "No matter what contacting seals we tried, and in various configurations, they all leaked and they all failed. We had to find an alternative. We couldn't find a solution among our traditional vendors. Flowserve wasn't a vendor then. Their non-contacting seal was attractive, but Flowserve had to prove that it would work in a reliable manner."

The Navy's pump configurations raised some tough engineering challenges. "The lube oil pumps pull suction from the sumps that are below the pumps," Hatala notes. "Shut down the pumps, and the liquid drains down. On startup, the contacting mechanical seals required liquid that wasn't there. As a result, on startup they would run dry and fail. We needed a non-contacting seal — one that required no liquid."

The Flowserve non-contacting seal the Navy chose is the GX-200, a dual-pressurized gas barrier seal that features the Flowserve non-contacting Advanced Pattern Groove System face technology. A reliable flow of inert barrier gas eliminates the need for a liquid to cool the seal faces. This avoids process contamination, reduces power consumption and offers zero process emissions in hazardous service. Welded metal bellows eliminate dynamic O-ring hang-up, and the compact cartridge fits ANSI- and DIN-standard bore seal chamber pumps.

"The Navy gave us lab conditions to test under," explains Epperson. "We shock- and vibration- qualified the GX-200 seal, then performed a shipboard evaluation." The seal passed the Navy's technical requirements after it continued operating beyond the mandated 1,000-hour test period. Full approval followed five months after the shipboard testing began.

Finally, the Navy vets programs predicated upon lifecycle cost of alterations. Alterations exceeding three years have less priority than those with return on investment (ROI) of less than three years. The GX-200 provided an ROI of less than nine months.

Outlasting pumps, gaskets

Approximately 50% of the GX-200 non-contacting gas barrier seals have been installed on multiple Navy ships. "Since October 2000, there have been some pump failures," Hatala adds, "We've already reused some of the Flowserve non-contacting GX-200 seals on replacement pumps. That's something the Navy has never done. It's extraordinary for the Navy to have a seal it can reuse."

"We simply take the GX-200 seal off the pump," Hatala adds. "Take it apart, wipe it down, clean it, reassemble it and put it back on a pump."

In search of **'vital air'**

Although the results are well worth the effort, replacing multiple installations is no small task. "Every ship and every crew are different, and ships are run in different ways," says Bob Epperson, Flowserve sales engineer. "Those circumstances affect how the installation is handled."

To ensure the highest reliability, the Navy's GX-200 solution uses what they call vital air — gas that supports vital shipboard equipment such as electronics and weapons systems. Interruptions in the availability of vital air are rare, and when they occur, seldom last more than 20 minutes and have accumulator systems in place.

To design a replacement system to support the GX-200 seals, Flowserve engineering examined the ship's drawings to identify places where they could draw two taps and run tubing. Once the designs are completed and approved, installation begins. Oilers and old seals are removed, the two taps are fitted and a gas panel identifying the locations of the new taps is installed.

A new adaptor plate replaces the old head plate. The gas seal itself is then installed, everything is reassembled and air is connected. The system is then turned on and pressure-tested. After motors are powered up, an operations test verifies performance and the entire system is put into service.

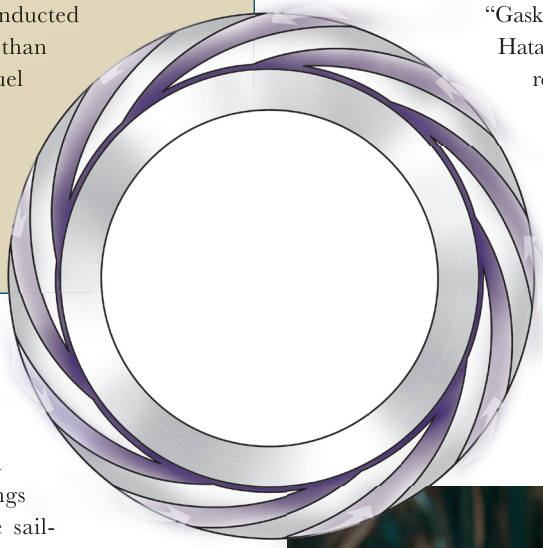
The barrier gas pressure is normally higher than the pressure in the seal chamber. "Even a failure in the barrier gas system won't faze the Flowserve GX-200," says Epperson. "When pressure is lost, the GX-200 operates under reverse pressure. It is a major accomplishment for a double gas seal, and one that prevents problems. Under reverse pressure, oil that got into the seal has been purged out when air pressure is restored. The seal isn't damaged so the pump keeps running."

Error-proofing the system

The Navy faces the same staffing and training issues that manufacturers face, so simplification is important. "That was one thing that the Navy wanted to see," says Hatala. "Flowserve knows that the Navy way of testing things is far beyond rigorous. We do things that

Working its way **through the fleet**

As of early 2006, the Flowserve GX-200 non-contacting, zero-leakage design has met every relevant Naval Sea Systems Command (NAVSEA) qualification requirement. More than 120 seals have been installed on multiple ships and class platforms. Fuel Oil Service MACHALT 562 applies to Warren 250 TS Screw Pumps and Lube Oil Service MACHALT 579 applies to Warren 575 TS Screw Pumps. Initial operational testing was conducted on the USS Monterey for more than 500 hours on the 1A and 2A Fuel Oil Service Pumps (FOSPs). Seals were installed on four FOSPs and one Lube Oil Service Pump (LOSP) in October, 2000.



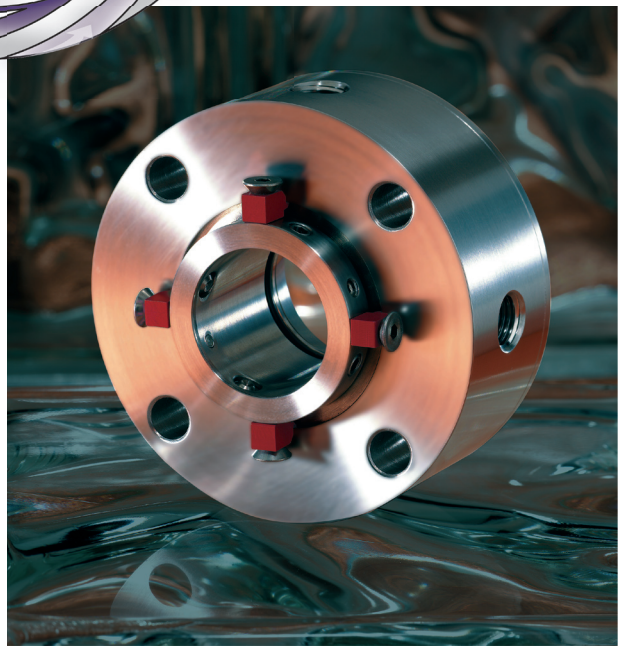
you'd never imagine. Because many young sailors are in a learning mode and our error-proofing is designed and intended to keep things running and not require sailors to know anything about non-contacting seals."

The GX-200 seal offers the installation simplicity of a cartridge design and Flowserve developed a lean installation routine. Because sailors spend less time maintaining pumps equipped with the GX-200 seal, the crew can be deployed to higher priority, mission-critical duties. "We touch on pump and seal replacement when we train sailors," Hatala says, "but sailors rotate off ships within three years and they don't necessarily remember maintenance details they don't use often."

To simplify installation, sailors follow a Shore Intermediate Maintenance Activity (SIMA). A preassembled machinery alteration (MACHALT) kit includes every part needed to install a GX-200 seal, including simple instructions with photos depicting each step to be followed.

The Navy regards the Flowserve GX-200 seals as highly reliable. Nevertheless, leaks do occur — and for surprising reasons. "The Flowserve seal had been in place for two years, and our old mechanical seals had failed in three months," says Hatala of a trip to San Diego to investigate a report of a leak. "We assumed, 'Finally, our first failure.' But the seal was fine. It was the gasket that had failed."

"Gaskets had never failed before," Hatala says, "With three-month replacements, they were never on the pump long enough to fail. Now we need a better gasket. The long life of the seal is identifying other issues. We may be coming to the point where we wear out a pump before we have to replace its seal. That's what the trend is showing."



Stepping up the pace

As industry puts a premium on bigger, better and faster, Flowserve rises to the challenge

Compressor manufacturers are capturing market share by designing equipment that operates at ever higher speeds. To ensure real-world reliability in the field, they equip their units with mechanical seals that can take the heat.

Active research in high-speed seal design is staying well ahead of industry trends at the Flowserve facility in Temecula, California. There, any new seal design intended for speed must prove its mettle by surviving a rigorous test regimen conducted on one of the company's two high-speed test rigs.

The first test rig, based on a Sundyne compressor platform, is capable of operating at about 40,000 rpm and developing a head of 1,500 psi. The second unit is based on a Cooper platform. This one can run at 80,000 rpm and develop 1,500 psi.

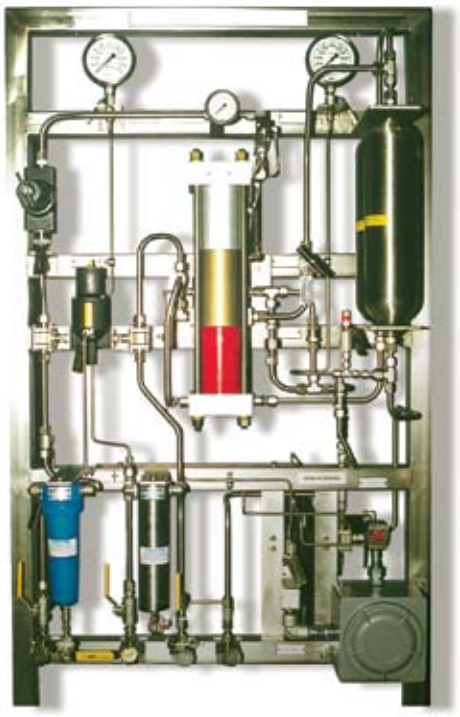
Some other recent developments coming out of Flowserve — specifically, the compressor seal-focused factory in Dortmund, Germany — are impressive. For example, Flowserve has developed a prototype compressor seal for Cooper-Joy Compressors that will be used in the oil and gas industry. This 0.8750 in. single Gaspac seal, Model KZ-10, operated successfully at a rotational speed of 60,113 rpm while at a pressure of 50 bar (732 psig). Those conditions correspond to a peripheral speed of 215 m/s (707 ft/s, Mach 2-plus).

Obviously, little room for error exists in these designs where even the slightest imbalance can be disastrous. To help mitigate such problems, Flowserve equips its high-speed seals with an engineered centering strip that maintains seal concentricity without damaging the shaft.

The compressor manufacturers designing for higher speeds know Flowserve is the only supplier of compressor seals that can furnish a cartridge unit tested at speeds approaching 80,000 rpm. That's real-world reliability.

Protecting the seals

Four ancillary technologies help ensure that Flowserve seals remain healthy



The easiest way to flush mechanical seals in most compressor applications is by using pressurized gas taken from the compressor's discharge. The major drawback, of course, is that the seal gas now carries the same contaminants present at the compressor outlet. Given the high sensitivity of every dry gas mechanical seal to solid and liquid contamination carried in the seal flush gas, Flowserve developed an arsenal of ancillary gas pretreating equipment designed to protect seals against contamination.

Normal shaft rotation is sufficient to maintain the thin separation between the faces of a dry seal. When the shaft slows, however, flow through the compressor decreases and seal gas flow can decrease to insufficient levels. When the seal gas flow is too low, untreated process gas can contaminate the seal chamber and the seal faces can come into contact, grinding any particulates into the surfaces.

The **Ampliflow Gas Booster** provides a flow of clean, filtered, pressurized seal gas when the compressor's speed and pressure differential are too low to keep the seal faces apart. Even at zero RPM, Ampliflow technology provides sufficient gas flow to separate the faces.

Using the compressor discharge to provide seal gas is a viable scheme only if the process gas is reasonably clean. Otherwise, any entrained liquids and particulates can contaminate the seal faces. In response, the Flowserve **Cleanpac** gas conditioning system eliminates those contamination issues by removing particulates as fine as 0.3 micron and as much as 10% by volume of liquid slugs.

The petroleum and petrochemical industries don't use air to flush noncontacting gas seals because of flammability issues. Instead, nitrogen is the gas of choice for protecting mechanical seals in applications handling hydrocarbons and flammable gases. But providing a reliable supply of inert material at remote locations might prove to be impractical or outright impossible. For these situations, Flowserve offers its **N2 Genpac**, a fully instrumented, standalone, membrane-based, modular air-separation system. This technology concentrates atmospheric nitrogen into a high-purity flow suitable for seals and separation gas supplies.

The American Petroleum Institute promulgates standards that recommend using heated, dry gas to protect mechanical seals. The goal is to maintain a 20°C (36°F) dew point margin. The Flowserve **Drypac** gas conditioning system features a refrigerated dryer to reduce the seal gas dew point and a reheater to raise the gas temperature enough to maintain the margin. The Drypac system integrates both Ampliflow and Cleanpac technology to enhance dry gas seal life to the maximum extent possible.

Keeping the home lights burning

Engineered seals overcome endless cycling to enhance the reliability of California's power grid

The Duke Energy Moss Landing Power Plant is about one mile inland of Moss Landing on the easternmost shore of Monterey Bay, midway between Monterey and Santa Cruz, Calif. As part of a 2002 plant upgrade, Duke Energy installed three Atlas Copco Energas 24,000-rpm, two-stage compressors to feed natural gas to four gas turbines. The compressors currently produce an outlet pressure somewhere between 485 psi and 500 psi, but they don't operate continuously. Six or seven weekly compressor start/stop cycles are the norm as the plant matches its power generation to demand.

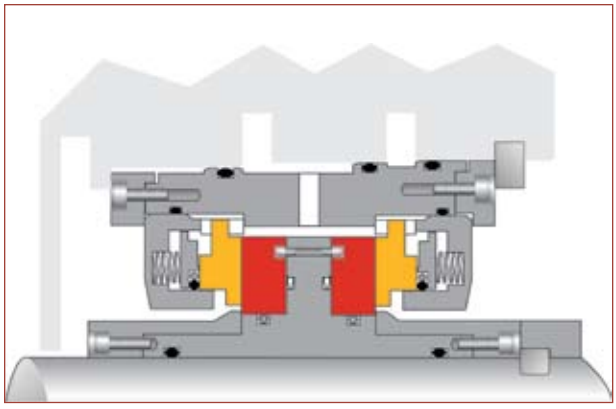
That single aspect of the operation highlighted a core design problem. The compressor seals are subject to California's zero-emission regulation. And the compressor's original OEM seals leaked.

"Starting and stopping," says Craig Hill, Duke Energy assistant engineer, "was the key factor in the original seal failures. When the shaft stopped, we had backflow, with natural gas coming out. We were getting only 2,500 hours to 3,500 hours of operation between failures when we should have gotten 50,000 hours." The failure rate led to no less than 17 original OEM seal replacements across the three compressors in slightly more than 18 months.

"The original OEM seal had no tech support in the United States," adds Hill. "We faced a six- to eight-month turnaround on new seals and repairs. It forced us into a position where we had to overstock our seals." To ensure adequate availability, Duke stocked about $250,000 worth of cartridge seals and rebuild kits.

Atlas Copco supported the investigation and relentless search for a solution to the seal leakage. When the dust settled, the presumed root cause narrowed down to degradation in some non-metallic seal component that contaminated the faces.

Duke Energy was already familiar with Flowserve seals in other plant applications, so it invited Randy Olson, owner of Sealtec Inc., the local Flowserve distributor, to weigh in on the matter.



Olson contacted John Marta, Flowserve senior compressor seal specialist in Littleton, Colo., who tracked the company's efforts to deliver an engineered seal. A Flowserve Gaspac "D" double opposing-face dry gas seal was crafted specifically for the Duke Energy 2.09-in. compressor shafts and housings with no required modifications. Being able to use the existing seal support system was also a big factor in the seal design selection process.

The original seal pair retrofitted in November of 2003 continues to operate without failure nearly 30 months later, with all compressors now fitted with Flowserve Gaspac seals.

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LifeCycle Advantage

The Right Teamwork Can Help You Achieve Your Goals

With Flowserve as your trusted partner, you can reach new heights of efficiency and profitability.

Flowserve LifeCycle Advantage is the industry's leading equipment management program. Customized to meet every customer's unique operating goals and rotating equipment, mechanical seal, or valve and automation requirements, it can lower the total cost of ownership of your equipment.

To learn how, contact your local Flowserve representative or visit our website at flowserve.com/lifecycleadvantage.

Experience In Motion

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