Power generation

Avoiding dry run conditions in plants

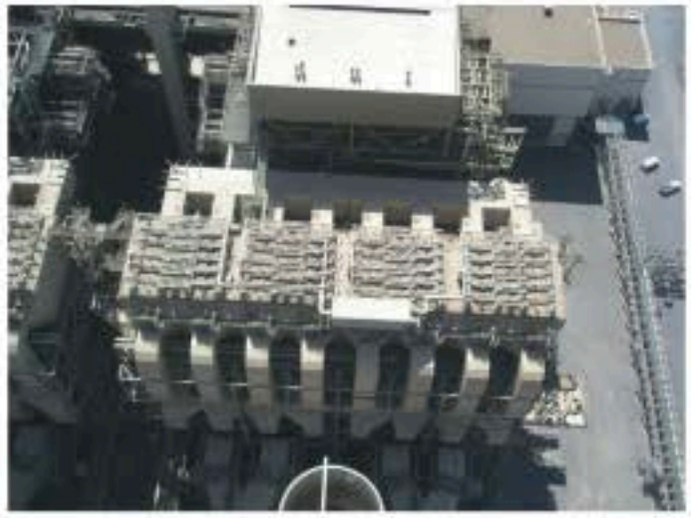
When one of the top electric generating plants in the U.S. experienced a cataclysmic event resulting in the shutdown of a critical high energy boiler feed water pump, operators called on Quadna, a DXP company, for help. The pump was sent to Quadna's headquarters for a teardown, upgrade and rebuild. Quadna engineers recommended using DuPont Vespel CR6100 for the booster pump's bushings and casing wear rings.

After a shutdown of a critical high energy boiler feed water pump in one of the top electric generating plants in the U.S., Quadna, a DXP company, stepped in to help the situation.

An unanticipated pump failure occurred in spring 2011 at the Navajo Generating Station (NGS), which is located on the Navajo Indian reservation near Page. The NGS is a 2,400-megawatt station with three 800-megawatt coal-fired units that serve electric customers in Arizona, Nevada and California. The plant is operated by SRP, headquartered in Phoenix, Ariz.

One of the plant's principal boiler feed booster pump (BFBP), a 10X17 Ingersoll Rand model J line, already was in need of a major design upgrade. So, Quadna engineers recommended using DuPont Vespel CR6100 for the booster pump's bushings and casing wear rings. One of Vespel's unique properties is that it gives equipment crucial protection because of its ability to run dry, which helps prevent major failures.

The pump in need of repair was Unit 1 C BFBP. It had failed catastrophically due to a run dry event during which the pump did not receive feedwater for approximately 60 seconds. The BFBP failed during an operational upset. This upset condition shut the feed water off to the pump for a brief time, causing the pump to fail. It seized which tripped the motor starter.



The Navajo Generating Station, which is located on the Navajo Indian reservation near Page, Arizona, is a 2,400-megawatt station with three 800-megawatt coal-fired units that serve electric customers in Arizona, Nevada and California.

The pump was sent to Quadna's headquarters for a teardown, upgrade and rebuild. Upon arrival, engineers and technicians noticed that the pump did not rotate freely. The first step in the disassembly process proved very challenging because the rotating assembly (RA) was unbolted. A 60t hydraulic press was used to press the RA out of the pump casing. This attempt also failed.

After Quadna's engineering team reviewed the situation, it was decided not to apply additional force to remove the RA. Engineering had concerns that if additional force was applied to remove the RA, it could complicate and damage the impeller and/or casing. Engineering recommended using a plasma cutter to cut the shaft so the RA could be removed. The first cut did not free the RA. As a result, the shaft was cut in three places yet the impeller still could not be removed.

The run dry condition caused such severe damage to the BFBP that the impeller sleeve nuts on the non-drive end (NDE) had to be galled to the shaft and bushing. When this occurred, the drive forces stripped the threads on the shaft and NDE sleeve nut. This action allowed axial movement of the impeller along the shaft.

The drive end (DE) impeller sleeve nut was galled in a similar fashion, however the

The high energy boiler feed pump is prepared for the installation of Vespel CR6100 to protect the booster's bearing bushings and casing wear rings.

A coating of Vespel CR6100 after being applied to the booster pump.

The newly installed boiler feed pump's throat bushing after being manufactured with Vespel CR6100.

threads were not stripped and the sleeve nut maintained its original position. The axial impeller movement was contained when the impeller seized to both the shaft and housing which is why the impeller would not press out of the galled position. The casing was put into a mill and the shaft machined out of the center of the impeller, freeing the last piece of the RA. Non-destructive testing methods were used to check the pump casing and impeller. Magnetic particle and die penetrant both were used before and after to determine if the cracks were properly mitigated.

Wear rings were manufactured from the Vespel CR6100. Normally, wear rings are made from a wide range of metals. The rings are installed with close radial clearances that allow for thermal growth at operating temperatures. Occasionally, there is contact due to shaft deflection as a result of off-design operation. When a run dry condition occurs, using metal-to-metal rings, galling can occur, resulting in a sudden high-energy failure.

This was the primary reason for selecting the Vespel for the wear rings and throat bushing/bearings. Additional benefits of Vespel are reduced radial running clearances. Quadna used Vespel's recommended clearances, which are approximately half of the required clearances recommended by API. The reduction of the radial running clearances improves pump vibration, reduces shaft deflection and increases mean time between failures (MTBF). This phenomenon occurs as a result of the close running clearances between the wear rings.

The fluid between the wear rings acts as a hydrodynamic bearing. The radial forces from the wear rings are a function of differential pressure, speed and fluid properties. As the wear ring clearances are reduced, so are the radial forces, therefore, reducing vibration. These principles generally are applied in seals and other close tolerance rotor stator applications. Other benefits are increases in efficiency, reduction in required horsepower and NHSHr.

This was the first time Vespel has been used by SRP NGS for bearings and wear ring in high temperature applications. Operations and maintenance have noted reduced vibration and bearing temperatures that they attribute to the upgrades made on the BFBP.

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