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Grand Coulee Dam Uses Six Cantilever Pumps to Ensure the Reliability of Three 805 Megawatt Turbines

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INDUSTRY: Power, Energy and Utility

ENTITY: Grand Coulee Dam

SOLUTION(S) PUMPED: Wastewater

PUMP TYPE(S): SUMP-GARD Thermoplastic Vertical Pump

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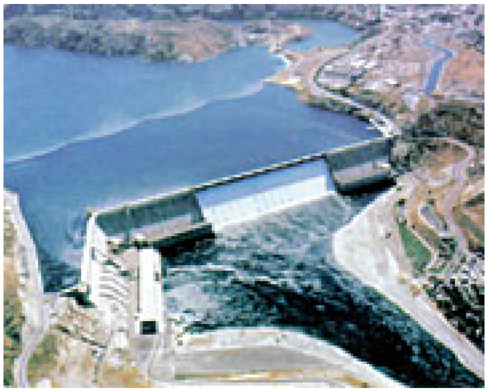

Mechanics of the Grand Coulee Dam incorporated six Vanton sump pumps to ensure reliability and operation of three 805 megawatt turbines.

Close-up of one of the six Thermoplastic Cantilever SGK sump pumps with dry-run capability.

Grand Coulee Dam Uses Six Cantilever Pumps to Ensure the Reliability of Three 805 Megawatt Turbines

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With an installed capacity of 6,809 megawatts, the Grand Coulee Dam located on the Columbia River in the state of Washington is the largest hydro project in North America.

For a short time following its completion, it was known as the largest hydro project in the world. Measuring more than a mile long (1.6 kilometers) and 550 ft tall (167.6 meters), it is the biggest concrete structure ever built, containing nearly 12 million cubic yards (339,847 cubic meters) of concrete.

Lake Roosevelt, which stretches out behind the dam, is approximately 150 miles (241 kilometers) long as it extends up the Columbia River to the Canadian border and to the Spokane River within 37 miles (60 kilometers) of the city of Spokane. As such, Lake Roosevelt contains more than five million acre-feet (6,167,409,188 cubic meters) of active storage capacity.

The Grand Coulee Dam releases, on average, 110,000 cubic feet (3,114.85 cubic meters) of water per second, primarily for generating electricity. Controlling high volumes of water requires giant-sized equipment, which can sometimes face giant-sized problems when problems occur.

Three of the 24 turbines are rated at 805 megawatts and are some of the largest turbines ever built. Making sure they consistently function in a reliable manner can present significant hurdles for maintenance engineers and mechanics.

Spotlight on the problem

Mentioned above, three of the turbines, Units G-22, G-23, and G-24, each are rated at 805 megawatts. Their main turbine shaft is approximately eight feet in diameter with shaft seals that consist of a set of braided packing rings, held in place by a gland within the stuffing box. Water supplies cooling and lubrication for the packing through a standard lantern ring located in the middle of the packing set. Leakage during operation is to be expected.

Further, the amount of leakage increases as the packing wears and ages. This leakage collects in the turbine pit and has to be pumped out periodically; otherwise it could damage the turbine.

Sump-Gard® SGKThermoplastic Cantilever Bearingless Vertical Pump

The original design for turbine pit drainage provided for two 200-gpm pumps, one designated as the lead pump and the other as backup. These pumps were controlled by a multi-step float switch system. If the leakage became severe, exceeding the ability of the pumps to keep up, the generator would have to be shut off.

Because it is highly undesirable to shut off the generator, maintenance personnel placed additional, small, submersible pumps to remove water from the turbine pit. The discharge from the pumps was sent to gravity drains or to adjacent units with less leakage.

The amount of packing leakage varies, depending on the unit load as well as other variables. Thus, the additional pumps are not needed all the time. When the water level eventually falls below the pump impeller, the seal in the suction cavity is broken. All cooling and lubrication provided by the water stops and the pumps overheat and burn up. The problem can be exacerbated by the fact that the added submersible pumps are not always visible to operations personnel.

To make matters worse, the water that comes out of the packing area mixes with water leaking out of wicket gates and other mechanical seals. As a result, the water often contains grease, rags and oil that sometimes clog up the added pumps.

One of the mechanics based at the Grand Coulee Dam suggested replacing one of the small pumps with a bearingless Vanton cantilever-shaft pump, which was specifically designed to operate under extended dry-run conditions. Because it incorporated a vortex pump head configuration to handle foreign objects without clogging, it was put to the test.

The original intent was to use it as a backup pump, which operators could simply start and leave running when one of the turbine units experienced severe leakage. To the surprise of the Grand Coulee Dam operators, the 600-gpm Vanton Sump-Gard® SGK polypropylene pump quickly drained the entire pit and handled the contaminated water without any problems and without the risk of damage associated with dry running conditions.

Because of the positive results, the Grand Coulee Dam retrofitted all three 805 MW turbines to use the cantilever pumps. There are two Vanton SGK pumps in each of the turbine pits, connected to a multi-stage float system that alternates running time. Although each pump is able to completely drain the pit, they are instrumented with level controls so the idle pump will kick in should the volume of the water in the pit get too high. These are the specifications for the installed pumps that have been providing uninterrupted, dependable service for the past two years.

Design specifications

To address the problem faced by the water leakage at the Grand Coulee Dam, various design specifications were indicated. For example, engineers required a rugged, thermoplastic vertical pump with cantilevered shaft and dry running capability that had no bearings immersed in the pump fluid.

The pump required a large diameter alloy steel shaft isolated from the fluid by a thick-sectioned thermoplastic sleeve and heavy-duty external hall bearings above cover plate, housed in epoxy-coated cast iron motor bracket to accommodate NEMA, IEC and European standard motors. All immersed pump parts and hardware were made of homogeneous thermoplastics so that no metal or thermoset composites are in fluid contact.

Finally, it was required the pump have a dynamically balanced semi-open impeller with embedded, molded-in stainless steel reinforcing insert and a vortex pump head to handle foreign objects without clogging.