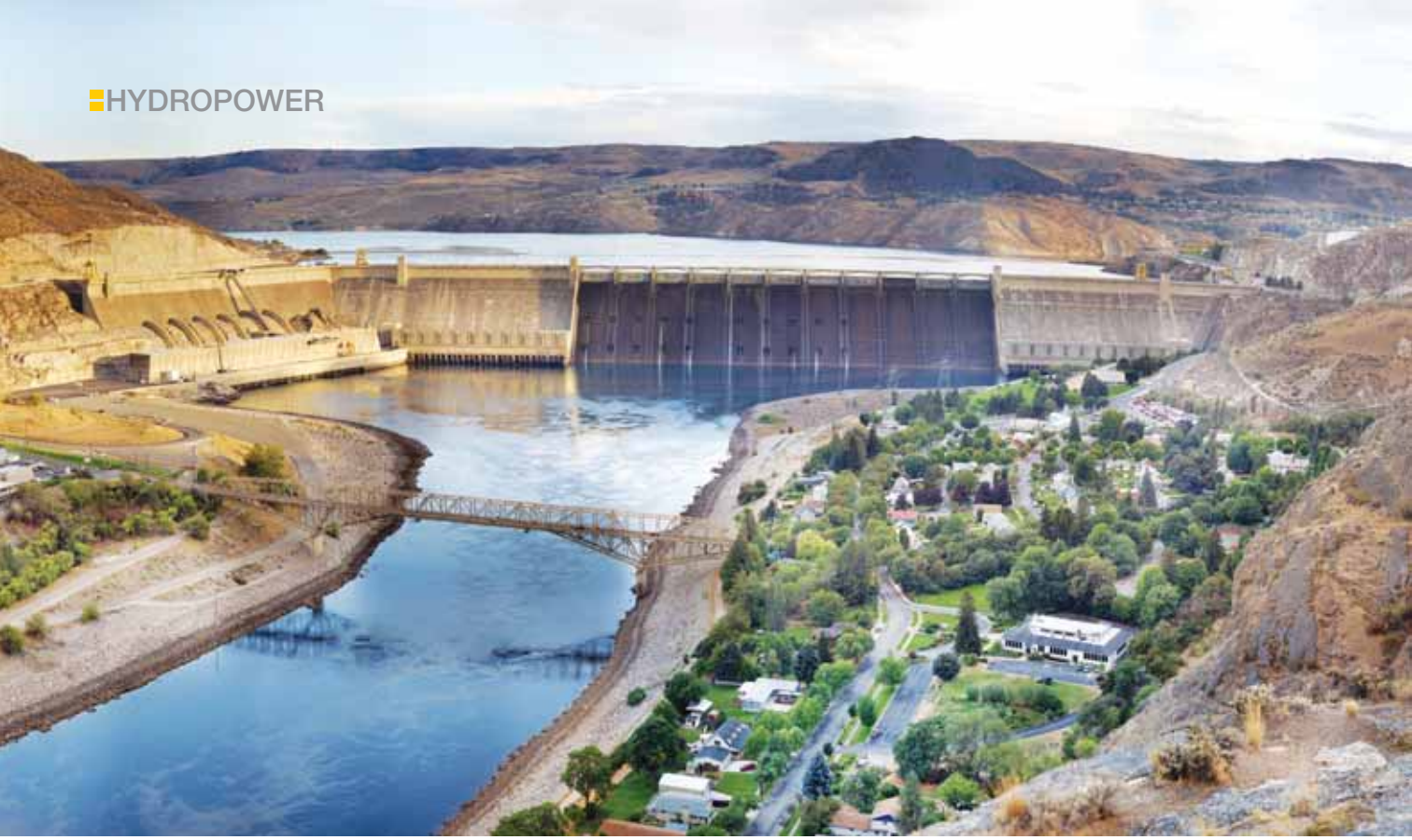


A Grand Facility

Gravity dam produces hydroelectric power & provides irrigation

By Marlee Rosen

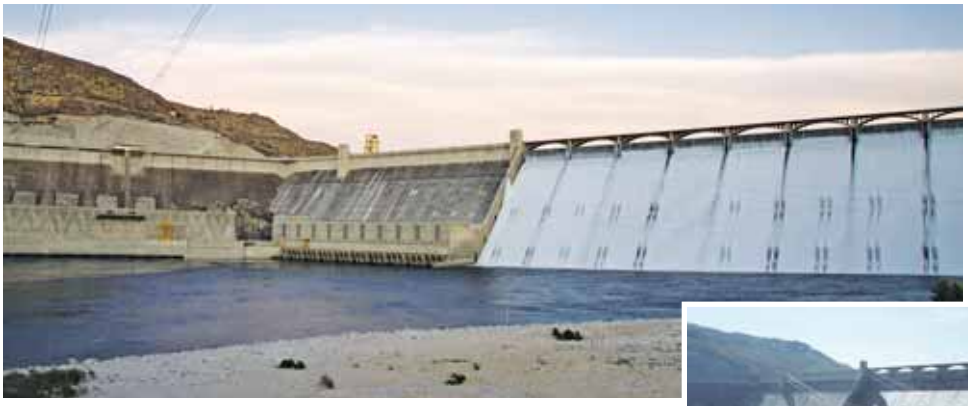
Grand Coulee Dam is a gravity dam on the Columbia River in the state of Washington built to produce hydroelectric power and provide irrigation. It happens to be the largest concrete structure built in North America. Raising the water surface 350 ft above the old riverbed, the dam is 5,233 ft long; 550 ft high; and contains 11,975,500 cu yd of concrete.

Operated by the U.S. Department of the Interior's Bureau of Reclamation, the Grand Coulee Dam plays an important role as an entity of the Columbia Basin Project in central Washington. It serves as a multipurpose project, providing flood control, irrigation, hydropower production, recreation, stream flows, and fish and wildlife benefits. Within the dam facilities, there are three power plants, a pump generating plant and three switchyards. Additionally, the Franklin D. Roosevelt Lake behind the dam, which is 151 miles long with more than 5 million acre-feet, provides active storage. Water is pumped for irrigation in the Columbia Basin to irrigate approximately 670,000 acres with an ultimate potential of 1.1 million acres.

Components of the Hydropower Plant

The power facilities at Grand Coulee Dam consist of a power plant on both the left and right sides of the spillway on the downstream face of the dam. The Third Power Plant on the downstream face of the forebay dam, the pumping generation plant on the left abutment of the dam, an 11.95/115-kV switchyard, a 230-kV consolidated switchyard, and a 525-kV Third Power Plant cable-spreading yard and switchyard all are located high in the hills west of Grand Coulee Dam.

One powerhouse contains three station service generators rated at 10,000 kW and nine generators rated at 125,000 kW. The second powerhouse contains nine generators rated at 125,000 kW. The Third Power Plant contains three generators nameplate rated at 600,000 kW—but able to operate up to 690,000 kW—and three generators rated at 805,000 kW. The pump generating plant contains six pumps rated at 65,000 hp, two pump generators rated at 67,500 hp, and four pump generators rated at 70,000 hp. Each of the generators is fed by an individual penstock with the largest approximately 40 ft in diameter and carrying up to 35,000 cu ft per second of water. One switchyard has 11.95-kV distribution and four 115-kV transmission lines; one switchyard has 230-kV generation (from 18 125,000-kW units) and 11 transmission lines; and the third switchyard has 525-kV generation (from six power plant units associated with the Third Power Plant) and six transmission lines. There are electrical connections through transformers between the 115- and 230-kV switchyards and the 230- and 525-kV switchyards. The main dam contains 11 drum gates, each 135 ft long, and 40 outlet tubes with 102-in. ring seal gates for spilling water.



Grand Coulee Dam is the largest hydropower plant in the U.S.

Hydropower accounts for 79.7% of Grand Coulee's purposes while irrigation and flood control comprise the rest.

Individual penstocks carry water to each generator at Grand Coulee. The largest carries water to the Third Power Plant, which, to give perspective, provides more than twice the average annual flow of the Colorado River. The dam complex's three switchyards transmit electricity into the regional power grid.

The total generating capacity is 6,809 MW and its average annual energy output is about 2,300 MW, or enough power to continuously supply the needs of two cities the size of Seattle.

Control Project Scope & Configuration

This means that the Grand Coulee Dam is the largest hydropower plant in the U.S. The Bureau of Reclamation's team must carefully control how it supplies power to the grid and safeguard the plants from any possible failures that could cause power spikes or dropouts. There is a project underway to retrofit the control system for the Bureau of Reclamation in cooperation with the Bonneville Power Administration, the U.S. Army Corps of Engineers Hydroelectric Design Center, the project's system integrator, and RTI Data Distribution Service to implement RTI's SCADA solution.

The dam network connects a 40,000-point SCADA system controlling 30 generators to the transmission switchyard. In the new architecture, RTI Data Distribution Service will integrate 50 to 60 Linux-based programmable logic controllers on the central control network with Windows Human-Machine Interface systems and various database and health monitoring servers. The system will run on standard, ruggedized commercial computing hardware. The architecture eventually will be deployed on a network of 12 dams in the Federal Columbia River Power System.

Trelleborg Sealing Solutions has been brought in to supply its hydro bearing material, Orkot TXMM, to be used on applications involving control gate link bushings, operating rings and wicket gate bushings starting with three of Grand Coulee's Third Power Plant units. The material comprises an advanced reinforced medium weave polymer (sometimes called synthetic polymer alloy) using a manufacturing process that provides a high concentration of polytetrafluoroethylene (PTFE) in the sliding area while maintaining high compressive strength. The PTFE layer is several millimeters thick, making it tolerant to wear, while maintaining its low friction properties throughout the service life of the bearing.

Currently, the 4,485-MW Third Power Plant is in the beginning stages of a major rehabilitation. The Orkot TXMM Hydro was chosen for this retrofit project for its ability to provide a specialized low friction-bearing surface to extend its dry running capabilities and further reduce friction and wear rates. This allows for tolerance to edge loading and misalignment even with the heaviest loads, and the hydro bearings are particularly suited to freeze fitting without the danger of shattering. The engineering team also had to have materials that proved to be delivering the highest wear resistance possible in addition to being dimensionally stable (no swelling in water). The fact that the materials also were tested by Powertech Labs and approved by the U.S. Army Corps of Engineers helped establish further confidence in the team's decision to use Orkot hydro bearings.

Quality Expectations & Future Plans

Hydropower accounts for 79.7% of Grand Coulee's authorized purposes, the others being irrigation and flood control. While hydropower is the primary purpose of the dam today, the public's desire for irrigation was the driving force behind its construction.

Work several years in the making is about to commence at the Third Power Plant of the 6,809-MW Grand Coulee project in Washington. Rehabilitation of all six units, including potential uprating of three of them, will ensure continued operation of this valuable asset and a possible extra 240 MW in generating capacity.

As the largest hydroelectric facility in the U.S., the 6,809-MW Grand Coulee project on the Columbia River in Washington is integral to power generation in the Pacific Northwest. The most recently commissioned powerhouse at the dam—the 4,485-MW Third Power Plant—began operating in 1975. The six units are reaching the end of their design life and require significant rehabilitation.

The Bureau of Reclamation's expectation of quality is high especially because careful planning for this rehabilitation has taken several years. Work on the overhaul of three of the six units started in March 2013 and is scheduled for completion in September 2017. The Bureau of Reclamation is under much scrutiny, as there has been significant investment in determining the scope of the work on the remaining three units, which is scheduled to begin in January 2018 and be completed in December 2022. When complete, the plant should operate reliably and securely for another 30 to 40 years. iWWD

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