Heavy Lifting Improves Hydropower Reliabillity

U.S. ARMY CORPS OF ENGINEERS **BUILDING STRONG®**

Providing clean, reliable, renewable, efficient and flexible hydroelectric power to the regional power grid is an important part of the Walla Walla District's mission, and many households and businesses rely on that effort. Maintaining reliable power takes a great deal of daily and long-term planning and effort.

McNary Lock and Dam is the district's largest single hydropower provider. It may be obvious that hydroelectric generation projects like McNary Lock and Dam's powerhouse require ongoing maintenance after they're constructed.

McNary Lock and Dam on the Columbia River near Umatilla, Ore.

What's less obvious is the amount of heavy lifting needed to replace power-generating equipment when large metal components reach the end of their normal lifespan. "Large" also means "heavy" when it comes to hydroelectric generators. The weight of generator components is enormous, and that complicates replacement of critical parts, which must be done safely.

McNary Lock and Dam's 14 hydroelectric generators were installed and operating in the powerhouse by 1957. They generate up to 980 megawatts of hydropower as part of the regional power grid. A megawatt powers about 700 homes. At full capacity, McNary's powerhouse can supply enough power for about 686,000 homes. During fiscal year 2009, 5.1 billion kilowatt hours of electricity were produced.

At the heart of each of the generators is a set or ring of rotating magnets with a diameter of about 35 feet. The magnets are part of a rotor assembly that weighs about 1200 tons. This is the portion of the generator that's turned at about 90 revolutions per minute by the force of the water fed through the powerhouse to the generator's turbine. The magnets on the outside of the rotor assembly rotate close to a stationary copper "stator" winding affixed to the powerhouse. The magnetic field produced by the rotating (rotor) magnets induces electrical current in the stator windings. This electromagenetic induction converts the power of falling water to hydroelectric power.

The generator magnets and stator windings have done their job well, and most of them for more than 50 years. But they've reached their original projected lifespan of 50 to 70 years, and four of the 14 generators have failed during the dam's lifetime. Stator windings were replaced on two failed generators in 1999 and 2006. So the Corps is working to replace 10 more stator windings at McNary during 2010 to 2014 to maintain reliable electric power generation. Two stator windings per year will be replaced.

Copper stator windings are revealed after the 1200-ton rotor assembly is removed.

This isn't like changing the spark plugs on a car. The removal and replacement of stator windings takes significant time, effort, financial investment, and both large bridge cranes built into the McNary powerhouse when the dam was constructed.

What's the cost? The five-year effort is expected to cost about $64 million. The Bonneville Power Administration is funding this project because of McNary's ongoing impact on the regional power grid.

How long will it take? The Corps will replace two stator windings each year for five years. To minimize impact on power generation, they'll be replaced during each year's July-through-December low-water flows when the powerhouse wouldn't normally be operating at full capacity.

Overall, it usually takes five to six months to disassemble a generator, replace the stator winding, and

reassemble it. The project involves massive lifts of very heavy generator components which must be lifted out of the way to get to the stationery stator in order to replace its windings. Then those heavy components must be reassembled.

Initially, it usually takes several weeks to disassemble the top portion of the generator in preparation for a stator winding replacement. Part of that initial effort includes about a week just to take precise measurements of the heavyweight components and clearances so that the generator can be re-assembled safely and correctly. The rotor alone weighs more than 600 tons, spins at 90 revolutions per minute (rpm) in normal operation, and the entire rotating turbine assembly weighs about 1200 tons. The clearance between the spinning rotor assembly and the stationery stator winding is only about an inch and a half. So it's important to get the measurements right when dealing with such massive weights and rotational speeds.

The first major "heavy lift" is to lift the "upper bearing bracket," which weighs 220 tons. The crew lifts it with one of the two permanent powerhouse bridge cranes and then sets it aside.

The next heavy lifts are to lift each generator rotor, which weigh more than 600 tons apiece. It takes both powerhouse cranes ganged together (attached together) to lift a single rotor and then place it out of the way. Three large lifting beams weighing a total of 40 tons are attached to each rotor to lift it. Those lifting beams were designed so the bridge cranes can make these heavy lifts.

Each of the two rotors is carefully lifted and placed on a custom concrete pedestal in a dedicated storage and maintenance area. Since the powerhouse was designed and built with only a single rotor storage pedestal, a second pedestal had to be constructed so that two units could be worked on at the same time.

220-ton upper bearing assembly is one of the first large metal components to be removed. Note worker on left.

After this heavy lifting, the stator windings are finally exposed, and work can begin on their replacement. The generator's stationery core holds the stator windings or coils. The existing copper coils are then removed from the slots, and the open slots are inspected and then prepared and painted with semi-conductive paint. Two layers of new pre-fabricated copper stator winding bars are installed in the slots. Temperature sensors are also installed. To keep the stator winding bars from moving when the generator vibrates during operation, wedges, fillers and packing material are installed.

Each stator winding holds about 45,000 pounds or 22.5 tons of copper. The old copper is recycled.

Eventually, the entire generator is reassembled using another series of heavy lifts. Finally, the entire system is tested to ensure proper and safe operation, and put back in service.

It's not simple nor easy to remove and replace hydroelectric generation equipment like this, but it's a necessary part of the district's mission as a key power supplier. The Corps of Engineers is dedicated to this mission and serving the public with reliable hydroelectric power.

Updated 10/06/2010 - 1100