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ADDRESSING UPLIFT CONCERNS AT MANSFIELD DAM

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Perspectives

Worth Quoting … and Re-Quoting

In this issue of Hydro Review, you’ll find several statements and phrases that — when put together — get you thinking about this industry’s future as well as can be used to tell a story of hydro’s value.

I hope you’ll share these items with colleagues in the powerhouse, in the break room, and in your office. I hope you’ll post something on LinkedIn about one of them, or send a tweet. I hope you’ll bring these items up in conversation with your neighbors and friends.

The saying goes: “You have to tell someone something seven times before they remember it.” The items below are certainly worth re-quoting at least seven times!

“Hydro is the perfect renewable”
One of the most exciting articles you’ll read in this issue begins on page 26. Tennessee Valley Authority (TVA) President and CEO Bill Johnson offers some great quotes about the value of hydro:

“…hydro should be the answer as the ultimate renewable.”

“…we need to get back to thinking about hydro as a primary resource …”

“…hydro is the perfect renewable, the perfect peaking power, the perfect load following power.”

People listen to what Bill Johnson has to say. After all, he runs the largest public utility in the U.S. Prior to joining TVA, he was chairman, president and CEO of Progress Energy; was a partner with Hunton & Williams, where he specialized in representing utilities; and served as a law clerk to Judge J. Dickson Phillips Jr. of the 4th U.S. Circuit Court of Appeals. He has been vice chairman and served on the executive committee of the Edison Electric Institute and chair of the board of directors of the Nuclear Energy Institute.

He sees power generation from a broad perspective, and he sees a specific role for hydro.

Please take a few moments to re-quote what Mr. Johnson has to say.

“People Building for People”
One of the advertisements in this issue uses this quote. Much of this hydro business IS about people. The genesis of the industry had to do with making lives better and safer for people. Hydropower development throughout North America has occurred (and, by the way, is STILL occurring) to help drive economies, to help raise people out of poverty, and to put people back to work.

In this industry, you do much more than just generate electricity. You take care of people. You provide them places to have fun with each other. You harness water for use in growing crops and meeting drinking water needs. You provide education and information on how to be good stewards of our natural environment. You ensure their safety. In fact, the cover story of this issue is focused on ensuring that people are safe.

People building for people. That’s a quote worth re-quoting!

“It’s affordable, it’s reliable, it’s available and it is certainly a very important part of our sustainable future.”
That quote is the first line in a new 10-minute video featuring the leaders of four hydro associations. (Read more on page 67 in the “From the Web” department.) In the video, the association leaders share their thoughts on the state of the hydro industry.

Watch it. Share it. Get your organization to post a link to it on its website. The video is an excellent tool we can all use to tell the story of the hydro industry and what’s in store for the future.

Marla J. Barnes
Publisher and Chief Editor
Obama, EPA release revised Clean Power Plan

U.S. President Barack Obama and the Environmental Protection Agency have unveiled a sweeping program to reduce carbon emissions in the country by more than 30% from 2005 levels by 2030. The program, called the Clean Power Plan, sets emissions reduction goals for fossil-fueled generating plants and will require individual states to establish plans to reduce their own emissions by September 2016. States will then have until 2022 to comply.

EPA said the plan is a necessary response to alarming trends regarding global climate change, with 14 of the 15 warmest years on record having occurred since 2000.

Exactly how much emphasis the Clean Power Plan puts on individual forms of energy generation is overall ambiguous, although the 1,560-page document seems to favor wind and solar. Language included in the plan does define conventional hydroelectric, wave and tidal power as “renewable energy resources.”

The plan is a revised version of one released in 2014. States are given an option to choose between two plans: Emissions Standards Plan or State Measures Plan. However, shortly after the plan was released, 16 states requested an “immediate stay” on the program, saying it “unlawfully exploits Section 111(d) of the Clean Air Act.” States signing the 14-page grievance are Alabama, Arizona, Arkansas, Indiana, Kentucky, Louisiana, Nebraska, Ohio, Oklahoma, South Carolina, South Dakota, Utah, West Virginia, Wisconsin and Wyoming.

Hydropower represented well in bipartisan Senate bill

Bipartisan energy legislation submitted to the U.S. Senate July 22 includes a section that defines hydroelectric power as a renewable, while also improving on existing hydropower regulation. The Energy Policy Modernization Act of 2015 was introduced by Sen. Lisa Murkowski, R-Alaska, and Sen. Maria Cantwell, D-Wash.

For conventional hydropower, some provisions are:
— Designates the Federal Energy Regulatory Commission (FERC) as the lead agency to set a binding schedule and coordinate federal authorizations in order to address permitting backlogs;
— Sets forth a Sense of Congress that hydropower is a renewable resource for purposes of all federal programs;
— Amends the federal purchasing requirement in the Energy Policy Act of 2005 (EPAct) to include all forms of hydro and raises the requirement for renewable energy from 7.5% to 15%;
— Extends preliminary permit terms to four years and lengthens the subsequent potential FERC extension to four years; and
— Directs FERC to compile and make public a comprehensive collection of studies and data; use existing studies in individual licensing proceedings; and ensure studies required for federal authorizations are not duplicated.

The act would also extend the incentives for hydroelectric production and efficiency improvements through Fiscal Year 2025.

Further stipulations increase support for ocean, tidal and wave energy by amending EPAct and the Energy Independence and Security Act of 2007 (EISA) to authorize the National Marine Renewable Energy Research, Development and Demonstration Centers to participate in demonstration projects, support in-water testing, support arrays of technology and serve as information clearing-houses. The bill increases EISA appropriations for MHK research from $50 million for each fiscal year from 2008 through 2012 to $55 million for fiscal years 2017 and 2018 and $60 million for 2019 through 2021.

Reclamation releases reports on Shasta Dam raise

The future of a proposal to raise California’s Shasta Dam by as much as 18.5 feet is once again in question, following the release of two reports by the U.S. Department of Interior’s Bureau of Reclamation in late July.

Reclamation’s final feasibility report and final environmental impact statement describe the technical, environmental, economic and financial evaluations used in determining a course of action. The reports also include proposals for identifying cost-sharing partners and project financing, should the project ultimately move forward.

However, the final feasibility report, which examines raises of six height increments, notes that the proposals’ price tags of $990 million to $1.28 billion remove the potential for full federal funding due to “unrealistic” expectations that the costs could be repaid through water and hydroelectric power sales in the 40- to 50-year time frame usually given for such infrastructure projects.

Project financing would likely then fall to a combination of agricultural, municipal and industrial partners who would benefit from the increased storage capacity in Shasta Lake, although the long-time proposal has seen opposition from those whose residential and commercial properties might have to be relocated to accommodate higher water levels.

The 602-foot-high structure was completed in 1945 and is home to the 633-MW Shasta hydroelectric plant.

Hydro Ottawa acquires 10 projects from Fortis

The acquisition of 10 run-of-river projects by Hydro Ottawa from Fortis Inc. adds about 31 MW of capacity to the Canadian utility’s fleet. The plants, spread across Ontario in Canada and New York in the U.S., will help Hydro Ottawa meet its four-year strategic goal of increasing its renewable offerings to account for about 25% of its overall energy mix.

“We want to increase renewable generation capacity and provide earnings that benefit our shareholder, the City of Ottawa, in an environmentally responsible way,” President and Chief Executive Officer Bryce Conrad said. “After significant due diligence, risk evaluation and a thorough technical assessment of all assets, we concluded that this was an excellent business opportunity.
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Hydro Ottawa said the New York assets have a combined capacity of 22.6 MW and Ontario assets combine for 8.3 MW.

The value of the deal — executed by Hydro Ottawa subsidiary Energy Ottawa — was not disclosed.

**Spending thaw to resume FERC licensing studies for 600-MW Susitna-Watana**

A thaw in the spending freeze on the 600-MW Susitna-Watana project will allow Federal Energy Regulatory Commission pre-licensing studies to resume.

Gov. Bill Walker issued an administrative order in December 2014 directing state agencies to stop non-obligated spending on six major projects due to a growing budget deficit related to falling oil prices. In response, AEA hydro project manager Wayne Dyok wrote FERC asking that the integrated licensing process for the project be suspended for 60 days. FERC granted the request in January and extended the delay again March 17 and May 13.

Dyok wrote the commission again July 2, saying that since AEA’s last report the Alaska Legislature elected not to reappropriate unspent and uncommitted funds previously appropriated to the project. “The governor signed appropriations bills on June 30, 2015, and AEA is awaiting further direction from the governor’s office,” Dyok wrote.

That direction came days later when news reports said a memorandum from the state Office of Management and Budget allowed that direction came days later when news reports said a memorandum from the state Office of Management and Budget allowed spending to resume on Susitna-Watana. The memo allows AEA to spend $6.6 million previously appropriated by the Legislature.

AEA spokeswoman Emily Ford said the goal is to finish studies that are near completion and put collected data into a usable format. Once that work is carried out to the limit of funding, the Legislature and governor are to determine whether additional funds will be allotted to the estimated $5.5 billion project.

**HydroVision International 2015 sets new record**

HydroVision International 2015 in Portland, Ore., was its largest ever with more than 3,760 attendees representing 60 countries. This year’s attendance breaks the previous mark of more than 3,400, set at HydroVision International 2011 in Sacramento, Calif.

HydroVision International 2015 began with a keynote session that featured officials from host utilities Pacific Power and Portland General Electric, as well as the U.S. Department of Energy, U.S. Department of Commerce and hydro industry associations.

“We are particularly proud to have HydroVision International here in Oregon,” said Maria Pope, senior vice president of power supply and operation for Portland General Electric. “The region’s rich resources have left us with a legacy of low-cost, reliable energy.”

Pope’s sentiments were shared by Pacific Power President and Chief Executive Officer Stefan Bird. “Hydro helps us achieve our public policy goals,” Bird said. “It helps us keep the lights on and allows for additional renewables.”

The keynote session also provided an update on DOE’s “Hydropower Vision” initiative, as well as an overview of international opportunities for American manufacturers.

Leaders from industry associations were included via a short documentary. Featured were International Hydropower Association President Ken Adams, National Hydropower Association Executive Director Linda Church Giacci, Canadian Hydropower Association President Jacob Irving and Northwest Hydroelectric Association Executive Director Jan Lee. View the video at www.hydroevent.com/hydro-tv.html.

**FERC license received for 5.25-MW Braddock Locks and Dam hydro project**

Hydro Green Energy LLC announced it received its Federal Energy Regulatory Commission license for the 5.25-MW Braddock Locks and Dam project in Allegheny County, Pa.

Hydro Energy subsidiary Lock+ Hydro Friends Fund XLII LLC filed an application for an original license for the project in 2012. The project is to be built at the U.S. Army Corps of Engineers’ Braddock Locks and Dam, one of nine Corps navigation structures on the Monongahela River.

The 50-year license authorizes installation of seven 750-kW low-head horizontal modular bulb turbine-generators in a large frame on the upstream face of the project’s left weir. The frame is to contain all generating and control systems and can be removed during maintenance or high water.

As proposed by the applicant, the levelized annual cost of operating the project would be $57.96 per MWh, or $21.05/MWh more than the cost of alternative power. With FERC staff mitigation and resource agency mandatory conditions, the annual operating cost would be $58.12/MWh or $21.21/MWh more than alternative power.

**Eagle Crest buys site for pumped-storage project**

Eagle Mountain LLC has agreed to buy the Kaiser Eagle Mountain near Desert Center, Calif., from CIL&D.

Eagle Crest Energy plans to transform the site into a pumped-storage station that can bank energy from solar, wind and geothermal plants for release during peak demand and to maintain grid stability. The proposal calls for converting two of the mine’s vacant pits into reservoirs and providing a capacity of up to 1,300 MW.

The proposal was licensed in 2014 after environmental reviews by state and federal energy and wildlife agencies, including the Federal Energy Regulatory Commission, U.S. Fish & Wildlife Service, and California State Water Resources Control Board.

The sale agreement between Eagle Mountain and CIL&D covers about 9,500 acres of land and mining claims. Of that, roughly 2,500 acres would be occupied by the energy storage facility. CIL&D, through a subsidiary, will retain the railroad and the right to sell iron ore tailings and rock from the property.

Water will be supplied by groundwater wells. Power will be transmitted to Southern California Edison’s Red Bluff substation via a 16.4-mile-long, double circuit 500-kv primary transmission line.

Editor’s Note: This content was originally featured on GenerationHub.com, a sister site of HydroWorld.com.
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Things in Texas sometimes are bigger by comparison, and Mansfield Dam is no exception. Assessing its foundational stability is paramount because Mansfield is the tallest dam in Texas at 278 feet and is classified as high hazard by the Texas Commission on Environmental Quality.
According to the National Dam Safety Review Board, the Federal Emergency Management Agency and federal agencies that build and manage dams, “high hazard potential” applies to any dam, should the dam fail, where human life is at risk.

To determine Mansfield Dam’s geotechnical foundational stability status, engineers needed to investigate the assumption that the original foundation drains significantly reduce uplift along the base. The investigation employed several field and laboratory tests to reach an engineering conclusion on the dam’s safety level.

Mansfield Dam is on the Colorado River about 13 miles from Austin, Texas, and consists of a 278-ft-tall concrete gravity section flanked by a zoned earthfill wing wall up to 100 ft tall. The dam impounds Lake Travis, a major water supply and recreational reservoir. The dam also serves as the only flood control structure for the Lower Colorado River Basin. A powerhouse next to the dam provides electricity via three turbine-generator units with a capacity of 108 MW.

The dam was designed by the U.S. Department of Interior’s Bureau of Reclamation and was constructed by the Lower Colorado River Authority (LCRA) and Reclamation between 1937 and 1941. Reclamation was prominently involved in operation and maintenance of Mansfield Dam until 1997, when LCRA assumed full ownership. The dam was initially called Marshall Ford Dam.

The original design incorporated two grout curtains and two lines of foundation drains. Sixty-two uplift monitoring stations were installed as part of construction. Subsequent reviews of the dam’s performance by Freese and Nichols under contract with LCRA and comparisons to state-of-practice design criteria revealed concerns that data from the uplift monitoring stations were not reliable. Several uplift monitoring points failed over the years due to corrosion. Stability analyses indicate effective foundation drains are critical to dam stability. As part of the current assessment performed by Freese and Nichols and Brierley Associates, site-specific values for the foundation rock and concrete/rock interface were obtained and vibrating wire piezometers were installed below the base of the dam for revised stability analyses. The piezometers provided the ability to measure and record rapid responses to changes in pore pressure beneath the dam with fluctuating reservoir levels.

**History of the dam**

Initial construction began in 1937, but after a severe flood in July 1938, LCRA opted to redesign and raise the height of the dam 80 ft to add storage capacity. The dam was constructed in two stages, with Stage 1 referred to as low dam and Stage 2 as high dam.

The concrete section in the first proposed dam was 198 ft tall and was well on the way to completion when the foundation “platform” for construction of the subsequent upstream raised dam section was started (see Figure 1).

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concrete/rock interface in each stage. The drainage galleries are located 12 ft and 73 ft downstream from the upstream face. A line of 25-ft-deep holes at about 10-ft centers was drilled at a 6-degree angle upstream in each of these galleries and filled with grout to reduce foundation permeability. Foundation drains were drilled at a 6-degree angle downstream from these galleries into the foundation. The foundation drains are 2 1/8 in diameter on 10-ft centers and are typically 60 ft deep.

The original 62 monitoring stations were installed in six lines from upstream to downstream to monitor the uplift profile across the foundation (see Figure 1 on page 10). The uplift monitoring points were constructed by placing 2-in iron pipe vertically in concrete with the bottom of the pipe 6 in above the rock surface. After the concrete was placed, 1 3/8-in-diameter holes were drilled through the pipe and into the foundation rock. The steel pipe was then routed to the drainage gallery and fitted with pressure gages.

Current stability assessment
Reclamation directed Mansfield Dam inspection and maintenance until 1997, when LCRA assumed ownership. In 2006, a review was conducted of the dam and its performance and previous studies or analyses relative to current state-of-the-art design. Review found that many of the values used in previous stability analyses were based on typical published values rather than site-specific data. Among the assumed values were the unit weight of concrete and the apparent cohesion and coefficient of internal friction of the foundation and dam/foundation interface.

In addition, dam stability was found to be sensitive to the uplift reduction assumed because of drain effectiveness. Previous stability analyses assumed a drain effectiveness of 67% because data from uplift monitoring stations suggested the drains were functioning properly and about 67% effective. However, the reliability and accuracy of the monitoring stations were questioned in several previous reports. The readings have considerable scatter and appear unrelated to lake levels. Many of the instruments show little change in reading even though the head fluctuates 90 ft over the period of record.

Figure 2 (on page 10) shows typical readings in the second dam stage, and Figure 3 (see page 14) shows typical readings in the first dam stage. The readings were further questioned as corrosion damage began to affect the exposed section of pipes, causing some of the monitoring points to stop working. The procedure for reading the instruments has varied several times in an attempt to collect reliable data.

Federal dam safety guidelines call for a reliable uplift data and regular drain maintenance program to justify 67% drains efficiency. Minimal drain maintenance has been performed at Mansfield Dam, involving only measuring drain depths several times and finding them to be nearly the same depth as they were at construction.
The comprehensive facility review found significant uncertainty in the dam’s previous stability analyses. Due to the lack of a drain maintenance program and the uncertainty surrounding the uplift monitoring data, 67% drain effectiveness was not justified. A sensitivity analysis of the dam stability found reductions in drain efficiencies, and unit weight of concrete or strength properties of the foundation would result in the dam not meeting required factors of safety for stability.

A risk assessment performed as part of the review suggested that action was required to further evaluate the risk.

The review team recommended drain effectiveness be investigated by installing modern piezometers to determine if the pressure gages were reporting correctly. It was also recommended that site-specific information be obtained on material properties and strengths such as unit weight, cohesion, and friction angle of the concrete and foundation rock.

After thoroughly inspecting research construction records, little available test data was found regarding the concrete unit weight or foundation strengths.

The next step was cleaning the drains in a 50-ft section to determine the effect on measured uplift pressures. The drain cleaning restored the drains to near original depth. Observed pressures in three of the 12 monitoring gages in this location were reduced, but they began rising again shortly after cleaning even though the lake level significantly dropped. The uplift readings were made with the original uplift gages, which have questionable accuracy. The results of the drain cleaning were inconclusive, and the data from the original gages were once again questioned.

**Foundation investigations**

In 2011, the primary purposes of the foundation investigation were to obtain material samples for testing and to install vibrating wire piezometers to verify the uplift monitoring station readings.

Twelve boreholes were drilled in the drainage galleries near the bottom of the dam. Due to limited access, a skid rig-boring machine was used. Power and water hoses were run hundreds of feet to reach the boring machine. Continuous core samples in the 40- to 75-ft-deep boreholes were taken. Coring through the concrete averaged 30 minutes per ft while coring through the rock averaged 11 minutes per ft.

All of the borings penetrated the base of the dam and extended into the limestone-bearing stratum. Vibrating wire piezometers were installed at the concrete/limestone interface in all the borings and at deeper depths in six of the borings.

Mansfield Dam is situated within a widespread outcrop zone of the Cretaceous-aged Glen Rose Formation. In the Austin area, the formation consists of about 700 ft of hard and soft limestone, dolomite and marl, which forms a distinctive, stair-step topography. The borings conducted for this investigation confirmed that the dam is supported directly on gray to tan limestone of the Glen Rose Formation.

In general, the foundation rock below the base of the dam consists of thin to thick beds of predominantly hard limestone with occasional softer argillaceous limestone seams and layers. Grout infilling of rock discontinuities from the initial construction activities was observed in a few of the borings drilled for this investigation.

Foundation hydraulic conductivity was measured with packer testing and slug testing. In the borehole, more than 100 packer tests were conducted in 10-ft sections and all but four had zero water-take. For the four that had water-take, hydraulic conductivity was calculated to be between 7.2 by 10⁻⁵ and 8.2 by 10⁻⁴ ft/min. Slug tests were performed on the entire hole at one time. The tests indicate that the hydraulic conductivity of the concrete and rock mass varied between 1.1 by 10⁻³ to 6.9 by 10⁻³ ft/min. The results of the packer tests and slugs tests indicate that the foundation rock and concrete at the base of dam are relatively impervious.

Unconfined compression tests were performed on eight concrete and 15 rock samples obtained from the borings. Unconfined compressive strength of the dam concrete was 3,612 to 8,467 psi, with an average of 5,550 psi. Unconfined compressive strength of the foundation rock was 599 to 6,117 psi, with an average of 2,874 psi.

Direct shear testing was performed to evaluate the structure’s resistance to sliding when water is stored behind the dam. Twelve direct shear tests were performed on selected core samples of concrete, limestone and the concrete/limestone contact interface. The contact between the dam and foundation was found to be intact (bonded) in eight of the 12 borings. Three direct shear tests were performed on fractured concrete/limestone interface and one on a saw-cut concrete/limestone interface. The friction angle ranged between 30 and 39 degrees. The cohesion intercept ranged between 59 and 80 psi for the three fractured surfac-
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es and was 25 psi for the saw-cut sample.

Based on these findings and interpretations of the direct shear test results, a cohesion intercept of 72 psi and friction angle of 36 degrees was used in the base sliding stability analysis. Previous analyses had assumed cohesion intercepts of 74 to 123 psi and friction angles of 37 to 45 degrees. The testing results indicated that the previous analyses overestimated the foundation strength.

Eight tests to determine the unit weight of concrete were run. The results ranged from 140 to 149 pounds per cubic ft (pcf) with an average of 146 pcf. This resulted in a 3% reduction in the mass of the dam from previous analysis, equal to about 115,000 pounds at the maximum section.

**Uplift findings**

As part of the foundation investigation, 18 vibrating wire piezometers were installed in the 12 boreholes. The instruments are automatically read by dataloggers four times each day. Figure 3 (see page 14) shows typical readings from two of the piezometers. The data indicate the uplift is directly related to lake level and data collected to date has much less scatter than the original uplift monitoring points. The piezometers generally indicate the upstream drain reduced uplift pressures to near tailwater and that the pressures were at tailwater by the downstream drain.

The stability of the dam was reevaluated, with the material properties based on the material testing. The uplift assumptions in the stability analysis used trends extrapolated from the second stage dam piezometers. A straight-line uplift was assumed from the lake level to the extrapolated upstream drain elevation and then straight line to tailwater. No reduction due to the second line of drains was assumed. The analysis found that the dam is stable against overturning and sliding using the uplift profiles developed from this study.

**Conclusions**

Key conclusions from this study include the following:

— Data from the geotechnical exploration and laboratory-testing program reveal the dam is founded on a firm foundation with an appropriate concrete/rock contact at the base of the dam. No weak layers below the interface were identified.

— Construction joints were not observed in the concrete core, suggesting an intimate bond between concrete lift joints.

— Data from the new piezometers supports the assumption that the original foundation treatment and drains result in significant uplift reductions along the dam base.

— Stability analysis found the dam to be stable, with the uplift reduction provided by the foundation drains.

**Authors**

Lewis Yates, P.E., is senior consultant with Brierley Associates. Dustin Mortensen, P.E., is project manager and Victor Vasquez, P.E., is senior engineer with Freese and Nichols. Nathan Gullo, P.E., is senior engineer with the Lower Colorado River Authority.

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Work that needs to be performed under water at dams and hydropower facilities can run the gamut from assisting with unit repairs to modifying infrastructure. Challenges abound with this type of work, and the below three case studies clearly illustrate what those challenges can be, as well as how they can be overcome.

**Upgrading a generator at Nine Mile**

Nine Mile Falls Dam is on the Spokane River about 16 miles from downtown Spokane, Wash. The dam and associated 26.34-MW generating facility are owned and operated by Avista Corp. Associated Underwater Services is performing work as part of a generator upgrade for Units 1 and 2. Because of mechanical failures and the high cost to repair the early 1900s vintage generators, these units have not operated for several years.

Preliminary underwater work on the upgrade started in 2012 with AUS performing an underwater inspection, using a remotely operated vehicle, of the tailrace and inside of each of the four draft tubes. One major finding from this inspection was that the draft tubes supplying water to Units 1 and 2 were nearly full of sand and debris from not operating for several years.

Max J. Kuney, based in Spokane, was awarded the contract for the generator upgrade work. The construction project started in the summer of 2014. AUS, also from Spokane, was chosen to perform the underwater work. The critical path underwater work was to create a dry work area inside Units 1 and 2.

By Elizabeth Ingram

Elizabeth Ingram is managing editor of Hydro Review.
This work started with the installation of two dewatering bulkheads upstream. This allowed work to begin on the removal of the old generators and the modification of the penstocks to accept the new generators. Sand removal started during the summer of 2014 and continued throughout the diving project, with new sand constantly migrating back into the work area.

The most challenging part of the project was dewatering of the downstream side of the dam. Working adjacent to the constant flow of water over the spillway created challenges in securing the work barge into position, as well as rough working conditions. To keep the work on schedule, AUS provided three dive crews with two day shifts and one night shift.

New draft tube stoplog guides would need to be installed underwater on the sides of the piers. AUS performed detailed surveys of the existing slots and found that the original guide slots were not in line with each other and were not plumb. A new design was developed by URS Engineering. The new design required the existing guide slots to be enlarged and new steel guides to be installed inside the larger guide slots.

To accomplish this task, a wall saw was set up on a vertical track to make vertical cuts in the concrete on both sides of the guide. The concrete was then chipped out by the AUS divers. A bottom sill plate needed to be installed, and this required several cuts in the floor to create a keyway for the new bottom sill plate. An underwater core drill was used to drill the holes for the rebar dowels, and these were installed with epoxy. The new guide beams were installed in one piece with a full-sized alignment frame. Once the new guide was in the slot, the entire assembly was jacked into position and rock bolted. The grout forms were wet welded into position by the divers. The forms were sealed with Splash Zone Epoxy and then the guides were grouted into position. After the grout cured, the alignment frame was removed with a crane. New guides were installed in all four draft tubes. New draft tube stoplogs were installed in Units 1 and 2 so that those entire units could be dewatered to continue the generator replacement work in the dry.

This phase of the underwater work was completed in April 2015. Work on the generator upgrade is still ongoing.

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**Dam spillway repair**

Underwater Construction Corporation (UCC) inspection crews reported a bulged area of sheet pile on a dam spillway apron during the summer of 2014, uncovered as part of a scheduled inspection at a facility in the northern Midwest. Once a report had been submitted to the dam owner on the results of this inspection, UCC began working with the dam owner to develop a repair plan. Repair methodologies, drawings and material specifications were created. UCC then developed a project budget and schedule. Mobilization commenced in November 2014.

The project required divers to repair the spillway toe of the dam by first cutting down the sheet pile to specified elevations...
using underwater cutting/burning equipment and techniques. Sheet pile was cut down 1 inch below the water line about 11 linear feet across. Divers then drilled a series of holes through the steel sheet pile into the existing concrete of the spillway for installation of eight anchors. Threaded rod anchors were installed and epoxied into place to reinforce the sheet pile and prepare for the new grout to be placed underwater. Solid carbon steel bar stock was welded vertically into place at the sheet pile knuckles to reinforce the structure following American Welding Society D3.6 standards. A geotextile membrane manufactured by US Fabrics Inc. was installed at the base of the spillway toe and custom grout bags were filled and anchored into the riverbed for future scour protection. Grout was than pumped in the voided area between the existing sheet pile and spillway apron. A final inspection of the repair was conducted and a comprehensive construction report was created as a submittal for future reference before demobilization from the site. The work took a total of 13 days.

Many challenges were successfully overcome during the work at this dam, including:

— Minimal water visibility, which required diving personnel with the skill set to work in this environment;
— Water temperature of 32 degrees Fahrenheit;
— Remote site location, which posed challenges with regard to equipment logistics; and
— Air temperatures of -10 to 20 F.

**Underwater tunnel repair using a robot**

The Puerto Rico Electric Power Authority (PREPA), owner of the 25-MW Yauco I and 9-MW Yauco II plants, was looking to perform maintenance on the tunnel systems to ensure their ongoing successful operation. At Yauco I, PREPA observed that debris was entering the turbines. This led them to suspect there was an issue with the trashrack downstream of the rock catcher and surge shaft. At Yauco II, the turbines and wicket gates required rehabilitation, but first the turbine shutoff valves needed to be rehabilitated so they could close properly.

To solve these issues and prepare the two facilities for ongoing

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generation needs, PREPA turned to ARG Precision to design low-risk remediation methods that could be carried out while water remained in the tunnel. This was important because: PREPA acknowledged that dewatering the tunnels could potentially lead to areas of collapse; the Yauco II tunnel had a tap for drinking water; and minimal flows needed to be maintained to allow for irrigation water for the surrounding communities. It was determined that dewatering was not a desirable option for the project. Further, it was desired that the remediation plans be designed to allow for the tunnels used to resume generation on short notice to meet demand needs.

ARG Precision hired Hibbard Inshore as the contractor for the underwater works, opting for a robotic repair solution rather than using divers because the work areas were confined inside the tunnels and penstocks, access space was limited, and depth was significant. Initially, Hibbard Inshore was tasked to perform underwater inspection within each tunnel and the penstocks to quantify sediment levels in the Yauco I rock catcher, assess suspected damage to the trashrack, and evaluate the Yauco II penstocks for plugging so that the turbine shutoff valves could be replaced.

At Yauco I, the rock trap and trashrack were located at about 355 feet of depth. One 4-by-8-foot section of the trashrack (weighing 2,500 pounds) had detached and moved down the penstock to about 850 feet of depth. The rock trap’s drain was no longer clearing sediment and the 100-foot-long trap was overflowing with sediment and rock. There were about 277 cubic yards of debris identified, and the rock trap was capable of holding 133 cubic yards of debris before its dividers were completely covered.

After the inspection, ARG Precision and Hibbard Inshore were tasked with providing robotic solutions for removing the debris and damaged trashrack components, dredging the sediment out of the rock trap and repairing the trashrack at Yauco I while also designing and placing a temporary bulkhead in the penstocks of Yauco II so that the turbine shutoff valves could be replaced without dewatering.

The first phase at Yauco I was to attach tooling to the ROVs to perform the cutting
and lifting operations necessary to remove the debris, conduit and damaged racks from deep underwater. The surge shaft was used as an access point into the tunnel because it was more practical to lift the ROVs, pump and tooling into the 5-foot-diameter shaft than it would have been to try to access the area from the intake end several miles away.

To fit into the shaft, a customized tooling skid had to be built for the Hibbard Inshore Mohican ROV. This skid would hold two five-function manipulator arms that could be used to operate tooling and to grab the structures to allow cuts to be made and rigging to be placed. The skid was built to allow the arms to fold at their shoulder so they would hang underneath the vehicle as it was inside the surge shaft. Cameras were added to the manipulator arms so the pilot could independently monitor the view from each arm.

The first tool attached was a rotary saw, which was used to cut through the steel conduit that was lying across the surge shaft. This conduit was removed by the vehicle through the top of the surge shaft.

A custom, high-head trash pump was lifted into the shaft to pump solids up to 2 inches in diameter the lateral distance of 100 feet as well as 355 feet vertically to remove sediment from the rock trap. The Mohican’s arms were used to maneuver the pump suction hose into all of the areas between the divider walls in the 100-foot-long trap to remove as much sediment and debris as possible. The ROV and pump removed 254 cubic yards of sediment from the rock catcher in this manner.

The Mohican ROV was then refit with a centerless saw that would allow it to make the deep cuts necessary to remove the existing trashrack support beam. The beam had buckled during failure of the trashrack and needed to be replaced.

Once the ROV had cut the beam and removed it through the surge shaft, the ROV was used to remove the two sections of the existing trashrack that were damaged too badly to be put back into place, including the section that had slid to a depth of 850 feet down a penstock with a 45-degree an-
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The Hibbard Inshore team used the Mohican ROV, along with a Navajo ROV, a pneumatic lift-bag, rigging, winches and hoists to retrieve the trashrack sections.

The ROVs attached lines to each section, used the lift bags for lateral transport through the tunnel back to the surge shaft, and then lifted them to the surface.

The rebuild process then started by installing a new support beam. The remaining trashrack sections were brought back into alignment and structurally supported by bolting into the new support beam. The Hibbard Inshore team redesigned the trashrack sections and support beam so they would have increased strength and could be installed by a ROV. Brackets were used to hold the sections together with bolts, and the sections were secured to the new beam.

The new beam had further bracing at each end to support the rack sections. Once the beam was in place, the new trashrack sections, brackets and bolts were put into place. The Mohican ROV was fit with a tool to torque nuts onto the bolts that pulled the trashrack sections into place properly.

Upon completion of the repairs at Yauco I, the crew moved to Yauco II. Data was collected to allow Hibbard Inshore to work with its plug manufacturing partners on the design of a temporary bulkhead that could be inserted into the tunnel and carried into place by the ROV. This bulkhead had redundant seals as well as pressure monitoring to allow the crew to determine if any of the seals were not seated properly or were not holding. The bulkhead was tested and brought to full working pressure before being shipped to the Yauco facility.

After the ROV inserted the plug into one penstock and actuated the seals, it was confirmed that the seals were holding, and water was drained only from the downstream side of the plug, leaving the water in the tunnel, second penstock, and portion of the first penstock upstream of the plug.

ARG Precision then worked with PREPA to have the valve removed and replaced. Once this was completed, the temporary bulkhead was removed from the penstock by the ROV and was then placed in the second penstock to allow that valve to be replaced. After the valves were replaced, the new valves could properly seal, allowing PREPA to complete the rehab work necessary on the wicket gates and turbines.

During this project, PREPA, ARG Precision and Hibbard Inshore worked together to devise an inspection plan, without dewatering, in areas of its intake tunnels that were difficult to reach. Further, once problem areas were identified, the three companies went to work to devise tooling and methods to remove debris, remove damaged materials, replace a trashrack and replace two turbine shutoff valves in those same, difficult-to-reach areas. This allowed PREPA to eliminate undue stress and the potential of tunnel collapse from dewatering, continue to provide water for drinking and irrigation, generate when necessary and avoid the safety risks of using confined entry crews.
Tennessee Valley Authority is a corporation owned by the U.S. government that provides electricity for 9 million people in parts of seven southeastern states at prices below the national average. TVA also provides flood control, navigation and land management for the Tennessee River system and assists utilities and state and local governments with economic development.

TVA was established by Congress in 1933 and now owns 72 power generation facilities with a total combined capacity of 33,300 MW. The authority’s 29 hydroelectric facilities and one pumped-storage station provide a capacity of 5,400 MW.

PennWell recently sat down with Bill Johnson, president and chief executive officer of TVA since January 2013, to discuss how hydropower (which founded the authority) fits into its current integrated generating portfolio and what lies ahead for this technology.

Q: You’ve been head of TVA for nearly three years now. What was your strategic vision for the authority when you took over, and what is your progress in meeting that vision?

Johnson: My experience is that even if you live in the area where TVA has generating facilities and you have been in the electric power industry for a long time, you don’t know anything about TVA and can’t understand it until you get here. TVA is that different from the general utility business.

I joined TVA during a time of significant change. The company was recovering from the ash spill at the Kingston Fossil Plant and its single largest industrial customer, which provided 10% of the company’s revenue, was closing. TVA also had a capital plan with a design to build plants for demand growth, and that was not going to happen after the financial crisis.

Instead, we needed a plan to get to a sustainable, steady state here at TVA. I focused on two particular things once I arrived. Those were: Rationalizing the capital and asset plan, which meant figuring out what we needed and building only that; and streamlining the organization pretty significantly to reduce costs, as a result of the loss of 10% of the business that I mentioned earlier. We also have been significantly reducing operations and maintenance spending, creating a sustained reduction of $500 million per year. And we have reduced TVA’s debt level by more than $1 billion.

I believe we have a good strategic plan in place here today, and now I’m just working the plan.
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Norris was the first dam built by the Tennessee Valley Authority. Construction began in 1933, just a few months after the creation of TVA, and was completed in 1936.

**Q:** TVA was established in 1933, but some of its dams and powerhouses are much older, with Ocoee No. 1 being 104 years old. I imagine there is significant rehab work going on at these facilities?  
**Johnson:** As a casual member of the public, you tend to think of dams as monolithic things, and then you learn they are living, breathing machines. They are complicated, even though they don’t look to be. They do require maintenance and observation. TVA has had a dam safety program forever, but in the past couple of years we have embarked on health checks. These involve looking at all 49 major dams and many of our earthen embankment dams to make sure we know the exact condition. Based on the results of these checks, we have performed work on the concrete, riprap, pilings, etc. The goal is that when your [Elizabeth Ingram’s] successor 100 years from now asks us that same question [about dam safety work], we’re still safely operating those dams.

**Q:** You recently experienced a sinkhole and seepage at your 89-MW Boone Lake Dam. Have you determined a way forward in dealing with this issue?  
**Johnson:** The situation at Boone is a result of several factors. First is the geology of the area. There is karst, sort of a cavernous limestone, under and around the dam, so there are a lot of pathways for water to flow. Second, the construction technique of 1950s, when this dam was built, involved hand tamping clay into the karst to provide a base, which is not as robust as current construction techniques. Third, age and time.
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Water is seeping through the earthen berm, not the concrete dam. That’s a common occurrence at this particular facility, but personnel have observed in the past year that sediment is coming through with the water. This is not a good sign. We have drawn the lake down to a good stable condition and are evaluating our options.

By the time this article is published, we expect to have announced what our plan is for dealing with this situation and what the duration of this work is, and we will be about fixing it. We want to do it once and do it the right way, and we want to make sure everybody downstream is safe. This means it takes us a while to get to the right answer, but that’s what we want to do.

Editor’s Note: After the interview was completed and before the article was published, TVA announced its repair solution for the dam. Read about it at www.hydroworld.com.

Q: There also have been concerns regarding seismic safety of Pickwick Landing Dam, which impounds water for a 160-MW powerhouse. What is the current situation there?

Johnson: This issue arose as we were looking at dams upstream of our nuclear plants after the Fukushima incident. We needed to make sure we had safety and seismic analyses done on these facilities. We started looking at the data from the new seismic analysis and realized we had questions we needed to answer about how each dam would perform under significant seismic activity. In the end, we concluded that Pickwick Landing Dam is stable and safe except under the most extreme seismic conditions. We have added an emergency warning system to alert the public in signs of trouble and we had significant educational outreach to communities so they understand exactly how to respond in the unlikely event of a major earthquake. That dam is safe and stable and being operated under normal conditions.

Q: TVA grew by building dams and hydroelectric facilities, but in the 1960s nuclear plants were added to the portfolio and later fossil-fueled generation. How do the nuclear, fossil and hydro facilities fit together?

Johnson: One of the great benefits we have at TVA is a very diverse generation portfolio. Think about nuclear as your base-load source, with coal as another baseload source. Natural gas also is making a big entrance into the generation space. But hydro is the perfect renewable, the perfect peaking power, the perfect load following power. All of those hydro units can spin up to full power within a minute. We are changing the makeup of our generating portfolio, reducing our coal usage dramatically, building more nuclear, more natural gas, and more renewables. But we have a really excellent fleet in terms of diversity.

Q: When you say you are building more renewables, you don’t mean hydro, correct?
Johnson: We actually are trying to get more out of the hydro system we have. TVA has been in a program we call hydro modification for several years, which involves looking at all of our hydro facilities over the next decade or more. We expect to get 200 MW more out of the existing hydro system. We have some spaces in our existing powerhouses where we can put in a turbine, and we might have some small pumped hydro applications. The system is pretty well built out but as we replace some original turbine equipment we can eke out a few more megawatts here and there.

The pumped hydro I am talking about is at existing TVA dams, where you pump water you’ve used back up over the dam and then run it through the turbines a second time. We also have some potential classical pumped storage sites in our service area. That is a difficult proposition economically, but as conventional hydro-power gets more expensive, we keep an eye out for what looks like a good site for pumped hydro.

Q: In 2010, TVA set out to become one of the nation’s leading providers of low-cost, cleaner energy by 2020. Why?
Johnson: First, in our charter we have a mandate for environmental stewardship. We are entrusted with the natural resources of the Tennessee valley, and it is important to honor that requirement. We can see greater environmental regulation on the horizon. Our public wants cleaner water, cleaner air and cleaner power.

Going back to the mid-1990s, 60% of the electricity TVA produced came from coal-fired facilities. That will be down to 20% by 2025. We have moved in a very purposeful and financially responsible way to do this, but we intend to be a cleaner and low-cost provider. Today, more than half of our energy is emissions-free. By the time you get to 2025 and 2030, it will be 65% emissions-free. And this has been done while maintaining some of the lowest electricity rates in the country.

We are believers here in management by objectives, and it seems to be working.

Q: What does this new direction mean for TVA’s existing portfolio of hydropower generation?

www.hydroworld.com
space, our objective is the lowest possible cost while balancing environmental stewardship. In my opinion, this is a little more delicate balancing act than others in the industry do because every decision TVA makes must consider the interaction among all three of these missions, to determine the best way to serve the people of the Tennessee Valley.

Q: What does the future hold for TVA’s 29 hydroelectric facilities?

Johnson: We are in the process of modernizing. We have some facilities that are 80 years old or more and still contain original generating equipment. We have laid out a long-term path to touch all the hydro facilities, the dams in terms of safety and stability and the plants in terms of production. We will continue to devote a good chunk of resources to maintain and hopefully grow what we consider to be the ultimate renewable resource.

Let me put it in perspective a bit. We get a drop of rain, we are going to use it more than a dozen times through the system.

Q: John McCormick, vice president of Safety, River Management and Environment, was recently named president of the National Hydropower Association. This is a significant time commitment for McCormick. How does TVA justify this level of involvement with an industry association?

Johnson: One thing that sets the electric industry apart from others is the amount of absolute cooperation we have with each other. If we learn how to do something better than others, the first thing we do is tell them. Involvement in national organizations is important for the industry, for TVA and for John. We are delighted John got this recognition. The best part is, we will learn more from this than we will give. For us, this is a great thing all the way around.

We consider this an honor for John and for TVA and strongly encourage this type of involvement.

Q: What do you see as the long-term prognosis for hydroelectric generation in North America?

Johnson: The trend in energy production is pretty clear both in this country and around the world: Cleaner and less environmental impact while maintaining low rates and reliability. Put those together, and hydro should be the answer as the ultimate renewable. Most of the good sites have already been built out, but I really feel we need to get back to thinking about hydro as a primary resource, and if we can do more then we need to do more.

TVA will be investing in hydropower in 2033, and I believe we will be investing in it in 2133.

In terms of water, for us it’s not just electricity. It’s also flood control and transportation. The Tennessee River is the second most transportation-intensive river in the country. And, recreation. Water usage on our part is a complicated event, and I’m glad to work at a place that’s so good at it.
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Simplifying Generator Circuit Breaker Life-Extension and Modernization

Hydroelectric projects that have aged circuit breakers must deal with age-related issues and learn present possible improvements associated with modernization and conversions of various types of older circuit breakers that are used to protect generator circuits.

By Larry E. Yonce

Many hydropower plants have been in service for 60 or more years with circuit breakers that are well beyond their expected service life. Some of these circuit breaker designs require more maintenance over time and genuine replacement parts are often not available, potentially resulting in improper circuit breaker function, downtime and increased maintenance expenses.

Additionally, some circuit breaker designs require more and more maintenance over time and if genuine replacement parts are not available, this can result in improper circuit breaker function that can cause catastrophic failure.

The resulting conversions have simpler design, fewer components, reduced maintenance and readily available replacement parts. They also provide higher reliability, extended insulation life and can help increase safety for personnel.

Factors impacting a generator circuit breaker’s useful life

Circuit breakers used in generator applications can have various types of interrupting technologies, require special operating parameters and may have exceeded their original design life.

The circuit breaker’s performance and longevity depend on:

- Switching rates;
- Number of switching operations and current magnitudes;
- Maintenance costs;
- Availability and cost of renewal parts;
- Maintenance intervals;
- Maintenance outage times; and
- Environmental concerns such as oil, polychlorinated biphenyls (PCBs) asbestos and possibly sulfur hexafluoride (SF6).

These parameters not only affect system availability and reliability, but also impact the ongoing financial viability of the generating station. When considering whether to modernize power circuit breakers used in generator circuits, there are a number of options involving available technology upgrades to consider. In most scenarios, there will be some type of conversion involved.

Common terms for equipment life extension and modernization of generator circuit breakers

IEEE Standard Requirements for Conversion of Power Switchgear Equipment C37.59-2007 is a process standard that provides guidance and testing methodology for power circuit breakers.

The standard defines important conversion terms that should be noted and included in specifications that outline customer requirements for equipment life extension and modernization of generator circuit breakers. Familiarizing yourself with these terms will help ensure you are receiving the correct services to meet your needs.

- Conversion: The process of altering existing power switchgear equipment from any qualified design.
- Compartment adaptor: A removable device designed for insertion into a switchgear circuit breaker compartment that provides mechanical support and interlocking plus the primary and secondary electrical connections to allow insertion of a draw out circuit breaker that differs mechanically from that which originally occupied that circuit breaker compartment.
- Design verification: The process of design qualification, in accordance with all appropriate standards, of any conversion by means of design testing and evaluation, supported by justified technical evaluation and documentation.
- Modular assembly: A circuit breaker element, including interrupters, operating mechanism, and connecting terminals, or an alternating current contactor element, including interrupters, operating mechanism, and connecting terminals, that has been tested and qualified to the appropriate industry standards.
- Qualified design: Any power switchgear equipment that has been tested and certified to...
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The nearly 50-year-old Lake Manatee Dam required emergency remediation to address an internal erosion and piping failure mechanism. Remediation consisted of a 3,000-foot-long and 100-foot-deep cutoff wall constructed in the critical areas of the spillway and adjacent embankment. Hayward Baker constructed a jet grout cutoff wall beneath the existing spillway and a Trench Cutting and Remixing Deep (TRD) soil mix wall on either side of the spillway. This hybrid cutoff wall proved effective in emergency remediation of a compromised earth dam and spillway.
appropriate industry standards.

— **Racking**: The act of moving a removable element physically between the connected position and the disconnected position in its compartment.

— **Reconditioning**: The process of maintaining existing power switchgear equipment in operating condition as recommended by the manufacturer’s instructions, using only qualified design parts. Reverse engineered parts (designs copied from existing parts by other manufacturers) are not considered to be qualified design parts unless specifically design verified.

— **Replacement interchangeable circuit breaker**: A circuit breaker that utilizes all new parts, has been design tested to IEEE Std. C37.09 or to ANSI C37.50-1989 or IEEE Std. C37.14-2002 as required, and requires no conversion of existing switchgear to maintain proper operation.

— **Replacement non-interchangeable circuit breaker**: A circuit breaker that utilizes all new parts, has been design tested to IEEE Std. C37.09 or to ANSI C37.50-1989 or IEEE Std. C37.14-2002 as required but requires conversion of existing switchgear to maintain proper operation.

— **Retrofill**: A conversion process that includes replacement of the circuit breaker and circuit breaker compartment functional components of a qualified design within a vertical section or compartment of a vertical section with functional components of a different qualified design.

**Important notes:**

— Circuit breakers used for generator service should also be design tested to IEEE Std. C37.013; and

— The term retrofit is not defined and is no longer used in IEEE Std. C37.59-2007.

**Understanding different life extension and modernization solutions**

Generator breaker conversion and modernization solutions are readily available from a number of sources. Site performance and financial requirements will drive the selection process. It is important to note the correct solution should provide the best long-range performance, so look for cost estimates and proposals from a number of sources. Typical solutions can be categorized as follows:

**Reconditioning**

If parts are available from the original equipment manufacturer, outage time is not an issue, the circuit parameters are less than or equal to the circuit breaker’s rating.
and the switching rate is low, reconditioning of the existing circuit breaker may suffice for at least three to five years. If OEM parts are not available for a rebuild, then the circuit breaker’s performance will be affected and a failure can occur. Reconditioning using third-party reverse-engineered parts, as cautioned by the IEEE Std. C37.59-2007, can be dangerous. Reconditioning does nothing to update technology or increase the circuit breaker’s capabilities. However, this is the lowest cost solution for extending operating life.

**New replacement circuit breakers**

These will either fit directly into a draw out arrangement or require minor structure or control wiring modifications to complete their interface. Complete stand-alone designs can be manufactured to replace existing fixed-mounted oil circuit breakers. In many instances, the fixed-mounted design can be replaced with a draw out configuration to enhance reliability and reduce maintenance outage time. The new design would be tested to the appropriate IEEE Standards.

**Retrofit conversions of existing installations**

Retrofit conversions are often good solutions, provided the existing enclosure has the capability and room to accommodate the conversion components. Newer technology and circuit breakers with increased capabilities can be interfaced into the existing enclosures. When installations are unique, a retrofit conversion is often the best solution. The cost is usually between that of new replacement circuit breakers and complete replacement.

**Complete replacement**

Installation of new switchgear with current technology circuit breakers is an always an option. Often extensive site preparation and reconfiguration is required to accommodate a different dimensional layout and new cabling is required. In addition, outage time, available space, conductor interfaces and total installed cost may rule out this option. This solution usually has the highest cost, but the cost difference for this option may afford increased efficiency and the safest equipment operation.
Simplifying circuit breaker maintenance through interactive training

To facilitate education and help address the knowledge gap, some vendors offer interactive video training modules to provide a starting point for circuit breaker maintenance and testing. Some of these available resources do not require any special software to operate and the vendors provide a portal for numerous test procedures, active animations and illustrations to guide personnel through maintenance and testing processes.

Closing thoughts

Generator circuits may present special requirements for the circuit breakers intended to protect them. Industry standards are available to identify the requirements and demonstrate the required capabilities. There are various methods available to extend the useful life of generator circuit breaker systems using reconditioning and conversions. Conversions also make it possible to modernize the system to current generator class circuit breakers. By incorporating newer interrupting technologies and other enhancements, a reduction in maintenance costs and reliability improvement can be realized.

Interactive digital training programs can also help accelerate the learning curve for maintenance personnel on new technology and existing testing techniques that are specific to generator class power circuit breakers.

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www.hydroworld.com
The National Hydropower Association Annual Conference focuses on bringing together industry leaders, state and federal regulatory officials and key legislative staff to discuss technology, policy and future development options for the hydropower industry.
Tech Briefs

Report shows how states advance clean energy, including hydro

A new report — Clean Energy Champions: The Importance of State Programs and Policies — investigates how U.S. states are advancing clean energy, including hydro. The Clean Energy States Alliance prepared this report to provide “the first-ever comprehensive review of all the significant ways in which states have advanced clean energy.”

The 130-page report highlights 31 case studies from 22 states covering a variety of state programs, such as renewable portfolio standards, rebates for purchasing solar panels, wind energy tax credits and lesser-known programs.

The report provides such hydro-related information as a case study on how Oregon has expanded opportunities for small hydropower. CESA also discusses “harnessing hydrokinetic energy from river flows,” citing the Alaska Hydrokinetic Energy Research Center. A case study provides more details on the testing being performed at this facility.

CESA is a nonprofit coalition of public agencies and organizations working together to advance clean energy.


Reclamation to use drones to survey Elephant Butte Dam

The U.S. Department of Interior’s Bureau of Reclamation plans to get inspection services at its Elephant Butte Dam that use unmanned aircraft systems (UAS).

The UAS’s, or drones, will be used to:

— Provide a three-dimensional model of the dam, spillway and powerhouse; and
— Perform concrete deterioration mapping including cracks, spalls and subsurface defects.

Technologies used to accomplish this will include light detection and ranging, multispectral and infrared sensors, orthophotographs, high-resolution video and a digital evaluation model.

Reclamation anticipates awarding the contract to the Unmanned Aircraft Systems Flight Test Center at New Mexico State University. This center specializes in unmanned systems flight testing and provides the capability to test several classes of UAS.

FRTC has an FAA Certificate of Authorization that permits UAS flights in more than 15,000 square miles of coordinated airspace in southwestern New Mexico.

Elephant Butte Dam is a concrete gravity dam 301 feet high and 1,674 feet long including the spillway. It was completed in 1916 and has a nearly vertical face, making...
inspection difficult. The dam impounds water for a 27.945-MW hydroelectric facility.

Market research will be performed to determine FTC’s capability of providing the sensors discussed above, mated to a UAS platform.

**App provides data on global renewable energy potential**

The International Renewable Energy Agency (IRENA) has launched a free app to allow smartphone users to access data on global renewable energy potential. The Global Atlas pocket combines 1,000 maps from 67 governments and 50 data centers to provide information on renewable energy resources worldwide.

According to IRENA, “The app turns mobile devices into renewable energy prospectors and can help answer questions like, can renewable energy power 100 percent of this island?”

The app can be used to screen renewable energy project sites before making an investment decision, create content on clean energy potentials in areas of interest and access images of growth areas for renewable energy infrastructure opportunities, IRENA says.

Global Atlas pocket is the mobile version of the online Global Atlas portal. The app is available on all platforms, including BlackBerry 10, iOS, Android and Windows Phone.

IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including hydropower and ocean energy.

**Best Technical Papers awards given at HydroVision International**

Authors of 15 technical papers and poster presentations received Best Technical Papers awards at HydroVision International 2015 in Portland, Ore., the week of July 13. These awards are given to the strongest technical papers presented over the three days of the conference program.

The winners were chosen by the HydroVision International 2015 technical papers committee. Committee members reviewed all technical papers and poster gallery presentations received in five categories: environmental and social, equipment and technology, market trends and strategies, project management and operations, and water management and movement.

Awards were announced for first, second and third place in each category. A list of the winning papers, authors and companies is available at [http://bit.ly/1IbQCfJ](http://bit.ly/1IbQCfJ).

**Hydraulic turbines forum now available at IGTC**

The International Generator Technical Community has added Hydraulic Turbines to its online power plant technical forums. IGTC’s Generator Forum was founded in 2010, and in 2014 members began posting hydraulic turbine questions to the Gen-
generator Forum. This led site management to develop the new Hydraulic Turbines Forum, with a group of expert moderators to address posted questions.

The forum master is Colin Clark with Brookfield Renewable Energy Group. Moderators of specific discussion categories are:

- Turbine design-specific issues and performance troubleshooting: William Fay of Tacoma Power and consulting engineer Lee Sheldon;
- Gates: Ken Hostler with Hydro Consulting & Maintenance Services (HCMS);
- Bearings: Lyle Branagan with Pioneer Motor Bearings;
- Governors: Roger Clarke-Johnson with American Governor; and
- Turbine maintenance and overhauls: Paul Bernhardt with Hatch and Clyde Kreutz with HCMS.

The forum is at www.powerplanttechnicalforum.org. Membership is free to qualified power industry professionals, and discussion is limited to technical issues.

**South Carolina Electric & Gas**

Cayce, SC

Fairfield Pumped Storage is a 576MW semi-outdoor generating station located between the Monticello and Reservoirs. The facility contains (8) reversible pump-turbine units. Work awarded to L&S Electric includes the design, supply and installation of PLC-based governor and unit control systems of units 1,2,3,4,7 and 8. Also included is a redundant plant HMI system along with new instrumentation for each of the generating units. The Fairfield project is unique because it is only one of several sites within the USA that does not incorporate a gate shift ring for the Francis-type turbines. Instead, 20 independent servomotors are positioned around each turbine pit to provide individual control of each wicket gate.

**NYPa executive receives award from APPA**

Randy Crissman with New York Power Authority has received the Harold Kramer-John Preston Personal Service Award from the American Public Power Association.

Crissman is NYPa’s vice president of technical compliance. He received the award “for his contributions to improve procedures for reliability compliance, monitoring and enforcement of government regulations” at public power utilities, according to a press release.

Crissman helped NYPa rapidly respond to a changing regulatory environment by implementing its first reliability standards and compliance program, which APPA says is now regarded as a model for other public utilities.

His other work at NYPa includes oversight of its physical infrastructure security and emergency management programs, quality assurance and code compliance, and coordination of participation in standards development programs at the North American Electric Reliability Corporation and Northeast Power Coordinating Council.

NYPa operates 16 generating facilities. APPA represents more than 2,000 publicly-owned electric utilities.

**Briefly...**

The U.S. Department of Interior’s Bureau of Reclamation plans to hire a company to install arc flash mitigation at the 25.5-MW Minidoka and 176.564-MW Palisades projects in Idaho.

For more technical news, check out the Technology and Equipment tab at [HydroWorld.com](http://hydroreview.hotims.com RS #35)
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Upgrading Controls for Pump-Turbines with Individually Controlled Wicket Gates

The 576-MW Fairfield pumped-storage plant, owned by South Carolina Electric and Gas (SCE&G), utilizes eight reversible pump-turbine units to provide peaking power for the central region in South Carolina. Each unit uses a design where the 20 wicket gates are individually controlled by a hydraulic servo, instead of a more commonly used design linking all the wicket gates together with a gate ring and servo pair. The unique design provided a number of challenges for SCE&G and its suppliers as unit and governor control upgrades were made.

Understanding the Problem
The Fairfield plant, located near Columbia, S.C., was originally constructed in the 1970s, with Woodward Cabinet Actuator turbine governor controls put into service in 1978. The control system’s hydraulic portions had significant oil leakage that had been inherent to the design and present from the beginning. These leaks and required a drainage sump located below the gate servomotors.

Meanwhile, its mechanical system design resulted in coarse and sluggish control of the wicket gate servos due to the many control linkages and mechanical restoring system.

Given its poor performance, the original system was unlikely to have met any of the modern Institute of Electrical and Electronics Engineers (IEEE) performance recommendations for governor control systems. After 30 years of service, SCE&G made the decision to replace them due to obsolescence and increasing maintenance costs. The utility also desired updates to utilize modern digital controls for the purpose of remote control, data logging, reporting, trending and alarming.

Testing the Waters
The original project was contracted to two separate vendors; one vendor was responsible for the controls upgrade while another vendor was responsible for the new gate ring design. Units 5 and 6 were selected by SCE&G to be the first pair upgraded, with a conversion from the 20 individually controlled servo design to a more conventional gate shifting ring design with four large servos in a push-pull configuration.

Updates also included Rockwell Automation ControlLogix Redundant PLC processors for unit control, along with a GE Cimplicity human-machine interface for reporting, trending, alarming and daily operation.

During the installation and commissioning of the new shifting ring for Units 5 and 6, the supplier encountered difficulties with the engineering and installation of the ring, along with gate alignment issues. Once completed, the upgrade of the governor and control systems worked as desired, but due to cost overruns and time delays associated with Units 5 and 6, SCE&G decided to upgrade the remaining units with a control system that would incorporate individual servo controls for each wicket gate.

L&S Electric was subsequently chosen to provide the new control system for the remaining six units. L&S Electric was selected based on the proposed control system solution, prior successful experience, competitive price and overall expertise.

Implementing Solutions
L&S encountered a number of technical challenges in engineering the electrohydraulic valves and associated digital control system to individually control each wicket gate of the turbines, including valve selection and design, valve performance testing, digital control system design and system performance testing.

Hydraulic Solution
A two-stage hydraulic control valve system was selected to interface between the new governor control PLC analog outputs and each of the 20 wicket gate servomotors. The two stage valves provide the ability to have integrated dual but independent rate limiters while also providing the required oil flow to meet the servo movement tim-
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The timing adjustments for the valves allow the valve to be setup for a range of both opening and closing maximum servo rates. The primary (pilot) stage control valve used an off-the-shelf D03 Bosch proportional valve. The second stage or distributing valve was designed specifically for this application to match the oil flow or timing requirements for the Fairfield application. The two control valves were integrated together along with a fail-safe hydraulic shutdown valve/manifold design with the primary function of delivering a secondary shutdown device required by the IEEE 125-2007 design standard.

Unit control system solution
Controller architecture technical challenges

Within the hydro facility there are two very different types of control requirements that encompass a complete control system: sequential functional control and high-speed process control.

Sequential functional control is best represented at a unit level PLC where functions such as start/stop sequencing, operational control modes and protective trip sequences reside. With this type of application the scan times of the program can approach, and even sometimes exceed, 100ms without degrading unit performance.

High-speed process control is best represented at a governor level PLC where functions such as real time speed, gate or power control reside. With this type of application the program scan time must be actively managed to ensure that the closed loop control on the gate and speed signals can be updated at intervals that do not exceed 10ms to ensure compliance with the performance standards outlined within IEEE Std. 125-2007 (IEEE Recommended Practice for Preparation of Equipment Specifications for Speed-Governing of Hydraulic Turbines Intended to Drive Electric Generators).

While the IEEE and regional regulatory entities are totally independent organizations that do not actively collaborate, it is important to note that the Std. 125-2007 is widely accepted throughout the industry as a minimum design guideline to ensure robust performance within each regulatory jurisdiction.

Compliance with this standard is even more critical with facilities that utilize individual servomotors for each wicket gate. Because of the need for 21 fast closed loop controls, the additional process control associated with a digital governor retrofit increases to a level that creates excessive software overhead for a single PLC-based control system, regardless of brand or supplier.

Controller architecture solution provided

To overcome the dual requirement of sequence control and multiple fast closed loop
controls of the servos and speed, the control system for this application has been separated into two independent PLC systems as opposed to a single PLC system design.

The control system includes a dedicated Governor PLC to support real time speed and power process control along with Servo Control to manage the 20 individual servo-motor controls and a dedicated Unit Control PLC for sequential functional control of each unit.

This control architecture offers the end user with the following notable cascading benefits throughout the life of the installation:

— Segregation of the control systems allows each PLC to be optimized for a specific function to ensure compliance with industry performance requirements.

— Optimized for a specific function, the overall program size for each PLC is incrementally reduced. This eliminates the need for program interrupts and other complicated methods of task scheduling.

— Simplification of the software design complexity translates directly into increased system troubleshooting efficiency while also minimizing the risk of program changes that can impact the response of the entire unit.

— Segregating the control functions also offers installation benefits that include optimization of the physical location of the controller.

— Optimization of controller physical location reduces the installation cost by minimizing field cable lengths.

— Minimizing field cable lengths reduces the potential for future issues with electrical noise associated with long cable runs.

The control system upgrade project for the six units was completed by L&S Electric at the end of year 2014. Currently, L&S Electric has been contracted to upgrade Units 5 & 6 and the plant common control system. This upgrade will effectively produce the same design philosophy L&S Electric supplied for the other six units.

Results and lessons learned
Collectively controlling individual gate servos as opposed to controlling a mechanically linked gate servo system does pose many technical challenges. Many of those challenges are the same as or very similar to those faced in engineering distributing valves and closed-loop control systems for shifting ring turbines and even Pelton turbines with deflectors and multiple needle servos.

The Fairfield project resulted in a successful and economical alternative to retrofitting the plant’s turbines with a mechanical gate shifting ring, and also poses new possibilities to potential adaptive controls that could help reduce rough zones, runner wear and maintenance of pump-turbines.

— By Kevin Schultz, lead controls engineer, and Bill Tarter, lead project manager, L&S Electric

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Jimmie Creek, Tahumming updates in latest quarterly report
Quarterly reports released in August by Alterra Power Corp. reveal milestones for the company’s Jimmie Creek and Tahumming hydropower projects.

According to the report, which examines financial and operating results for the three- and six-month periods ending June 30, construction of the 62-MW Jimmie Creek plant is ahead of schedule.

HydroWorld.com reported in September 2014 that Alterra had closed a C$110 million (US$100.5 million) loan facility to finance the Jimmie Creek project, which will be located on the Toba River Valley near Powell River, British Columbia.

The project includes a rubber diversion dam, a 3-kilometer-long buried penstock and powerhouse, and two 32.5-MW turbine-generators. Power generated by the run-of-river facility will be sold to BC Hydro under a 40-year deal.

Jimmie Creek is expected to begin generating power in summer 2016. The plant is a joint venture between Alterra, which owns 51% of the project, and Fiera Axium Infrastructure Inc.

Meanwhile, an agreement signed with the Klahoose First Nation will allow for the development of the 15-MW Tahumming plant. The project will be located on the Tahumming River near the Jimmie Creek and 234-MW Toba Montrose projects in traditional Klahoose territory.

Ontario Waterpower Association calls for award nominations
The Ontario Waterpower Association is calling for nominations for a variety of awards it will give out at its Power of Water Canada conference in October.

The deadline to submit nominations for these awards is Sept. 30.

The awards, which highlight the hard work and dedication of industry leaders, are:

— R.R. Dodokin Award. Ronald R. Dodokin was a driving force in Ontario’s waterpower industry in the 1980s and 1990s, defining the entrepreneurial spirit and commitment that typifies waterpower proponents. Recipients of this award are leaders in their field and share Dodokin’s drive and passion for the industry.

— Innovation Award. This award recognizes organizations that have shown leadership in innovation through the development of important advancements, which will result in benefits to the waterpower industry. Innovations may be technical, operational or affect any aspect of developing and operating waterpower facilities.

— Stewardship Award. This award is...
in integral part of OWA’s commitment to environmental responsibility and sustainable development. It is given out annually to recognize those organizations that have demonstrated leadership in the waterpower industry through sustainable development.

**BC Hydro awards contract for north bank preparation**

Canadian utility BC Hydro has awarded a contract to Morgan Construction and Environmental Ltd. for preparation activities on the 1,100-MW Site C project’s north bank.

Work to prepare the construction site, on the north bank of the Peace River, includes the excavation and disposal of about 3 million cubic meters, quarry development including riprap production of about 100,000 cubic meters, building 7.25 kilometers of access roads, and clearing and grubbing 115 hectares.

Site preparation will begin in August and be complete by the end of June 2016.

The north bank site preparation deal is only the most recent Site C award offered in recent months.

The $8.8 billion project is part of the province’s plan to meet what it anticipates will be a 40% increase in the province’s demand for power over the coming two decades.

**Canadian Energy Strategy recognizes hydro’s contribution**

Canada’s Premiers have released the Canadian Energy Strategy, and hydro is recognized for its significant contribution to electricity generation in the country.

This strategy is intended to provide the foundation for provinces and territories to work together on energy priorities and the shared goals of ensuring Canada is a recognized international leader in sustainable and secure energy production, supply and transportation.

The provinces and territories are constitutional owners and managers of Canada’s natural resources and thus share a responsibility to ensure the country’s energy security, the strategy says.

Canada is one of the world’s five largest energy producers and ranks third in global hydroelectricity generation, which is used to generate 63% of electricity across the country. Seventy-nine percent of Canadian electricity generation comes from low or zero carbon-emitting sources. The energy industry directly employs more than 280,000 Canadians and almost 10% of Canada’s gross domestic product is from the energy sector.

The strategy expresses a renewed vision for the energy future in Canada and expresses a set of objectives and principles for future work in the sector that could benefit Canadians for many years to come.

The entire strategy is available to read or download at: [www.CanadasPremiers.ca](http://www.CanadasPremiers.ca).
Marine Hydrokinetics

DOE’s Wave Energy Prize narrowed to 20 teams
The U.S. Department of Energy originally accepted 92 teams from industry and academia to compete in its Wave Energy Prize program that seeks to encourage the development of wave energy conversion devices.

The DOE Office of Energy Efficiency and Renewable Energy introduced the program in April during the National Hydropower Association’s Annual Conference in Washington, D.C. The program is a design-build-test competition that supports the department’s goal of making marine hydrokinetic generation more competitive with traditional forms of production.

Program registration closed June 30, and teams worked on the first requirement for the prize -- a technical submission describing their concepts that was due in July. In mid-August, a panel selected the top 20 teams, with those groups invited to build a 1/50th scale model for small-tank testing.

Teams will compete for a prize purse that totals more than US$2 million.

“We’re extremely pleased with both the quantity of teams and the diversity of participants reflecting broad expertise from so many established companies in the ocean energy space, universities, and newcomers to the industry,” said Julie Zona, Wave Energy Prize administrator.

The pool will be further culled through committee selection by March 2016, and the remaining two teams will receive seed money to build a 1/20th scale prototype. Prototypes will undergo tank testing at the Naval Surface Warfare Center’s Maneuvering and Seakeeping (MASK) Basin in Carderock, Md., beginning summer 2016.

The judging panel will include technical experts from Sandia National Laboratories, National Renewable Energy Laboratory, Naval Surface Warfare Center – Carderock Division, and Ricardo Inc.

“The composition of the participating teams truly demonstrates one of the benefits of a prize challenge, which is to encourage the inclusion of new perspectives,” Zona said. “We’re very hopeful that the diverse backgrounds of these teams will help lead to the prize’s goal of achieving game-changing performance enhancements to wave energy technologies.”

Full profiles for the teams can be found at http://waveenergyprize.org/teams.

ORPC seeks license extension for Cobscook Bay Tidal project
Ocean Renewable Power Co. has asked the Federal Energy Regulatory Commission for a two-year extension of its hydrokinetic pilot project license for the 300-kW Cobscook Bay project in Maine.

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For more ocean/tidal/stream news, see the Hydro Project Activity tab at

http://hydroreview.hotlms.com RS #47

Wave Energy Week mixed marine developers with traditional hydro

Oregon Gov. Kate Brown proclaimed “July 13-17, 2015, to be Oregon Wave Week in Oregon and encourages all Oregonians to join in this observance.”

Brown made this proclamation June 24, just ahead of the 10th Annual Ocean Renewable Energy Conference sponsored by the Oregon Wave Energy Trust (OWET). OWET is a nonprofit, public-private partnership that is helping to develop ocean energy.

The ORE Conference was co-located with HydroVision International 2015 at the Oregon Convention Center, July 14-17.

“We appreciate Governor Brown’s support for marine renewable energy and its responsible development in the state of Oregon,” said OWET Executive Director Jason Busch. “We also thank the governor for proclaiming ‘Oregon Wave Week.’”

The events provided marine renewable energy community members with tremendous networking opportunities.
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Kaukauna Utilities believes in making people their highest priority. This has been a focus since the inception of this utility, whose seven hydropower facilities service more than 15,000 customers in northeast Wisconsin. It is in this spirit of “value to community through innovation” that Kaukauna Utilities leaders partnered with the local Park Elementary School to form a new learning experience called Park Community Charter School.

Utility leaders were among the initial members of a governance council that fostered the concept and brought forward the National Energy Education Development (NEED) curriculum. Today, the collaboration offers a number of programs designed to spark an interest in science, engineering and other fields related to energy production and management.

Addressing a challenge
Built in 1897, Park Elementary School is located high atop one of the main streets in Kaukauna, Wisc. Until Fall 2011, the school provided a traditional elementary education to about 200 Kaukauna area residents. During Spring 2009, the leadership at Park Elementary proposed a differentiation in its learning experience and began the process of converting the school to a publicly-funded charter school.

Consultants were contracted to provide experience in the conversion. They toured the city and felt a number of local entities and historical sites — most within walking distance from the school — would be great candidates for learning opportunities and partnerships, including the city’s 1000 Islands Nature Center and Kaukauna Utilities.

Planning and implementation grants were written and a governance council that included Kaukauna Utilities General Manager, Jeffery Feldt, was created. A number of key building blocks also had to be developed, namely the core curriculum and guiding principles.

The group eventually chose to emphasize place-based learning, a respectful climate and community connections as its core tenets.

Filling a NEED
In addition to selecting the school’s central values, the governance council chose the NEED curriculum as its core curriculum.

The NEED curriculum encourages students at all grade levels to learn about the forms of energy — including heat, light, motion, sound and electrical — with an emphasis on the scientific process and hands-on explorations.

Although numerous topics could be provided to students by Kaukauna Utilities, it is important that topics tie into the educators’ goals. Initially, brainstorming was undertaken to develop the initial group of offerings. Subsequent annual meetings have confirmed the initial offerings and opened the door for new offerings.

Kaukauna Utilities currently offers a number of programs for Park Community Charter School’s students, with many related directly to hydropower and facility operations and maintenance, including:

— Hydropower: Introduces students to hydroelectric generation and how it works, with visits to an operating generating facility;
— River Safety: Introduces students to low-head dams as well as the hazards they can present;
— Water System and Water Conservation: Students learn how potable water is procured, filtered, stored and used, along with grid concepts and resource management; and
— Operations Center and River Management: Students learn about maximizing hydropower generation and what environ-
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mental considerations must be taken into account while optimizing facility efficiency.

Other Kaukauna Utilities programs expose students to concepts of utility operations, energy efficiency, sustainability, solar and wind energy, safety, line maintenance and more. Since Park Community Charter School was formed in 2011, more than 500 students have had the opportunity to participate in the various Kaukauna Utilities programs. During any given school year, 250 Park Community Charter School students in kindergarten through fourth grade will learn about the many different aspects of Kaukauna Utilities.

The NEED curriculum inspired Park Community Charter School’s students to participate in a challenge hosted by Wisconsin civic group Sustainable Fox Valley, which pitted Park against four other neighboring schools in the Fox Valley area. The students and their families made energy-saving actions over a 12-week period, beating the other schools and earning a $1,500 reward for Park.

Results
Following its second year under the charter title in the 2012-2013 academic year, Park Community Charter School was again named Wisconsin Primary School of the Year and was a finalist for the National Primary School of the Year by the NEED Project Board of Directors. Four students attended the presentation of these awards in Washington, D.C., with expenses for two of the students provided by Kaukauna Utilities.

In addition, Kaukauna Utilities was awarded an Outstanding Stewards of America’s Water award in 2014 for its efforts to educate young people using energy and water wisely through its partnership with Park Community Charter School.

This award represents Kaukauna Utilities’ commitment to providing educational opportunities for local students. Ultimately, the results of this endeavor will come many years down the road, when these young people become adults.

Kaukauna Utilities hopes the experiences provided to the students will result in a lifelong appreciation for their community, lifelong energy and water efficient behaviors, and a passion to further their education in the electric or water industries.

This fall, Kaukauna Utilities will enter its fifth school year in partnership with Park Community Charter School. Each new year brings exciting opportunities to expand the program to provide unique learning opportunities.

While the biggest cost is allocating staff time to work with the students on the various programs, the reward of knowing Kaukauna Utilities is making a difference in these students’ lives is well worth it.

— By Jeffery Feldt, general manager, Kaukauna Utilities
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**BC Hydro to hire wildlife mitigation, monitoring for Site C project**
Canadian utility BC Hydro will hire companies to provide wildlife mitigation and monitoring services for the construction phase of the 1,100-MW Peace River Site C project in British Columbia.

BC Hydro plans to hire qualified biologists or wildlife technicians to provide general wildlife support to the project during construction and to assist in planning and initiating wildlife mitigation and monitoring programs. The utility will award a blanket contract with the scope of work to be defined through work orders issued from time to time as needed.

**CEATI releases maturity matrix for outage planning**
CEATI International has released “Technology Review: Outage Planning Maturity Matrix - Methods & Processes for Minimizing Monetary Impacts from Outages.”

This technology review, prepared by the Hydropower Operations and Planning group, discusses how a maturity matrix is an efficient way to document processes and to compare the activities performed by an organization with the best known practices, leading to plans for improvements.

Electricity companies must rely on a high level of availability of their assets. To keep these assets in reliable condition requires outages to perform recurrent annual maintenance, multiannual major overhauls and refurbishments, CEATI says.

In building a maturity matrix, this project provides the opportunity to produce an inventory of what is accomplished in the field of outage planning, CEATI says. It covers all activities for outage planning, including the scheduling and impact evaluation of outages in the forecast mode, the evaluation of actual data impacts computed after the face, and issues pertaining to efficient communications within the organization.

To request a price quote, visit www.ceati.com/publication-details/?pid=0424.

**NOAA compiling hydrographic services advisory panel**
The National Oceanic and Atmospheric Administration (NOAA) is compiling a Hydrographic Services Review Panel, a federal advisory committee that advises the NOAA administrator on the agency’s hydrographic programs, products and technology.

The panel advises NOAA on operations and research issues related to hydrographic surveying, nautical charts, tides and currents, geodetic and geospatial measurements, and coastal resilience.

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“Quality data is essential to NOAA maritime programs,” says Russell Callender, acting assistant NOAA administrator for the National Ocean Service. “As we determine future priorities, we depend on advice from actual users of our products, and this panel is a vital part of that information gathering process.”

NOAA’s mission is “to understand and predict changes in the Earth’s environment, from the depths of the ocean to the surface of the sun, and to conserve and manage our coastal and marine resources.”

Kim Ogren: Graduating Researcher of the HRF
Kim Ogren graduated in July with a PhD in geography from Oregon State University in Corvallis. Her research focused on Improving Water Governance Processes: Development of an Evaluation Framework and Application to the Columbia River Treaty Reviews. Through the development and testing of a framework based on existing frameworks and resilience and socio-ecological systems theories, this work will make evaluation of water governance processes feasible. The framework was applied to the recent reviews of the Columbia River Treaty in Canada and the U.S., which focuses on hydropower as one of the two primary purposes of the agreement.

These two case studies demonstrate two water governance processes striving to make the same decision in the same basin, allowing for comparison. At the same time, the unique contexts for the U.S. and Canadian reviews will aid in identifying potential barriers or building blocks to good water governance decision-making processes in the Columbia River Basin.

This research will help improve how governments engage the hydroelectric power industry and how the industry engages others (e.g., customers, tribes) in their decision-making processes.

The Hydro Research Foundation supports graduate students to conduct research related to conventional and pumped storage hydropower. These students are funded through the U.S. Department of Energy’s Water Power Program and industry partners through a two-year $1 million grant.

To learn more about the Research Awards Program, email info@hydrofoundation.org or visit www.hydrofoundation.org.

For more research and development news, see the Technology & Equipment tab at
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Spillway collapse at Erity Dam due to unattended dam safety needs

On June 22, after unusually higher than normal seasonal rainfall, according to local officials, the right spillway of Erity Dam collapsed. Erity Dam does not have a powerhouse and it is on the River Rouge in Beverly Hills Village, Mich., a suburb of Detroit.

Erity Dam is a 102-year-old concrete gravity dam 16 ft high and 240 ft long. The dam creates Rouge River Pond, a 27-acre catchment area that has a 200-acre-feet maximum capacity. From it, the dam has a maximum discharge of 2,550 cubic feet per second.

Inspection reports dating back to 2007 from the Michigan Department of Environmental Quality (DEQ) and private engineering firm Hubbell, Roth & Clark gave no specific time period, but the reports indicated Erity Dam’s level of disrepair and lack of maintenance would lead to a structural failure.

No injuries resulted from the failure, but locally published reports said the spillway collapse caused the loss of several trees, “severe” erosion below the spillway and slight damage to nearby Evergreen Road.

DEQ and private sector engineers estimate costs to repair and maintain the dam range from US$250,000 to $3 million, according to Chris Wilson, village manager.

In his 2009 report to the Beverly Hills Village council, Wilson that wrote the DEQ notified the village in December 2007 that the dam contained some structural deficiencies.

After being hired by Beverly Hills Village, its May 2013 report to the village council, Hubbell, Roth & Clark stated, “If left in their current state with no maintenance or dam removal, the structures will ultimately fail.” Immediately after the collapse, Wilson said, “The DEQ had just come out earlier in the month [June 2015] and told us failure of the dam was imminent.”

Lake Delhi Dam construction slows after a temporary wall fails

A temporary steel construction wall placed at the site to aid installation of the new Lake Delhi Dam failed June 14. High water flow on the Maquoketa River is being blamed for the incident, during which the steel construction wall broke away from the concrete wall behind it. Heavy rain in July resulted in flash flooding in eastern Iowa.

The area of the failure was about 10 feet wide in a wall that is about 350 feet long.

The original Lake Delhi Dam failed in July 2010 after two days of heavy rain, and the lake was drained and has since sat empty.

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At the time of the failure, floodwaters were 25,000 to 30,000 cubic ft per second. The new dam and spillway should be able to handle flows as high as 69,000 cfs.

The Lake Delhi Combined Recreational Facility & Water Quality Board made a unanimous decision to rebuild the dam in February 2014.

This work, to be conducted in two phases, included rebuilding of the dam and construction of public access points. Total cost of the project was expected to be about US$16 million. Before this most recent incident, construction of the replacement Lake Delhi Dam was scheduled to be complete by the end of October.

The original dam was completed in 1927 and included a small hydropower project until the 1970s. There have been discussions about adding a 1.5-MW powerhouse at the dam, although we are not aware of any decision having been made.

**Dam safety construction at Addicks, Barker dams in Texas**

After extending its initial timeline from July 6, the U.S. Army Corps of Engineers closed its deadline for bids on July 17 for dam safety construction at Addicks and Barker dams, which protect the Houston area from flooding.

The US$25 million to $100 million project is expected to require 1,340 days to complete.

The district plan will see construction of new outlet structures and cutoff walls at Addicks and Barker, which were built in response to flooding in Houston in 1929 and 1935. The Corps said the dams underwent evaluation under the Corps’ Dam Safety Program, which expressed concern about the outlet gates that allow outflow to Buffalo Bayou, and about the ends of the dams.

Work is to comprise constructing new outlet works structures for each dam, including intake towers, steel-lined conduits, parabolic chutes, stilling basins, cutoff walls and downstream filters.

**US$10 million needed for dam safety repairs in Minnesota**

Minnesota’s Department of Natural Resources is petitioning the Minnesota State Legislature for US$10 million to repair six high-hazard dams, including the one that impounds water for the 8.8-MW St. Cloud hydroelectric project.

The spillway at St. Cloud Dam allows water flow either through the turbine-generator units or over the top of the dam. Several wooden lift-up gates divert the water level up to 3 ft higher to provide optimal conditions for electricity generation. Installation of a new automatic gate system would be a priority.

The other five high-hazard dams on the priority list include: Bronson, Lanesboro, Pelican Rapids, Norway Lake at Pine River, and the Canby impoundment.
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From the Web

Live from Portland
Whether you missed HydroVision International 2015 or just want to see recaps of conference sessions, announcements from exhibitors or news from the world’s largest gathering of industry professionals, HydroEvent.com has a catalog of video highlights from Portland. These videos can be found in a section called “Hydro TV,” under the Home tab at the top left.

Hydro in pictures
With installations in some of the world’s most scenic locations, hydropower plants look great in pictures. A new slideshow from Kiewit highlights some of these, along with development and rehabilitation work performed by the company. The slideshow and other archived slideshows are available for viewing at HydroWorld.com.

Safeguarding assets in a digital age
A new white paper prepared by PennWell’s Hydro Group and sponsored by Lockheed Martin provides an in-depth look at how cybersecurity is more important now than ever before. The free white paper, titled “Cybersecurity and Infrastructure Protection at Hydroelectric Facilities,” features input from four industry experts and touches on the scope of threats, how to react to an incident, and where utilities are investing their resources.

On the road for hydro
With dozens of association meetings, conferences and trade shows held each year around the world, knowing what is going on where can be difficult. But, HydroWorld.com can help. With a comprehensive schedule of events from around the world, it’s easy to plan your next trip. The Events calendar is located under the Home tab at the top left. Contact the Hydro Group to submit an event for inclusion on the HydroWorld.com event calendar.

Suggestions
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Hydro Review always welcomes your suggestions for articles and departments you believe would be helpful to colleagues.

Please send your ideas to the Editor, Hydro Review, 1421 S. Sheridan St., Tulsa, OK 74112; (918) 918-383-9175; E-mail: elizabethi@pennwell.com.

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