Glen Canyon Dam

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COATING MAINTENANCE CHALLENGES AT THE BUREAU OF RECLAMATION

The U.S. Bureau of Reclamation was established in 1902 and today is the largest wholesale water supplier and the second-largest producer of hydroelectric power in the United States. The Bureau operates facilities in the 17 western states, provides water for more than 31 million people, and its 53 power plants produce enough electricity to serve 3.5 million homes. This article explores current coating-maintenance challenges faced at Reclamation facilities.

At each of its facilities, Reclamation conducts a comprehensive review that includes inspection of coatings, structure, concrete, and soil stability every three to six years; performed by its Technical Service Center (TSC) and Materials Engineering and Research Laboratory. If corrosion is discovered during coating inspection, action is prescribed and decisions are made, such as spot coating vs. blasting and recoating.

Paul Scannell is a field mechanical engineer at the Glen Canyon Dam. Each year inspections are conducted at the facility by in-house inspectors. More in-depth inspections are done every three years by Reclamation engineers from within the region, and every six years by Reclamation engineers from the TSC. Scannell maintains that having different sets of eyes reviewing is an asset to the inspection process there.

At Glen Canyon, touch up and recoating of smaller systems is performed as necessary and is ongoing. Larger projects such as penstock and outlet works are done on an annual basis and major recoating projects are based on projections made from inspection.

COATING CHEMISTRY CHALLENGES

Reclamation’s facilities are old, some over 100 years, and were originally coated using lead-based paints, vinyl resins and coal-tar enamels. These coatings have performed well in this challenging environment for more than 50 years and in some cases, as long as 80 years, but they are starting to fail and Reclamation is seeing more frequent need for blasting and recoating. They have chosen to spot repair for as long as possible because they have yet to find a replacement coating system that will provide this kind of service life.
Reclamation previously repaired damaged coal-tar enamel by grinding the area and repairing with coal-tar epoxy. They learned that the grinding damaged more of the existing coating than necessary and the grinding wheels plugged up constantly. Richard Pepin, senior coatings specialist with Reclamation adds, “When the coal-tar epoxy is used for repairs, the solvent in it loosens and lifts the undamaged coating it comes into contact with. A better way is to clean the surface by sanding, needle gun or wire wheel abrader and applying 100%-solids epoxies as the repair material.”

Going forward, Reclamation has decided to specify greener technology and as the coal-tar enamels continue to fail, the TSC is faced with the prospect of replacing them with coating types that won't last nearly as long and could result in a restructuring of their coating maintenance plans and budgets.

Therefore, finding out why these older coating systems worked so well for so long under these extreme conditions is of major interest. Today TSC personnel are heavily involved in research and testing of replacement options. Pepin says, “We independently test every coating that we use before we will specify it for new or existing projects.”

**ECONOMIC CHALLENGES**

As with maintenance of anything, funds are often an issue and the situation at Reclamation is no different. The government initially paid to have these facilities built and each was paid off within 40 or 50 years. Congress continues to provide an annual budget for a small amount of routine maintenance but most funding is obtained through the sale of power and reimbursement for operation and maintenance expenses from water project beneficiaries.

Coating maintenance at Reclamation facilities is impacted by many peripheral factors. Outages, access, safety, ventilation and handling of hazardous materials are dominant issues and have considerable bearing on finances. “It costs a lot of money to take a facility out of service,” says Pepin.

Removing the old coating systems presents hazardous-material concerns. Proper removal and disposal of these materials is an expense consideration. Areas of confined space present danger as well as ventilation-cost concerns.

Physical logistics at these facilities are challenging as well. Some areas have very limited access — there’s one way in and one way out. Some are very steep and extreme heights exist. Pepin says that access issues account for the largest portion of their coating budget. “We are constantly looking at
new materials, processes and safety," says Allen Skaja, coatings specialist at Reclamation.

As these supplemental concerns have a substantial effect on cost, they are given strict consideration when coating project determinations are made. Skaja continues, “Sometimes in the decision-making process, we decide to not repair any coating due to the expense of conducting spot repairs. Instead we’ll wait for the coating to fail more before doing anything. At around 15-percent corrosion it typically becomes cheaper to abrasive blast and recoat rather than spot repair.”

**MUSSEL INFESTATION CHALLENGES**

Leonard Willett is the environmental compliance manager and quagga mussel coordinator for the Bureau of Reclamation. He works out of the Hoover Dam and is all too familiar with the initially microscopic, aquatic mollusks that are said to cause millions of dollars in damage, if not more.

First observed in the late 1980s in Lake Erie, these invasive organisms are believed to have arrived in the U.S. via ballast water discharge from transoceanic ships. With life spans of only about three years, they are prolific, reproducing about six times annually. Willett maintains that the female quagga mussel lays up to 60,000 eggs at each cycle and that there are about 55,000 mussels per square foot of occupied area.

According to Willett, quaggas are a major problem at the Hoover, Parker and Davis Dams. Last year, adult mussels were discovered at the Glen Canyon Dam and signs there point to imminent infestation. Reclamation’s San Justo
and Glen Elder Dams are infested with zebra mussels, a close relative of the quagga.

Quagga mussels block water flow by attaching to immersed coated-steel surfaces. They gather in clumps and eventually die. When these clumps get too heavy they detach, fall, and accumulate and block water flow where they land.

As if their blocking capability isn’t problematic enough, quagga mussels also secrete corrosive material. They are filter feeders; pulling water into their shell cavities, extracting the desirable particles, and expelling what they don’t want. That expelled substance is corrosive to paint and steel and an adult mussel is capable of filtering more than one liter of water per day.

Mussels attach to any exterior surface at these dams. The surfaces, all comprised of coated steel and all under water, include trash racks, radial arm gates, spillway gates and penstock gates. A trash rack is a type of screen that prevents debris from entering the system. Trash racks are generally cast steel with four inches between each bar. Annual inspection of a trash rack that is 100 feet tall will often reveal that when the upper 60-foot section is blocked with mussels and debris, the lower 40-foot section will be clear because the water is of a higher velocity in that area and the mussels don’t attach, most likely because it is more difficult to stay attached.

Annual inspections are done with ROVs — remote-operated vehicles — no human drivers and equipped with cameras. Outages are scheduled to scrape off any blockages.

Finding a coating that quagga mussels won’t attach to is a top priority. Reclamation’s Technical Service Center has been testing contenders for six years. A silicon-based coating that prohibits mussel attachment has been identified (available from multiple manufacturers), but it is not nearly durable enough for these service conditions.
Hoover Dam & Glen Canyon Dam

**Hoover Dam**, constructed from 1931 to 1936, is located in the Black Canyon of the Colorado River about 35 miles southeast of Las Vegas, and spans the Arizona-Nevada state line. It is a concrete thick-arch structure, 726.4 feet high and 1,244 feet long. The dam contains 3.25 million cubic yards of concrete; total concrete in the dam and appurtenant works is 4.4 million cubic yards. Its penstocks and outlet pipes were formed from 44,000 tons of steel and welded into 14,800 feet of pipe varying from 8.5 to 30 feet in diameter.

Each spillway tunnel decreases in size from 48 to 41 feet in diameter.

The power plant at the toe of the dam is comprised of four 118,750-kilowatt and four 136,562-kilowatt generators driven by eight turbines. Eight penstocks transport water to the turbines and each penstock decreases in size from 15 to 14 feet in diameter.

Reclamation facilities primarily coat steel but also coat concrete on occasion, chiefly to mitigate moisture on decks and power plant roofs. Says Pepin, "Because of their age and design we have leaks. We do crack injections and put in new water stops, but at times may also seal the whole deck."

Pepin’s article, “Concrete Crack Repair and Deck Sealing at the Durango Pumping Plant,” *JPCL*, December, 2013, describes such a project.

**Glen Canyon Dam**, constructed between 1956 and 1966, is a 710-foot-high structure with a concrete arch dam that has a crest length of 1,560 feet and contains 4,901,000 cubic yards of concrete. Its penstocks and outlet pipes were formed from 44,000 tons of steel and welded into 14,800 feet of pipe varying from 8.5 to 30 feet in diameter.

Facing coating challenges is a never-ending job at the Bureau of Reclamation, as it is at many types of industrial facilities. Taking a proactive approach by investing in education, testing, timely inspections and awareness of new technological developments and advances can pay dividends down the road with respect to service life, money and time.

Pamela Simmons (psimmons@paintsquare.com) is the editor in chief of *JPCL*.

Special Thanks

Richard Pepin, PCS, is a senior coatings specialist with the Bureau of Reclamation Technical Service Center.

Dr. Allen Skaja, PCS, is a coatings specialist with the Bureau of Reclamation Technical Service Center.

Leonard Willett is the environmental compliance manager and quagga mussel coordinator with the Bureau of Reclamation and works at the Hoover Dam.

Paul Scannell, until recently, was a mechanical engineer at Glen Canyon Dam. *JPCL*.

That was the case until December of 2013 when two new coating formulations emerged. One is a commercial product from an international company. It’s a self-cleaning coating and the mussels clean off of it with very little water flow or force. The second is an experimental coating from a university and not yet commercially available. The mussels don’t attach to this coating at all. Testing to date indicates that both formulations will provide the required durability.

At press time, Reclamation’s Technical Service Center personnel are involved in testing, technical review and the preparation of a report on these two coatings, which will be published on their website later in 2014. They could not provide the author with any further information about either coating but are optimistic about the results.

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