Hydro Hall of Fame: Recognizing Hydro's Long-Lasting Value

The two 1997 inductees to the Hydro Hall of Fame have many common bonds. Perhaps most important, the plants have played a critical role in the economic health of their surrounding communities for more than 100 years.

When we established the Hydro Hall of Fame in 1995, *Hydro Review* saw it as an opportunity to recognize one of hydropower's more important characteristics: longevity. By featuring plants that have been operating at least 100 years, the Hall of Fame program emphasizes the reliability and durability of hydro's basic machinery and systems. Telling the story of these facilities also highlights the vision, creativity, and hard work of the people involved: the designers, the constructors, the owners, and the operators.

As it has unfolded, however, the Hall of Fame effort has done much more. The stories about Hall of Fame inductees and other generating plants with long records are sending a clear message about the positive outlook for hydro in the brave new world of power generation. It is not by chance that these hydro plants have long lives...it is because they have remained economically viable for years and years.

Consider the stories of the two projects being inducted into the Hydro Hall of Fame for 1997: Fulton Hydroelectric Station in New York and Pelzer Mills Lower Hydroelectric Project in South Carolina.

The Fulton project, which began operation in 1884, is the oldest hydro plant still in operation in the state of New York. Its age and service make it well worthy of membership in the Hydro Hall of Fame. Especially worth noting is the plant's role as a centerpiece in the evolution of the area of northern New York State between Syracuse and Lake Ontario from an agriculture-based economy to one relying on modern manufacturing. Electricity from the Fulton project's two 250-kW generating units supplied the electric power needed for electric motors installed in many manufacturing plants in that area, as well as to provide street lighting and lights in residences.

The plant later was acquired by a predecessor to its current owner, Niagara Mohawk Power Corporation, and refurbished. Today, the plant has two units with a combined capacity of 1.25 MW and provides 5,360 megawatt-hours a year of low-cost and clean electricity to Niagara Mohawk customers.

The other 1997 honoree, the Lower Pelzer project near Greenville in the northwestern South Carolina, has been making history every day for more than 100 years. Initially, the facility made news for being the first hydro project to use overhead wires to transmit electricity for a long distance. The plant was developed by a successful operator of cotton mills as a cost-effective source of electricity. However, the hydro site was almost 3 miles from the mills, so the then-long distance transmission link was necessary.

The plant's enduring "claim to fame" lies not in the headlines it created in the early days but in how little news it has made since. Except for refurbishment and maintenance outages, the Lower Pelzer hydro station has been operating continuously since it started up in 1895. Now owned by a unit of Consolidated Hydro, Inc., the plant's five units have a combined capacity of 3.3 MW and produce about 11,400 megawatt-hours per year in renewable energy for sale to Duke Energy.

The stories of these and other hydro plants with long records of effective and efficient performance provide an important message for the hydropower industry in North America. As one hydro professional said in nominating a candidate for the Hydro Hall of Fame: "As we move toward an uncertain energy future, and the search for alternate energy sources continues, hydro stands as a testament to the dependable, clean, efficient way of generating electricity."

Past Hall of Fame Inductees

Plant	*Year In Service*
Bridge Mill Power Station (1.7 MW) Pawtucket, Rhode Island	1896
Columbia Canal Hydro Plant (10.6 MW) Columbia, South Carolina	1896
Lanesboro Electric Power Plant (240 kW) Lanesboro, Minnesota	1895
Stairs Station (1.2 MW) Salt Lake City, Utah	1895
T.W. Sullivan Plant (16 MW) Oregon City, Oregon	1895
Vulcan Street Hydroelectric Central Station (12.5 kW) Appleton, Wisconsin	1882

Fulton Hydro Station:

Partners with the Oswego River Since 1884

The story of the 1.25-MW Fulton Hydroelectric Station, a 1997 inductee to the Hydro Hall of Fame, is more accurately the story of a river, the Oswego, and the hydro station's partnership with that river. Since 1884, the river has driven Fulton's turbine-generators. Together they have powered the founding, growth, and success of a city and region.

The power station, owned by Niagara Mohawk Power Corporation of Syracuse, New York, now teams with the 8-MW Minetto and 8.8-MW Varick hydro plants to form the Oswego River Project. The plants supply low-cost power to the utility's grid, and preside over the dams, canals, and locks of the river, whose uses in this modern era have changed. Instead of a solid stream of commercial vessels passing, recreational boats of all sorts—from small salmon fishing boats to 80-foot pleasure yachts—now squeeze through the locks past the plants.

"The river is mostly for pleasure now," said Robert Brown, a 38-year veteran of Niagara Mohawk who retired in 1990. "Commerce on the river has been a slowly dwindling affair, probably stopping almost completely in the 1980s. The last regular transport, the Peckenpaque, carried loads of cement from Lake Ontario up the Oswego River."

Pleasure boats leaving Lake Ontario's Thousand Islands recreational area for the winter begin the route south on the Oswego River. At the top of the Oswego, boats take the left fork into the Oneida River and into Oneida Lake. From there, they cross the Erie Canal to Albany and the Hudson River, then south through New York City to Florida and the Bahamas.

"Some of the most beautiful cruisers you've ever seen come through the lock right by the Fulton plant going south for the winter," Brown said. "We'd stand in the plant and talk with the crews about what they were going to do in the Bahamas."

Though the river's other uses have changed, the Fulton hydro plant continues to meet its primary mission: generating low-cost, clean, and renewable electricity for Niagara Mohawk customers. The utility applied to the Federal Energy Regulatory Commission (FERC) for relicensing of Fulton in 1991, and there are no major operational or environmental issues standing in its way. (FERC is expected to issue a ruling on Fulton by early 1998.)

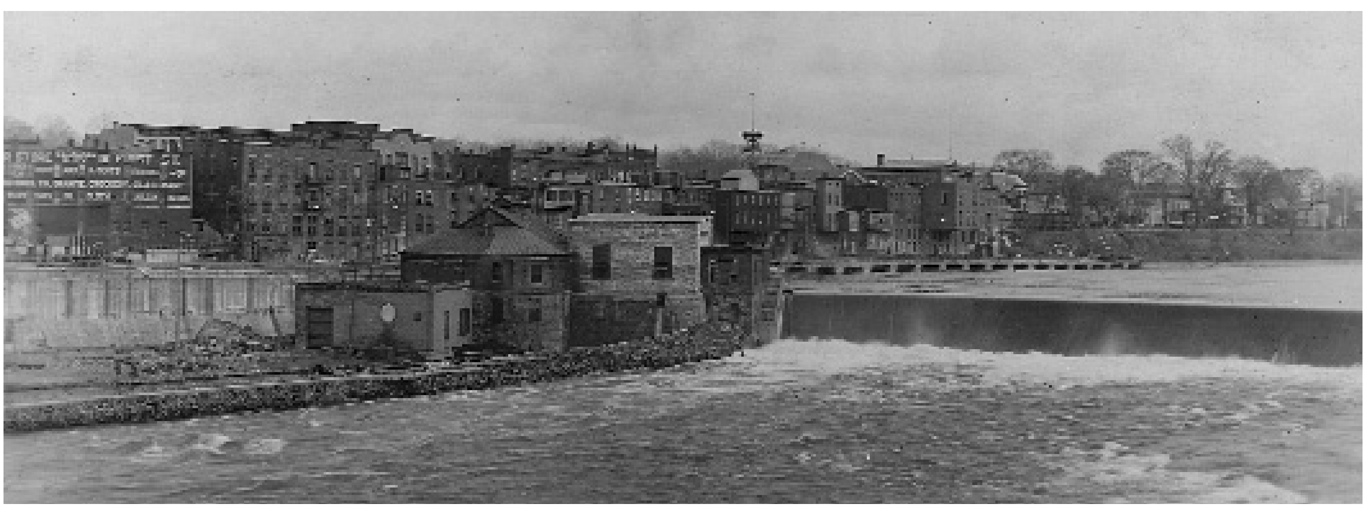
The Fulton plant was automated in the 1950s and is now operated remotely. The turbine for the 800-kW Unit 1 was replaced in 1935 with a vertical fixed-propeller turbine. The turbine for the 450-kW Unit 2 was replaced in 1928 with another fixed-propeller turbine, making it ideal for use when the river is at low flow during the summer. Extensive modifications of the powerhouse were required during the replacements, and in 1985 remaining portions of the original superstructure were removed.

"It's an old plant, but it's still trudging along," said Jorge Villali, who is working on the Fulton relicensing effort for Niagara Mohawk. "Operate another 100 years? It very well could."

First, There Was the River

The city of Fulton, population 13,000, is located in the northern part of New York State between Syracuse and Lake Ontario. In the early 1800s, Fulton, a tiny village on the east bank of the river, entered a period of transition from its agricultural/lumbering foundation toward a role in commerce and manufacturing. Another village, Oswego Falls, was located on the west bank, but in the early 1900s Oswego Falls became part of Fulton.

The region has a rich history, most of it revolving around the Oswego and other streams in an 8,000 square-mile watershed that is one of the larger ones in North America. The Oswego, formed by the confluence of the Seneca and Oneida rivers, flows from south to north just a little more than 16 miles to Lake Ontario. Over those 16 miles, it became the commercial lifeline for burgeoning milling and manufacturing interests.



The 1.25-MW Fulton Hydroelectric Station sits between the Oswego River channel and a canal and lock that provides flow to run Fulton's two turbine-generators. This vintage photograph shows the town of Fulton, New York, in the background. Fulton experienced accelerated growth when the power station began operation in 1884. (Courtesy Niagara Mohawk Power Corporation)

The river varies from a flow of 800 cubic feet per second (cfs) up to 20,000 cfs in the spring runoff. And it is steep. The Oswego drops 117 feet in 10 miles, from the town of Phoenix to Fulton. A series of white-water rapids turn the river to froth. Novelist James Fenimore Cooper in *The Pathfinder* has his hero fleeing by canoe from Indians, and gaining a large advantage in the downriver race by catapulting across a falls 12 yards through the air. Local stories suggest the race was on the Oswego and point out a particular waterfall as the one that was used.

Traders and other users of the river had to portage some eight times on the way to Lake Ontario. Beginning in the 1820s, construction began on canals and locks around those portages. That was the beginning of the modern era on the river.

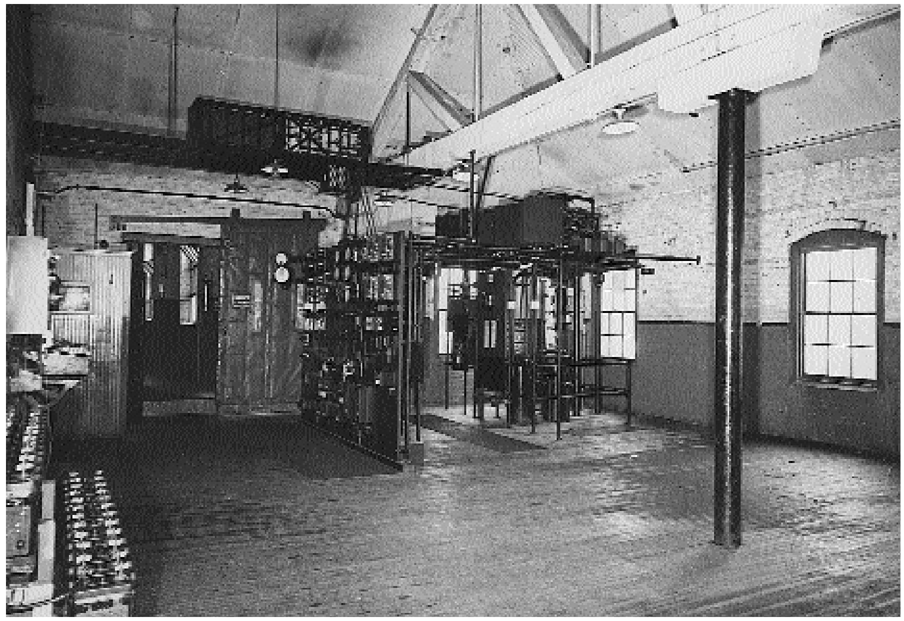
The Oswego Canal Company completed the first lock and canal on the river at Fulton in 1826. In 1830, a grinding mill beside the canal, powered by a waterwheel, was completed. A granite keystone, dated 1830, was installed, and still can be seen in the building that is now part of the powerhouse of the Fulton Hydroelectric Station. In all, eight locks were built, two upstream from Fulton and the rest downstream, but two were later removed. Eight timber dams gave way to six masonry dams, with the last one completed in 1873. All but one of the dams contain a hydropower station. The dams and locks are all owned and maintained by New York State.

Commercialization of the River Begins

Completion of the canal and lock at Fulton in 1836 signaled the beginning of growth for the city. Mechanical wheels in the canal led to establishment of a seed-grinding mill, forges, and manufacturing plants. A sawmill opened. Later, Standard Oil Co. established a plant for making boxes. At Minetto, the Columbia Shade Cloth Company made window shades.

Four decades of slow growth ensued. As the 1880s approached, Fulton neared another era of transition. On July 24, 1880, the Grand Rapids (Michigan) Electric Light and Power Company demonstrated 16 brush arc lamps powered by a dynamo belted to a water turbine. That likely was the first hydroelectric plant in the U.S. Nearer to Fulton, on December 14, 1881, a Brush dynamo generated power for an arc lighting system in the city of Niagara Falls, New York. With those first projects, hydroelectricity took its place as the ideal solution for generating power in remote regions of North America.(See "Tracking the Pioneers of Hydroelectricity," in this issue on page 46.)

Three years later, two water-driven, 50-kW, 250-volt, direct-current (DC) generating units were installed at the seed-grinding mill in Fulton. The power station was operated by the Fulton Electric Light and Power Company. Electricity from the hydroelectric units supplied electric motors in Fulton's various manufacturing plants, powered street lights, and lighted residences. Longtime Niagara Mohawk employee Brown said that, at about the same time, the Greyson Tanning Company installed the city's first



New controls and switchgear were added to the Fulton Hydroelectric Station in 1952 when the power station was automated. The plant's turbine-generators are now remotely controlled. (Courtesy Niagara Mohawk Power Corporation)

Technical Information
Fulton Hydroelectric Station

General Information

Location: On the east side of the Oswego River in Fulton, New York

Owner: Niagara Mohawk Power Corporation, Syracuse, New York

Capacity: 1.25 MW

Expected Annual Generation: 5,356 MWh

Head: 17 feet

Efficient Hydraulic Capacity: Unit 1, 650 cfs; Unit 2, 359 cfs

On-Line Date: 1884

Equipment

Turbines (2 units)

Unit 1 installed in 1935

Unit 2 installed in 1928

Vertical, fixed-propeller turbines

93 inches in diameter

Unit 1: 1,100 horsepower, 150 rpm

Unit 2: 600 horsepower, 200 rpm

Generators (2 units)

General Electric synchronous generators with governors

Unit 1: 800 kW

Unit 2: 450 kW

3 phase, 60 Hz, 2,300 V

Construction

Powerhouse

Reinforced concrete substructure

Brick and steel superstructure

43 feet long, 35 feet wide, 55 feet high

Dam

Stone masonry, with a concrete cap

509 feet long, 15 feet high

Forebay pond

Vertical slide gate for each turbine

Cast steel draft tubes

Built in 1914

Prior to dam construction, flow taken from navigation canal electric motor, a machine that itself cost $1,000.

For the next 15 years, power from the Fulton hydro plant cost a flat rate: for commercial outlets, the price was $5 per month for each 16 candlepower lamp (equivalent to a 50-watt bulb); the residential rate was 30 cents per month for the first lamp and 10 cents per month for each subsequent lamp. In 1901, when the Fulton plant switched to delivering alternating-current (AC) electricity, a metering system was installed in homes and industries—the load immediately dropped by 50 percent.

In about 1910, downstream at Minetto, a company named the Niagara Lockport and Ontario Co. built a DC hydro plant that generated 25-cycle power to run a new trolley line from Oswego on Lake Ontario to Syracuse, a distance of about 30 miles. The trolley became the primary form of transportation in the region. Other hydroelectric plants were built, including—in the late 1910s—a plant across the river from Fulton named Grandby. Ownership and the names of the plants changed as the years passed.

Fulton Electric Light and Power Company by the early 1900s was the Fulton Light, Heat, and Power Company. That company got into some trouble. Records from 1910 say the Oswego County treasurer announced it would take over the powerhouse and sell it for back taxes. Fulton Light, Heat, and Power quickly paid up, delivering a check for the total due: $17 in taxes, plus a fee of 18 cents and interest of 86 cents.

In the late 1920s, the Fulton plant was acquired by Niagara Hudson Power Company. In 1950, all of the plants came under one corporate umbrella, Niagara Mohawk Power Corporation.

Establishing a Partnership With the River

The Oswego River was polluted during the early decades of the 1900s, according to Niagara Mohawk's Brown. Camps and manufacturing companies did not have septic systems, and they dumped refuse into the river.

However, Niagara Mohawk, he said, has been as good to the river as the river has been to the utility. Niagara Mohawk maintained septic systems for all of its facilities. For its powerhouses, the utility designed and built its machinery to ensure that none of the huge amount of lubricating, insulating, and transformer oils ever leaked, long before such measures were required by state and federal regulating agencies.

For its part, the river has taken care of the electrical users living around it. An excellent example occurred during the massive blackout of the eastern seaboard during the 1960s. When the blackout struck, the Oswego River area cut itself off from the national grid by switching off highlines. The Fulton plant was started. Within a few minutes, light and power returned to commercial and residential customers throughout the city. Brown said commercial airline pilots later commented that Fulton, New York, was a small island of light amid a sea of black across the eastern seaboard.

"Other small towns probably did the same thing," Brown said. "But I was involved in this one. It was really neat. I tell you, she's a grand girl, that river. She was good to me."

For more than a century, the Oswego River and the Fulton Hydroelectric Station have been partners in producing low-cost, clean electricity.

—By Edward Fulton, associate editor of Hydro Review.

Lower Pelzer:

A First for Long-Distance Transmission

HYDRO Hall of Fame

Visitors to the Lower Pelzer Hydroelectric Project today could be forgiven if they didn't notice anything particularly unique about this 3.3-MW station on South Carolina's Saluda River. They would have to know the history of electricity in the U.S. to realize that this plant attracted a great deal of national attention in 1895, when it was built, for being the first hydro project to use overhead wires to transmit electricity for a long distance. Today, it claims the added distinction of having three generating units in continuous operation for nearly 103 years.

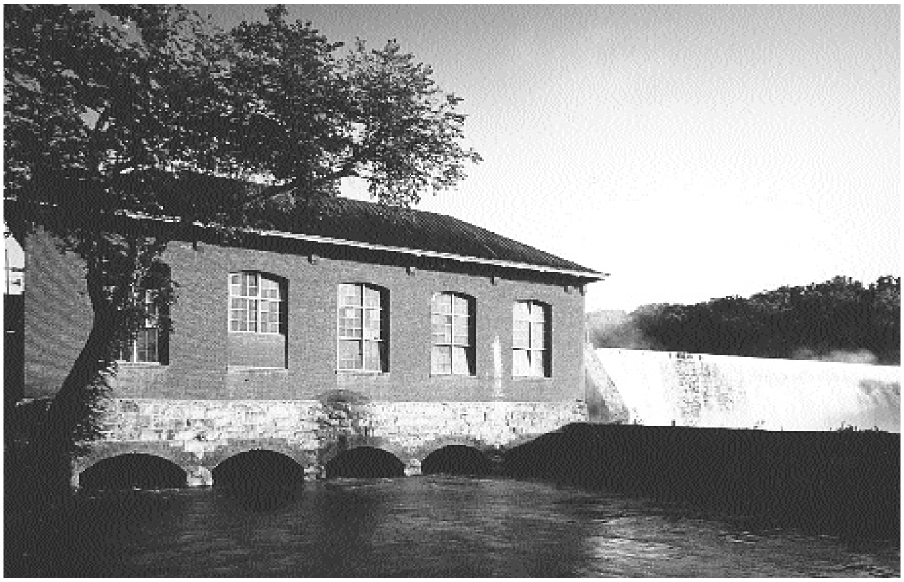
Officially named the Pelzer Mills Lower Hydroelectric Project, the run-of-river plant is located just outside the town of Williamston, near Greenville in the northwestern corner of South Carolina. (Yes, there's also an "Upper Pelzer" project, a 2-MW plant located a few miles upstream in the village of Pelzer. But, the Upper Pelzer is "only" about 85 years old.) Both Pelzer projects originally were industrial generation plants powering the textile industry in the southeastern U.S. Today, they are owned and operated by Consolidated Hydro Southeast, Inc. of Greenville, a subsidiary of Consolidated Hydro, Inc. (CHI) of Stamford, Connecticut. The plants operate as independent power production facilities selling capacity and energy to Duke Energy.

Serving the Cotton Industry

The Lower Pelzer plant was completed in December 1895 by the Pelzer Manufacturing Company, a successful owner of cotton mills like many such companies that were booming in the Southeast U.S. at that time. Established in 1860, Pelzer had built three mills in the mill village of Pelzer, two powered by waterwheels and the other using a steam engine. By 1893, Pelzer's president, Captain E.A. Smythe, had made plans to double the company's spinning capacity and was looking both for an appropriate mill site and for a source of additional power.

A power source was readily available, since the company already owned the rights to a site on the Saluda River about 3 miles from its existing mills. Better yet, the technology now existed to convert water power to electricity. The first hydroelectric installation in the area was already under construction for the purpose of powering a textile mill—the Columbia Canal plant in Columbia, South Carolina, which was inducted into the Hydro Hall of Fame in 1996. [For more information, see "Columbia Canal Hydroelectric Plant: Dreams of Water Travel Lead to Electricity" beginning on page 30 of the September 1996 issue of *Hydro Review.*] The Columbia Mills plant was eventually completed in April 1895 and featured a transmission line running 700 feet from the plant to an adjacent mill.

But for Captain Smythe, there was



The brick powerhouse and masonry dam at the Lower Pelzer Hydroelectric Project near Williamston, South Carolina, appear essentially unchanged from when they were constructed in 1895. The project was the first to use long-distance overhead transmission of electricity, powering a textile mill approximately 3 miles away.

still a problem to be solved. To save money, he much preferred to locate the new mill in the village of Pelzer, near the existing mills. How, then, could electricity from the hydro plant be transmitted to the new mill?

Captain Smythe decided on a solution that was on the technological cutting edge of the time: running transmission lines 3 miles from the hydro plant to the new mill. Unlike the short power line at the Columbia plant, which was to be installed along a short bridge and underground, the Pelzer lines would need to be strung overhead.

Captain Smythe signed a contract with the General Electric Company for purchase of the hydro generating equipment, and commenced work on the dam and powerhouse. According to documents in the General Electric Hall of History in Schenectady, New York, the price of Pelzer's stock fell $25 per share after word got out about the company's risky enterprise. Despite the public's skepticism, construction work continued and the project was ready for operation by the end of 1895, overhead wires and all.

A General Electric historical account of the project describes the public's view of the Pelzer scheme: "The skeptical reaction of the public at the time of the Pelzer electrification was but an indication of the general attitude towards electricity and the common misunderstanding of its principles... One of Captain Smythe's acquaintances, whom he met on the afternoon of the day the plant was put into operation, offered his condolences to the Captain in the "failure of the electrical transmission system," saying that he had watched the wires all day long and they had not moved...[I]t was his belief that the wires must travel, as if operated by pulleys, between the power house and the mill. The transmission line passed over the mill village and some of the operatives placed pails beneath the wires "to catch the electricity that fell off."

On the contrary, of course, the transmission of electricity at the Lower Pelzer plant was a great success, and was the subject of detailed reports in technical journals of the time. A March 1896 article in *The Electrical World* summarized the advantages of long-distance overhead transmission to the Pelzer's manufacturing operations:

— Proximity to the other mills, thus saving duplication of mill offices, stores, schools, churches, and other mill village necessities;

— The choice of the location of the mill, as in this case it is located in what is practically a level field, in close proximity to the railway and near the other mills; and

— The savings of the annual consumption of 2,500 tons of coal, costing approximately $9,000, by the substitution of [an electric] motor for the steam engine.

According to General Electric accounts, the success of Lower Pelzer and subsequent similar installations in the Southeast helped the textile industry in the region quadruple its production capacity during the first quarter of the twentieth century.

Testifying to Longevity

The entire Lower Pelzer facility is a testament to the longevity of hydropower

Technical Information
Pelzer Mills Lower Hydroelectric Project

General Information

Location: On the Saluda River approximately 1 mile from Williamston, South Carolina

Owner: Consolidated Hydro Southeast, Inc., Greenville, South Carolina

Capacity: 3.3 MW

Head: 40 feet

Annual Average Generation: 11,400 MWh

On-Line Date: December 1895

Equipment

Turbines (2 units)
4 double-runner horizontal Francis
3 at 750 kW each
1 at 300 kW
Manufactured by Stillwell-Bierce
1 double-runner horizontal Francis
750 kW
Manufactured by S. Morgan Smith

Generators (5 units)
Synchronous with governors
3-phase
Manufactured by General Electric

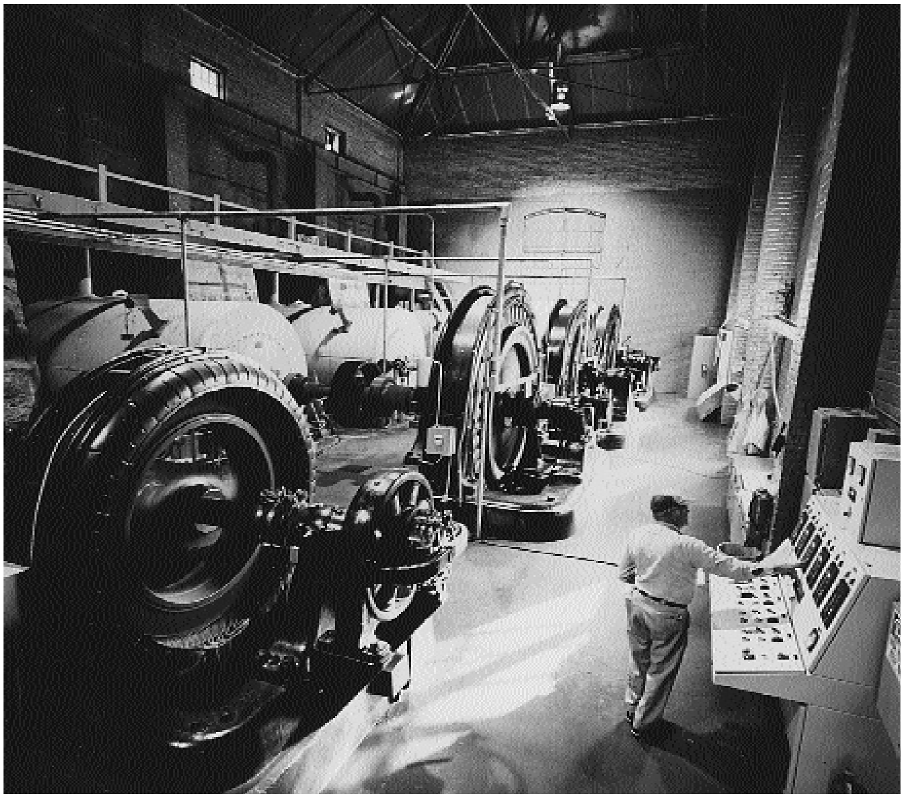
Construction

Powerhouse
Brick walls on granite masonry foundation
Integral with dam
68 feet wide; 110 feet long

Intake
5 intake gates
Manually operated

Transmission

Originally, a 3.3-kV overhead line extending approximately 3 miles to a textile mill in the village of Pelzer; now interconnected with Duke Energy



Inside, the Lower Pelzer powerhouse blends the old with the new. Three of the 750-kW generating units have been in continuous operation since December 1895. A 300-kW unit and a fourth 750-kW unit were added in 1905 and 1930, respectively. The new control panel on the right of this photograph was part of a control upgrade and overall refurbishment undertaken by Consolidated Hydro shortly after it acquired the plant in 1990.

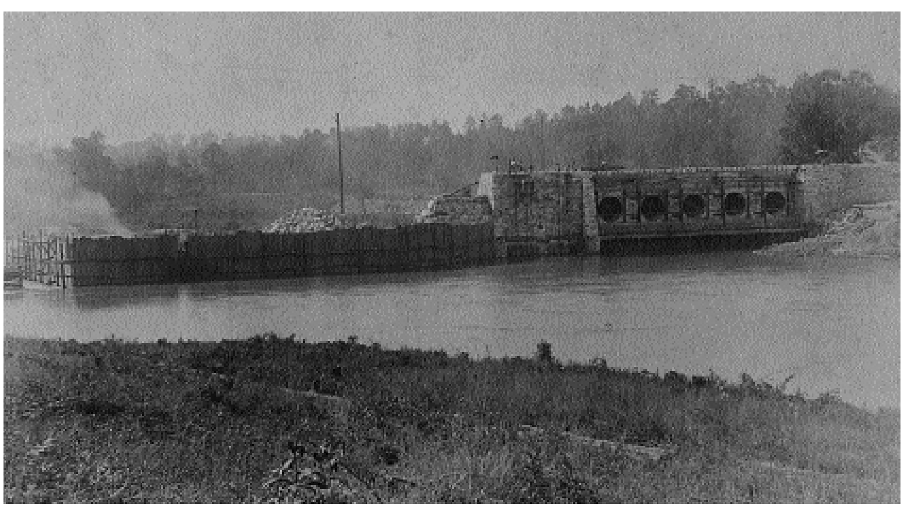
projects, as well as to the quality of workmanship that was standard 100 years ago. Not only are three of the five generating units part of the original installation, but the main structures also are essentially as they were constructed in 1895.

The dam is built of random rubble masonry—large granite stones with spaces completely filled with a mixture of cement and smaller stones. Facing the project from left to right, the dam includes a 310-foot overflow spillway, a 40-foot non-overflow section with two gates, the powerhouse (110 feet long), and another non-overflow section (236 feet long). The overflow section is 32 feet high, with an additional 4 feet of flashboards. The dam impounds a water surface area of approximately 80 acres, with net storage capacity of only about 160 acre-feet.

The powerhouse structure has a rubble masonry foundation, above which is red brick construction extending 60 feet high and 68 feet wide. For a height of 3 feet above the normal waterline, the brick walls were waterproofed by hand-painting six coats of thin Portland cement. The interior floor is a cement slab poured over multiple courses of 6-inch-thick concrete. The generating units are on granite supported by I-beams embedded into the concrete floor. The powerhouse roof is tin, as was commonly used for roofing at the time.

The generating equipment includes four 750-kW units and one 300-kW unit. The three original 750-kW turbines were manufactured in 1894 by Stillwell-Bierce of Dayton, Ohio, with the generators manufactured by General Electric. Equipment for a 300-kW unit was manufactured by the same companies about ten years later. Another 750-kW unit was manufactured in 1930, and consists of an S. Morgan Smith turbine and a General Electric generator.

The project has been found eligible for the National Registry of Historic Places and is the subject of a Cultural Resources Management Plan prepared by CHI in accordance with the terms of the project license. CHI has committed to operating, maintaining, and repairing the project so as to preserve its historic significance.



The Pelzer Mills Lower Hydroelectric Project in South Carolina has a granite masonry dam. This photograph shows the structure during construction around 1894. The dam functioned with minimal maintenance for more than 100 years, before the top 7 feet were destroyed in 1995 flooding. Reconstruction using compatible materials was completed in the spring of 1997.

Recent History

The Lower Pelzer plant served the Pelzer Manufacturing Company and its successors in the textile industry for more than 90 years of continuous operation without a license from the Federal Energy Regulatory Commission (FERC). However, in 1987, the then-owner, Soft Care Apparel, Inc., applied for a FERC license for the project (along with the younger Upper Pelzer plant) as a means of protecting them from the possibility of development claims from competing hydro owners. The licensing process was uneventful, with significant conditions limited to maintaining minimum flows and preparing a cultural resources plan.

Shortly after receiving FERC licenses, the Pelzer projects were purchased by Aquenergy, Inc. of Greenville, a developer and owner of other small hydro projects in the Southeast. Aquenergy obtained power purchase agreements from Duke Energy for both plants. The agreements remain in force today. In 1990, Aquenergy and its projects, including the Pelzer plants, were purchased by CHI. CHI, which employs three operators for the two Pelzer sites, has upgraded switchgear and control systems, refurbished the generators and turbine wicket gates, and replaced turbine bearings.

According to Jim Fulmer, who heads CHI's southeastern operations, the company and its plant operators are always conscious of Lower Pelzer's history. "It's hard not to be aware of it when you're surrounded every day by the old machinery and architecture," Fulmer says. "It makes you appreciate hydro as a generating resource and the role it has played in helping industrial development in the United States."

Recently, CHI had an opportunity to show its regard for the project's historic significance after Tropical Storm Jerry destroyed the top 7 feet of spillway portion of the masonry dam in August 1995. The storm had increased Saluda River flows from a daily average of 792 cfs to approximately 12,000 cfs, causing the first major damage to the project structures. The restoration work was performed using reinforced concrete and split stone facing to maintain the original appearance. At the same time, the dam was reinforced by installing rock anchors to tie the dam to the bedrock. Plant operations were halted entirely for several months, but were able to resume at partial capacity prior to completion of the work. The restoration was finished in May 1997 at a cost of more than $2 million.

In many respects, the restoration of the Lower Pelzer dam—blending the old with the new—is a fitting metaphor for the plant itself as it moves into its second century of operation. Employing the very newest in electric transmission technology when it was built, the plant stands today literally as a classic example of hydro's value as a resource: reliable, cost-effective, environmentally benign, and capable of producing many more decades worth of renewable energy for electric consumers of the future.

—By Chris Hocker, vice president, corporate affairs, Consolidated Hydro Inc.