National Historic Mechanical Engineering Landmark
Michigan-Lake Superior Hydro-Power Plant
Sault Ste. Marie, Michigan
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The American Society of Mechanical Engineers

NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK

Michigan-Lake Superior Hydro-Power Plant

1918

This low-head operating plant is representative of nineteenth-century hydro-power plant practice using many small turbines in contrast to twentieth century use of few large turbines and generators.

Its 40,000-horsepower capacity made it the largest in the country using turbines of American design (McCormick-Francis). The contemporary and larger Niagara installation used turbines of French design (Fourneyron)

The entrepreneur of this plant was Francis Clergue, a lawyer, who employed as his chief engineer Hans A.E. von Schon, a German immigrant who had served with the U.S. Army Corps of Engineers.

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Introduction

When Francis H. Clergue and Hans von Schon designed the Sault Ste. Marie Hydro-Plant, it was to be the largest in the world in terms of the volume of water passing through its penstocks (30,000 cubic feet per second[cfs]). A penstock acts as a conduit directing water to the turbines. The power house was designed to contain more turbines (160 in 80 penstocks) and more generators (80) than any contemporary plant. Only the then recently completed Niagara Falls Power House No. 1, which had a much higher operating head, matched the capacity of the Sault Ste. Marie Plant. The "operating head" is the difference in water levels at the plant forebay and tailrace. The effective head in the plant is 18.4 average feet.

Excavation of the plant's canal began in September 1898 and was completed in June 1902. The length of the canal from intake to powerhouse is 11,850 feet. It varies from 200-220 feet in width at water level and is approximately 24 feet deep. The entrance of the canal is controlled by four steel headgates.

Construction of the powerhouse began in March 1900 and was completed in 1902. It is constructed of stone and steel and is 1,340 feet long and 80 feet wide. There are 78 horizontal turbines; 41 were installed in 1902, 37 in 1915-16. Each turbine unit has four runners which drive 74 60-cycle generators and four exciter units which provide field current. Net plant capability is 36,000 kilowatts. The power output is dependant on the amount of water available and the plant operating head. At the opening of the plant October 25, 1902, the plant was second only to the installation at Niagara Falls.

Clergue and Sault Ste. Marie

Numerous attempts prior to Clergue's arrival in Sault Ste. Marie, Michigan had been made to build a canal. One of the first attempts occured in 1844, but this and subsequent projects failed, mostly due to lack of funding.

When Clergue offered to buy the rights to a partially completed canal, the survivor of a failed project on the American side, he revived the nearly forgotten scheme to build a major canal and make Sault Ste. Marie an industrial city. In August 1895 the transfer of deeds to the American canal was completed.

Turbine Installation

Three basic decisions in 1898 fixed the size and nature of the canal and played a major role in the turbine selection and penstock design: the decision to accept a 260-foot-wide right-of-way through the city; to build a plant to develop 40,000 horse-power; and to design the plant to power pulp grinders or Horry carbide furnaces or both.

Calcium carbide produced in Horry furnaces, was valuable at the time as an illuminating gas. The Lake Superior Carbide Company at Sault Ste. Marie was one of the few successful firms in the U.S. producing calcium carbide. It and two other manufacturers were combined to form the Union Carbide Company in 1898. The new corporation's interest in expanding its manufacturing facilities, which would require large quantities of cheap electrical power, coincided with Clergue's wish to find a major power customer before construction began on his plant. That year, Clergue signed a contract with Union Carbide agreeing to deliver 20,000 horse-power for the operation of their furnaces within four years. Pulp grinders were never established in the plant.

Forebay side of hydro plant during installation and construction of the turbines in 1902.

Inspection of turbines in 1970.

The anticipated scope of power development led von Schon to design 80 penstocks, each directing water to the turbines at the rate of 375 cfs. Thirty-three-inch horizontal turbines were chosen and arranged in pairs. This arrangement would produce the required 500 horsepower per penstocks. To secure this horsepower four runners were placed in tandem in each penstock. The runner is the revolving element of a hydraulic reaction turbine consisting of suitably curved blades (or vanes). A turbine runner of 33 inches was the most efficent size under the hydraulic conditions of the site. Arranging runners in tandem was common in turn-of-the-century hydroelectric plants. The advantage of horizontal turbines was the possibility of mounting more than one runner on the same shaft without loss of head. By using multiple runners, the power output could be increased while maintaining the shaft speed of a single unit.

When turbine specifications were set in 1899 they had been revised slightly. They called for 564 horsepower and 180 rpm, operating at an 80 percent efficiency. Webster, Camp & Lane Machine Company of Akron, Ohio, was the lowest bidder. It entered into a special agreement with the J. & W. Jolly Company of Holyoke, Massachusetts to manufacture Jolly-McCormick turbine runners.

Turbine specifications in 1899 called for 564 horsepower, at a 16-foot head and 180 rpm, with a discharge of 391 cfs and at least 80 percent efficiency. Webster, Camp & Lane Machine Company of Akron, Ohio, was the lowest bidder. It entered into a special agreement with the J.& W. Jolly Company of Holyoke, Massachusetts, to manufacture Jolly-McCormick turbine runners.

Conclusion

By the time of the grand opening of the plant in 1902, the Michigan Lake Superior Power Company (as it was now styled) was in deep financial trouble. It owed $5,900,000 on its first and second mortgages, $l,000,000 on unsecured debts, and $300,000 annual interest on its bonds. In order to pay off those debts it would have had to go into full production immediately. However, due to a legal battle with a local power company over riparian water rights, this was impossible.. It was not until 1913 that the company overcame its financial difficulties under the receivership of the United States Mortgage & Trust Company.

After 1920 the power plant reached an era of stability with few changes. By 1945 the company (now the Carbide Power Company) held the power house and had been selling power to the Union Carbide plant for fifty years.

Union Carbide, in need of a larger facility to meet its growing demands, moved out in 1963. The Edison Sault Electric Company purchased the plant and canal in May of 1963 and converted the 25-cycle generating units to 60-cycle units. It now generates, electricity for some 50 percent of the Upper Eastern Peninsula of Michigan.

Seventy-eight dual turbines in 78 penstocks are working today. Two penstocks on either end are vacant. The Edison Sault Electric Company operates the generating plant only. The plant's present condition is testimony to the durability of von Schon's design.

Below:
An aerial view of the water canal and hydro-electric plant in Sault Ste. Marie. Located at the beginning of the canal (see upper left below and insert at right) are the headgates controlling water flow into the canal.

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