# Kakabeka Falls: A Century of Reliable Operation

*The 24.6-MW Kakabeka Falls generating station in Ontario, Canada — the Hydro Hall of Fame inductee for 2006 — continues to generate electricity using much of the same equipment commissioned 100 years ago. Station owner Ontario Power Generation recently completed upgrades at the facility, preparing it for another century of service.*

*By Roma Kopechanski*

Since 1906, the 24.6-MW Kakabeka Falls generating station, located in the village of Kakabeka Falls, Ontario, Canada, has safely provided clean, renewable electricity. Today, the station generates enough power to meet the electricity needs of about 14,000 homes. Most of the station's original equipment, commissioned 100 years ago, is still in operation. This fact serves as a tribute to those who have maintained the plant over the past century. As it enters its second century of operation, Kakabeka Falls continues to be a valued asset for owner Ontario Power Generation (OPG).

## Developing Kakabeka Falls: A decade of planning

The story of the development of the Kakabeka Falls generating station begins in 1896 when an entrepreneur, Edward Spencer Jenison from Chicago, Ill., approached the provincial government. Jenison sought approval of a plan to construct a facility to generate electricity using the water in the Kaministiquia River near Kakabeka Falls. His objective was to serve the electricity demands of customers in the growing Lakehead communities of Fort William and Port Arthur (now known as Thunder Bay) in northwestern Ontario.

Jenison's proposal was seen as a great venture in the 1890s — a time when hydropower development was in its infancy. Not only was the proposed enterprise regarded as almost a pioneer undertaking from the point of view of hydroelectric construction, it also posed transmission challenges. Power from the station would have to be transmitted a distance of about 32 kilometers. This was a significant challenge in those early days when alternating current was just passing out of the experimental stage.

Jenison's request was granted by an enactment of the Ontario Legislature. The act, in part, set out that the petitioner "within three years after the date of the agreement will construct works sufficient to produce 5,000 horsepower (hp) and will install and maintain electric machinery sufficient to create and distribute at least 1,000 hp (about 745 kW) of energy to supply the customers, and as much more machinery as will create and supply 25 percent more electric power than there may be demand for at all times thereafter, and that he will furnish this power to the customers at such cities as the Lieutenant-Governor in Council may approve and that he will make provision to pass over Kakabeka Falls at least 113 cubic meters of water per minute at all times."

The penalty for non-fulfillment of these terms was the forfeit to the Crown of all lands and rights granted for carrying out the project. Even at this early date, there was a growing public sentiment in favor of the development of the waterpower resources of the province.

The first decade of the 20th century was one of tremendous growth for Ontario. In 1905, the cities of Port Arthur and Fort William became grain ports, flour milling industries started, and the demand for electricity became urgent. However, shortly after gaining the rights to develop Kakabeka Falls, Jenison sold the rights to three prominent Canadian businessmen, C.R. Hosmer, F.W. Thomson, and H. Holt. These three then formed the Kaministiquia Power Company specifically to develop the Kakabeka Falls site and sell power.

## Kaministiquia Power begins construction of the station

By September 1905, the trio had finalized and begun execution of a plan to build and operate a generating station on the bank of the Kaministiquia River. The project employed more than 600 men and resulted in the immediate installation of two 7,000 hp (5.3 MW) units with potential for another 21,000 hp (16 MW) to be installed in the future when demand increases warranted.

The two-unit plant and primary installations were completed in October 1906. On October 4, 1906, the plant began producing power for the city of Fort William.

The station has had a history of steady growth since that date. Further extensions in 1911 added a third 5.3-

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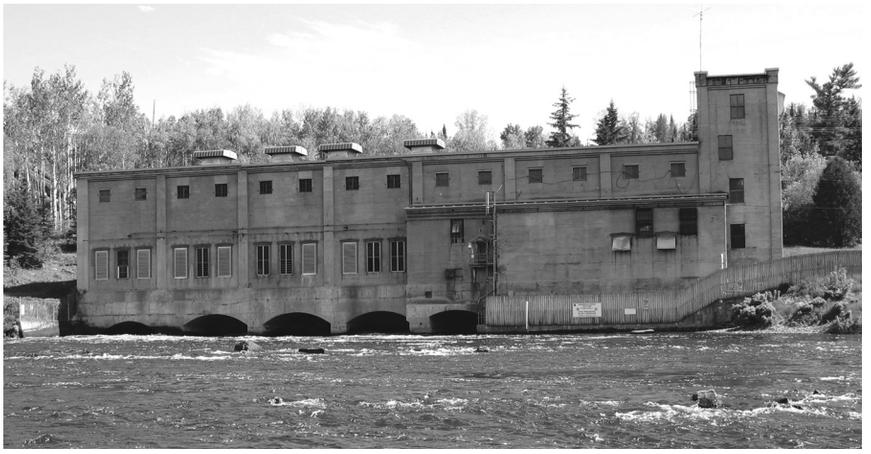


The powerhouse for the 24.6-MW Kakabeka Falls project was built in 1906 and expanded to its present size in 1914.

MW unit. The final development to the limit of streamflow was made in 1914 by the addition of an 8.7-MW unit, the fourth unit. To accommodate the increase in capacity, a third aqueduct was added.

It was not until the late 1990s that the original three aqueducts were demolished and replaced with a new single aqueduct, capable of handling the maximum flow requirements for the four-unit station.

### Ontario Hydro purchases Kakabeka Falls station

Kaministiquia Power Company operated the plant from 1906 through 1949. In 1949, the Hydroelectric Power Commission of Ontario (later known as Ontario Hydro) purchased for $5 million the business and assets of the Kaministiquia Power Company from the company's parent, Abitibi Power and Paper Company in Toronto. The purchase included the Kakabeka Falls station, as well as the storage dams and other associated facilities in the vicinity of the plant. The Kakabeka Falls facilities consist of a control dam, intake, aqueduct, surge chamber, penstocks, and the generating station.

With the purchase of the station, the Hydroelectric Power Commission was in a position to amalgamate all the power resources in northwestern Ontario. By doing so, the commission was able to guarantee more reliable electrical service.

### Description of the project features

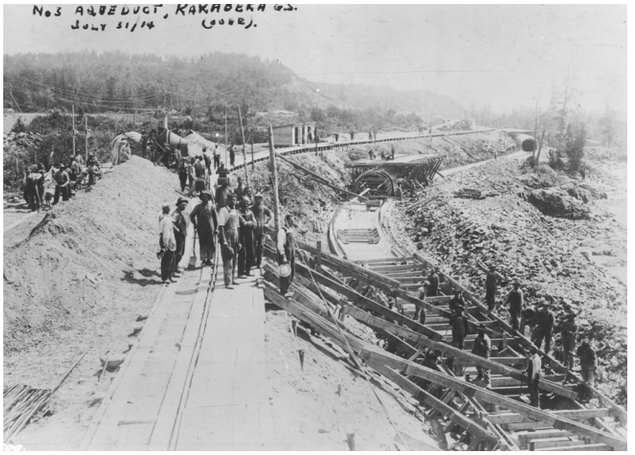
While the station has been maintained on an ongoing basis to ensure both reliability and safe operation, the powerhouse today looks much as it did in 1914. Remotely operated from Thunder Bay, the powerhouse is mass concrete on rock up to the generator room floor level. The reinforced concrete superstructure with structural steel roof trusses supports a concrete slab and membrane roof. The building is 67 meters long, 16 meters wide, and 9 meters high with adjoining valve house, machine shop, and a switching tower located at the south end.

The station site includes a main dam section about 2 kilometers upstream of the powerhouse. This dam controls and diverts water flow to the generating station. It is comprised of one automatic sluice gate remotely controlled from Thunder Bay and six stoplog sluices operated at site. The headworks, located on the east side of the main dam, consists of three gated intake openings. These openings allow the control of water flow into an aqueduct 5 meters in internal diameter. The aqueduct terminates at a large surge chamber, which transitions to four steel penstocks — one for each unit — all founded on the natural slope of the escarpment. The penstocks are sized to allow the required rated flow to each of the units.

The turbine-generator sets, installed in 1906, still operate. The turbines were supplied by J.M. Voith of Heidenheim, Germany, and the generators were made by the Canadian General Electric Company. At its total rated output of 24.6 MW, the station uses water at a rate of about 60 cubic meters per second (cms).

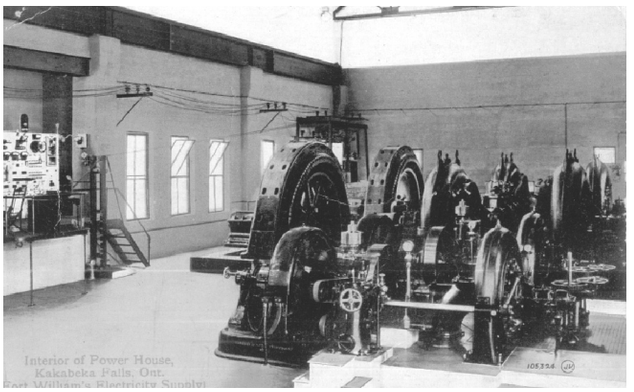
Water is conveyed to the generating station through the intake structures at the headworks. The water moves through the large aqueduct and into the surge chamber. It then flows through the penstocks and into the generating station, discharging back into the Kaministiquia River.

The main dam also operates to allow excess water to bypass the generating




A third aqueduct was added to the 24.6-MW Kakabeka Falls project in 1914 to carry water to the new fourth turbine installed the same year.

In 1998, a new single aqueduct capable of handling the maximum flow requirements for the station replaced the original three aqueducts.




The four turbine-generators that provide electricity at the 24.6-MW Kakabeka Falls project are the original units installed starting in 1906. The station generates enough power to meet the electricity needs of about 14,000 homes.

station. Water flowing through this dam goes over Kakabeka Falls and past the generating station down the Kaministiquia River. OPG provides scenic water flows over the falls of at least 4.25 cms on weekdays and 8.5 cms on weekends during daylight hours from late May to mid-October.

### Investing to ensure future reliability

In addition to an annual preventive maintenance program that ensures the station's efficient operation year after year, OPG has invested in several major upgrades over the past decade.

Most notable was the $27 million investment in 1998 to replace the three original concrete aqueducts with one large cast-in-place concrete aqueduct.

In 2000, there was a major electrical upgrade during which the switchyard was removed from the station and all the transformer breakers were moved inside. This upgrade included installation of new vacuum breakers, station service transformers, and station service switchgear. This upgrade resulted in more reliable performance.

That same year, OPG installed a new powerhouse crane at Kakabeka Falls.

In the past four years, major overhauls on each of the four units — which included new generator windings, field pole restoration, runner welding, and wicket gate refurbishment — have been completed.

## Technical Information
## Kakabeka Falls

### General Information

*Location:* Kaministiquia River, in the village of Kakabeka Falls, about 30 kilometers west of Thunder Bay, Ontario
*Owner:* Ontario Power Generation
Capacity: 24.6 MW
*Rated Head:* 59.1 meters
*Flow:* 60 cubic meters per second
*Annual Generation:* 147,000 megawatt-hours
*On-Line Date:* October 4, 1906 (first two units), 1911 (third unit), 1914 (last unit)

### Equipment

**Turbines (4)**
Horizontal Francis
Manufactured by J.M. Voith
*Units 1-3:*
277 revolutions per minute (rpm)
5.3 MW
*Unit 4:*
257 rpm
8.7 MW
**Generators (4)**
4,000 volts, three phase, 60 Hertz
Manufactured by Canadian General Electric Company
*Units 1-3:*
6,350 kilovolt amperes (kVa)
0.85 power factor
*Unit 4:*
9,367 kVa
0.80 power factor

### Construction

**Dam**
Concrete gravity
21 meters high
**Penstocks (4)**
Riveted steel plate
*Penstocks 1-3:*
2.3 meter diameter
*Penstock 4:*
3.4 meter diameter
**Powerhouse**
Mass concrete on rock with a reinforced concrete superstructure
67 meters long, 16 meters wide, and 9 meters high

### Commitment to the environment

As a conscientious steward for the watersheds on which it operates, OPG strives to optimize the energy output of its plants while respecting the environment and needs of others. Working closely with the Ontario Ministry of Natural Resources (MNR), and in consultation with various other stakeholders on the watershed, OPG has developed a water management plan for the Kaministiquia River system. The plan supports sustainable development of water resources for water power and other uses, while protecting and enhancing the natural ecosystems. The plan identifies how Kakabeka Falls generating station and the other facilities on the system will operate to manage water levels and flows in order to balance environmental, social, and economic objectives.

As part of the water management plan, OPG is partnering with MNR to conduct studies of lake sturgeon to understand and assess spawning locations, success, and flow requirements in the Kaministiquia River. Studies will be conducted over the ten-year term of the plan. Results are expected to be considered in the development of the next water management plan in 2015.

In addition, Kakabeka Falls is included in OPG's environmental management system (EMS) for the utility's Northwest Plant Group. The EMS is certified to the International Organization for Standardization's (ISO) 14001 standard.

### Public safety is a priority

OPG is clearly focused on continuously improving public safety around its hydroelectric sites. The company raises public awareness across the province about the importance of staying clear and safe near hydroelectric facilities through advertising, brochures, DVDs, children's games, presentations in the community and in schools, and safety open houses. With Kakabeka Falls being located right in the village of Kakabeka Falls and neighbored by Kakabeka Falls Provincial Park, in 2003 OPG installed additional signs, fencing, video surveillance, and a new wooden boom at the station's headworks to help people stay clear and safe. ■

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