Manitoba Hydro

Jenpeg Generating Station

Manitoba Hydro's Jenpeg Generating Station, located on the upper arm of the Nelson River, is one of the components that contributed to the successful development of the hydroelectric potential of northern Manitoba. In addition to generating electricity, Jenpeg's powerhouse and spillway structures are used to control and regulate the water outflow of Lake Winnipeg, which in turn is used as a reservoir to store water, ensuring that water is continuously available to operate the generating stations on the lower arm of the Nelson River. Regulating the waters of Lake Winnipeg for the purpose of producing electricity is in accordance with the terms of a license granted to Manitoba Hydro in 1971.

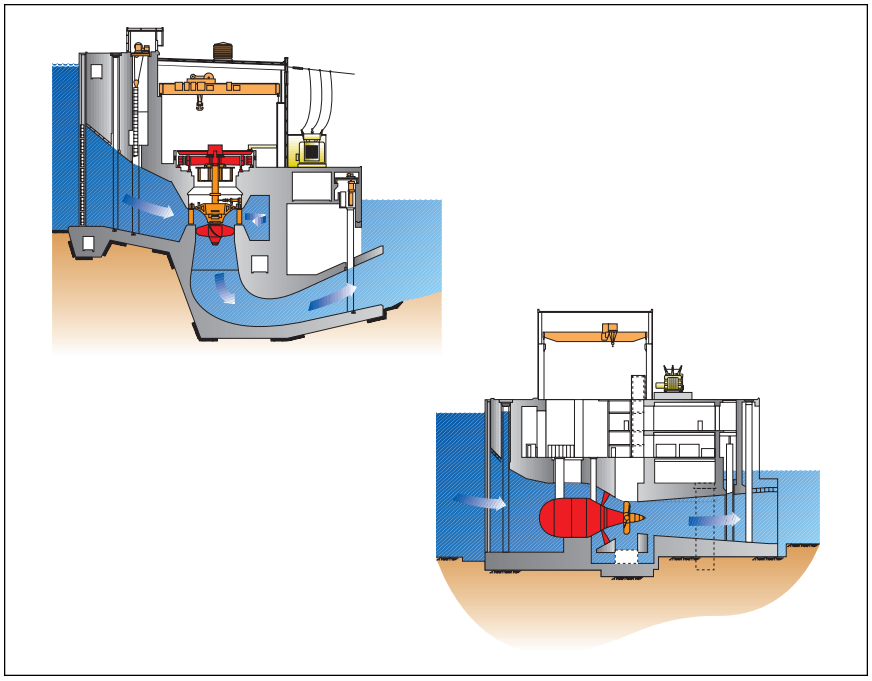
Jenpeg is located 525 kilometres (km) north of Winnipeg, at the point where the west channel of the Nelson River flows into Cross Lake. The generating station is accessible by Provincial Highway #6 and Provincial Road #373. The nearest community to Jenpeg is Cross Lake, which is about 19 km to the northeast.

The powerhouse and spillway

Jenpeg's powerhouse is capable of producing 97 megawatts (MW) of electricity. It is the first generating station in North America to use bulb-type turbine generators (called units) - a European design developed to harness a low operating head, which is the waterfall created by the generating station's structure. The bulb-type unit is positioned horizontally and is set directly in the stream of water flowing through the intake gates. Its design does not require as deep a pit in the ground as conventional vertical units, which eliminates having to excavate deeply into the bedrock under the river. It also reduces the size of the powerhouse structure. (A drawing of the bulb-type turbine is on page two.)

The powerhouse is 73 metres (m) wide, 169 m long and 39 m high from the bedrock to its roof. The level of the water in the forebay (the lake-like body of water upstream of a generating station) ranges from about 214 m to 218 m above sea level (ASL). The most effective operating head at Jenpeg is 7.32 m.

Jenpeg is a "run-of-river" structure – which means a large



A cross-section comparison of two types of hydroelectric turbine generators (called units). At the top is an example of a bulb-type unit, similar to those installed at Jenpeg Generating Station. At the bottom is an example of a conventional unit, similar to those used at all of Manitoba Hydro's other hydroelectric generating stations.

forebay is not formed upstream, and the river's water flow is used immediately. The spillway adjacent to the powerhouse contains five 1.2-m thick steel gates, each measuring 13 m wide by 13 m high. Inside the hollow interior of each gate are two 72-kilowatt (kW) heaters that help prevent freezing and condensation. The gates, each weighing 102 tonnes (t), are usually opened and closed from the generating station's control room. However, they can also be operated from Manitoba Hydro's System Control Centre in Winnipeg.

The station's construction

Construction began in 1972 with the excavation of the spillway and powerhouse channels through solid granite bedrock. These channels were excavated leaving a portion of the rock along the riverbank as a plug to prevent the river from flowing in. The rock plug was removed later, and the river was diverted into the powerhouse and spillway channels. The first concrete was poured in 1973, and all six of the generating units were up and running by 1979.

Jenpeg's main rockfill dam is one of the few permanent structures of its kind in the world. It was built almost entirely "in the wet", which means it was built without the benefit of a cofferdam (a temporary, watertight, island-like enclosure often used to build river-located generating stations in dry conditions.)

The main dam, which diverts water into Jenpeg's powerhouse and spillway, extends across the west channel of the Nelson River, where the river flows into Cross Lake. The main dam is 289 m long and at its maximum height it rises 24 m above the river's bedrock. About 764,000 m^3 of fill material was used in Jenpeg's main dam and secondary dykes.

The excavation of about 352,000 m^3 of earth and rock (mostly rock) was necessary at the site where the powerhouse and spillway were built. And when finished, 33,339 t of concrete and 6,441 t of reinforcing steel had been used to build the generating station. Valued at $56,440,000, its construction was carried out by Jenpeg Constructors, a consortium of civil contractors formed by BACM, C.A Pitts, Loram International, and Janin Construction.

The Lake Winnipeg Regulation Project

When Manitoba Hydro decided to develop the hydroelectric potential of the Nelson River in 1966, the plan was based upon the idea of using

Lake Winnipeg as a natural reservoir. By excavating channels to increase the natural outflow capacity of the lake, and by building Jenpeg to regulate its water flow, adequate minimum flows are guaranteed in order to keep the river system in a healthy state for all other users of the water downstream of Jenpeg.

In its natural state, Lake Winnipeg's flow into the Nelson River depends upon the water level of the lake and – during the winter – upon the degree of obstruction of the river's channels by ice cover.

Ironically, the natural water outflow of Lake Winnipeg into the Nelson River is more abundant in the summer than in the winter – the opposite of what the utility requires to meet the electricity needs of Manitobans. The Lake Winnipeg Regulation project has altered the annual water pattern by decreasing the outflow in the spring and early summer and storing the water to make it available for use in the fall and winter.

In its natural state, the water outflow of Lake Winnipeg in the winter was impeded by narrow and shallow outflow channels. To improve this situation, three wider and deeper diversion channels were built:

1. The 2-Mile Channel, which augments the natural outlet of Lake Winnipeg, cutting across the narrowest point of land between the north end of Lake Winnipeg, and Playgreen Lake about 10 km northwest of Warren Landing.

2. The 8-Mile Channel, which connects Playgreen Lake with the southern end of the Kiskittogisu Lake, thus increasing the water flow from Playgreen Lake.

3. The Ominawin Channel, which bypasses natural restrictions in the Ominawin River.

The interior of the Jenpeg's powerhouse.

The Kiskitto Dam

The higher water levels, caused by Jenpeg's construction, made it necessary to build a control dam at the outlet of Kiskitto Lake to prevent water from backing up into the lake.

The Kiskitto Dam is about 600 m long and has a maximum height of 15 m. The lake is regulated within its natural range, and its water levels are controlled to best suit fish and wildlife habitats, and also recreational activities.

Sixteen separate dykes measuring a total of 14 km protect the lake from the higher water levels of the Nelson River's west channel.

A gated culvert was installed to supply water from this channel, while a small channel and control structure were built to keep the lake from exceeding its normal levels – during periods of high precipitation – by flowing into the Minago River system.

The Cross Lake Weir

With the implementation of regulation, the historic pattern of water levels and water fluctuations at Cross Lake was reversed (levels drop in the spring and rise in the fall). Also, both minimum and maximum levels became lower on average than they were before regulation.

To try to restore the former environment and living conditions as far as possible, the Cross Lake community and Manitoba Hydro worked together over a number of years to find a way to raise the lake's water levels. In 1990, a mitigation agreement was reached for the construction of a $9.5 million rock weir and a channel excavation project at the outlet of Cross Lake as it flows back into the Nelson River. A weir is a dam constructed on the reaches of a river to retain its water and regulate its flow. Construction of the Cross Lake Weir took place between May and October of 1991.

The weir and related operations at Jenpeg Generating Station gradually raised the minimum water level on Cross Lake by nearly 1.38 m. The minimum water level is 206 m ASL, at a minimum flow of 2,322.5 m^3/s. Fluctuations from season to season are more moderate and gradual than in the past. The effectiveness of the weir continues to be monitored.

The channel excavation project was overseen by a committee comprised of four community representatives from Cross Lake and four Manitoba Hydro officials. The committee ensured maximum involvement and input from the community on all aspects of the project.

Jenpeg Generating Station facts

Construction started	1972
Construction completed	1979
Cost	$310 million
Capability	97 MW
Average annual generation	910 million kW.h
Waterfall drop	4 m to 12.5 m (most effective, 7.32 m)
Powerhouse	Length: 169 m
Number of turbine generators (units)	6 (each turn at 62 rpm)
Production of units	About 16 MW each
Intake gates for water inflow	For each unit, one set of 6 stoplogs, 15.5 m long, 2.7 m high
Units' total discharge capability	2,634 m^3/s of water
Forebay area	25,413 km^2
Forebay's normal water level	214-215 m (winter), 217.9 m (summer)
Spillway	5 gates measuring 13 m x 13 m
Spillway's total discharge capability	4,361 m^3/s
Transmission line	230-kV to Ponton

When the Cross Lake Weir was constructed, the workers and heavy equipment were transferred by barge to the construction site. The weir was built across the Nelson River's centre channel - one of four channels that allow water to flow out of Cross lake and on down the river.

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02 10